

"A better world with Quality!"

July 13 - 15, 2016 Guimarães, Portugal

Book of Proceedings

TECHNICAL RECORD

Title

Proceedings book of the 2nd International Conference on Quality Engineering and Management, 2016

Authors/Editors

Sampaio, Paulo; Domingues, Pedro; Barros, Síria; Carvalho, André; Casadesús, Marti; Costa, Acácio; Fernandes, Ana Cristina; Marimon, Frederic; Melo, Mónica; Oliveira, Rui; Pires, António Ramos; Saraiva, Pedro.

Publisher

International Conference on Quality Engineering and Management

Date

July 2016

Cover Design

Luís Coutinho

ISBN

978-989-20-6814-5

2nd Edition

200 units



A better world with Quality!

July 13-15, 2016 University of Minho, Guimarães, Portugal This edition is published by the International Conference on Quality Engineering and Management.

Portuguese National Library Cataloguing in Publication Data

Proceedings book of the 2nd International Conference on Quality Engineering and Management edited by Sampaio, Paulo; Domingues, Pedro; Barros, Síria; Carvalho, André; Casadesús, Marti; Costa, Acácio; Fernandes, Ana Cristina; Marimon, Frederic; Melo, Mónica; Oliveira, Rui; Pires, António Ramos; Saraiva,

Pedro

ISBN 978-989-20-6814-5

Publisher: International Conference on Quality Engineering and Management

Book in 1 volume, 908 pages

This book contains information obtained from authentic sources.

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International Conference on Quality Engineering and Management Paulo Sampaio - Conference Chair
School of Engineering, Systems and Production Department
Campus Gualtar, 4710-057 Braga, Portugal
http://icqem.dps.uminho.pt/
icqem@dps.uminho.pt

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FOREWORD

Welcome to the 2nd International Conference on Quality Engineering and Management!

After the successful organization of the 1st International Conference on Quality Engineering and Management in 2014, it is our pleasure to welcome you to the conference 2nd edition at the University of Minho, again in the historic city of Guimarães, Portugal. This event combines two areas that are not usually brought together: Quality Engineering and Quality Management. We hope that the results of our effort will translate into a successful venture, making gradually of this conference an important scientific event in the field of Quality. As was our aim, since the beginning, the conference covers different topics related to Quality Management and Quality Engineering, including Standards, Continuous Improvement, Supply Chain Quality Management, Management Systems, Six Sigma, Quality Tools, Quality Management in Higher Education, Quality Management in Services and Total Quality Management.

In this 2nd edition the balance between Quality Management papers and Quality Engineering ones is more clear, thus accomplishing one of the fundamental goals of this conference. Approximately 120 papers have been submitted and almost 85 were accepted for presentation, after review from the Conference Scientific Committee. Additionally, some of these papers were selected by the Scientific Committee to be considered for a special issue that will be published by the International Journal of Quality and Reliability Management (SCOPUS indexed journal). Papers accepted correspond to authors from all around the world, with more than 20 countries represented at this level. Therefore, a warm acknowledgment to all speakers and authors is well deserved – Thank You! The success of this second edition derives from their efforts and participation!

We would like to thank all of our four keynote speakers, who will be with us during the two days of the event: **Eric Rebentisch**, **Jiju Antony**, **Lars Sorqvist** and **Marco Reis**. We have here the chance to listen to their contributions and new research development insights, coming from some of the most influent current Quality Academicians. Many thanks also to all the excellent work carried out by the Scientific Committee during the papers selection process. We must acknowledge as well the institutional support received from the School of Engineering of the University of Minho, University of Coimbra, University of Girona, International University of Catalunya, Portuguese Association for Quality, Algoritmi Research Centre, Luso-American Foundation, American Society for Quality, Portuguese Institute for Quality, Brazilian Association of Production Engineering, Brazilian Society of Quality and Excellence in Management, Quality for Excellence Consultancy, BQualidade, Target and Cempalavras.

Again, let's take advantage of this great opportunity and make with your contributions an event with Quality, shared and built by such a top level group of participants!

Enjoy your conference! Thank you all!

University of Minho, July 14, 2016.

Paulo Sampaio (Conference Chair)



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SUBMITTED PAPERS

Framework for monitoring process control with finite mixture distribution: Application in company of alimentary sector

Vicentin, D.S.¹⁾, Silva, B.B.¹⁾, Piccirillo, I.N.¹⁾Bueno, F.C.¹⁾ and Oprime, P.C.¹⁾

Department of Industrial Engineering
Federal University of São Carlos
São Carlos, SP, Brazil

ABSTRACT

Purpose. The main objective of this study is develop an application with finite mixture of probability distributions control charts, we selected a process of a company in the food sector, whose products consist of dough with wheat-based.

Design/methodology/approach. This article has an approach of the case study in company of alimentary sector with the following steps: i) to collect the master sample from different production batches; ii) with graphical methods verifying the quantity and the characterization of the number of mixing probability distributions in production batch; iii) to adjust the theoretical model of probability distribution of each subpopulation in production batch; iv) statistical model considering the mixture distribution of probability and assuming that the statistical parameters are unknown; v) with numerical methods finding the constant statistical K that results in a type I average error $\alpha = 0.27\%$ when the process is under control. This study was applied to a food industry in which π subpopulations were identified to find the finite probability distributions, and, for after, we have been finding the K constant by type I error of 0,27%.

Findings. This search results in a complex graphic because it involves more parameters to be considered in its calculation. Nevertheless, it can help the practitioners to monitor on a single graph multiple streams of the production process with similar efficiency to the traditional control chart.

Originality/value. This article is contributing with a statistical graphic design for monitoring production batches from different machines, processes or flows. Customers have applied this graphic design when they continuously receive product batches from a supplier and they need to monitor statistically the critical quality characteristics of the product. There is another practical situation that can affect the performance of control charts and it has only few studies about it.

Keywords: Mixture distributions, Control chart, Quality Management, Alimentary sector

Paper type: Case study

INTRODUCTION

Control chart is a technique that is used to monitor and improve production processes and is applied to many industries (Woodall, 1985). Control charts have been using for monitoring the process, showing the occurrence of lack of control and or trend of this occurrence, avoiding unnecessary efforts and interference costs or inadequate corrections on the process when this intervention is not really necessary (Baker and Brobst, 1996; Graves et al., 1999; Elg et al., 2008; Yang et al., 2012). The online monitoring of process variability using Shewhart control charts can ensure high standards of quality levels and maintain acceptable levels in the number of nonconforming items.

According to Montgomery (2013), Walter A. Shewhart developed in 1924 the concept statistical control chart, which is considered generally as the formal beginning of statistical quality control. According to Bersimis, Psarakis and Panaretos (2007), in the industry, there are many situations in which monitoring of one or more characteristics related to quality procedures is necessary. For this purpose, control charts play a key role in ensuring the monitoring and control of critical product quality characteristic processes.

The classical concept of control charts recommends stopping the process when there is indication of special causes, in order to keep the production process at a stable variation level. However, there are cases in which it is not financially viable to intervene, even in the presence of special causes. It is our opinion that the goal of a process control system is also making economic decisions about the process, and it means analyzing the impact of taking an action when it is not necessary (overcontrol). When the benefits of stopping the process in the presence of special causes are lower than the costs it may be considered an overcontrol.

Unfortunately, the use of statistical estimators for unknown parameter, turn control chart limits into random variables, due to estimate errors. This fact compromises the control charts performance in phase II (Epprechet et al., 2015; Saleh et al., 2015; Castagliola et al., 2013; Castagliola et al., 2009; Shawiesh, 2009). The control chart performance is evaluated according to its capacity to detect special causes with the lowest type I error. This performance in phase II is evaluated through the expected average run length (ARL) and the standard deviation of the average run length (SDARL), which are influenced by the estimated parameters (Saleh et al., 2015).

Although all of these studies, is not observed in the literature studies that focus on a common problem in industrial processes: the finite mixtures of probability distributions. For these cases, the traditional chart \bar{X} is not convenient for reasons of costs and the normality assumption of the probability distribution. The development and application of finite mixture models distributions can be found in studies such as, for example, Everitt and Hand (1981), Titterington, Smith and Makov (1985) and West (1992). The finite mixture models offer an interesting alternative for the non-parametric modeling, to be less restrictive than the usual distribution assumptions (Diebolt, 1994).

The probability distribution of the mixture can be characterized as a probabilistic combination of two or more random variables (Dixon, 2012). Mixtures of distribution models are formed from a weighted combination of two or more underlying distributions with $g(x) = \sum_j \alpha_j f(x)_j$; $\sum \alpha_j = 1$. These models often appear on statistical models of perception, cognition and action in which a finite number of discrete internal states probabilistically is inserted through a series of tests (Yantis; Meyer & Smith, 1991).

This paper has the objective to analyze the construction of graphs of statistical process control with a mixture of probability distributions. Thus, for the purpose of developing an application of control chart with finite probability distributions mixture about a selected process from a company in the food sector, whose products consist of dough with wheat base. For this case, it is proposed to analyze the process considering the finite mixture of probability distribution. It is proposed to build statistical control limits of quality characteristics, whereas the overall probability distribution resulting subsets of the manufacturing process with a probability distribution function (*f.d.p.*) known. A theoretical model will be developed and evaluated the performance of these graphics, considering two scenarios: 1) assuming that the parameters of *f.d.p.* are known; and 2) in the case where the average is unknown.

Description of the proposal. It will be applied the method in an industrial process whose quality characteristic is derived from finite mixtures of probability distributions. The result of this approach will be compared to the traditional approach of Shewhart charts. Figure 1 represents the histogram formed by an expanded sample of 4000 units, extracted at random, at the end of the line of a manufacturing process of pasta, whose quality characteristic is the weight of each processed unit (detailed steps of the process are presented in Figure 2, which is in section 5). The histogram in Figure 1 indicates a mixture of probability distributions arising from the process characteristics, in particular, the error of the cylinder shape that generates non-uniform thickness and therefore different weights.

The mixture of probability distributions for different subpopulations of the process precludes the use of traditional control charts. An alternative is to monitor that subset (in this case, each position of the cylinder). However, it is a costly alternative. The proposal is to develop a control chart considering the combination of the different functions of probability densities and thus build a unique graphic control, whose samples are collected regardless of the origin of the extracted sample.

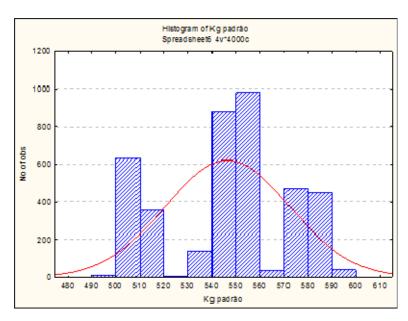


Figure 1 – Characterization of the distribution of the manufactured units weights.

MIXTURES OF FINITE PROBABILITY DISTRIBUTIONS

Let X be a random variable, whose values are contained in a sample space, Ω , and its distribution can be represented by a probability density function for continuous variables or mass function for the discrete case as (Titterington; Smith and Makov, 1985):

$$p(x) = \pi_1 f_1(x) + \pi_2 f_2(x) + \dots + \pi_k f_k(x)$$

Where $\pi_{j} > 0$, $\sum_{j}^{k} \pi_{j} = 1$; j = 1, ..., l e $\int f_{j}(x) dx = 1$. The parameters π_{j} are weights of the mixture of the distributions or subpopulations. Because the probability density functions have parameters, a finite mixture of probability distributions can be represented generally $\pi_{1}f_{1}(x|\theta_{1}) + \pi_{2}f_{2}(x|\theta_{2}) + \cdots + \pi_{l}f_{k}(x|\theta_{k})$, where θ represents the parameters $f_{j}(x)$. For example, for a mixture of two normal distributions with the same standard deviation σ , different averages μ_{1} and μ_{2} , and the total density function of the parameters that is $\omega = (\pi, \mu_{1}, \mu_{2}, \sigma)$, and the probability represented by:

$$p(x|\omega) = \pi \emptyset(x|\mu_1, \sigma) + (1-\pi)\emptyset(x|\mu_2, \sigma)$$

It can be written a generic function of the probability density function of a finite mixture with k subpopulations as:

$$p(x|\omega) = \sum_{j=1}^{k} \pi_j f(x|\theta_j)$$

The equation of the mixture probability density functions indicates which categories (subpopulations or sources) in which the experimental unit is obtained in which the x value of the variable X is derived from one of these k categories. Thus $\mathbf{f_j}(\mathbf{x})$ summarizes the probability distribution of X wherein the observation is obtained from a category \mathbf{j} and $\pi_{\mathbf{j}}$ indicates the probability of observing be from one of these categories (Titterington; Smith and Makov, 1985).

A variety of important properties mixture distributions has been known, and these properties have been exploited to identify mixture distributions. Clearly, if the reference distributions have comparable variations and are sufficiently different in the central position measurements, a mixture of the two distributions is bimodal, where there is a mixture of three or more is multimodal distributions (Dixon, 2012).

To identify the mixture probability does not seem to be a trivial task. The existence of bi- or multimodal is a way to identify the existence of subpopulations mixture. The mode is a maximum point, and the existence of k-modal can be an identification mixture. Through a histogram, it is identified if there is a multimodal distribution. However, there is the possibility of errors to occur. On the one hand, the unimodal distribution can hide the existence of two subpopulations; on the other hand, to identify if there is more than one mode by a histogram does not necessarily conclude that there is more than one subpopulation in mass data. In general, it is considered that a pure component is unimodal but this is not always true.

There are charts and multivariate methods such as cluster analysis and discriminant function that can be used to identify a mixture of probability distributions (Titterington; Smith and Makov, 1985). In this

article, it is believed that mode can be a mixture indicator despite the arguments against. It will be explored with a histogram with graphs of normality tests and bitangentiality to identify mixtures of probability distribution.

Decomposition of the variability with mixture of probability distributions. The overall variance consists of the internal variance of each subpopulation, σ_1^2 plus the variability that caused differences in the averages between subpopulations. Let $SQ = \sum_{l=1}^a \sum_{j=1}^b (x_{lj} - \bar{x})^2$ be the total sum of squares to / subpopulations with b individuals, $SQe = \sum_{l,j} (x_{lj} - \bar{x}_{l})^2$ be the sum of squares internal to each subpopulation, $SQw = \sum_{l,j} (\bar{x}_{l} - \bar{x})^2$ be the sum of squares among subpopulations, and σ^2 be the internal variance of the subpopulations. It can be defined that $\mu_0 = \frac{1}{l} \sum_{l} \mu_l$ and $\gamma_l - (\mu_0 - \mu_l)$, where μ is the overall average and the averages of each subpopulation (μ_0, μ_l) . If $\mu_0 = \mu_l + \delta_l \sigma$, it implies that $\delta_l = \frac{(u_0 - \mu_l)}{\sigma} = \frac{\gamma_l}{\sigma}$.

Since that $nE(SQ) = (kb-1)\sigma^2 + b\sum \gamma_k^2$ and, dividing this equation (ab-1), it follows that:

$$\frac{E(SQ)}{(ab-1)} = \frac{(ab-1)\sigma^2}{(ab-1)} + \frac{b\sum \gamma_t^2}{(ab-1)}$$

Thus, you have the following relationship:

$$\sigma_{t}^{2} = \sigma^{2} + \frac{b}{(ab-1)} \sum_{k} \gamma_{t}^{2} = \sigma^{2} + \frac{b}{(ab-1)} \sum_{l} \delta_{l}^{2} \sigma^{2} = \sigma^{2} + \frac{b}{(ab-1)} \sigma^{2} \sum_{l} \delta_{l}^{2}$$

Where σ_t^2 is the total variance. By dividing the expression above σ^2 , obtains the following relationship: $\frac{\sigma_t^2}{\sigma^2} = 1 + \frac{b}{(ab-1)} \sum_l \delta_k^2.$

If it is assumed that $\frac{b}{(ab-1)} \cong \frac{1}{t}$, and extracting the root, it follows that:

$$\sqrt{\frac{\sigma_t^2}{\sigma^2}} = \sqrt{1 + \frac{1}{l} \sum_{l} {\delta_l}^2}$$

This estimation should be observed carefully. It is considered reasonable for a ratio smaller than 5%, or it can be valid when $\frac{a}{(ab-1)} \cong \frac{a}{ab}$.

Performance of control charts with finite mixture of probability distribution. The performance of control charts is evaluated in terms of the distribution of the expected value of the Average Run Length (ARL) when the parameters are estimated for the determination of the control limits. This study will assess the performance of the proposed charts when there is mixture of distributions through E(ARL) for the unknown mean and known standard deviation equally for each k category. For simplicity, assume that there are $\mathbf{k} = \mathbf{3}$ categories with different means. First, it will be analyzed the case when the parameters and probability distributions are known; in this case, it is assumed that each $f_{\mathbf{j}}(\mathbf{x})$ have the normal f.d.p.

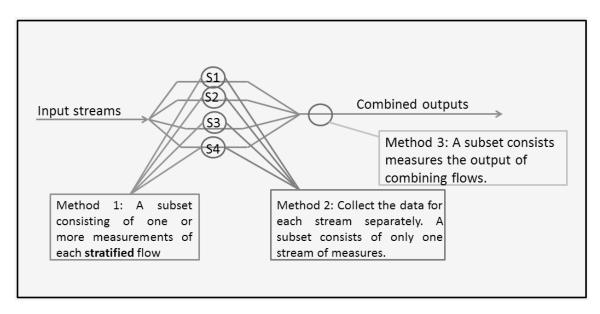


Figure 2 – Characterization of methods to collect data from multiple process flows for construction of control charts. Source: *Automotive Industry Action Group* (AIAG, 1991).

As Automotive Industry Action Group (AIAG, 1991), it assumes also that the samples are taken at random and are examined together, in which it is built a control chart for the entire set of collected data, as described in Method 3 of Figure 2, which presents three methods for data collection when the production process is composed of multiple streams. Thus, it is important to understand the sources of variation between and within subgroups to analyze and interpret the control chart and how they affect the process.

Figure 3 shows the production plan with four streams (F_1 , F_2 , F_3 and F_4) and how they can be united in one control chart rather than building separate graphs for each stream. This production plan scheme can be very useful for obtaining information necessary at the end of the production line to be delivered to the customer.

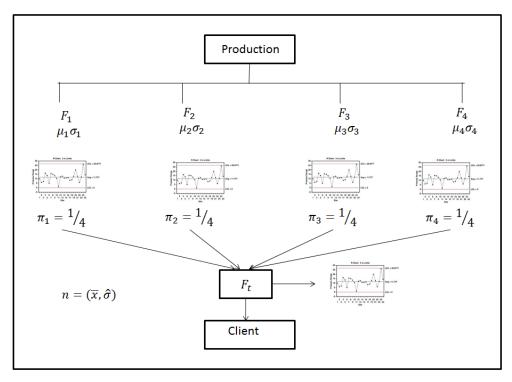


Figure 3 - Production Plan

Case 1: Parameters of the functions of density of known probability. Since X is a random variable drawn from a population, for example, with k = 3 categories or subpopulations, normally distributed with parameters $\theta = (\mu_1, \mu_2, \mu_3, \sigma_1, \sigma_2, \sigma_3)$, with the following probability density function:

$$p(x|\omega) = \pi_1 \emptyset(x|\mu_1, \sigma_1) + \pi_2 \emptyset(x|\mu_2, \sigma_2) + \pi_3 \emptyset(x|\mu_3, \sigma_3)$$

Also for simplicity, we consider that $\sigma_1 = \sigma_2 = \sigma_3 = \sigma$; and also that the global average is obtained by $\mu_0 = \frac{\mu_1 + \mu_2 + \mu_3}{3}$. Another assumption is that each n extracted sample have probability π_k to be from the subpopulation k. The estimator of the population mean it is the sample mean given by $\bar{x} = \frac{1}{n} \sum_{t=1}^{n} x_t$. The upper and lower control limits (UCL; LCL) are calculated by:

$$UCL = \mu_0 + \frac{k\sigma_t}{\sqrt{n}}$$
 $LCL = \mu_0 - \frac{k\sigma_t}{\sqrt{n}}$

Being the center line of the graph (LC) at μ_0 , the probability that a point be within the control limits is:

$$P(\bar{x} \in [LiC, LSC]) = \pi_1 P(LiC \le \bar{x} \le LSC|\mu_1, \sigma) + \pi_2 P(LiC \le \bar{x} \le LSC|\mu_2, \sigma) + \pi_3 P(LiC \le \bar{x} \le LSC|\mu_3, \sigma)$$

Expanding this formulation, it follows:

$$\begin{split} \pi_1 P\left(\mu_0 - \frac{k\sigma_t}{\sqrt{n}} \leq \bar{x} \leq \mu_0 + \frac{k\sigma_t}{\sqrt{n}} \left| \mu_1, \sigma \right. \right) + \pi_2 P\left(\mu_0 - \frac{k\sigma_t}{\sqrt{n}} \leq \bar{x} \leq \mu_0 + \frac{k\sigma_t}{\sqrt{n}} \left| \mu_2, \sigma \right. \right) \\ + \pi_3 P\left(\mu_0 - \frac{k\sigma_t}{\sqrt{n}} \leq \bar{x} \leq \mu_0 + \frac{k\sigma_t}{\sqrt{n}} \left| \mu_3, \sigma \right. \right) \end{split}$$

In state of control, each subpopulation has average $\mu=\{\mu_{10},\mu_{20},\mu_{30}\}$. Given that there is indeed mathematical relationship between the average distances of each subpopulation and the overall average, and assuming that $\mu_0=\mu_{20}$, then we have the following relationships between the overall average and average each subpopulation: $\mu_0-\mu_{10}+\delta_1\sigma_t$; $\mu_0-\mu_{30}-\delta_3\sigma_t$, where δ if the number of standard deviations of the difference between the subpopulations. In this specific case, for k= 3 and where the averages of the subpopulations are equidistant, $\delta_3=\delta_1=\delta$ and $\delta_2=0$.

Following the proposed expansion, considering the possibility of a process to be out of control also in terms of the number of standard deviations, this process state is represented as follows:

$$\mu_1 = \mu_{10} + t\sigma_t$$
 $\mu_2 = \mu_{20} + t\sigma_t$
 $\mu_3 = \mu_{30} + t\sigma_t$

If $t \neq 0$, the process is out of control. Otherwise, the process is in a control state.

Considering these relations and assumptions, that the probability distribution of subpopulations are represented by normal distribution, with known parameters and whose samples are from subpopulation with π_t probability. Thus, it is possible to determine the sample probability with n size to be in region inside the control limits, subtracting μ_k from inequalities of each subpopulation, we get the following result:

$$\begin{split} P(\overline{x} \in [LiC, LSC]) \\ &= \pi_1 P\left(\mu_0 - \frac{k\sigma_t}{\sqrt{n}} - \mu_1 \leq \overline{x} - \mu_1 \leq \mu_0 + \frac{k\sigma_t}{\sqrt{n}} - \mu_1 \middle| \mu_1, \sigma\right) \\ &+ \pi_2 P\left(\mu_0 - \frac{k\sigma_t}{\sqrt{n}} - \mu_2 \leq \overline{x} - \mu_2 \leq \mu_0 + \frac{k\sigma_t}{\sqrt{n}} - \mu_2 \middle| \mu_2, \sigma\right) \\ &+ \pi_3 P\left(\mu_0 - \frac{k\sigma_t}{\sqrt{n}} - \mu_3 \leq \overline{x} - \mu_3 \leq \mu_0 + \frac{k\sigma_t}{\sqrt{n}} - \mu_3 \middle| \mu_3, \sigma\right) \end{split}$$

Replacing μ_0 and μ_k , from the relations showed in above, to δ and t, we obtain:

$$\begin{split} &\pi_1 P\left(\mu_{10} + \delta_1 \sigma_t - \frac{k\sigma_t}{\sqrt{n}} - \mu_{10} - t\sigma \leq \overline{x} - \mu_1 \leq \mu_{10} + \delta_1 \sigma_t + \frac{k\sigma_t}{\sqrt{n}} - \mu_{10} - t\sigma \left| \mu_1, \sigma \right. \right) \\ &+ \pi_2 P\left(\mu_{20} - \frac{k\sigma_t}{\sqrt{n}} - \mu_{20} - t\sigma \leq \overline{x} - \mu_2 \leq \mu_{20} + \frac{k\sigma_t}{\sqrt{n}} - \mu_{20} - t\sigma \left| \mu_2, \sigma \right. \right) \\ &+ \pi_3 P\left(\mu_{30} - \delta_2 \sigma_t - \frac{k\sigma_t}{\sqrt{n}} - \mu_{30} - t\sigma \leq \overline{x} - \mu_3 \leq \mu_{10} - \delta_2 \sigma_t + \frac{k\sigma_t}{\sqrt{n}} - \mu_{20} - t\sigma \left| \mu_2, \sigma \right. \right) \end{split}$$

And multiplying each inequality by $\frac{\sqrt{n}}{\sigma}$,

$$\begin{split} \pi_1 P \left(\delta_1 \frac{\sigma_t}{\sigma} \sqrt{n} - \frac{k \sigma_t \sqrt{n}}{\sigma} - t \sqrt{n} \right. &\leq z \leq \delta_1 \frac{\sigma_t}{\sigma} \sqrt{n} + \frac{k \sigma_t \sqrt{n}}{\sigma} - t \sqrt{n} \right. \left. \left. \left. \mu_1, \sigma \right) \right. \\ &+ \pi_2 P \left(-\frac{k \sigma_t \sqrt{n}}{\sigma} - t \sigma \leq z \leq \frac{k \sigma_t \sqrt{n}}{\sigma} - t \sigma \right. \left. \left. \left. \mu_2, \sigma \right) \right. \\ &+ \pi_3 P \left(-\delta_1 \frac{\sigma_t}{\sigma} \sqrt{n} - \frac{k \sigma_t \sqrt{n}}{\sigma} - t \sigma \leq z \leq -\delta_1 \frac{\sigma_t}{\sigma} \sqrt{n} + \frac{k \sigma_t \sqrt{n}}{\sigma} - t \sigma \right. \left. \left. \left. \mu_3, \sigma \right) \right. \end{split}$$

Replacing, in the above equation, the relation $\frac{u_t}{\sigma} = \sqrt{1 + \frac{1}{t} \sum_{l} \delta_{l}^{2}}$

$$\begin{split} &P(\bar{x}\in[LIC,LSC])\\ &=\pi_1P\left(\delta_1\sqrt{n}\int 1+\frac{1}{l}\sum_{i}{\delta_i}^2-k\sqrt{n}\int 1+\frac{1}{l}\sum_{i}{\delta_i}^2-t\sqrt{n}\leq z\leq \delta_1\sqrt{n}\int 1+\frac{1}{l}\sum_{i}{\delta_i}^2+k\sqrt{n}\int 1+\frac{1}{l}\sum_{i}{\delta_i}^2-t\sqrt{n}\left|\mu_1,\kappa_1|+\frac{1}{l}\sum_{i}{\delta_i}^2-t\sqrt{n}\left|\mu_2,\kappa_1|+\frac{1}{l}\sum_{i}{\delta_i}^2-t\sqrt{n}\left|\mu_2,\kappa_1|+\frac{1}{l}\sum_{i}{\delta_i}^2-t\sqrt{n}\int 1+\frac{1}{l}\sum_{i}{\delta_i}^2-t\sqrt{n}\int 1+\frac{1}{l}\sum_{i}{\delta_i}^2-t\sqrt{n}\int$$

Making this relation in terms of normal *f.d.p.*, it can obtain:

$$\begin{split} P(\bar{x} \in [LIC, LSC]) \\ &= \pi_1 \left[\emptyset \left(\delta_1 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} + k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sqrt{n} \right) \right. \\ &- \emptyset \left(\delta_1 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sqrt{n} \right) \right] \\ &+ \pi_2 \left[\emptyset \left(k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) - \emptyset \left(-k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) \right] \\ &+ \pi_3 \left[\emptyset \left(-\delta_3 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} + k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) \right. \\ &- \emptyset \left(-\delta_3 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) \right] \end{split}$$

For this case, the number of parameters for $P(\bar{x} \in [LIC, LSC])$ calculation is $\omega = \{\pi_1, \pi_2, \pi_3, k, \delta, t, n\}$, and the sample mean number to detect a point outside of the control limits is obtain like:

$$ARL = \frac{1}{1 - P(\bar{x} \in [LIC, LSC])}$$

Case 2: When the probability mean functions are known. For μ_{10} , μ_{20} and μ_{30} unknown, $\bar{x} \in \left(\bar{X} - \frac{\kappa \sigma_t \sqrt{n}}{\sigma}; \bar{X} + \frac{\kappa \sigma_t \sqrt{n}}{\sigma}\right) = \left(LCL; \overline{UCL}\right)$, which $\left(LCL; \overline{UCL}\right)$ are assumptions of control limits. Assuming $\left(X_{t,1}, \ldots, X_{t,n}\right)$, $t = 1, 2, \ldots m$ are independent sample of random variables from subpopulations finite mix, which the estimation of average is given by:

$$\bar{x} = \frac{1}{mn} \sum_{j=1}^{m} \sum_{t=1}^{n} x_{tj}$$

In the fase II, the n sample size are taken without category or subpopulation distinction and the sample mean is calculated \bar{X}_t from $\{X_{t,1}, X_{t,2}, \dots, X_{t,n}\}$. Making the development, we have the sampling probability within the control limits, in the following way:

$$\begin{split} P(L\widehat{C}L_{\overline{X}} \leq \overline{X} \leq U\widehat{C}L) \\ &= \pi_1 \left[\emptyset \left(\frac{w}{\sqrt{m}} + \delta_1 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} + k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sqrt{n} \right) \right. \\ &- \emptyset \left(\frac{w}{\sqrt{m}} + \delta_1 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sqrt{n} \right) \right] \\ &+ \pi_2 \left[\emptyset \left(\frac{w}{\sqrt{m}} + k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) \right. \\ &- \emptyset \left(\frac{w}{\sqrt{m}} - k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) \right] \\ &+ \pi_3 \left[\emptyset \left(\frac{w}{\sqrt{m}} - \delta_3 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} + k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) \right. \\ &- \emptyset \left(\frac{w}{\sqrt{m}} - \delta_3 \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - k \sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{l} \delta_l^2} - t \sigma \right) \right] \end{split}$$

The number of involved parameters, in this case, when the averages are known, is $\omega = \{\pi_1, \pi_2, \pi_3, k, \delta, t, m, n\}$ and the expected average number of samples until the occurrence of a point outside the control limits is given by:

$$RL = ARL(\pi_1, \pi_2, \pi_3, k, \delta_1, \delta_2, \delta_3, t, m, n) = \int_{-\infty}^{\infty} \frac{1}{[1 - P(\widehat{LCL}_{\overline{X}} \leq \overline{X} \leq U\widehat{C}L)]} \varphi(w) dw$$

Where φ the probability density function of the standard normal distribution. The expansion for k> 3 can be made in the same way.

CASE STUDY

Process description and control plan. As mentioned, for implementing the proposed improvement, it was selected a company process in the food sector, whose products consist of dough with wheat-based. The example shown is similar to the processes of metalworking industries, a process in which product can pass through different production lines, with different parameters and probability distributions. The general feature of the process is illustrated in Figure 4. The manufacture starts with the preparation of the dough, placing the wheat in the trough base for homogenization. Then the mass is removed en bloc and placed in cylinder mold and processed to obtain a uniform thickness. After that, it is bent and back cylinder and cut into discs coming out in horizontal rows arranged in five positions.

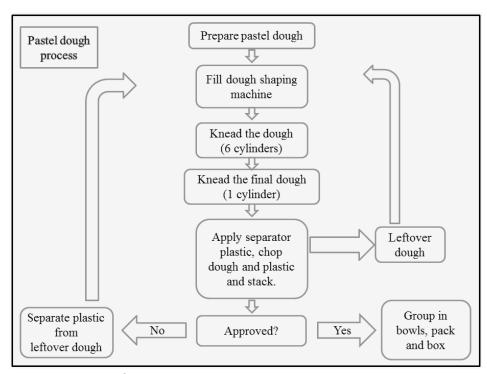


Figure 4 – Scheme of the production of pastry dough line process.

Graphical identification of the mixture and the weight of probability distributions. The first step is to identify the mixture of subpopulation that is part of the process shown in Figure 1. The aims are to verify if the database is from a mixture of probability distribution, to identify the amount of these mixtures (k mixtures), to calculate the probability of these distributions and to estimate the parameters for each of the k probability functions.

One of the techniques for achieving these aims is with the graphic based on the density of probability function. The Figure 1 shows at least three probability distributions. The Figure 5 shows the normal graph of probability distributions for the database of Figure 1 which indicates two clear inflection points at the ends of the standard curve and two or more probability distributions in the center of the intersection.

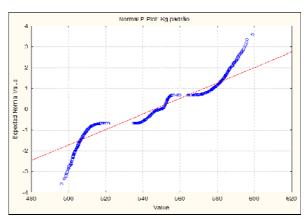


Figure 5 – Plotting the normal graph of probability distributions for the database of Figure 1.

The Figure 6 shows the same information but there are deviations of the score in the normal distributions for each value in the real scale. If there is a pure mixture without subpopulations then what is expected is that the normal patterns of values fluctuate around zero. The challenge is to find how many populations are on the database.

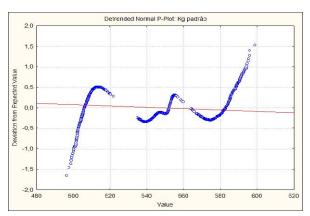


Figure 6 – Expected deviations of the scores in the standard normal distribution for the database of Figure 1.

It was tested three and four subpopulations through the graphical method and it was identified four subpopulations as shown in Figure 7. When three subpopulation were tested, the subpopulation from the mass data center has points of inflection and light fluctuations of normal non-random scores around zero. The mass data was divided into four subpopulations with density functions of Gaussian probability because the Chi-square test indicated no statistical evidence to reject the hypothesis of non-normality for each of the probability distributions.

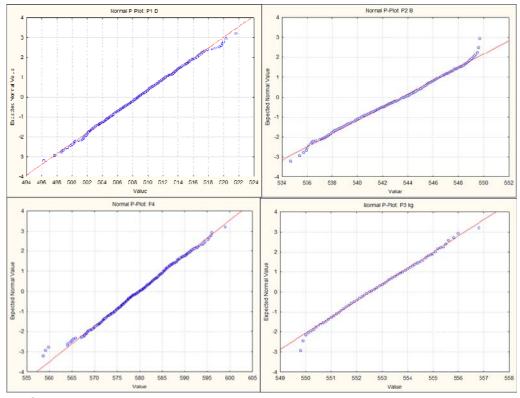


Figure 7 – Clockwise from left to right, plotting normal scores from position 1 to 4, considering four subpopulations.

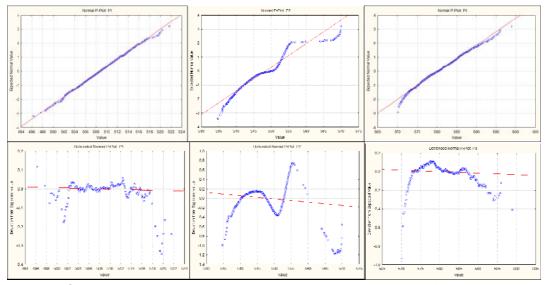


Figure 8 – Clockwise from left to right, plotting normal scores from position 1 to 3, considering three subpopulations.

When identified subpopulations, it is necessary to identify the parameters of these subpopulations. In this case, as the distribution of the normal will be adjusted so μ , σ and the weights of π_i will be estimated.

The Table 1 shows the estimated parameters and it can observe that the weights are approximately equal to each subpopulation.

Table 1 – Estimated parameters of subpopulations.

Sub population	Valid N	Mean	Median	Mode	Minimum	Maximum	Std.De	Skewnes s	Kurtosis
1	1000	508.7	508.7	508.1	496.3	521.6	3.7319	0.0824	0.0826
2	1002	543.5	543.7	544.6	534.7	549.7	2.9900	-0.1900	-0.4133
3	998	552.5	552.5	Multiple	549.8	556.8	1.2245	0.1583	-0.2983
4	1001	579.9	579.9	Multiple	558.6	598.9	5.6569	-0.0395	0.2906
Population	4000	546.2	549.7	Multiple	496.3	598.9	25.6965	-0.1815	-0.9390

Table 2 – Estimated parameters of π and δ .

Subpopulations	π_{j}	δ	$\sqrt{1+\frac{1}{k}\sum_{k}{\delta_{k}}^{2}}$
1	0.2500	1.4575	
2	0.2505	0.09546	2.2179
3	0.2495	-0.2470	
4	0.2503	-1.3133	

GRAPHIC PERFORMANCE ANALYSIS

In the case, there are subpopulations k=4 whose probability density functions are adhered to normal and estimated parameters from the data of Figure 1 are shown in Tables 1 and 2. Then, it can be written in the mathematical function of AARL in which parameters involved are $\omega=\{\pi_1,\pi_2,\pi_3,\pi_4,k,\delta_1,\delta_2,\delta_3,\delta_4,t,m,n\}$, but as $\pi\cong\pi_1\cong\pi_2,\cong\pi_4$ will be considered equal weight for each f.d.p Thus, the expected average number of samples until the occurrence of a point outside the control limits is given for (when t=0, the process is in control):

$$E(ARL) = AARL(\pi, k, \delta_1, \delta_2, \delta_3, \delta_4, t, m, n) = \int_{-\infty}^{\infty} \frac{1}{\left[1 - P(L\widehat{C}L_{\overline{X}} \leq \overline{X} \leq U\widehat{C}L)\right]} \varphi(w) dw.$$

$$\begin{split} &(I\widetilde{C}L_{\widetilde{X}} \leq \widetilde{X} \leq U\widehat{C}L) \\ &= \pi_1 \left[\emptyset \left(\frac{w}{\sqrt{m}} + \delta_1 \sqrt{n} + k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sqrt{n} \right) \right] \\ &- \emptyset \left(\frac{w}{\sqrt{m}} + \delta_1 \sqrt{n} - k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sqrt{n} \right) \right] \\ &+ \pi_2 \left[\emptyset \left(\frac{w}{\sqrt{m}} + \delta_2 \sqrt{n} + k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sigma \right) \right] \\ &- \emptyset \left(\frac{w}{\sqrt{m}} + \delta_2 \sqrt{n} - k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sigma \right) \right] \\ &+ \pi_3 \left[\emptyset \left(\frac{w}{\sqrt{m}} - \delta_3 \sqrt{n} + k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sigma \right) \right] \\ &- \emptyset \left(\frac{w}{\sqrt{m}} - \delta_3 \sqrt{n} - k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sigma \right) \right] \\ &+ + \pi_4 \left[\emptyset \left(\frac{w}{\sqrt{m}} - \delta_4 \sqrt{n} + k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sigma \right) \right] \\ &- \emptyset \left(\frac{w}{\sqrt{m}} - \delta_4 \sqrt{n} - k\sqrt{n} \sqrt{1 + \frac{1}{l} \sum_{i} \delta_i^2} - t\sigma \right) \right] \end{split}$$

FRAMEWORK FOR PRODUCTION WITH MIXTURE DISTRIBUTIONS

To illustrate and to assist in defining control chart design (size and amount of samples) was done a framework (Figure 9) that provides instructions when production consists of several flows and the data belong to a mixture of probability distributions.

When:

$$\mu_1 \neq \mu_2 \neq \dots \neq \mu_k \qquad \qquad k = \{1, 2, \dots, i\}$$

$$\bullet \quad \overline{X}_{k = \sum_{t=1}^{N_k} \frac{X_t}{N_k}}$$

$$\bullet \quad N_k = \text{sample size of subpopulation k}$$

$$\bullet \quad \pi_k = \frac{N_K}{N_T}, N_k = \sum_{t=1}^K N_k$$

$$\bullet \quad S_k = \sqrt{\frac{\sum_{t=1}^K (X_{tk} - \overline{X_k})^2}{N_k - 1}}$$

$$\bullet \quad \delta = \mu_k - \mu_0, \qquad \mu_0 = \text{global average}.$$

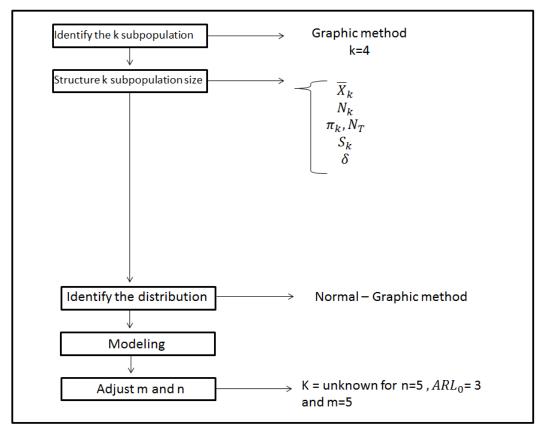


Figure 9 – Flowchart for control chart for distributions mixture.

The results obtained by simulation of Maple program (see table 3), using of framework of figure 9 as a guide and the model developed in section 5.2, show that for a production in control, for k=2.325, the type I error is 0.00273 (traditional value in the literature is 0,0027). So, it is expected a value to ARL equal to 366.12, in other words, it is expected to occur a point outside the limits control for each 366.12 samples extracted in the process.

		-	
k	AARL ₀	k	AARL ₀
2.050	54.93	2.250	207.27
2.075	63.90	2.275	249.47
2.100	74.64	2.300	301.56
2.125	87.55	2.325	366.12
2.150	103.14	2.350	446.47
2.175	122.01	2.375	546.86
2.200	144.96	2.400	672.79
2.225	172.97	2.425	831.40
		2.450	1032.00
			· · · · · · · · · · · · · · · · · · ·

Table 3 – Estimates of parameters $AARL_0$ and K generated by Maple.

For the procedure shown, traditionally assuming a type 1 error 0.0027 (α =1/366.1), it is necessary to follow the steps:

- Remove an odd sample size;
- Estimate the mean and standard deviation (x, σ) ;
- Plot a control chart;
- Operate the production system Phase II.

CONCLUSION

This study contributes to industry and researches who working in cases where there are different machines and flows for production of products once it presents an alternative solution to Shewhart charts. The purpose of this study was to analyze the construction of graphs of statistical process control with a mixture of probability distribution.

The case analyzed showed an application of control charts with finite mixture of probability distributions in a process of a company in the food sector whose products consist of dough with wheat-based. It was observed that proposed graphic of this research is more complex because it involves more parameters to be considered in its calculation. Nevertheless, it can help the practitioners to monitor on a single graph multiple streams of the production process which explains the development and implementation of this study.

As the research limitation, there is application in a single case requiring checking in other cases with similar issues.

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Instrument that evaluates the IMS and sustainable performance

Poltronieri, C.F.¹⁾, Gerolamo, M.C.¹⁾, Dias, T.C.M.²⁾ and Carpinetti, L.C.¹⁾

1) University of Sao Paulo (USP)

²⁾ Federal University of Sao Carlos (UFSCar)

ABSTRACT

Purpose - The number of management systems standards has increased and among the most recognizable ones are ISO 9001, ISO 14001 and OHSAS 18001. The need for integration has arisen due to such an increase and adoption of more than a management system by companies, and this process is known as Integrated Management Systems (IMS). Some authors have argued the use of IMS contributes towards sustainability. This manuscript presents an instrument for the assessment of the integration of different management systems and sustainable performance.

Design/methodology/approach - A review of IMS, maturity of IMS and sustainability was conducted for the preparation of the instrument. For the questions about IMS, it is used this references: Domingues (2013), Poltronieri (2015), Bernardo *et al.* (2009) and ISO 9001:2015. For the questions about performance it is used GRI. The test was sent to 19 individuals for evaluate the instrument.

Findings - One answer was excluded, because it was half answered and the 11 others improved the understanding of the questionnaire. As a result, the order of some questions was changed, some others were reformulated, and a new classification was created.

Originality/value - The importance of this study lies in the development of an instrument that helps the assessment of the maturity of integration of management systems and evaluation of sustainable performance. The instrument can be applied as a survey for the analyses of the IMS contribution to sustainability.

Keywords: Integrated Management System, performance, sustainability

Paper type: Research paper

INTRODUTION

There is an increase of organizations adopting standards of management systems. One of the most widespread is the ISO9001 (Quality Management System), which was established in 1987. However, there are many others standards, some general and others for specific sectors. Among the generic standards, we can mention: ISO14001 (Environmental Management System) and OHSAS 18001 (Health Management System and Safety).

Some problems happen when companies adopt more than one management system separately. Zeng et al. (2007) pointed some troubles such as duplicate efforts in terms of documentation, control forms and procedures; and the difficulty of ensuring alignment of strategy with different management systems. With the increase of certification's number and the adoption of more than one management system, companies have been worried with the integration. Therefore, IMS (Integrated System Management) emerges in this context. The integration can occur in different ways and in different levels. The maturity's approach is the origins in quality area in 1979 with Crosby's Quality Management Maturity Grid. According to Maier et al. (2012), maturity models assist in the representation of cumulative number of stages that facilitate the visualization of where the company is and how much longer to achieve best practice. In the specific case of IMS, there are two papers that address the evaluation of maturity: Domingues (2013) and Poltronieri (2015). This evaluation is important because it help to promote greater integration and consequently take advantage the benefits that integration provides, such as decrease of documents, reducing costs and reducing the number of audits. Another issue that has been highlighted is the sustainability. Brundtland (1987) establishes that sustainable development should ensure the needs of the present without compromising the needs of future generations. Elkington (2001), in his book "Cannibals with Forks," introduces the concept known as triple bottom line, which states that to achieve sustainability is necessary to be aware of the social, environmental and economic dimensions. Based on the dimensions introduced by Elkington, the GRI (Global Reporting Initiative) has established guidelines for preparing sustainability reports. According to Santos (2009), others studies have emerged adding others dimensions for sustainability, nevertheless what has prevailed is still the socialenvironmental-economic tripod.

There is in the literature studies about specific standards and performance, IMS and performance, IMS and sustainability, but none of these studies address the issue of integration and maturity of IMS, linking these issues with their impact on the environmental, social and economic. One way to verify if the integration of management systems contributes to sustainability is analyze the relationship between integration and performance's social - environmental - economic. It was developed an instrument that is presented in this article to check in practice the relationship between IMS and sustainability, which has been tested in people who work in industries and specialists.

LITERATURE REVIEW

Management systems

ISO (2015a) define a management system like a set of procedures that an organization needs to follow if it wants to achieve your goals. In small organizations, the way of doing activities normally it is done informally and for few persons. The process to make clear what should be done and how it should be done is known as the management system.

The number of management systems is growing, among them: ISO9001 (Quality Management System), ISO / TS 16949 (Quality Management System focused on the automotive sector), ISO14001 (Environmental Management System), OHSAS 18001 (Occupational Health and Safety Management System), ISO22000 (Food Safety Management System), ISO50001 (Energy Management System), ISO27001 (Information Security Management System), NBR 16001 (Social Responsibility Management System). The research of ISO

(2015b) revealed that between the years 2004-2014, the number of ISO9001 certification worldwide increased from 660.132 to 1.138.155. In the same period, the number of certified organizations in ISO14001 rose from 90.554 to 324.148.

Jørgensen *et al.* (2006) have pointed to the fact that the standards are becoming more consistent over time and have emerged framework for integration in different countries. The ISO (2008) published a book called "The integrated use of management system standards", which provides advice on how to integrate standardized management systems. The ISO established the Annex SL for management systems standards to facilitate the integration and consistency of the different standards. The purpose of Annex SL is to provide a similar structure, with texts and terms in common (Tangen and Warris, 2012).

The organizations have adopted more than one management system, which has led the search for the integration of these systems. According Karapetrovic and Willborn (1998), the emergence of Integrated Management System (IMS) happens when two management systems come together and resulting in the loss of independence of one or both, but without giving up their individual identities. In accordance with Beckmerhagen *et al.* (2003), the integration of management systems can be defined as the process of uniting different specific functions of management systems within a single system.

The main benefits of integration cited by several authors are: reduces of documentation, improves communication, reduces number of audits, improves both decision-making process and resource utilization, facility in promoting continuous improvement, promotes a better alignment with strategic planning, holistic view, better involvement of employees, reduces bureaucracy and costs, eliminates conflicts, among others (Poltronieri, 2015).

Evaluation of maturity

Maturity model is a structure constituted of parts that define the maturity in a specific area (PMI, 2003). The maturity models help the company to see where and how far to achieve best practice. The Crosby's Quality Management Maturity Grid is considered the first maturity model that has knowledge (Maier *et al.*, 2012).

The maturity models are widely used and it is possible to find specific models for quality management, product development, innovation, software development, as well as several others areas. According to a systematic review by Wendler (2012), although there are maturity models for various areas, the highest concentration is in the areas of software development and software engineering. The author said that the number of publications about maturity model has grown over the years, in 2003 there were 15 articles about this area and in 2009 the number increased to 34.

The CMM (Capability Maturity Model) is a maturity model that was developed by the Software Engineering Institute (SEI) at Carnegie Mellon University, which served as the basis for preparation of various others models. One of the most popular models drawn from the CMM is the CMMI (Capability Maturity Model Integration), which has the objective of promote the improvement of development of products and services, beside to seek greater integration of CMMs (Carnegie Mellon Institute, 2006).

In the quality area, there is a maturity model to evaluate the Quality Management System introduced by ISO9004. It is composed for 5 levels and is assessed 5 aspects of the standard: managing for sustained success; strategy and policy; resource management; processes management; monitoring, measurement, analysis and review; and improvement, innovation and learning (Associação Brasileira de Normas Técnicas, 2010).

Maturity models contribute to improving organizational performance and help to identify strengths and weaknesses (Khoshgoftar and Osman, 2009).

In the literature, there are two works that use the concept of maturity models for evaluating the integration of management systems. This researches will use them as the basis for this research. One of them was prepared by Domingues and the other by Poltronieri, both will be presented then.

Domingos's work was used statistical concepts and CMMI. The model consists of three dimensions: KPA's (Key Process Agents), 8 pillars of excellence in management and external factors. The level of maturity is determined for the combination of these 3 dimensions. The external factors are sustainability, macroergonomics, life cycle analysis and social accountability. There are 21 KPA's and some of them are integration of policies, implementation supported by a framework, integration of document, the existence of integrated indicators, integration of audits, among others (Domingues, 2013).

The work presented by Poltronieri used four management systems (ISO9001, ISO14001, OHSAS18001, NBR16001), CMMI and the maturity model presented in ISO9004 for the preparation of an instrument for the evaluation of integrated management systems. The instrument has 21 questions divided into four areas: policy, planning, implementation / execution, and verification / action. Within these four areas, there are several points such as: the existence of integrated policy, preparation of planning, control of procedures / instructions / records, training, resources, internal audit, nonconformities / corrective and preventive actions, among others (Poltronieri, 2014; Poltronieri *et al.*, 2015).

The research of Bernardo *et al.* (2009), although it does not use the concept of maturity models, it is an important reference in the IMS area and evaluates various topics through 3 levels: not integrated, partially integrated and fully integrated. There are 3 areas assessed: human resources; goals and documentation resources; and procedures. The human resources are evaluated if the team of inspectors, management system manager and management system representative are integrated or not. In the goals and documentation resources are analyzed policy, objectives, manual, procedures, instructions and records. On the procedures are verified the planning, internal audit, management review, control of nonconformance, preventive and corrective actions, product realization, resource management, determination of requirements, improvements, document control, record control and internal communication.

Sustainability and performance

The concept of sustainable development emerged in the late twentieth century due to concern for the environment combined with the reflection about the influence of society on the economy. This concept was introduced in the Brundtland Report in 1987. It is characterized by the ability of current generations to meet their needs without interfering with future generations (Leite *et al.*, 2011).

The prospect of sustainability put into question the current model of development so far. For the authors, it is need to move from a society focused in the economy, which are measured in terms of growth of production and consumption of raw materials, for a society that will value the reduction of consumption and an economy that will focus in service (Manzini and Vezzoli, 2008).

The measurement of sustainability is an activity of great importance in the decision-making process and organizational management system. The sustainability assessment can be made through index or set of indicators. Among some of these initiatives may cite the GRI (Global Reporting Initiative) and the Dow Jones Sustainability Index. The management of sustainability and their measurements are often underused in the decision-making process, being restricted their use in reporting. There is some pressure for companies to report, however, the measurement of sustainability is not yet fully mature and is still very common measurement of only one dimension as environmental (Delai and Takahashi, 2011).

The GRI (Global Reporting Initiative) is an international organization that helps companies to prepare sustainability reports. It appeared in 1997 in Boston and is currently present in more than 90 countries (GRI, 2015). The organization that resolved to use GRI can choose two options: essential and comprehensive. The essential mode contains essential elements of a sustainability report and must contain at least one indicator

related to each identified aspect. The comprehensive mode contains the elements of essential mode and at the same time requires disclosure of more information about strategy, analysis, governance, ethics and integrity (GRI, 2013).

The report based on GRI's instructions has two types of standard contents: general and specific. The general contents are divided into 7 parts and include information on: strategy and analysis; organizational profile; identified material aspects and boundaries; stakeholder engagement; report profile; governance; and ethics and integrity. If this information has already been disclosed in another report, the organization can only to do the reference (GRI, 2013).

The specific contents are divided between information on the form of management and indicators. Information about management allows the organization to explain how economic, social and environmental impacts are managed, and that this information provides subsidy for the indicators. Indicators inform about the performance or aspects (economic, social, environmental) related to their material aspects, and the materials aspects reflect the significant impact or influence the decisions of stakeholders. It is worth noting that the economic category is not as focused on the financial situation of the organization, but the impact on economic systems at local, national and global level. It is suggested a total of 9 economic indicators, 34 environmental and 48 social. For example, in the environmental category, the aspect of materials can be measured by two indicators: materials used broken down by weight or volume; and percentage of materials used that are recycled (GRI, 2013).

METHOD AND DEVELOPMENT OF THE INSTRUMENT

The survey research has been widely used in operations management area and consists of a long process that requires the existence of a theoretical model. This process includes: translation of the theoretical domain to the empirical; process of designing research and pilot test; collection of the data itself; data analysis, interpretation of results and writing (Forza, 2002).

Forza (2002) recommends that when planning a survey, it is determined the unit of analysis (individual, group, plants, business, among others) and the collection method (email, phone, personal visit). Programs that collection data may be helpful in the evaluation of the data, because they prevent the incorrect filling of the same. In this research the unit of analysis is by plants and the collection method is through survey software called Survey Monkey. In the development of the instrument, it is important to consider: structure of instrument, scale, who the respondents, avoid very long issues with preferably up to 20 words per line, elaborate a good introduction where it can clarify the purpose of the research and provide instructions. According to Renner and Bloom (2010), it is important to avoid questions where the response is binary (yes / no), this being an alternative to the open questions or the formation of an alternative grid.

In this study, it is elaborate a questionnaire to be applied in professional that working with management systems. The full questionnaire is in Appendices. The purpose is collect information about the maturity in IMS and sustainable performance. The questionnaire is divided into three sections: general questions; maturity on IMS; and sustainable performance.

In general questions are required information about the organization and the respondent, as well as information on their management systems. It is not requested to identify the respondent and your company. It was done to prevent that respondents stayed afraid to answer questions.

For elaborate the part of maturity of the integration of management systems, it was used two research that evaluate the maturity using the concept of maturity models (Domingues, 2013; Poltronieri, 2015), a work that shows levels of integration and served as basis for several others jobs in the area (Bernardo *et al.*, 2009), and the new version of ISO9001 (ISO, 2015c). This new version is based on Annex SL, which will guide the new

standards for management systems as well as the existing updates. It was done 19 questions that assess different angles of integration such as objectives, resources, structure, audits, risk management, among others.

Although the basis for assessing the maturity has been working Poltronieri (2014), it was decided to make some adjustments as using the highest level of maturity and make changes to become more clear and easy to be answered. From this level, it asked respondents indicated in a 5-point scale that ran from "strongly disagree" to "strongly agree", which option was more in line with the reality of your company. By checking the "strongly disagree", it is understood that the company is further from the maximum level of maturity and, therefore, would be closer to the level 1 of maturity. This adjustment was made to the original instrument, as if they were placed the description of all levels, respondents would take a much longer time for reading, which could adversely affect the answers.

The sustainability performance questions were elaborated through the aspects and indicators suggested for the development of the GRI report (GRI, 2013). As the number of suggested indicators is very large (91 in total), it was considered the aspects (46 in total). It was elaborated the questions based in the perception through indicators.

Ketokivi and Schroder (2004) present a classification to measure performance in the operations management area: operational measures, perceptual measures and quasi-perceptual measures. Operational measures use indicators that it is exact measurements. A problem in its use is the respondent feel cornered spending that kind of information. An example of operational measure is the ROI (return on investment). Perceptual measures verify how the respondent feel about a particular aspect, being used scales that usually range from "strongly agree" to "strongly disagree". The risk is that the respondent can to have a higher or lower perception of reality. For example, the respondent may consider the average performance of your company above the average, while, in reality, it should be considered close to the average. Quasi-perceptual measures are a mix of the two previously mentioned. The content of the measure is defined according to the operational definition and measurement units are of perception. For example, you can ask for the respondent rank on a scale of 1 to 5 what is your perception of the performance indicator ROI relative to competitors, defining what exactly would ROI. In the case of instrument developed, it was decided to use perception measures.

Perceptual measures have traditionally been developed by psychology area. The scale developed by Likert began to be widely used for various areas of knowledge (Hensley, 1999). The number of points used in Likert scale can vary widely, however, from 5 to 10 points can be favorable when the respondent discriminating values. In addition, a scale with many points it is difficult to find distinct verbal terms to describe each of the points (Kline, 2011). In this work will be used the Likert scale of 5 points.

In survey research, it is important to test the instrument before applying to a large number of respondents and this process known as a pilot test. According to Forza (2002), the pilot test helps verify that the questionnaire is good, because even with all the planning there may be difficulties in understanding the issues. An author's suggestion is to conduct the pre-test by sending the questionnaire to colleagues, experts and target respondents. Another suggestion is to include questions about the clarity of the questionnaire and difficulties, leaving room for the participant to suggestions that may contribute to a better understanding of the issues. Both suggestions were used in developing the instrument presented in this article.

It was done a test with 19 people, of which 14 people worked in industries that had at least two management systems (ISO9001, ISO14001, OHSAS18001) and 5 of them was sent to content analysis only. Of these five, three people worked in the academic area, one of them was a consultant and the other person worked in an industry with a single management system. The content analysis consisted in assess the understanding of the questionnaire and content, in which participants did not answer the questionnaire itself like the other participants made thinking about the reality of your organization.

Participants in the pilot test were selected based on contacts that the researcher already had, plus the selection of random companies that had the ISO14001 implemented in conjunction with other standard. In

the latter case, it was used to select the companies the yearbook 2013/2014 prepared by the Publisher Analysis titled Environmental Management. There were 12 questionnaires returned. Two of the responses were from people who analyzed the content, 9 people working in the industry and one of the questionnaires were answered by half, being discarded.

All 19 people were hired prior to verify the possibility of participation, some of them was making contact by email and social network, others through phone call. The group of respondents was formed by people who worked directly with the management systems. An e-mail was sent on 11.26.2015 containing the link to complete the survey, and two others emails were sent in order to remember the response time limit (03.12.2015 and 07.12.2015). With the test's help, we have changed the order of some questions, questions are reformulated, in addition to a new form of classification of companies was created.

In the pilot test, it is used the classification established by the IBGE (Brazilian Institute of Geography and Statistics) and called CNAE (National Classification of Economic Activities). The CNAE divided into major categories called sections ranging from letter A to U. In this research, it is used the C section (manufacturing industry), being considered the 24 divisions in this section and the sections D (electricity and gas) and F (construction). It added to an alternative called "other" for the company to put in case did not fit. It was observed that the respondents have difficulty using the CNAE (National Classification of Economic Activities). For example, there were cases where the CNAE classification the company fell within the existing options; however, the respondent put it as the "other" option. In the time to specify what would be this "other", the respondent put option already existing. Because of this, another classification was created in order to facilitate understanding of the respondent, taking as a basis for this creation the CNEA. The new classification was made up of the following categories: aeronautics, food, banking / financial, pulp / paper / printing, construction, cosmetics, electricity / gas, pharmaceutical, tobacco, computer / electronics, machinery / equipment, office supplies, metallurgy, furniture , oil / derivatives, chemicals, clothing / textiles, glass / ceramic / cement, other.

In the pilot test was included a question to check how long the respondents suggested to answer the questionnaire. An average, it is suggested 21 minutes. The lower suggested time was 15 minutes and the largest was 30 minutes. An average provided by software was done, excluding three responses out of 11 questionnaires returned. Two of them because it was expert who replied and therefore evaluated only the contents. One of them, by having given six hours. Probably the person started to answer and stopped for a period, returning later. Based on others 8 responses, the average time was 17 minutes. Therefore, it is believed that the average time to answer the questions is less than 21 minutes suggested. Based on all these observations made during the pilot test, it was possible to reach the final instrument presented in this article.

CONCLUSIONS

This article presents an instrument that will be used to verify in practice if there is relationship between the integration of management systems (ISO9001, ISO14001 and OHSAS18001) and sustainability. For preparing the part relating to management systems, it is used the work of Domingues (2013), Poltronieri (2014), Boiral et. al (2009) and the ISO9001:2015, while preparing for the sustainability performance was used the GRI, being considered separately the social, environmental and economic performance.

A test was performed in order to evaluate the proposed instrument. It was sent the questionnaire to 19 people, obtaining the return of 12 of them. However, one of them replied in half, being necessary to exclude. With the suggestions given by the respondents, it was possible to reach the final version presented in the appendices. Because of the suggestions given, it was possible to improve understanding of the proposed instrument by restructuring issues, change order of the questions and creating a new classification for companies.

The next step is the application of this instrument in survey in Brazilian companies that have at least two of the following management systems: ISO9001, ISO14001 and OHSAS18001.

AKNOWLEDGEMENTS

CNPq - National Council for Scientific and Technological Development for the financial support.

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APPENDICES

Questionnaire complete and revised

General Questions of Demographic Order:

- 1. In which state the company you work for is?
- 2. What is the hierarchical level of their position? (Analyst, Coordinator / Supervisor, Manager, Director, Others)
- 3. What is the area where you work? (Operations, Quality, Environment, Health and Safety, IMS, Sustainability, Officers, Others)
- 4. How big is the company? (1 19 employees, 20 99, 100 499, more than 500 employees)
- 5. Which sector the company operates?
- 6. What management systems the company has? When was the first certification of each?
- 7. Did the management systems are integrated? Which are? When did this integration?

Evaluate of maturity of IMS

For each question, consider the following degrees of agreement 1-5, with 1 being "Strongly Disagree" and 5 being "Strongly Agree". If you are not sure of the answer or consider that it does not apply, check the alternative N/A.

As for the management systems used by the company, it is clear that:

- 1. The evaluation of the organization's context and interested parties is made considering the various management systems
- 2. The leadership treats their different management systems joint and unified way
- 3. There is a single policy that is integrated and it is deployed in constantly revised indicators
- 4. Roles, responsibilities and authorities are assigned and communicated contemplating different management systems
- 5. The planning is done jointly, resulting in a single plane
- 6. The company performs risk analysis in an integrated manner
- 7. Objectives, targets and requirements are aligned and integrated
- 8. The resources (human, infrastructure, financial) are distributed considering the needs of the rules together
- 9. The establishment of the necessary skills is done considering the demands of the different management systems, providing training and other activities in a unified manner
- 10. There is a unique structure that takes care of the whole process of communication (internal and external communication)
- 11. The creation, control and disclosure of all documented information is treated in an integrated manner, with a process of disclosure to ensure that everyone has access

- 12. Operational control is done jointly, considering the different processes required meeting the requirements of different management systems
- 13. The assessment of the management systems (monitoring, measurement and analysis) is seen in an integrated way, and the indicators are treated together and reviewed constantly
- 14. Internal audits are made while considering the requirements of the different management systems
- 15. The management review is done jointly, resulting in a single document
- 16. The treatment of nonconformities is done considering the different management systems
- 17. There is a single organizational structure area responsible for management systems
- 18. The selection of indicators are taken jointly and the results are widely available, and they are constantly revised
- 19. External audits (the certifying body) are made while considering the requirements of the different management systems

Evaluate of sustainable performance

Taking into account the reality of the company where he works, consider the scale in which one end is "very low" and the other "very high". If you are not sure of the answer or consider that it does not apply, check the alternative N/A.

Economic

The economic dimension in this case concerns the organization's impacts on the economic conditions of its stakeholders and on economic systems. It does not focus on the financial situation of the organization.

According to the economic aspect, it is possible to note:

- 1. Economic performance distributed through community investments such as charities, NGOs, research institutes, among others
- 2. Proportion of employees with salary above the local minimum wage
- 3. Investment in infrastructure, which may include transportation networks, utilities, sports centers, health centers and social welfare, among others
- 4. Proportion of spending on local suppliers

Environmental

According to the environmental aspect, it is possible to note:

- 5. Use of waste and recycled materials
- 6. Efficiency in energy consumption
- 7. Efficiency in water consumption
- 8. Habitats protected and / or restored
- 9. Control of atmospheric emissions
- 10. Control of effluents and waste
- 11. Control of the environmental impacts of products and services

- 12. Compliance with environmental laws and regulations
- 13. Control of the environmental impacts of transporting products and materials used for the organization's operations, taking into account not only transport within the organization as well as external
- 14. Total investments and spending on environmental protection
- 15. Number of suppliers selected based on environmental criteria
- 16. Service of the aspects related to the environmental impacts from the perspective of various stakeholders, observed by the low number of complaints and claims

Social

According to the social aspect, it is possible to note:

Labor Practices and Decent Work

- 17. Retention of employees
- 18. Agility in the notification of employees about operational changes that may affect them
- 19. Accident prevention
- 20. Investments in career development programs
- 21. Fairness in terms of diversity and equal opportunities considering the aspect of gender and age
- 22. Equal pay for women and men
- 23. Number of selected suppliers based on criteria relating to labor practices
- 24. Service of the aspects related to labor practices from the perspective of various stakeholders, observed by the low number of complaints and claims

Human rights

- 25. Inclusion of issues related to human rights in the company's training
- 26. Combating cases of discrimination (race, color, gender, etc.)
- 27. Respect for freedom of association and collective bargaining
- 28. Number of shares that guarantee the eradication of child labor
- 29. Number of shares to combat forced labor or slave
- 30. Percentage of security personnel trained in policies or procedures relative to human rights
- 31. Combating cases of violation of indigenous and traditional people's rights
- 32. Operations submitted in analyses or assessments of impacts related to human rights
- 33. Evaluation of suppliers on human rights
- 34. Treatment of the aspects related to human rights from the perspective of various stakeholders, observed by the low number of complaints and claims

Society

35. Concern with local communities

- 36. Combating corruption
- 37. Concern about the assessment of contributions to politicians and political parties
- 38. Fight the problems related to unfair competition
- 39. Compliance with laws and regulations
- 40. Number of suppliers selected on the basis of social impacts
- 41. Treatment of the aspects related to impacts on society from the perspective of various stakeholders, observed by the low number of complaints and claims

Product Responsibility

- 42. Concern in the evaluation of products and services that can impact on customer health and safety
- 43. Concern labeling of products and services in order to report the impact of the product or service on sustainability
- 44. Be careful in checking if the product is banned in some market
- 45. Concern customer's privacy in order to prevent the violation of privacy and loss of customer data
- 46. Compliance with laws and regulations concerning the provision and use of products and services

The impact of the lecturer experience on students' satisfaction

Berbegal-Mirabent, Jasmina.¹⁾, Mas-Machuca, Marta.¹⁾ and Marimon, Frederic.¹⁾

¹⁾ Universitat Internacional de Catalunya. Social Sciences and Economics Faculty.

C/ Immaculada, 22. 08017 Barcelona

jberbegal@uic.es; mmas@uic.es; fmarimon@uic.es

ABSTRACT

Purpose – The paper is twofold aimed. We first examine the relationship between teaching experience and students' satisfaction. In a second stage we explore the mediating effect of research intensity in this relationship.

Design/methodology/approach – Data gathered in 2014 come from 229 different subjects offered at the Universitat Internacional de Catalunya, Barcelona (Spain). The reliability and validity of the students' satisfaction constructs is assessed using structural equation modelling (SEM). A couple of nested models are analysed in order to assess the mediation effect of research in the relationship between the lecturer experience and the student satisfaction attained.

Findings (Mandatory) – Results support the thesis that teaching experience is a determinant of student satisfaction, but on the other hand, the lecturer research acts as a negative mediator to explain satisfaction. Taking into account both effects, the total effect between experience and satisfaction is non-significant. There have been also found evidence that current incentive systems at universities are research-biased, negatively impacting on teaching quality, and consequently on student satisfaction.

Practical implications – The findings suggest that current incentive systems at universities are research-biased, negatively impacting on teaching quality, and consequently on student satisfaction

Originality/value – The paper contributes with the analysis of the decomposition of the total effect between experience and students' satisfaction in the direct effect and the mediated effect of research effort.

Keywords: higher education, teaching experience, research intensity, student satisfaction.

Paper type: Research paper.

INTRODUCTION

With the rise of the evaluative state, the assessment of university quality has become a meaningful topic amongst academics and policy makers. Indeed, both public and private bodies, as well as universities, are designing and implementing strategies to ensure a proper performance of higher education institutions in their daily activities.

Different types of evaluations are envisioned; however, those adopting a lecturer-centred approach are gaining popularity. Lecturers are in charge of teaching students but also of actively participating in research activities. This suggests that both teaching and research quality are in their hands (Bentley et al., 2013). Given this high responsibility that lecturers have acquired, university managers must ensure that lecturers are qualified and competent for their job. Teaching and research are the two categories of academic work for which faculty are usually evaluated. Different attempts and measuring systems are found in abundance, however, there is a fierce debate concerning the suitability of the proxies used to evaluate each type of activity.

Indeed, the relationship between teaching and research activities is a controversial issue in the field of higher education management (Halse et al., 2007; Robertson and Bond, 2005). Over the years, teaching and research functions have increasingly acquired separate identities, and nowadays there is as growing awareness that they have become separate activities of faculty work (Barnett, 2005; Jenkins and Zetter, 2003). However, when both activities are viewed from the standpoint of a learning process, they are expected to be mutually reinforcing (Becker and Kennedy, 2005; Brew, 2003; Burke and Rau, 2010).

Previous studies examining the trade-offs between teaching and research activities have reported different results (Durning and Jenkins, 2005), providing well justified arguments for a positive, negative and even a null effect. However, to the best of the authors' knowledge, literature is inconclusive regarding how students' satisfaction is determined by lecturers' performance in these two activities.

Students' choice is found to be highly influenced by teaching quality and university's prestige (which is related to research quality) (Gautier and Wauthy, 2007). Because students are one of the main customers of the higher education system (Woodall et al., 2014), in this study we examine how faculty members' prior teaching and research achievements are shaping students' satisfaction. We posit that prior teaching experience positively influences students' satisfaction. Nevertheless, we argue that this relationship is mediated by the research intensity of the lecturer. Aiming at explore these relationships we propose an exploratory analysis based on the specific case of the Universitat Internacional de Catalunya, a private university in Barcelona (Catalonia, Spain).

The remainder of the paper is organized as follows. We first review the literature on the potential trade-offs between teaching and research activities. The next section provides the theoretical framework and the development of the hypotheses. After this, we describe how constructs are operationalised and the methodological approach used. Results are reported in the next section. The discussion of the findings and concluding remarks are put forward in the last section.

TEACHING QUALITY VERSUS RESEARCH PERFORMANCE

Most higher education systems expect lecturers to excel at both teaching and research activities. Literature examining the tensions between the teaching and research role of lecturers is rich, although unclear. Figure 1 summarises the three main scenarios reported in the literature.

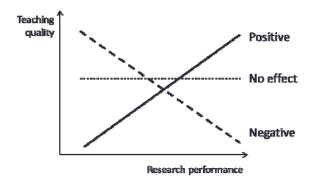


Figure 1 – Potential scenarios resulting from the teaching/research nexus paradigm.

A positive relationship is assumed if we look at the abilities underlying a good teaching and a successful research. Attitudes, values and competencies that lead to teaching excellence are also likely to lead to research quality (uz Zaman, 2004). Both teaching and research activities require the lecturer to be creative (e.g. imagination, originality, inventiveness), highly committed with his/her tasks (e.g. perseverance, dedication, hard work), possess critical analysis, and be good in disseminating and communicating knowledge (Hattie and Marsh, 1996). Reinforcing effects between teaching and research are thus accepted in both directions (Shin, 2011). On the one hand, research contributes to teaching because research-active lecturers are at the cutting-edge of their filed, which translates in more accurate and up-to-date material that captures more easily students' attention (Marsh and Hattie, 2002). Likewise, presenting the researcher's own material adds a sense of authenticity that differs from presentations where teachers discuss the work of others with neither passion nor an active involvement (uz Zaman, 2004). On the other hand, there are also claims that research benefits from teaching. Preparation of teaching materials as well as students' suggestions at class may help identify gaps in the literature and detect new research directions (Coate et al., 2001). Also, sharing the results of one's research efforts with an appreciative audience provides priceless feedback that could be used to improve research outcomes. All in all, these studies indicate that there a number of ways in which knowledge production and student learning can be brought together (Griffiths, 2004). Nevertheless, following Robertson (2007) to mutually reinforce, the teaching/research nexus needs to be expanded and include the phenomena of learning, knowledge and their inter-relation.

A second bunch of studies argue that teaching and research are conflicting activities, pointing to a negative relationship between them (Parker, 2008; Serow, 2000). A divergent reward system model is one of the main arguments supporting this thesis (Hattie and Marsh, 1996). Both teaching and research are time-consuming activities. As time is a scarce resource, faculty members tend to prioritize those activities that are going to report them a greater benefit, a benefit which is usually measured in terms of stability within the academia. Considering the weight given to research outputs in evaluation processes for tenure and promotion, young academics that need to carve out an academic career are more likely to reduce the time and effort spent on teaching in favour of research, as this long-distance race is conditioned, to a great extent, to their research capacity (Marsh and Hattie, 2002). Likewise, faculty members might also be tempted to spend their time in research activities in detriment to teaching ones because research may entail contracts with third parties, implying additional revenues. In this respect, teaching does not usually significantly contribute towards overall salary (uz Zaman, 2004).

Finally, teaching and research have been also considered as separate activities with little impact on each other (Noser et al., 1996; Ramsden and Moses, 1992). Authors supporting this premise claim that in some research centres where there is no teaching, high quality research is performed (Ramsden and Moses, 1992). This means that teaching and research could be considered independently. Another argument holds that these activities are different enterprises because they involve different tasks, which in turn, require different preparation and personality traits (Shin, 2011). While teaching concentrates in the transmission of knowledge,

research stresses the discovery of knowledge. An effective teacher may not be an effective researcher, and vice versa. As a result, one might expect a zero effect between these two activities.

There is another stream of literature that also might shed light on the topic: the role of conflict on this matter. The tension between the two roles is also mediated by some exogenous factors that are not captured in our database structure.

Theoretical framework and hypotheses development

Teaching experience

If a lecturer is committed with teaching excellence, his/her work will be highly valued by students (Xiao and Wilkins, 2015). The underlying rationale behind this argument is that irrespectively of the teaching experience, those lecturers who are good communicators, motivated and feel what they teach, are concerned with an effective student learning, consequently, they are interested in improving their teaching skills and can obtain high records in students' evaluations.

Although both youth (young lecturers) and maturity (senior faculty) can generate an interest for teaching, there is however a widespread consensus on the positive relationship between the years of teaching experience and teaching performance (Drule et al., 2014). While in the early career stages lecturers might be concentrated in defining the objectives and the content of the course, until the lecturer does not achieve teaching maturity, he/she will not really in-depth and experiment with different learning methods and fully engage students in their learning process.

Certainly, experience is the father of wisdom. Previous experience gives academics the tips and tricks on how to better attract students' attention, which consequently, increase their satisfaction with the course. Novel lecturers and doctoral students that have to perform teaching duties are thus in a disadvantaged position. Aiming at compensate this lack of experience they usually take formal courses on teacher training (Gibbs and Coffey, 2004).

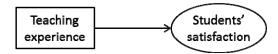
Previous studies examining the impact of teaching experience on student satisfaction is quite limited. For the purpose of this study the works of Prieto and Altmaier (1994) and Shannon et al. (1998) are remarkable. These authors examined the influence of previous teaching experience on graduate students at university and found that those lecturers with previous teaching experience rate more positively than those without such teaching experience. More recently, Madsen and Cassidy (2005) examined how different levels of teaching experience affect perceptions of teaching effectiveness and student learning, concluding that teaching experience do have an impact on the perception of teaching quality. Accordingly, we hypothesise:

Hypothesis 1: Prior teaching experience positively influences students' satisfaction.

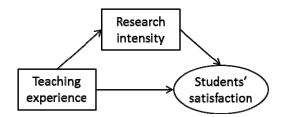
The mediating role of research intensity

Considering the teaching/research tensions described in the literature one may argue that because time is a scarce resource, lecturers might manage it according to their interests and needs (Gautier and Wauthy, 2007). It is thus reasonable to suggest that the relationship between teaching experience and students' satisfaction might be mediated by the commitment of the lecturer in performing research activities. A second hypothesis emerges:

Hypothesis 2: Research intensity mediates the relationship between teaching experience and students' satisfaction.



Model 1a. Total effect of teaching experience on student satisfaction.



Model 1b. Mediator effect of research intensity.

Figure 2 – The two models to be tested.

Stability

Furthermore, we put forward that the commitment to teaching and research activities experiment significant fluctuations throughout the academic life of an instructor. Curriculums are usually driven by research interests, therefore, during the first career stages, research will be occupying most of the time of a lecturer (Boardman and Ponomariov, 2007). This may lead to instructors less available for students and less concerned about their opinions and educational needs. These situations are undoubtedly perceived by students, increasing a sense of carelessness towards teaching that can generate dissatisfaction.

As a lecturer advances in the academic career, two main different behavioural paths are envisioned. The first pattern is followed by researchers aimed at building a solid research reputation. Herein, the pressure for producing and disseminating research outputs might have transformed into something vocational, but much more demanding as research projects tend to rapidly scale. The second pattern is shaped by obligations. Seniority within academia tends to involve holding academic posts that entail some degree of responsibility (i.e. head of the department, deputy head of faculty, dean, etc.). Regardless the pattern followed, in both cases teaching is relegated to a second place. However, we argue that because of the teaching experience they have gained over the years, they are able to compensate the limited time devoted to teaching activities, and consequently, obtain better results than young researchers in students' satisfaction surveys. Accordingly, our last hypothesis follows:

Hypothesis 3: There are significant differences between permanent staff and non-permanent staff in terms of the mediating effect of research intensity in the relationship between teaching experience and students' satisfaction.

METHODOLOGY

Sample

For the purposes of this study, 1077 different subjects offered at the Universitat Internacional de Catalunya (UIC) were considered. Data were collected during the first term of academic year 2014/15. After filtering in order to get records with the complete information required for our study, 229 valid subjects remained. Note that the unit of analysis is the subject, and for each subject we then gathered information about the corresponding lecturer. No bias gender was detected. Table 1 shows the main characteristics of the sample.

	Number	%					
Gender							
Male	114	49.8 %					
Female	115	50.2 %					
Total	229	100.0 %					
Main discipline	Main discipline						
Architecture	40	17.5 %					
Health sciences	75	32.8%					
Social and law sciences	25	10.9 %					
Humanities	89	38.9 %					
Total	229	100.0 %					
Stability							
Organic staff	123	53.7 %					
Functional staff	106	46.3 %					
Total	229	100.0 %					

Table 1 – Characteristics of the sample

Measures

Students' satisfaction

Student voice is now being heard more than ever. Students are the direct recipients of university teaching, becoming primary consumers of the higher education system. They have the most first-hand information concerning their instructors' teaching performance (uz Zaman, 2004), therefore asking them directly about their perceptions of teaching effectiveness is crucial.

A common practice for obtaining students' perceptions of lecturers consists in the use of surveys, where students are asked to fill in an evaluation sheet. Questions typically refer to those characteristics that have been found to describe what constitutes an effective teacher: whether the lecturer is knowledgeable about, demonstrates a strong interest in the subject, is organized and prepared for class, is able to assist with and encourage student learning, is dynamic in the classroom with effective presentation skills, or is fair and equitable in the evaluation of students. The reliability and internal validity of these instruments has been tested and there is a consensus among academics that data obtained through these instruments is consistent (Gravestock et al., 2008; Kulik, 2001) and essential for a comprehensive evaluation of university quality (Seldin, 2004; 2006).

At this point, it is remarkable to highlight that responses coming from students' surveys capture whether faculty members are interested and committed with their teaching activities regardless the academic position hold by the instructor. In fact, students are rarely aware of how the academic career and the promotion system work. Because of this characteristic, student satisfaction surveys are very attractive.

According to Pratt (1997) student satisfaction surveys have to consider three aspects of teaching: organization and planning (reading list, timing and workload), implementation and interaction (technical skills and class management) and results (learning outcomes and effectiveness). In this respect, UIC created a scale to fulfil these requirements. The questionnaire contains 10 items and employs a five-point Likert scale. It was validated in 2007 for two subjects from the two different campuses of the university. The 10 items are grouped in: (i) organization and planning, items 1-3; (ii) implementation and group interaction, items 4-9; and (iii) results, item 10. Table 2 contains the full scale.

Organisation and planning

- 1. The reading list and additional materials for the course contributed to improving my appreciation and understanding of the subject.
- 2. The course organisation and activities were well prepared and thoroughly explained by the lecturer.
- 3. The workload of this course was appropriate to set time for learning.

Implementation and interaction

- 4. The lecturer clearly presents and highlights the most important points of the course.
- 5. The students were encouraged by the lecturer to take part in the class discussions.
- 6. The lecturer properly answers students' questions and guides students in the development of the different tasks to be completed.
- 7. The lecturer uses didactic resources that facilitate the learning process.
- 8. The content of the exams and other assessed assignments matched the course content and the emphasis placed on each topic by the lecturer.
- 9. The lecturer showed a genuine interest in all of the students and was readily available to students outside of class time.

Results

10. The task performed by this lecturer has helped me to improve my knowledge, skills or attitudes.

Table 2 – Items included in the students' satisfaction survey

Control variables

There are, however, a number of additional factors shaping students' satisfaction that need to be controlled. First, we control for gender invariances. Second, we differentiate by knowledge field (Lindblom-Ylänne et al., 2006). Taking into account the academic offer at UIC, there are four main disciplines: architecture, health sciences, social and law sciences, and humanities. Third, we distinguish between undergraduate and master level (Coate et al., 2001; Noser et al., 1996).

Several are the voices that claim that despite the proliferation of students' satisfaction surveys, a combination of multiple sources can provide a more accurate, reliable and comprehensive picture of teaching than just one sole source (Berk, 2005). In this sense, evidences from the candidate and reports elaborated by peers constitute other ways of gathering valuable information (Seldin, 2006) that can help identifying areas of improvement which students are not yet able to perceive (uz Zaman, 2004). We thus introduce a four control variable, and examined whether the results of the internal teaching assessment performed by the university are consistent with students' opinions. At UIC the Department of Innovation and Educational Quality is in charge of perming this assessment. Evaluations range from unfavourable, favourable with conditions, favourable, or highly favourable. A combination of multiple evidences is used to determine the level of teaching quality: (i) a report elaborated by the head of the department; (ii) a self-assessment report, providing a reflective appraisal of how the instructor has designed and delivered the course (this report is usually complemented with examples of course materials and sample student assignments); and (iii) an in-class evaluation performed by another professor.

Teaching experience

Teaching experience has been measured through the number of years that a lecturer has been teaching at UIC. We acknowledge the limitation of using this metric as it does not capture previous teaching experience of the lecturer in other universities prior to joining UIC. Unfortunately, it was not possible to obtain this information, consequently, we only account for years of teaching experience at UIC.

Research intensity

Concerning research metrics, common indicators tend to use bibliometric data (Sarrico et al., 2010). Information of this type is widely available, including measures such as the number of papers published in scientific journals indexed in specific databases and citations counts. All these metrics are accepted to reflect both the quantity and quality of the research activity (Abramo et al., 2008). However, these variables are usually criticised because they can be influenced by self-citation and friend-citation practices (Toutkoushian et al., 2003) and are incomplete (Van Raan, 2005), representing and incomplete picture of the research dimension.

Recent studies suggest that a more convenient measure of research intensity would be that one including weighted composites of different research results (Turner, 2005). While some academics suggest that aggregate dimensions can be obviated for introducing biases (weights are not objective) and not being a substantive basis in the literature for making such judgments (Salerno, 2004), other authors argue that only composite indices can really reflect research quality (Tyagi et al., 2009).

Similar to composite indicators are the assessments performed by external agencies to academic staff. Quality assurance criteria and guidelines in the European Higher Education Area are sponsored by the European Association for Quality Assurance in Higher Education (ENQA) and include the assessment of academic staff. Although these procedures entail a holistic evaluation of academics' performance, they tend to be research-biased. Consequently, the assessment they provide is much more able to reflect research activities than teaching ones. In Catalonia, two external agencies are in charge of performing this assessment process: the Catalan University Quality Assurance Agency (AQU), acting at the regional level, and the National Agency for Quality Assessment and Accreditation of Spain (ANECA) covering the whole Spanish territory. When a Catalan university needs to replenish a vacant position, it takes in account whether the candidate holds any of the accreditations issued by either AQU or ANECA. Although both agencies are operating under the same European principles they use own standards and the names of the resulting categories (according to the level of achievement) are also diverse.

Table 3 summarises the main academic categories that exist in the Catalan higher education system. The category in the first row indicates that the lecturer is still in his/her initial stage so that his/her research outputs are reduced (in terms of publications, conferences, research projects, patents, etc.). On the contrary, last row represents a lecturer with a solid career, accordingly, research outputs are numerous and of great quality.

Coding	Category	Original name	Accreditation agency
_	Temporary lecturer	Profesor colaborador	ANECA
	Temporary lecturer	Professor col·laborador	AQU
	PhD assistant lecturer	Profesor ayudante doctor	ANECA
2	Tenure-track lecturer	Lector	AQU
2	PhD lecturer	Profesor contratado doctor	ANECA
3	Teaching staff at private university	Profesor de universidad privada	ANECA
4	Senior lecturer	Profesor titular	ANECA
5	Tenured assistant professor	Professor agregat	AQU
6	Professor	Profesor catedrático	ANECA
7	Full professor	Catedràtic d'universitat	AQU

Table 3 – Categories within the Catalan higher education system, ordered according to their level of requirement.

Aiming at overcoming some of the drawbacks of the different metrics summarised above, for the purpose of this study research intensity has been operationalised through a 7-point scale, according to the category each lecturer is occupying.

Some criticism might arise using "research category" as a proxy of "research intensity", due to the fact an accreditation is composed by some teaching outputs and research outputs (as well as other kind of indicators such as management responsibilities) at the same time. Nevertheless, the nature of these accreditations is such that the higher accreditations are more demanding in terms of research that the lower ones and it allows us the use this variable as a proxy of research intensity.

Stability

The type of contract, permanent or fixed-term, has also been shown to drive lecturers' decisions on which activities to dedicate more time and efforts (Coate et al. 2001; Shin, 2011). At UIC, the academic career begins in a "functional" category (fixed-term contract). Internal promotion policies are tied to research achievements, therefore, as the lecturer attain higher research accreditations, he/she is given the opportunity to appoint for the "organic body" of academic staff (permanent contract). In addition to having a more stable relationship with the university, organic positions are better remunerated. Aiming at examining the effect of stability in our model, a variable capturing the type of contract (fixed-term or permanent) is used.

Method

The empirical application is divided in three main stages. The first one consists in assessing the psychometric features of the scale used to assess students' satisfaction. The reliability and internal consistency of the two subscales of quality (organization and interaction) are thus analysed. In order to better understand the students' satisfaction construct, we then next analyse potential differences in its dimensions attending to a series of factors that might divide the sample into different subgroups. Using the factors identified in the previous section as control variables, we perform several non-parametric tests. For dummy variables (i.e. gender, and study level), the Mann–Whitney U test was conducted. The null hypothesis is that the two samples come from the same population against an alternative hypothesis. For those variables with more than two categories, the equivalent test is the non-parametric Kruskall-Wallis test (i.e. knowledge area, and internal teaching assessment), which extends the Mann–Whitney U test to more than two groups.

In the second stage we analyse the relationship between teaching experience and student satisfaction. We also test the mediating effect of research intensity in the aforementioned relationship. For this purpose, we adopt the methodology suggested by Baron and Kenny (1986) and revised by Zhao et al. (2010), using structural equation modelling (SEM). According to Preacher and Hayes (2004) it is preferable to use SEM for assessing mediation because it offers a reasonable way to control for measurement error as well as some interesting alternative ways to explore the mediating effect.

Lastly, in the third stage we perform a multigroup analysis to test the existence of diverse behavioural paths due to the type of contract (fixed-term or permanent). This method is appropriate for testing whether both the factor structure and the factor loadings are invariant.

RESULTS

Psychometric features of the students' satisfaction construct

A confirmatory factor analysis (CFA) was conducted with the three items of the "organization and planning" dimension and another CFA with the six items that measure "implementation and interaction". CFAs were estimated by using the robust maximum likelihood method from the asymptotic variance—covariance matrix. Each CFA extracted only one factor, confirming the unidimensionality of both dimensions.

Validity of individual items were confirmed (0.781 - 0.963). The internal consistency of the two dimensions was analysed through the alpha of Cronbach and the composite reliability. Additionally, the convergent validity was probed with the average variance extracted (AVE) and with the high robustness of the loads, all significant at 0.05 level (see Table 4).

	Organisation and planning				Implementation and interaction			
	item	standardized load	t-value	r²	item	standardized load	t-value	r²
	P1	0.890	-	0.792	P4	0.949	-	0.900
	P2	0.908	14.854	0.824	P5	0.924	22.408	0.853
	Р3	0.900	14.205	0.810	P6	0.963	39.599	0.927
					P7	0,955	26.583	0.912
					P8	0,906	18.893	0.821
					P9	0.781	9.071	0.609
Alpha Cronbach	0.922			0.968				
CR	0.927			0.969				
AVE	0.809			0.837				
Fit indices	Identified model			Satorra-Bentler scaled χ ² = 31.58 (9 freedom degrees) p-value = 0.00024 Comparative Fit Index (CFI) = 0.944 RMSEA = 0.105				

CR: Composite Reliability

AVE: Average Variance Extracted

Table 4 – Loads of the two CFA and statistics for the reliability analysis.

Next step consisted in the analysis of a third CFA to assess the "student satisfaction" construct as a whole, that is, including the two aforementioned dimensions together with a third dimension composed by only one item that accounts for the "results" (item 10). The Satorra-Bentler scaled $\chi^2=81.80$ with 33 degrees of freedom (p-value = 0.00001), alongside with a CFI of 0.935 and a root mean-square error of approximation (RMSEA) = 0.081 vouched for the fit of the data.

It is worth mentioning that the correlations among the three dimensions are rather high, arising some concerns about the discriminant power of the three concepts. Nevertheless, we rely on these dimensions as their design is supported by the literature and because of the fit of the model which has been proved to be appropriate.

Factors shaping student satisfaction

In order to analyse differences in the distribution of the dimensions of the student satisfaction construct, four non-parametric tests were conducted. Results are displayed in Table 5, revealing that there are some factors, namely knowledge field and internal teaching assessment that point to significant differences. As for the former, the best results are achieved in the fields of health sciences (average value: 4.2864) and architecture (average value: 4.1430). Further studies should examine the use of different teaching methods to better understand these differences. Concerning the internal teaching assessment, results confirm that those lecturers that obtained a higher score in this internal assessment procedure are also obtaining better results in terms of students' satisfaction records. No differences are found by study level or gender.

Non-parametric test for independent samples	Categories comparison	Test for independent samples	Dimension	Significance	Result	
_	Women, Men	Mann-	Planning	0.896	No difference	
Gender		Whitney U	Interaction	0.814		
		test	Results	0.734		
Knowledge field	Architecture, Health Sciences, Social and Law Sciences, Humanities	Kruskall- Wallis test	Planning	0.001	Significant differences	
			Interaction	0.003		
			Results	0.024		
Study level	Master, undergraduate	Mann-	Planning	0.202	No difference	
		Whitney U	Interaction	0.191		
		test	Results	0.483		
Internal teaching assessment	Improvement is required, favourable, very favourable	Kruskall- Wallis test	Planning	0.003	0	
			Interaction	0.015	Significant differences	
			Results	0.019		

Table 5 – Results of the tests performed in order to determine if the different variables have the same distribution among their categories.

Mediating effect of research intensity

In order to proceed with the analysis of the mediating effect, two SEM were conducted one for each of the models illustrated in Figure 1. Results are presented in Table 6.

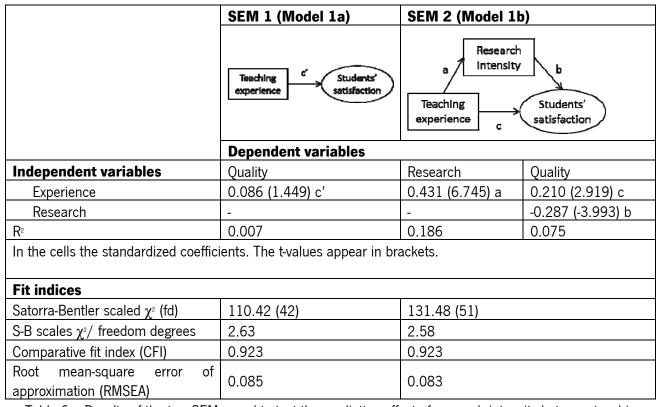


Table 6 – Results of the two SEMs used to test the mediating effect of research intensity between teaching experience and student satisfaction.

By using a row of three regression analysis, Baron and Kenny (1986) established that three conditions must hold in order to establish mediation. Similar to Preacher and Hayes (2004) we express these conditions in terms of SEM as follows. Note that only two SEMs are needed: one for the total effect (c') and a second SEM for simultaneously assessing the direct effect (c) and the indirect effect (a*b). The first condition is that the independent variable (teaching experience) has to significantly predict the mediator (research intensity) in Model 1b (i.e., a \neq 0, Table 6). The second requirement states that the independent variable (teaching experience) must predict the dependent variable (students' satisfaction) in Model 1a (i.e., c' \neq 0, Table 6). Lastly, the third condition is that the mediator (research intensity) must significantly predict the dependent variable (students' satisfaction) (i.e., b \neq 0, Table 6) controlling for the independent variable (i.e., c \neq 0, Table 6) in Model 1b.

For the purpose of our study, the second condition is not satisfied since the coefficient is not significant (t-value = 1.449). However, Zhao et al., (2010) argue that this condition is not necessary. These authors demonstrate that there is only one requirement to establish mediation: the indirect effect a^*b should be significant. Preacher and Hayes (2004) also provide methodology for this case, based on the work of Sobel (1982). Relying on the empirical demonstrations provided by these authors we thus proceed with the analysis, and observe that the critical ratio for the indirect effect is t = -3.412, confirming the significance of the indirect effect and vouching for the subsequent analysis.

Based on the typologies of mediation characterised by Zhao et al. (2010), our case responds to that of a competitive mediation, as it accomplishes the following three conditions: (i) a*b is significant, (ii) c is significant, and (iii) a*b*c is not positive. Thus, both the mediating effect (a*b) and the direct effect (c) exist, however, they point to different directions. Particularly, the total effect of teaching experience on students' satisfaction (c' = 0.086, not significant) is explained through the direct effect (c = 0.210) and the indirect effect (a*b = -0.124). Both effects are statistically significant, therefore, giving support to hypothesis 1. This translates into saying that, as expected, teaching experience positively impacts students' satisfaction, reinforcing the argument that seniority gives lecturers the skills and techniques that allow them to better communicate and interact with students, resulting in higher satisfaction rates from students. In addition, our results confirm that seniority also leads to increased levels of research intensity, which negatively impact on students' satisfaction. There is therefore empirical evidence that research intensity mediates the relationship between teaching experience and students' satisfaction, validating hypothesis 2.

These findings bring to light a genuine dilemma for university managers. On the one hand, the reputation of a university is highly tied to research achievements, which are key determinants for obtaining a good positioning in popular rankings. Likewise, evaluation processes conducted by governmental bodies to validate the academic offer of universities (i.e. undergraduate, postgraduate, master and doctoral level) also mainly rely in the quality and quantity of the research outputs of the academic staff. In addition, the academic career and internal promotion policies are also research-biased. All in all, this situation brings research activities to the spotlight. Research is highly instilled by the university and the future of the university is subject to research. However, on the other hand, private universities (such as the case under analysis) need to stand out for the quality of their teaching, as for the most part, incomes come from students' tuition fees.

Testing the influence of contract type

A multigroup analysis of Model 1b to test invariance between the two categories of labour contract type (fixed-term and permanent) is performed. The sample of academics with a temporary contract is of 123 and 106 for those enjoying of a permanent relationship with the university. The model is estimated using the robust maximum likelihood method from the asymptotic variance—covariance matrix. Five constraints were established accounting for the invariance of the structural paths of the model. It is important to remark that the parameter between the "organisation and planning" dimension and the second order factor of the

students' satisfaction construct is fixed to a constant in order to fix the scale; consequently, it cannot be imposed as a restriction.

The fit indices are satisfactory: χ^2 Satorra-Bentler was 205.92, with 107 degrees of freedom, χ^2 /df was 1.92, which was below the acceptable limit of 5, RMSEA was 0.090 and the CFI was 0.913. To locate parameters that are non-invariant across groups, we looked for probability values associated with the incremental univariate χ^2 values that are < 0.05. A review of these values reveals that all parameters operate equivalently across fixed-term and permanent staff, excepting the parameter that links the research intensity with students' satisfaction. Table 7 reports both the standardized and non-standardized paths. The non-standardized have been constrained to be equal.

	Standardized Paths		Non	Univariate increment	
	Functional subsample	Organic subsample	standardized paths (t-value)	χ^2	Probability
Research intensity → Students' satisfaction	-0.181	-0.354	-0.089 (-3.927)*	4.620	0.032
Teaching experience → Teaching quality	-0.011	-0.022	-0.002 (-0.294)	1.556	0.212
Teaching experience → Research intensity	-0.042	-0.043	-0.019 (-0.978)	1.465	0.226
Students' satisfaction → Results	0.942	0.895	1.163 (16.903)*	0.547	0.460
Students' satisfaction → Implementation and interaction	0.993	1.000	1.214 (15.098)*	0.010	0.919

^(*) Significant at 5% level

Table 7 – Paths for each group in the multigroup analysis and univariate increment analysis

Hypothesis 3 is partially accepted as the only difference between fixed-term and permanent staff is the path between research intensity and students' satisfaction. This path is statistically significant and more negative for permanent staff. This result suggests that apparently, academics that have reached a high level of research activity are however abandoning their teaching responsibilities. Several are the factors that might explain this behaviour. First, the higher the research level an academic attain, the higher the likelihood to get involved in more demanding research projects. Second, reaching a permanent position in the university entails less uncertainty and thus, job security, leading to a potential "relaxation" situation. This statement particularly holds in terms of teaching tasks. As academics consolidate their careers, promotion to superior positions are mainly determined by research achievements, providing a clear inducement for lecturers to render careless to teaching in favour of research. Incentives for conducting high quality teaching are only subject to the willingness of the lecturer to improve his/her teaching skills.

DISCUSSION

Herein we have analysed the relationship between teaching experience and students' satisfaction and the mediation effect of research intensity. However, we note the explanatory power of the model is moderated,

attending to the r² of the dependent variables. Based on our results, we can conclude that, for the sample considered, the research effort is strongly "competing" with teaching commitment. From the standpoint of a university that strives to survive in a competitive and global environment, the research mission is essential. Therefore, the production of high quality research outcomes is a clear objective in its strategic planning. Nevertheless, from the students' lens, high quality teaching is paramount to ensure a positive word-of-mouth and generate brand awareness. As tuition fees are important for sustain the economic viability of private universities, the teaching mission is another objective that needs to be accomplished. How to appropriately balance teaching and research is still the key of success. Unfortunately there is no magic recipe for how to do it.

In terms of policy implications, we argue that promotion incentives are central to the teaching/research nexus debate. It is well documented that research has outranked teaching in the university's faculty reward system (Parker, 2008). Indeed, reward structures (including tenure, promotion and faculty salaries) are clearly favouring research activities over teaching ones (Fairweather, 2005). Many academics attributed this to the impact of university rankings which had prompted universities to accentuate the importance of research (Taylor, 2007). Additionally, research outcomes are much easier to be quantified and compared than teaching ones.

Incentives are clearly affected by the career stage of the lecturer (Baldwin et al., 2005). Academics in a weaker contractual position would have stronger incentives to conduct research in order to create reputational signals that are expected to increase their probability to be appointed by universities. To the contrary, full professors have less exogenous incentives to make visible their research, being their only motivation endogenously determined by their own interest in strengthening their curriculum vitae. Moreover, when looking at the specific weight that promotion assessments give to the teaching dimension of academic quality, we can observe that it tends to be underscored. Indeed, maintaining a minimum standard in student satisfaction surveys is enough. Consequently, instructors that are in their initial stages would not have such a strong incentive to deliver good lectures as they do have for conducting quality research.

All in all, this situation leads us to conclude that current accreditation systems are not obtaining the expected results in terms of teaching quality. While teaching and research activities should be complementing and enriching each other, empirical evidence suggests that students perceive disadvantages from staff involvement in research activities. In this respect, previous studies indicate that those academics whose research efforts are in areas strongly related with their teaching may be favoured in comparison to their counterparts who can more difficultly incorporate knowledge into their classroom practice (Shin, 2011). In view of that, we argue that more emphasis should be put in trying to align teaching workload with research interests of lecturers. We acknowledge that in some disciplines and depending on the academic offer of the university this task might not be an easy one. Nevertheless, given the pressure to which academics are subjected to, it seems reasonable to try to facilitate their tasks by narrowing the gap between teaching duties and research interests. This way, it would be possible to obtain economies of scale, so that the efforts spent performing teaching activities are also useful in terms of research, and vice versa.

Concluding remarks

Universities are expected to be centres for high quality education and hubs of research and innovation. Therefore, examining how students' satisfaction is shaped by the profile of the lecturer (teaching or research-oriented) is of great interest. In view of that, this paper contributes to the existing literature that investigates the trade-offs between teaching and research activities, responding to the call of previous studies to in-depth in this particular matter. Particularly, our study examines the relationship between teaching experience and students' satisfaction, and the mediating effect of research intensity in this association. In addition, we explore the potential dissimilarities in this relationship due to academic status (permanent staff and non-permanent staff).

High quality teaching and high levels of research intensity are both desirable outcomes. For sure, universities would like their lecturers to excel in both dimensions, nevertheless, very little is known about how to effectively accomplish with this ideal. We encourage future studies to examine which mechanisms or incentives schemes could be articulated in order to motivate lecturers to equally engage in both teaching and research activities.

Probably the main limitation of this study relates to the specific analysis of a Catalan private university and the reduced sample considered. Future studies should be conducted with bigger samples and in other universities with a similar regulatory framework. Another limitation deals with the measures selected to capture teaching experience and research intensity. Although it was possible to create valid and reliable measures that consider viewpoints from different stakeholders, university quality is a broad term that, while in theoretical models seems to be relatively easy to be measured, its practical operationalization is constrained by the feasibility of obtaining appropriate data.

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The prioritization of Attributes - A New Perspective on the RBV

Migowski, S.A.¹⁾, Teixeira, R.²⁾, Libânio, C.S.³⁾, Migowski, E.R.⁴⁾ and Duarte, F.D.⁵⁾

¹⁾ IFRS and Unisinos

2) Unisinos

3 UFCSPA and PPGEP/UFRGS

4) Fadergs

5) Fundação Saint Pastous

ABSTRACT

Purpose – The purpose of this essay is to contribute to a debate on the VRIO Model, based on the Resource Based View, suggesting that the model is applicable only empirically if a prioritization of the Organization attribute about the others is performed.

Methodology – To this end, the reformulation of formal and informal systems of management control, with greater flexibility and autonomy for middle managers and other professionals operating sectors, is proposed.

Findings – Through the implementation of the concept of Business Units, it is possible to decentralize decision-making and to change processes, creating more efficiency and quality in the products/services produced, which results in higher added value. As this step takes time and is derived from the involvement of several actors, there is the causal ambiguity and path dependence as generating factors of the attributes rarity and imitability.

Research implications — This study argues that in order to implement these changes, the development of the constructs leadership, trust, and quality is required, especially in the context of intermediate managers, actors who are no longer mere passive executors of strategies, taking the protagonists' position. Finally, a conceptual framework is proposed, besides some premises for future research.

Keywords: VRIO Model, Strategy, Business Units.

Paper type: Conceptual paper (e.g.)

INTRODUCTION

For the Resource Based View (RBV), an organization is only able to obtain an above-average performance relative to its competitors if it is able to protect and better use certain features, classified as tangible and intangible (Hansen and Wernerfelt, 1989). Both tangible (raw materials, equipment, physical structure) and intangible resources (knowledge, relationships, communication) therefore play an important role in creating value and achieving a superior performance (Collis and Montgomery, 1995). Therefore, since not all features are equally important for building competitive advantages, the success of an organization resides in generating conditions that allow their identification, thus creating a favorable environment for their maintenance and development, so that their potential competitors were unable to copy them (Barney, 1991).

Barney (1991) considers that the company should have attributes that give it sustainability over-time: the value of the resource, rarity (amount of actors able to hold such resources), low grade of imitability, and low risk that competitors are able to use similar resources that would enable the generation of similar (non-replaceable) strategies. These attributes were known by the acronym VRIO, relating the value with the possibility of the organization to adopt strategies that would generate gains in efficiency and effectiveness of their operations.

The author added to this theoretical perspective the emphasis on the importance of path dependence and causal ambiguity as factors that hindered the imitability. While the first is linked to the organizational values, the improvement of routines, and the development of innovations over time by a company, enabling the knowledge to be passed to collective dominance, the causal ambiguity hinders that competitors understand the reasons leading to the generation of those competitive advantages. It could be one or more factors acting alone or the result of their combination in proportions that only the learning generated by the practice would enable to know (Barney, 1991).

Later, Barney and Hesterly (2007) replaced the "N" by the "O" of organization, thus showing its importance for obtaining competitive advantage, and included substitutability on imitability (VRIO). This study emphasizes the importance of the organization to be prone to changes, when the path dependency, the structure, and the difficulties to replicate and to imitate are addressed. In this attribute, resources such as hierarchical composition, formal and informal systems of management control and its remuneration policies would be limited if used alone, but when combined with other resources they could generate a sustainable competitive advantage (SCA). Recent studies have attempted to validate the VRIO Model (Lin et al., 2012; Bresser and Powalla, 2012; Knott, 2015; Cantrell et al., 2015) and will be presented in the forthcoming section.

This entire process in an organization, however, is not simple and depends on the decision-making, drawing on the different knowledge of its members and internal routines, in order to allow them to make strategic decisions that could choose the right resources, in order to generate a competitive differential. Therefore, assuming that the knowledge needed for decision-making is tacit (Polanyi, 1958), it must create ways to articulate the various individual tacit knowledge in order to create conditions for better use of these internal resources.

Therefore, this essay argues that the Organization attribute, which is the formal and informal systems of management control, plays a key role to the best use of scarce, valuable, and difficult to imitate resources. These are management systems that define, by means of the decision-making, which features will be selected and used. This view, however, is contrary to many studies defining other attributes as SCA generators.

The studies of Hsu and Ziedonis (2013), King (2007), King and Zeithaml (2001), and Mosakowski (1997) stated that the attribute imitability is the main contribution of RBV since the

difficulty in mimicking enables obtaining isolation mechanisms in relation to other authors. Foss and Knudsen (2003) highlighted that the immobility associated with the uncertainty are the determining attributes. Bromiley and Rao (2014) proposed that the formulation and implementation of routines are, in fact, SCA generators. Shafee and Trott (2014), among many other considerations, suggested that the VRIO Model is too generic and applicable to any context. Armstrong and Shimizu (2007) and Newbert (2007) were even more critical to the model. They pointed the small number of empirical papers as a sign of weakness of the applicability of the VRIO model and suggested that the reason for this is that other attributes to generate SCA are necessary.

Besides these criticisms, several others were prepared on the applicability of the model since it does not indicate which resources should be transformed to generate competitive advantages (Priem and Butler, 2001; Connor, 2002; Miller, 2003) or did not point to the causal relationship (Foss and Knudsen, 2003). The dynamic capabilities also came along addressing the adaptive capacity of the firm to face the environmental dynamism (Teece et al., 1997), but criticism to this view soon were shown. Eisenhardt and Martin (2000) and Zahra, Sapienza and Davidsson (2006) agreed that it is necessary to pay attention to environmental changes, but criticized the work of authors, because they did not explained how the resources should be reconfigured and integrated to generate competitive advantages.

This paper disagrees with the criticism of the VRIO Model and argues that the attributes of this model remain valid, but agree that the way it was exposed does not help their applicability. Therefore, this paper proposes the prioritization of the attribute Organization in relation to the others that are also important, but will only be incorporated into the organization if it has created environmental conditions for this. Through a prior change in formal and informal management systems with the introduction of the concept of business units, it would be possible to obtain and combine other attributes of the VRIO Model needed to build competitive advantages.

For this to occur, greater efficiency in internal processes must be sought, while developing the managerial skills of the various professionals involved, through a reformulation of formal and informal systems management. By granting autonomy to the various operational sectors through the management style change, the environment of trust and cooperation among members of a team is expanded, reflecting on the concept that quality must be defended by all. To this end, they are able to make the appropriate decisions for choosing strategic resources, which means working with management indicators to assist in the review and shared creation of various internal processes and processes common to other sectors.

When seeking joint solutions to the existing bottlenecks, there is greater agility in solving problems, feeling of belonging of the participants, and their ability to contribute with strategic actions that help achieving the targets goals in the institutional strategic planning, which would include the ability to replicate the model even in high consolidation environments (fusions and acquisitions), as those that have occurred in recent years (Ovtcinnikov, 2013; Bauer and Matzler, 2014). Through the attribute organization, a solid foundation is built, so that constructs such as leadership, quality, and trust become sources of lasting competitive advantages, reflecting on the alignment of work processes, retention, and sharing of specialized knowledge and efficient cost management. By emphasizing the attribute Organization, consequently, the other attributes of the VRIO model arise, allowing the generation of SCA.

To assist in understanding this problem, this paper aims to achieve the following objectives: a) conduct a literature review, to support the construction of a conceptual framework; b) prepare the conceptual framework, so that it is possible to understand the reflections generated when the organizations promote changes in their management control systems; and c) to propose assumptions that serve as the basis for future discussions.

The construction of the theoretical framework involved a systematic review using the keywords 'Resource-Based View;' 'Resource-Based Theory; and 'Resource-based' in Business Source Premier (EBSCO Publishing) and the keyword 'VRIO' in the Capes portal. Here, the period chosen included 2010 to 2015, generating a total of 53 papers. To reduce the search scope, only those that contained the keyword 'VRIO' in the abstract and were published since 2012 were used, thus leaving then 4 articles. In the EBSCO portal, with the keyword 'Resource-Based Theory' for the period of January 2002 to December 2015, 265 articles were found and have been reduced to 191 articles, after duplications were identified. The keyword 'Resource-Based View' generated 429 articles, while the keyword 'Resource-based' generated 623 articles. Because of the high number of papers, the reading was restricted to only those that contained the keywords in the abstract and were published between 2013 and 2015, thus resulting in 26 articles.

The present essay is structured in ten sections. Starting with this first introductory section, the second section presents the theoretical perspective of the Resource-Based View. The next sections address the constructs leadership, trust, and quality. The following section presents the importance of reviewing processes to obtain the best results, followed by the section presenting the concepts of business units. After the theoretical discussion, a suggestion of a conceptual framework that is capable of assisting in the academic discussion on the prioritization of the attribute Organization in the VRIO Model. Finally, the main considerations of the essay as a whole, in addition to the assumptions that will be used for future studies are presented. In the last section, the references used in the study and preparation of this paper are indicated.

THEORETICAL DISCUSSION

Resource-based View (RBV)

The economic changes, with greater emphasis from the 1980s, brought a discussion about whether the strategies would be linked more strongly to external factors; in this case, the industry in which it was inserted, or if the internal resources would have greater relevance. The RBV perspective led to a discussion about the Porterian vision, when considering that it treated the companies of the same sector evenly and with extensive mobility of resources.

For those who defended RBV as theoretical support, the organization's performance would be linked to the allocation of accumulated or acquired resources and to the way they would be combined. The performance would determine the competitive advantages that cause the differences between organizations (Foss, 1997; Barney, 1991; Prahalad and Hamel, 1990). Wernerfelt (1984) proposed that a competitive advantage should be durable over time and capable of generating entry barriers for competitors because of resource mobilization and the profitability generated compared to their competitors. Barney (1991), citing the Schumpeterian shocks, stressed that having a competitive advantage does not mean that it would last forever since other companies could imitate it. In addition, when facing such shocks, which can be a competitive advantage in a context, it could fail to be so in another.

In the early 1990s, in other authors' publications (Grant, 1991; Collis and Montgomery, 1995), the RBV establishes itself as an analytical approach to the strategy capable of generating competitive advantage, making it up as the coordination of internal resources as a mean to face external threats. This approach allowed for a greater interface between the rational economic and the behavioral view.

The ability to organize routines was recognized by Grant (1991) as a coordination of complex patterns between people and resources, in which knowledge plays a key role. For these features to have a recognized value as skills, they should, as Barney (1991) and Porter (1986), combine scarcity (or

rarity) and appropriateness and own demand. At the intersection of these factors, there would be value creation, which is essential for a resource to be recognized as an ability.

The analysis based on internal resources could be synthesized via two generalizations made by Foss (1997):

- 1) there are asymmetric differences between the companies because of the control of the necessary resources to implement strategies; and
- 2) these differences are relatively stable.

Therefore, companies have different levels of efficiency due to the skills and positioning adopted on the market (Collis and Montgomery, 1995; Peteraf, 1997). Thus, the strategy starts to focus on those resources capable of generating competitive advantage, even if based on scale economies, patents, brand reputation, or experience curve. It would also be up to the organization to guide its efforts to acquire resources, whose combinations would result in entry barriers for other competitors (Grant, 1991).

Thus, the sustainability of the competitive advantages would be linked to the organizational experience and the implementation of routines, which would make the operational activities more efficient due to the accumulated knowledge and experimentation (Collis and Montgomery, 1995; Grant, 1991). From the perspective of Collis and Montgomery (1995), organizational capabilities built over time would be resources or intangible assets incorporated to the routines, processes and culture, able to generate a competitive advantage. As they cannot be patented and, in general, be implied, such intangible assets should be incorporated by the companies, in order to not suffer disruption in their activities (Sveiby, 1997).

For the internalization of such assets to have an effect, the decision-making must be decentralized. Wernerfelt (2013), when revisiting his earlier articles, stated that decentralization reduces transaction costs, helping also the interorganizational negotiations, for various ranks would have access to that information, which is usually held only by some members of the high rank. A similar analysis was made by Schmidt and Kel (2013), who argued that the experience of managers coupled with the knowledge they possess are critical to identifying resources able to generate SCA resources. The next section will present studies on various sectors that used the RBV as a theoretical perspective, followed by the subsection whose studies are critical to the VRIO Model.

Some studies in light of RBV

Several knowledge fields have used the theoretical perspective of the Resource-Based View in their studies. Alkhatib et al. (2015) analyzed the logistics from the RBV perspective, to identify which tangible and intangible resources would provide the best performance. The authors identified human resources as the most important factor, as they related to all other resources. The performance limitations of these were directly linked to the qualification of the individuals involved in the processes.

Similar results were obtained by Verbeke and Yuan (2013) in a study of inter-organizational relationships. Sixty-six subsidiaries of Canadian companies based in China were analyzed. The human resources directly influence the ability of these organizations to engage in highly dynamic environments.

Lin et al. (2012) assessed through VRIO model the internal activities of the largest chemical company in Taiwan with subsidiaries around the world. The authors concluded that the application of the model allowed understanding which resources were able to contribute to the creation of value and enabled to identify which organizational capabilities needed an intervention for improvement. Following the model, they managed to compare the organization with its main competitors.

Bresser and Powalla (2012) compared the VRIO Model with two decision-making tools for the acquisition of shares in a hypothetical scenario, but true their reality. They were surprised with the results, highlighting the effectiveness of analyzes based on it, especially in dynamic and volatile environments, such as the stock market.

Knott (2015), also using experimental analysis, had the help of two groups of participants (27 and 36 subjects), with market experience oscillating between 10 and 15 years. The participants applied the VRIO Model into the analysis of various business and stated that the model helped to identify resources that influenced not only the organization itself but also its competitors.

Cantrel, Kyriazis and Noble (2015) attempted to understand the behavior of large corporations in relation to donations to charity and, therefore, analyzed the 23 largest corporations are located in Australia, using the VRIO Model. During their analysis, they identified that reputation was the resource that would encourage them the most to donate, since not only its relations with other organizations were improved, but had highly positive effects on its employees.

Wu and Hu (2012) analyzed internal resources in 144 hospitals in Taiwan in 2008, seeking the relationship between the assets related to knowledge and the development of specific skills. They concluded that there is a significant interaction between them since the knowledge that is held by each individual involved in internal processes is improved, as new processes were performed (e.g., doctors and nurses already enter the hospitals with prior knowledge, but each treatment performed generates new knowledge). This virtuous cycle, in turn, has been reflected on the financial performance of the hospital.

Zigan (2013), in a study of three hospitals in Germany in 2012, found a great link between the financial situation of these hospitals and their intangible resources (intra- and inter-organizational relationships and internal processes). Since they operated in a highly regulated market, which gave little flexibility to the overall management, it was up to the performance of the human resource management of those hospitals to facilitate the recognition of their teams, increasing their job satisfaction and the alignment of the various work processes between the sectors involved. As a result, there was a better use of internal resources, thus affecting the financial performance of the hospital.

The same occurred in the results on knowledge sharing (Wu and Hu, 2012), in innovation capacity (Su et al., 2009), or alignment of internal processes (Zigan, 2013). Without a reformulation of formal systems of management control, creativity was not encouraged and people felt insecure in sharing any knowledge (Kaasa and Vadi, 2010).

These studies align with others about the construction of the construct Quality. As the pursuit of quality cannot be restricted to an individual, but permeated throughout the organization (Slack et al., 2009; Deming, 1990), it is necessary that all stakeholders participate in its construction and maintenance, which means sharing knowledge, training those involved, and changing the hierarchical structure. Therefore, they are coalitions of individuals and groups and their degree of dominance that will determine the direction of the decisions made (Mintzberg et al., 2004; Provan, 1991). This group of individuals presents the responsibility to identify and solve problems and the strength of their union will determine their degree of influence on the organization (Miles and Snow, 1978).

Counterpoints to the VRIO Model

In an interesting analysis of strategic positioning, with a sample of 11,577 customers of hypermarkets, electronics stores and department stores in major Chinese cities, Siebers, Zhang, and Li (2013) identified different retail formats using similar positioning strategies. These strategies

contributed evenly to the good performance of all formats, which contradicts the imitability as one of the key attributes for the creation of SCA.

Moreover, Hsu and Ziedonis (2013) pointed to imitability as the main attribute capable of producing SCA. They conducted a study with 370 startups of the semiconductor sector and elected the patent as the main competitive strategy of these organizations.

Another study that contradicts the VRIO Model is of Weigelt (2013). The author concluded that the siting of an outsourced service of Information Technology (IT), together with the absorption capacity of the knowledge generated was able to produce SCA. This contradicts one of the RBV bases that argue that the best use of internal resources is the one that can develop such advantages. Students of RBV understand that, being an outsourced firm, any competitor could have access to their knowledge. Thus, they ignore that the expertise held by a third party, when spread on the contracting organization, can become a source of SCA. As the contracting organizations have distinct characteristics, access to knowledge from a third party would not generate the same benefits. In addition, for this interrelationship to generate SCA, it is necessary that the occupants of the management positions are able to identify which resources should be internalized and which is the best way to deploy them (Weigelt, 2013).

Foss and Knudsen (2003) stated that, as the discussions about the RBV have occurred, its limitations started to appear. Therefore, they proposed that the immobility associated with the uncertainty were the determining attributes for obtaining SCA and any other attribute only added to them. Immobility can be obtained from the possession of valuable resources and properties of the organization while the uncertainty, like Barney (1991), seek to enable resources to be differentiated and difficult to be imitated.

For Foss and Knudsen (2003), two consolidated organizations can develop similar learning curves, causing them to adopt similar strategies being unable therefore to generate SCA. They also criticized the VRIN Model proposed by Barney (1991) for not clarifying how these attributes interact to obtain SCA. Their criticism aimed, in particular, at the absence of a causal structure that would enable the attribute model to generate SCA.

Bromiley and Rao (2014) suggested that obtaining SCA lies mainly in formulating and implementing routines, which once they are combined end up by generating such advantages. Thus, they proposed the PBV (Practice-based View) as a theoretical perspective able to offer in a more prescriptive way a model to achieve SCA.

For the studies presented in this section, the VRIO Model remains in the field of thoughts without their applicability actually occurring in real-world organizations. Some of them show even different attributes from those in the proposed model. This essay, on the other hand, argues that the attributes of the VRIO Model are correct, but, as in other studies (Foss and Knudsen, 2003; Armstrong and Shimizu, 2007; Newbert, 2007), believes that the absence of a causal relationship makes its application difficult.

To make this possible, it is suggested to prioritize the attribute Organization, leading to the improvement of internal processes through reformulating formal and informal management structures, in order to obtain improved organizational performance (Kaasa and Vadi, 2010; Wu and Hu, 2012; Zigan, 2013). For this reformulation to be successful, it is necessary that organizations realize the validity of some constructs: leadership, trust, and quality.

Leadership

In times of little change and environmental stability, management models based on the authority established by the hierarchical structure were sufficient to lead the organizations. These models, however, no longer find a place on the search for competitiveness (Bennis and Nanus, 1988). The pursuit for sustainability requires leaders with extraordinary abilities, in order to be able to act as interpreters of a complex environment and as mediators within an organization (Metcalf and Benn, 2013).

The leader must stimulate innovation by influencing the behavior of other individuals (Hersey and Blanchard, 1986), creating an environment involving people in the development of new experiences (Kets de Vries, 1997). Influencing others means also encouraging them to make voluntary decisions to assist in improving performance because often the leader cannot be omnipresent, controlling and monitoring, when the only alternative left is trusting their subordinates (Tichy and Cohen, 1999).

Leadership has now a new connotation: it is about making something for others (Tichy and Cohen, 1999), no longer a contest of strength to be based on in a respectful and energizing relationship between leaders and followers (Burns, 1978). For some authors (Gemmil and Oakley, 1992; Barker, 2001), leadership is a social process of dynamic collaboration, in which individuals allow each other to interact, while experiencing new forms of social and intellectual significance, assuming different styles, according to the context in which they are inserted.

The division of responsibilities within a team extends the commitment and enhances the trust between the members. However, it should be noted that communication, coordination, and simplification of the management structure under the command of a formal leader is vital to the relationship of these individuals (Huesch, 2013).

The environment created by the leadership style determines how team members interact with each other and can stimulate cooperation and genuine motivation (Hunter et al., 2013; Jaramillo et al., 2015). Moreover, information sharing between the leader and the led is vital to achieving superior performance (Lam and Huang, 2015).

The effectiveness of leadership is associated with three contingency or situational dimensions (Northouse, 2004):

- a) the degree of trust in the relationship between leader and led the respectful relations of the leader towards the other team members tend to influence the actions of these individuals;
- b) task structure the detailing of the task helps in understanding the importance and its effective implementation; and
- c) the position of the leader the higher the formal power of this leader is, the greater the likelihood of being effective is.

For this process to occur, an environment of trust must be created for the promotion of welfare, honesty, and commitment (Rogers, 1995), without incurring excessive workload (Ulrich, 1998).

Trust

The construct Trust used in this study is not the one used in economic relationships when seeking to control another's behavior in the expectation of reciprocal gains (Williams, 2005). Such a concept would serve only to economic transactions, which does not enable the existence of cooperation among individuals in an organization (Kramer, 1999).

The concept of trust used here is the one reducing social complexity, providing greater security in the decisions, even when there is little information available (Luhmann, 1979). Organizations tend to be more efficient, and cooperation occurs spontaneously when there are shared ethical values and the prior moral consensus serves as a basis of mutual trust of individuals, without the need for contracts or legal action (Fukuyama, 1996). The Toyota Production System, for example, is entirely dependent on the high degree of trust between the members of the organization because of the flexibility and autonomy granted to them (Shimokawa and Fujimoto, 2010).

Trust in organizations tends to flow from the upper to the lower ranks. Clues, signs, and symbols displayed by the members of the upper ranks are disseminated throughout the organization and will determine the development of trust among stakeholders. Moreover, if it is observed that such principles are based on mere exploration of other people's knowledge, the opposite will occur (Davenport and Prusak, 1998).

Thus, trust results from intensity, which means that the action should be a fair translation of what is said (Drucker, 1997). Communication, therefore, plays an important role because the information and the organizational values must be disseminated with great clarity and truthfulness (Drucker, 1996); otherwise, the other team members are unable to act within the expected ethical limits (Lehman and Dufrene, 1999).

Trust can thus be defined as a relationship between two or more parts and in which there is a mutual expectation to fulfill what was agreed, without the presence of opportunism (Novelli, 2004). Naturally, the time of the relationship will help to build a reliable look from one part to the other (Giddens, 1991), which means increasing their vulnerability based on the signed commitments (Hacker and Willard, 2002).

Trust was the study topic of Holste and Fields (2010), who found that trust based on affection has more influence on knowledge sharing than trust based on cognition. Trust based on affection allows the individual to worry and wish well to each other, waiting for reciprocity. And quality relationships tend to generate a positive impact in the workplace, enabling the achievement of desired results (Leana and Buren III, 1999) that can be translated into increased productivity, quality and reduction of output intentions of the members of the organization (Jones et al., 2009).

Quality

In the dictionary *Aurélio* (Ferreira, 1999), quality comes from the word in Latin *qualitate*, which means the feature that characterizes a person or a thing and distinguishes it from the others. The discussion on quality is not new. Juran and Gryna (1991) defined it as *fitness for use*, while Garvin (1987, 1992) adopted eight dimensions when attempted to define it: performance, characteristics, reliability, compliance, durability, service, aesthetics, and perceived quality, emphasizing that a product or service can only be well recognized in only one of the dimensions.

Crosby (1994) defined it as a compliance with the requirements; Oakland (1994) stated that the notion of quality depends on the individual perception. Deming (1990) understands quality as a continuous meeting to the needs and expectations of customers and at a price they are willing to pay. For Slack, Chambers, and Johnston (2009), the quality improvement strongly influences the result of the organization, acting in the performance of production and increasing profits by increasing revenues.

Regarding the quality related with products or services, Bateson and Hoffman (2001) highlighted the difficulty in defining a pure product or pure service. According to the authors, there is an overlapping between them: there is no product without product, and vice-versa. Regarding satisfaction

mechanisms in providing a product or service, Oliver (1999) considered that there is no distinction between them, but stressed that during service delivery, human interaction between the client and the professional involved determines the perception of the first. Therefore, it is a short-term emotional reaction before a specific service experience (Lovelock and Wright, 2003).

Iztok (2011) points out that the quality in the service sector is determined by customers' subjective assumptions, according to their previous personal experiences and own perception. Thus, the quality of service ends up constituting a major form of differentiation from competitors (Kotler, 2001) and it is the perception of quality for the customers that will take them to make purchase decisions (Churchil and Peter, 2005). Therefore, understanding which situations and behaviors can lead to customer satisfaction or dissatisfaction is paramount. In general, they are more easily identified by the professionals who are on the front line (Bitner et al., 2001).

The health sector, for example, despite its specificity, represents the service sector and has seen a substantial growth in quality programs because of the rising costs of hospital care. Several features are similar to other services, but there are others that are specific to that segment (Gurgel Júnior and Vieira, 2002):

- a) market laws do not overlap to human needs, which impacts on production costs since they cannot stop using a drug in a treatment, for example, due to its high cost;
- b) competition is not a strong element, given it is segment that is chronically absent in several countries;
- c) the healing needs vary from patient to patient, making it difficult to standardize care processes;
- d) there is no symmetry of information because customers are generally lay and unable to judge their treatment, and they cannot always choose a provider due to a lack of another option on a given location;
- e) the service consumption is immediate, preventing that there is quality control or stock for inspection;
- f) the production of the service is performed by a multidisciplinary team, with different backgrounds and economic interests; and
- g) the medical profession usually has strong resistance to quality programs because they feel they are monitored and hampered in the clinical management practiced.

Despite these specific characteristics of the health sector, all organizations, regardless of their nature, are subject to changes in the external environment, which ultimately determine the development of rapid and effective response capabilities to these transformations (Bressan, 2004; Hung, 2007). Thus, the need to choose a business model that allows them to be flexible before the need for permanent connection to its context and, in addition, being able to carry out the quality management in a market known for the constant lack of resources appears to be a difficult paradox to transpose in contexts of permanent transformation and competition.

The management style determines the degree of confidence of the professionals involved, which is reflected on the turnover indicators and, finally, the very organizational performance (Deconinck, 2011; Call et al., 2015). In this context, the ongoing review of processes becomes even more relevant.

The Importance of Process for Obtaining Results

By analyzing the three concepts of Donabedian (1980) on services in health care (structure, process, and outcome), it is seen a strong resemblance to the concepts developed by the researchers of service management. Instead of process and result, for example, Johnston and Clark (2002) preferred experience and result since their focus on service occurred from the customer's perspective.

Regardless of the term used, it is the process that determines the quality of the result (Santos, 2006). It connects with the entry of inputs (suppliers) and those interested in owning them (clients). In addition, this step is composed of all the professionals involved in their transformation, who are influenced by the leadership style, degree of trust and intent of cooperation between those involved, which will determine the added value and, consequently, quality perceived by the client (Figure 1):

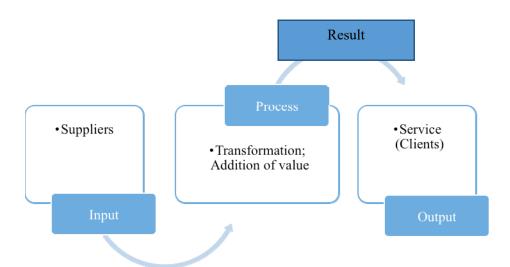


Figure 1 – Flow of Production of Services – Service = Process + Result.

Adapted from Santos (2006, p. 29).

In the service sector, the processes involved in their production determine the resulting quality and it is how it is perceived (Kotler, 2001) that will promote their purchasing intention (Churchil and Peter, 2005). Surprisingly, until Skinner published his seminal work *Manufacturing – Missing Link in Corporate Strategy*, in 1969, the operational area was perceived inside an organization as a reference a tedious work and thus relegated to a second plan, including the organizational strategy (Skinner, 1969).

The processes, however, highly depend on the operations sector, as later stated by Wheelwright and Hayes (1985). These authors introduced a four-stage model enabling the classification of the degree of development of operations strategy within organizations:

- Stage 1 neutral role of operations, the manufacturing initiatives are discouraged, including the high management;
- Stage 2 operations would seek equivalence to their counterparts in other industries, in order to remain competitive;
- Stage 3 operations, through their decisions, would act in a coherent and consistent way with the organizational strategies; and
- Stage 4 the organizational strategies would be based on operations skills that should be developed or acquired, so that their full potential could be explored.

In the fourth stage, the authors defended the need to give equal weight to both the structural activities (buildings and equipment) and the infrastructure (management policies) in order to achieve continuous improvement and competitive advantage.

Therefore, organizations, usually inserted in a competitive environment, must first seek to reduce costs and increase quality (Butler et al., 1996). All strategies should be directed to operational decisions involving the development of the structure, infrastructure, and their professionals to obtain new skills or higher capacities. Thus, the proactivity of the actors involved in the production of services must be developed, which means focusing investment on these areas, rather than alienating them from the decision-making process (Goldstein and Ward, 2004).

A few years after the study of Wheelwright and Hayes (1985), Roth and Van der Velde (1991) proposed a four-stage model adapted to the operations of services that was based on an empirical research on the retail-banking sector:

- 1° Stage *Revolving Door.* the existing capacities do not add value when maintaining or building the market share. They are used internally for tactical and control ends.
- 2° Stage *Minimum Daily Requirements*: these capacities help the companies to obtain some degree of priority with their competitors. It serves to retain existing customers, avoiding dissatisfaction. In this stage, the operations support marketing.
- 3° Stage *Gateway*: the capacities are now perceived as appealing to the market. The operational capacities not only maintain the market share, but also generate important differentials to the market.
- 4° Stage *Golden Handcuffs*: capacities that create significant barriers of entry, representing the state of the art. The operational functions are integrated to the marketing and act proactively to retain and attract customers.

In both four-stage models, the fourth stage represents the importance that must be given to the operational sector, which is the major executor of most processes of any organization. In particular, in a segment as complex as the hospital one, attention to the processes is even more crucial because its development is reflected on the quality and results of the care provided. In other words, the inefficiency of their processes is more impactful to the client. Given its importance to society, in this section, some researchers of the operational management area that focused their research on this segment will be presented.

Li, Benton, and Leong (2002) studied 151 US community hospitals. They found that the hospitals that focused on improving the decision-making process of the operational sector, rather than investing, first, in the structure (technology, physical structure), had better outcomes. After consolidating these intermediate decision-making processes, they experienced structural improvements resulting from better decisions for longer terms.

Kunkel, Rosenqvist and Westerling (2009) conducted a study with 386 departments of 92 Swedish hospitals and found that performance improvement is directly linked to the possibility of contribution of the various internal sectors in both preparation and implementation of strategies. In spite of this result being higher than those hospitals that adopted the top-down decision-making model, it was only successful when the various professionals involved were able to help in the many stages of planning.

Hospitals focused on managing processes were able, for example, to improve the productivity of a cancer unit of a Dutch hospital in 90%, using the same amount of resources. It reflected not only on treatment but also on a more rapid diagnosis (Romero et al., 2013). In another study, this time with

465 Australian hospitals, it was evidenced a directly proportional relationship between a management of interdependent processes and improvement of the outcomes of the practiced quality in patient care and financial performance (Towsend et al., 2013).

Therefore, the analysis of these models, supported by other studies presented, indicates that the studies on operational strategies should be integrated with theories based on the management of internal resources, as a way for organizations to develop more competitive advantages and better results. In a literature review, Gagnon (1999) argues that these studies should be the basis of what she calls the New Resource-based Operations Strategy). The operational sector leads the building of capacities that cause the organization to be competitive due to the constant search for operation excellence.

All the studies presented have in common the indication of the need for inter-sectorial cooperation to improve the organizational performance. For some time, some researchers have developed the concept of Business Units (BU) as a way to manage organizations, whose expansion prevented them from performing daily management of its operations. In addition, precisely in its ability to generate specific strategies is where the greatest contribution of the BUs to the company's performance as a whole lies, given the flexibility gained in this format (Porter, 1999; Buzzel and Gale, 1991). Mintzberg and Quinn (1991) point out that the strategy should not be restricted to management and directive levels, but be distributed throughout the organization, taking into account the different degrees of importance to each hierarchical level to achieve the organizational objectives.

BU as a strategy to reformulate the management control systems

Initially described by Ansoff (1975), the business strategic unit (BSU) was a subdivision of the business reality of an organization, with relative autonomy in order to take advantage of the characteristics of the region where it is located. Other authors (Bartlett and Ghoshal, 1998) define it as a corporation with scattered and specialized resources, where the ability to generate the several capacities is the source for creating competitive advantages. Thus, each subsidiary would play a different role according to the importance of the location and complexity of the resources and capacities (Bartlett and Ghoshal, 1998).

This concept was applied in General Electric, in 1971, as a way to decentralize the control before the diversity of businesses with which the company was involved. As the products and services offered by GE were diversified, so were the environments where they were inserted. Basically, each BSU should develop strategies considering their capacity and competitive needs, while being consistent with the corporate strategy (Hall, 1978).

Thus, a BSU can be defined as a division, products line, or profit center of a company. Among their characteristics, the following can be found: it can produce and commercialize a set of well-defined products and services; it generally serves a defined set of clients in a delimited geographical area; and it competes with a specific set of competitors. Thus, it is a more basic business unit that, along with other units, forms a company (Buzzel and Gale, 1991).

Gupta (1999) stresses five elements considered as critical when managing strategies of the Business Units (BUs):

- definition of the business unit scope;
- stablishing the goals for business units;
- definition of the bases intended for the competitive advantage;

- project for a constellation of values;
- management of internal value chain of the business unit and its integration with the value chain of partners and customers.

The diverse sectors of an organization, be it related to products or services, can be compared to the BUs, as they have similar characteristics, through its several processes, are embedded in its own environment of relationships, and contribute to achieve organizational strategies. Internally, all are customers and suppliers of each other. The stock sector, for example, is a customer of external suppliers, acting as a supplier for the productive sector. This takes the role of suppliers of the commercial sector since it depends on the sales made there to plan their production. The commercial sector, on one hand, is a customer of the marketing sector and the design sector, which determines what is going to be produced and consequently commercialized.

Given these concepts, before the specifics of each sector, a BU can establish specific goals that, together with other sectors, enable building values for the entire organization. However, when restructuring the management system offering greater autonomy for decision-making, the high management should encourage the creation of a collaboration culture, otherwise, as in other segments, there is a competition for results between the BUs (Porter, 1999; Buzzel and Gale, 1991). Among the positive effects of adopting this format, there is the speed of decision-making and response on customer-oriented services as key factors critical to the organizational performance in dynamic environments (Kownatzki et al., 2013; Dong et al., 2012).

There are several internal processes, as well as several characteristics of each sector. Thus, it is not possible to expect that unique strategies are able to bring positive results in the face of such diverse operations. In common, the sectors have teams coordinated by one or more individuals who must be involved in a context permeated by the constructs leadership, reliability, and quality. These constructs eventually are reflected on the collective construction of specific strategies of that UN, increasing the chances of success in implementing them and without facing resistance from other sectors. In an environment where the inter-sectoral cooperation is stimulated, strategies now belong to everyone, which is in line with the Barney's studies (1991).

Their reflexes can be seen in the improvement of the UN's organizational climate (lower turnover, greater sharing of knowledge) and care provided to other sectors with which they have common processes. This results in generating higher quality perceived by all involved. Finally, it is seen the construction of sustainable competitive advantages, which leads this essay to propose a theoretical framework.

A framework proposal

When applying a hierarchy to each attribute of the VRIO Model (value, rarity, imitability, and organization) proposed by Barney and Hesterly (2007) and validities by several recent studies (Lin et al., 2012; Bresser and Powalla, 2012; Knott, 2015; Cantrell et al., 2015), it is proposed to restructure the roles played by the managers of the many sectors of an organization. Then, this implies the way the sectors of an organization are structured. Figure 2 uses a care admission unit (AU) of a hospital organization to assist in proposing this approach:

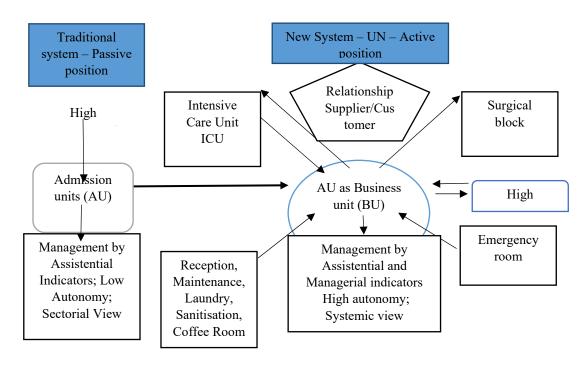


Figure 2 – Care unit as business unit.

In the proposed restructuring of a hospital organization, the inpatient units cease to act as passive agents, with control only of the care quality indicators and as mere executors of strategies devised by high management. As a BU, they begin to worry not only with their performance, but also with the other sectors, which ends up reflecting on the performance of the hospital. Because of the interrelationship between the sectors, which allows the construction and the collective implementation of strategies, the various BUs become active agents, using process efficiency indicators. Thus, the bottlenecks that reduce the efficiency of a process can be eliminated because there will be a collective discussion on the factors that lead to their existence

However, for this new management control system to occur, it is necessary that some constructs be developed in management control systems. To this end, the theoretical framework in Figure 3 is proposed:

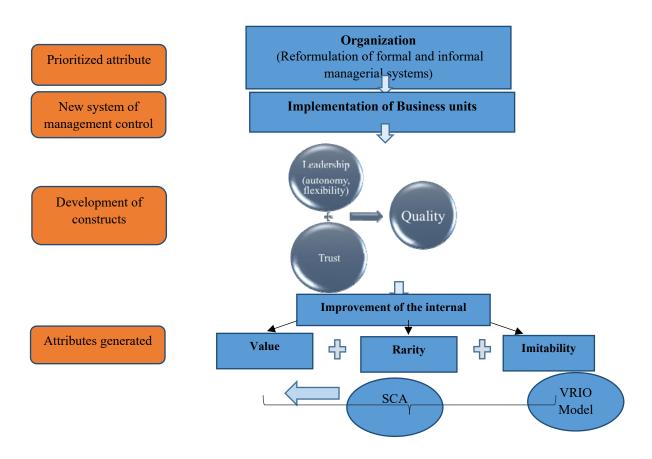


Figure 3 – Theoretical Framework – Prioritization of the attribute Organization of the VRIO Model.

When prioritizing the attribute Organization of the VRIO Model, conditions to the improvement of the internal environment so that the processes are reviewed through reformulating formal and informal management systems. This is achieved by the development of autonomy, enabling the active participation of members from various sectors in the decision-making process and creation of strategy. The intermediate managers of each sector, in turn, are encouraged to adopt a new managerial style that allow them to count on other professionals that stop acting mere executors, while abandoning the passive position to which they are generally assigned.

Therefore, their skills for leadership are developed, obtaining as a result the other team members to build a culture of trust. Trust triggers a cooperative work, where the main objective is the collective gain. Consequently, many processes become more efficient and tend to generate results with better quality and value, including from the customer's perspective. As these changes occur through various actors, one must rely on the causal ambiguity that hinders imitation by other organizations, which will be reflected on the degree of rarity of the services provided. The result for the organization is that it improves its performance and becomes more flexible in the face of environmental changes since the decision level is no longer limited to the high management.

When they work with teams, they feel they are part of the solution. All members start to pursuit the quality in the processes (Huesch, 2013; Slack et al., 2009; Deming, 1990), which is reflected on more productivity and the best use of the human resources (Barney and Arikan, 2001; Barney and Hesterly, 2007; Verbeke and Yuan, 2013; Alkhatib et al., 2015). When developing in the managers the ability to participate in the decision-making process and the creation of strategies, restructuring the management system generates other positive effects: enables the direct action on the problems,

enhancing the positive results (Sayles, 2006), and cause the managers to become disseminators of knowledge and the link between high management and operational level (Mintzberg et al., 2006; Mintzberg et al., 2004).

By turning the internal sectors into BUs, they start to be managed by indicators that can measure the efficiency and effectiveness of intersectoral relations and their clients. As a BU, it is possible to establish specific mutual goals; bases are built to obtain competitive advantages; and the management of the value chain both with clients and with other sectors (Gupta, 1999). Moreover, the flexibility given in the new structure turns the implementation of organizational strategies easier (Porter, 1999; Buzzel and Gale, 1991; Mintzberg and Quinn, 1991) because the performance aimed is obtained through the contribution of each one of their BUs. As the processes become the domain of all, even in contexts marked by turnover or consolidation processes (mergers and acquisitions), the BUs can continue the operations without incurring a quality loss.

By prioritizing the Organization attribute in the VRIO Model, conditions for the development of the constructs leadership, trust, and quality are created and now belong no longer to the individual but the organization. The following other attributes of the model emerge from the combination of these constructs: value (successful implementation of rare and difficult to be imitated strategies), rarity (few competitors hold these resources), and imitability (obtained by causal ambiguity and path dependency). This set of attributes results finally from the VRIO Model, thus becoming in entry barriers for the other competitors (Grant, 1991).

The concepts presented here reinforce the purpose of this essay that the organization is the attribute to be prioritized over the others. Through the redesign of formal and informal systems of management control, a management style capable of involving all front-line professionals is created, providing them with the necessary information for a safe decision-making. The feeling of belonging flows, being supported in an environment permeated by trust and cooperation between those involved, adding value to the products/services generated. As changes in management systems take time to consolidate (learning curve) and result from various causes (causal ambiguity), the difficulty in imitating increases considerably, thus generating the rarity required to obtain SCA. Moreover, prioritizing this attribute would solve the problems of applicability, as pointed out by Armstrong and Shimizu (2007) and Newbert (2007), and of causality, as pointed out by Foss and Knudsen (2003).

And it is precisely because of this logistic that this essay is not in line with the studies of Hsu and Ziedonis (2013), King (2007), King and Zeithaml (2001) and Mosakowski (1997), to whom imitability is the main attribute, even with the patent pointed out as one of the key resources to obtain SCA (Grant, 1991). The patent, for example, can be broken by a government decision, as it was the case of drugs used to treat AIDS in Brazil (Navarro, 2011) while the management control systems depend only on the organization itself.

In the model of four stages proposed by Roth and Van der Velde (1991), a restructuring of the management control systems would take organizations to the fourth stage, given the barriers that would be created for new entrants. The same would happen with the model of Wheelwright and Hayes (1985) since the 4th stage provides for the use of the full potential of the operations sector.

FINAL CONSIDERATIONS

The prioritization of the attribute Organization, with the introduction of the concept of business units, enables developing the constructs leadership, trust, and quality. They are required to empower and to grant decision-making autonomy to all involved in the daily operational processes of an organization. They are also consolidated as the concept of the BU is being implemented. The result is

the creation of value, rarity, and imitability, affecting the performance and competitiveness of the organization. When they are no longer perceived only as cost centers, but as an active and integral part of the management system, the various sectors create the conditions for building competitive advantages.

Finally, this paper as a contribution to the academic discussion, proposes a number of assumptions:

- a) Organizations compete primarily more with its inefficiencies than with other actors, which is reflected on their performance. The reason is the lack of autonomy of the operational sectors because of a centralized management control system.
- b) Involvement and capacitation of the intermediate managers are essential to improve the organizational performance.
- c) The leadership style of intermediate managers will determine the degree of trust of the other members of the operational sectors, which is reflected on the quality of the product/service developed.
- d) The attribute Organization of the VRIO Model must be prioritized in relation to the other attributes, in order to promote the restructure of formal and informal management control systems based on the constructs of leadership, trust, and quality.
- e) The attributes Value, Rarity, and imitability occurs only after the restructuring of formal and informal management control systems because it is the attribute Organization that enables the reformulation, development, and implementation of processes, generating causal ambiguity and increasing the path dependency.
- f) The implementation of the concept of business units in the internal sectors makes it possible to create an environment where the constructs leadership, trust, and quality help in the generation of the attributes Value, Rarity, and imitability.

It is expected that future studies can use these premises to generate new data. From this research, perhaps an improvement in the performance of organizations is possible, with a better meeting of the needs of its members and the replication of this framework as an empirical application of the original model proposed by Barney and Hesterly (2007) and Barney (1991).

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Combining Quality Tools for Effective Problem Solving

Matthew Barsalou

BorgWarner Turbo Systems Engineering GmbH

ABSTRACT

Purpose

This paper provides quality practitioners with a diverse set of tools that have a wide range of uses. These tools are already known to many professionals in the field of quality; however, this paper will use a hypothetical case study to show how the use of quality tools can be interlinked. Readers of this paper will also understand how to take a collection of brainstorming ideas and turn it into actionable items.

Design/methodology/approach

Quality tools from the literature are briefly discussed and illustrated with a simple example. A hypothetical case study is then used to show the use of the tools for addressing a realistic situation. The examples are generic so that they can easily be understood across manufacturing and service industries.

Findings

The concepts presented are illustrated by a hypothetical case study at the end of the paper.

This paper provides quality practitioners with guidance on the use 14 of simple and easy to use tools with a wide range of applications. In addition, it shows how the use of one tool may lead to the use of a different tool.

Originality/value

Although the quality tools presented are not new, the translation of an Ishikawa diagram into an action item tracking list is unknown in the reviewed literature and will be a great asset to those who have multiple hypotheses to investigate during a root cause analysis.

Keywords: Quality tools, Problem solving, Issue management, Root cause analysis.

Paper type: General review

INTRODUTION

This paper will discuss using quality tools for effective problem solving. The talk will first review the seven classic tools, which are the cause and effect diagram, scatter diagram, control charts, histograms, check sheets, Pareto charts, and flow charts. The seven new management and planning tools will then be discussed. They consist of affinity diagrams, interrelationship diagrams, tree diagrams, arrow diagrams, matrix diagrams, prioritization matrix, and the process decision program chart.

These tools have the advantages of being easy to learn and yet still highly effective for a wide range of uses. They can be used to provide structure in a brainstorming session or to assist with communication in a team. They can also be used to assist in decision making or to analyze a defective product or sub-optimal process and can be used during quality improvement projects. The tools are effective in both manufacturing and service industries and they will be illustrated using simple examples so that the examples can be understood across industries.

The seven classic tools and the seven new management and planning tools are themselves not new to industry. This talk will describe the ways in which one quality tool can transition to another tool to achieve maximum value for the use of the selected tools. A hypothetical example of problems in a coffee making process will be presented to illustration the concepts in a matter that can be easily understood by both those in manufacturing and those in service industries.

The example will include a flow chart can be used for gaining an understanding of a process. Once the team understand the process, an affinity diagram will be depicted for illustration how it can effetely use for collecting ideas from a quality improvement team. The ideas from the affinity diagram are then structured in a cause and effect diagram that can be expanded beyond technical ideas.

Although a cause and effect diagram is a powerful problem solving tool; it can be difficult to turn the items in the cause and effect diagram into action items; therefore, a worksheet based action plan will be shown depicting the cause and effect diagram items as action items with assigned evaluation tasks, responsible parties, and deadlines as well as the investigation results. A prioritization matrix will then be shown illustrating the way in which various improvement options can be compared and evaluated once the action items actions are carried out and the root cause or root cases are understood.

This paper will provide a basic understanding of common quality tools as well as the ways in which their use can be integrated. They will also be capable of translating a cause and effect diagram into an action plan for ensuring necessary tasks are performed and evaluating the results.

RESEARCH METODOLOGHY Quality Tools

Quality tools can serve many purposes in problem solving. They may be used to assist in decision making, selecting quality improvement projects, and in performing root cause analysis. There are many benefits to using quality tools. They are useful for providing structure to brainstorming sessions and communicating information and sharing ideas with in a team. They also help with identifying potential root causes of problems and selecting improvement activities identifying as well as identifying the optimal option to select when more than one potential solution is available. The use of quality tools can also provide assistance in managing a problem solving or quality improvement project.

Seven Classic Quality Tools

The Classic Seven Quality tools were compiled by Karou Ishikaw in his book *Guide to Quality Control* (1991). They are also known as "The Seven Tools" and "The Seven Quality Tools" and these basic tools should be understood by every quality professional. The Classic Seven Tools were first presented as tools for production employees to use in analyzing their own problems; they are both simple enough for everybody to use, yet powerful enough to tackle complex problems. The seven tools consist of cause and effect diagrams, scatter diagrams, control charts, histograms, check sheets, Pareto charts, and flow charts.

A cause-and-effect-diagram is used to list potential causes of a problem. It is also known as an Ishikawa diagram or fishbone diagram. Typically, the main branches are man, material, methods, milieu

(environment), machine, and measurement. Sub-branches are listed under the main branches with twigs containing the potential problem causes. A cause-and-effect diagram can be used to assist when the team is brainstorming and it can also be used to quickly communicate all potential causes under consideration.

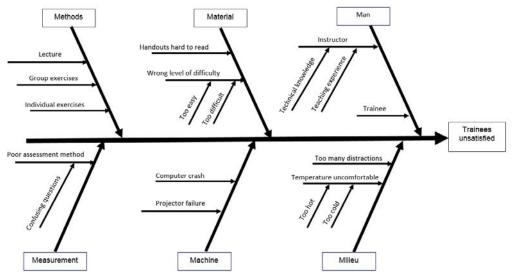


Figure 1- Cause-and-effect diagram.

A scatter diagram graphically depicts paired data points along and X and Y axis. The scatter diagram can be used to quickly identify potential relationships between paired data points. Figure 2 depicts varies potential correlations ranging from no correlation to strong negative and strong positive correlation. It is important to remember that a strong correlation does not necessarily mean there is a direct relationship between the paired data points; they may be following third unstudied factor.

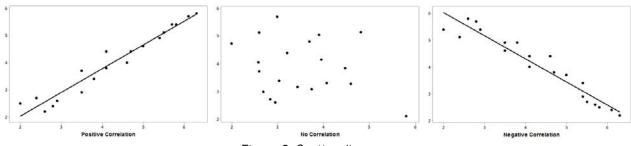


Figure 2- Scatter diagram.

Control charts are used to evaluate and monitor the performance of a process (Wheeler 1995). There are many types of control charts available for Statistical Process Control and different charts are used deepening upon the sample size and the type of data used. An individuals chart is used when the sample size is one. The formulas for an individuals chart are shown Table 1 and an example of an individuals chart for a shaft diameter is shown in Figure 3. The data is in a state of statistical control when all values are within the control limits, which contain 99.7% of all values.

Table 1- Formulas for center line and control limits when sample size is one.

Center Line	Lower Control Limit	Upper Control Limit
$\bar{x} = \frac{\sum x_t}{x_t}$	$\bar{x} - 2.660mR$	\bar{x} + 2.660 $m\bar{R}$
27		

Note: $m\overline{k}$ is equal to the mean of the difference between the individual values and is calculated by the first value from the second value, then the second value from the third value and so on and then determining the mean of the results

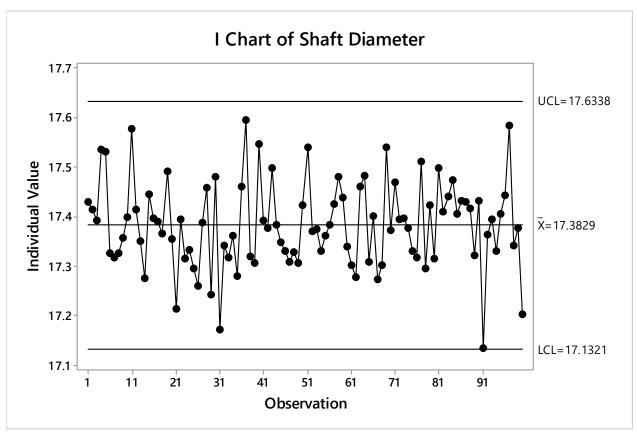
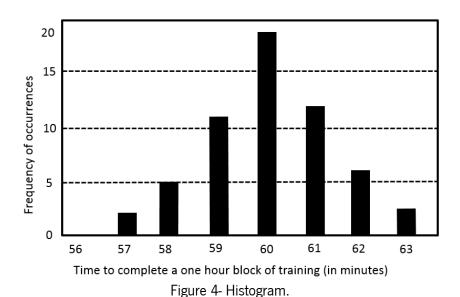


Figure 3- Control chart.

Histograms are used to visualize the distribution of data (McClave and Sincich 2009). The y-axis shows the frequency of occurrences and the x-axis shows the actual measurements. Each bar on a histogram is a bin and bin size can be determined by taking the square root of number of items being analyzed. Using a histogram can quickly show is the data is skewed in one direction or another. Figure 4 shows a histogram for data that fist a normal distribution with half of all values above and below the mean.

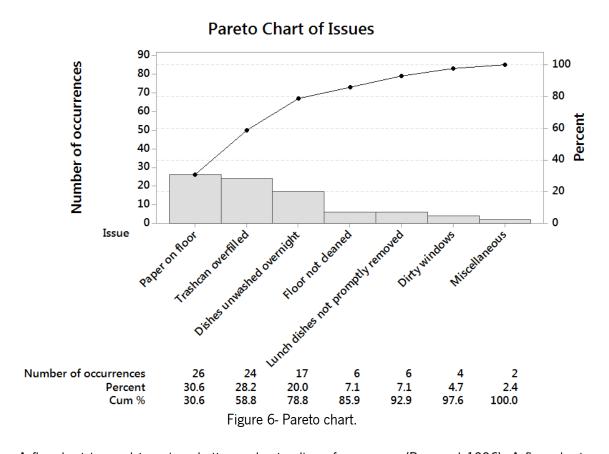


Check sheets are used for the collection of data (Borror 2009) such as when parts are being inspected. The various failure categories or problems are listed and hash mark is placed next to the label when the failure or problem is observed (see Figure 5). The data collected in a check sheet can be evaluated using a Pareto chart.

Issue	Occurrences	Total occurrences
Floor not cleaned	### 1	6
Dishes unwashed overnight	### ### ### ##	17
Lunch dishes not promptly removed	### 1	6
Trashcan overfilled	### ### ### ### ###	24
Dirty windows	IIII	4
Paper on floor	### ### ### ### I	26
Miscellaneous	11	2

Figure 5- Check sheet.

A Pareto chart is used for prioritization by identifying the 20% of problems that result in 80% of costs (Juran 2005). This can be useful when searching for improvement projects that will deliver the most impact with the least effort. Figure 6 shows a Pareto chart with three out of seven problems accounting for 80% of al problems. Those three would be the priority for improvement projects.



A flowchart is used to gain a better understanding of a process (Brassard 1996). A flow chart may provide high level view of a process such as the one shown in Figure 7; or, it may be used to detail every individual step in the process. It may be necessary to create a high level flow chart to identify potential problem areas and the flow chart the identified areas in detail to identify steps that need further investigation.

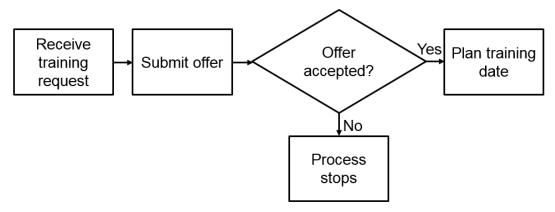


Figure 7- Flow chart.

Seven New Management and Planning Tools

The seven new management and planning tools are based on operations research and were created between 1972 and 1979 by the Society for QC Technique Development in Japan. They were first translated into English by GOAL/QPC in 1983 and consist of the affinity diagram, interrelationship diagram, tree diagram, arrow diagram, matrix diagram, prioritization matrix, and process decision program chart (PDPC) (Brassard 1996).

An affinity diagram identifies points by logically grouping concepts (ReVelle 2004). Members of a team write down items that they believe are associated with the problem under consideration and these ideas are then grouped into categories or related points.

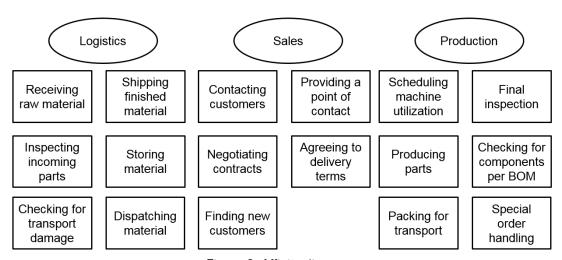


Figure 8- Affinity diagram.

The interrelationship diagram depicts cause and effect relationships between concepts (Westcott 2014) and is created by listing problems on cards. These cards are then laid out and influenced are identified arrow pointing at the items that are being influenced. One item with many arrows originating it is a cause that has many influences and much can be achieved by correcting or preventing this problem.

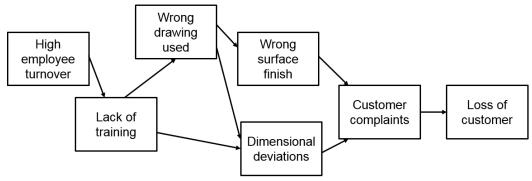


Figure 9- Interrelationship diagram.

A tree diagram assist in moving from generalities to the specifics of an issue (Tague 2005). Each level is broken down into more and more specific components as one moves from left to right in the tree diagram (see Figure 10).

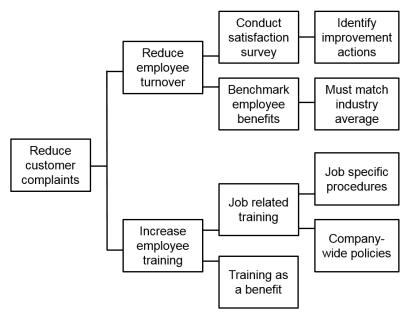


Figure 10- Tree diagram.

An arrow diagram is used to identify the order in which steps need to be completed to finish an operation or project on time (Brassard 1996). The individual steps are listed together with the duration in the order that they occur. Using an arrow diagram such as the one in Figure 11 can show steps that must start on time to prevent a delay in the entire project or operation.

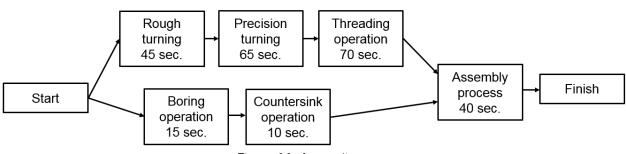


Figure 11- Arrow diagram.

The matrix diagram is used to show relations between groups of data (Westcott 2014). The matrix diagram in Figure 12 depicts three suppliers as well as their fulfillment of the three characteristics listed on the left side of the table. In this example, only two suppliers share the characteristic "ISO certification."

	Supplier 1	Supplier 2	Supplier 3
Local	Yes	No	No
ISO certification	No	Yes	Yes
Experience	Yes	No	Yes

Figure 12- Matrix diagram.

The prioritization matrix is used to select the optimal option by assigning weighted values to the characteristics that must be fulfilled and then assessing the degree to which each option fulfills the requirement (ReVelle 2004). The prioritization matrix in Figure 13 is being used to select the best option for a staffing problem.

	Weighted value	Hire more staff	Bring in temps	Outsource
Protect proprietary information	10	10	4	1
Use employees skills in the future	8	10	1	1
Flexibility	8	1	10	8
Avoid over capacity	6	1	10	10
Keep short-term costs down	4	4	4	2
	Total	210	196	150
	%	58.3	54.4	41.7

Degree of fulfillment: 1= not at all and 10 = best

Figure 13- Prioritization matrix.

Process decision program charts (PDPC) map out potential problems in a plan and their solutions (Tague 2005). The example in Figure 14 shows the potential problems that could be encountered when conduction employee training as well as solutions to these problems.

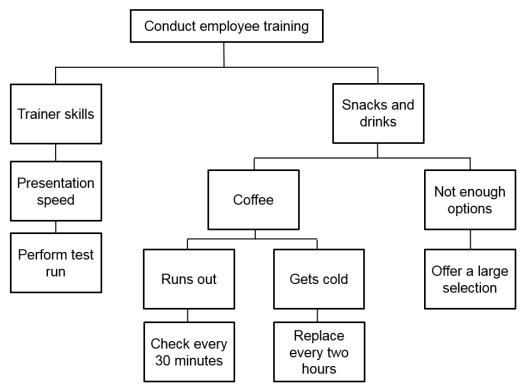


Figure 14- Process decision program chart.

RESULTS

Example of Combining Quality Tools

Multiple quality tools can be used in succession to address a problem (Barsalou 2015). The tools should be selected based upon the intended use and information from one tool can be used to support a later tool. The first step to take is to create a detailed problem description that fully describes the problem. In this example hypothetical the problem description is "Coffee in second floor break room tastes bad to the majority of coffee drinkers; this was first noticed in February 2015." The hypothetical problem solving team then creates the flow chart shown in Figure 15 to better understand the process.

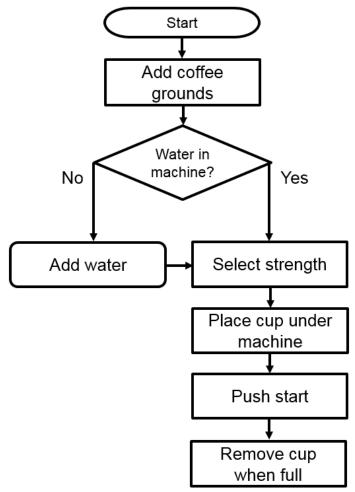


Figure 15- Flow chart for coffee making process.

The team then brainstorms potential causes of the problem. These ideas come from the team ember's experience with comparable previous issues and technical knowledge and understanding of the process. The ideas are written on note cards and then the note cards are grouped into related categories to create an affinity diagram using the headings of the 6Ms used for a cause-and-effect diagram as shown in Figure 16.

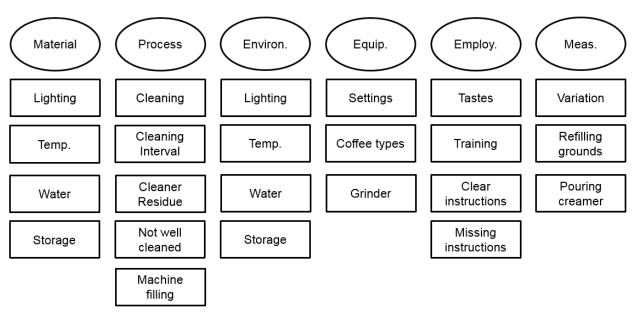


Figure 16- Affinity diagram for bad tasting coffee.

The affinity diagram is then turned into the cause-and-effect diagram depicted in Figure 17. The team can then expand the cause-and-effect diagram if necessary. The cause-and-effect diagram provides a graphical method of communicating the many root cause hypotheses. This makes it easy to communicate the hypotheses, but is not ideal for tracking the evaluation cations and results.

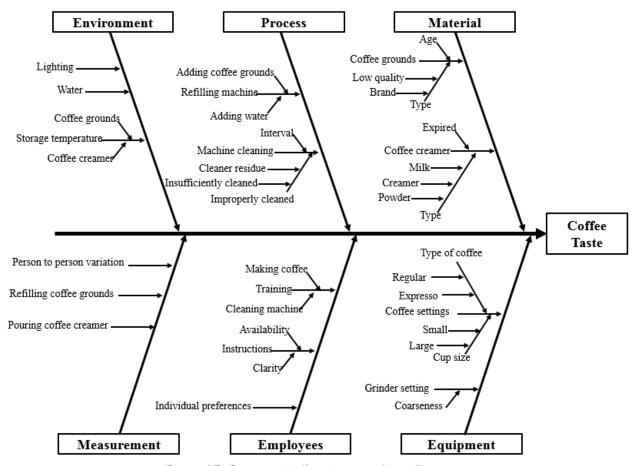


Figure 17- Cause-and-effect diagram for coffee taste.

Cause-and-effect diagram items are then transferred to worksheet shown in Figure 18. The hypotheses are then prioritized so that the most probable causes are the first ones to be investigated. A method of evaluation is then determined and a team ember is assigned the evaluation action item and a target completion date is listed. A summary of evaluation results is then listed and the conclusions are color coded to indicate if they are OK, unclear, or potentially the root cause. Unclear items as well as potential root causes should then be investigated further and OK items are moved from consideration.

Item	Element	Prio. (prob./ ease)	Evaluation method	Responsi ble	Target date	Comp. Date	Results	Conclusion
1.0	Material							
1.1	Coffee grounds: Age	1	Check to ensure grounds are not expired	Joe Smith	22 May 15	22 May 15	Not expired	OK
1.2	Coffee grounds: Type - Brand	1	Ensure only one type of brand is in use	Joe Smith	22 May 15	22 May 15		
1.3	Coffee grounds: Type - Low quality	1	Determine if discounted coffee is being	Joe Smith	22 May 15	22 May 15		
	Coffee creamer: Type - Milk	1	Create checklist to identify type of					
1.4			creamer (if any), type pf coffee and machine settings used when bad coffee is identified and run chart to identify bad coffee	Joe Smith	29 July 15			
1.5	Coffee creamer: Type - Creamer	1	See item 1.4	Joe Smith	,		Only one type used; however, creamer found to have expired; unclear if this contributed to taste of coffee. Further results expected after completion of	
1.6	Coffee creamer: Type - Powder	1	See item 1.4	Joe Smith	29 July 15		See item 1.4	
2.0	Equipment		0.5.44	1 0 21	00 1 1 45		0.2.44	
2.1	Grinder setting: Coarseness	1	See item 1.4	Joe Smith		_	See item 1.4	
2.2	Coffee settings: Type of coffee - Regular Coffee settings: Type of coffee -Expresso	1	See item 1.4 See item 1.4	Joe Smith Joe Smith	29 July 15		See item 1.4 See item 1.4	
2.4	Coffee settings: Cup size - Small	1	See item 1.4				See item 1.4	
2.5	Coffee settings: Cup size - Small Coffee settings: Cup size - Large	1	See item 1.4 See item 1.4	Joe Smith		-	See item i.4	
3.0	Corree settings: Cup size - Large Process		See Rent 1.4	oce amith	29 July 15	\vdash		
$\overline{}$	Refilling machine: Adding coffee grounds	2	Go to Gemba and observe how coffee	James	02 June			
3.1			grounds are added	Smith	15			
3.2	Refilling machine: Adding water		See item 3.1			0/11	5	
3.3	Machine cleaning: Interval	1	Check cleaning interval and determine if it is per machine manufactures recommended interval	Jerry Smith	23 May 15	24 May 2015	Potential root cause of the issue. There is no cleaning interval; last cleaning believed to have occurred during the Hoover Administration. Corrective actions: immediate cleaning and creation of cleaning schedule. All other coffee machines to be checked for this issue. Quality department to create SPC chart to monitor long-term coffee taste; HR to organize training in filling out control chart.	n.OK
3.4	Machine cleaning: Improperly cleaned - Cleaner residue	2	Check for cleaner residue	Jerry Smith		24 May 2015	Not applicable; never cleaned. See item 3.3	ОК
3.5	Machine cleaning: Improperly cleaned -	2	Check for cleanliness per coffee	Jerry Smith	23 May 15		Coffee machine failed cleanliness test per	n.OK
4.0	Insufficiently cleaned Employees		machine cleanliness Work Instruction			2015	WI 72.4v3. See item 3.3 for details	
4.1	Individual preferences	3	Identify method to determine if individual preferences are an influence on the problem	Jamie Smith	07 June 15			
4.2	Training: Making coffee	2	Check to ensure training records are up to date	Jessica Smith	23 May 15	23 May 15	One employee (tea drinker-has never made coffee) has not attended training; will receive training during next round of orientation training	ОК
4.3	Training: Cleaning machine	2	Check to ensure training records are up to date	Jessica Smith	23 May 15	23 May 15	Training on coffee machine cleaning has never been conducted; Jerry Smith is to have a training session prepared by 7 June	n.OK
4.4	Instructions: Availability		Check availability	Jessica	23 May 15			
4.5	Instructions: Clarity	3	Ensure instructions are easy to	Jessica	23 May 15	23 May 15		n.OK
igsquare			understand (Flesh-Kincaid Readability	Smith	⊢—	<u> </u>	tasked with rewriting instructions	
5.0 5.1	Environment Lighting	2	Ensure luminance of coffee room is ≥ 300 lux	Jamie Smith		28 May 15	Room tested as 370 lux; however vale drops significantly if light is shut off. Installation of a motion detector to ensure nobody makes coffee in the dark is under consideration	Unclear
5.2	Water	3	Water is from municipal source and expected to be consistent; not testing planned at the moment	Jamie Smith	28 May 15			
5.3	Storage temperature: Coffee grounds	2	Ensure storage temperature is ≤ 72°F	Jamie Smith		28 May 15	may vary so building maintained is installing a monitoring system. To be completed 17 June 2015	Unclear
5.4	Storage temperature: Coffee creamer	1	Ensure storage temperature is ≤ 40°F	Jamie Smith	28 May 15	28 May 15	All creamers found to be stored in refrigerator at 38°F	OK
6.0 6.1	Measurement Person to person variation	2	Perform an attribute gage R&R	Jane Smith	18 May 15	18 May 15	Employees were able to differentiate	OK
6.2	Refilling coffee grounds	3	Perform MSA on coffee scoop	Jane Smith	16 June 2015		between good and bad tasting coffee	
6.3	Pouring coffee creamer	3	Perform MSA on creamer dispenser	Jane Smith		18 May 15	Creamers (milk, powder, and creamer) are poured without aid of a dispenser. Industrial engineering department is investigating various pouring methods. Studu to be completed by July 2015	Unclear

Figure 18- Cause-and-effect diagram worksheet for coffee taste.

Figure 19 shows a close up view of the cause-and-effect worksheet. Often, the cause-and-effect diagram item is not clean in how it is related to the problem. In such a situation, it can be expand in the worksheet to turn it into a clearer hypotheses. For example, "Water" in the cause-and-effect diagram can be changed to "Water from the city water system containing chemicals leading to coffee tasting bad" in the worksheet.

		Prio.			_			
Item #	Element	(prob./ ease)	Evaluation method	Responsible	Target date	Comp. Date	Results	Conclusion
3.0	Process							
3.1	Refilling machine: Adding coffee grounds	7	Go to Gemba and observe how coffee grounds are added	James Smith	02 June 15			
3.2	Refilling machine: Adding water		See item 3.1					
3.3	Machine cleaning: Interval	1	Check cleaning interval and determine if it is per machine manufactures recommended interval	Jerry Smith	23 May 15 24 May 2015	2015 2015	Potential root cause of the issue. There is no cleaning interval; has cleaning believed to have occurred during the Hoover Administration. Corrective actions: immediate cleaning and creation of cleaning schedule. All other coffee machines to be checked for this issue. Guality department to create SPC chart to monitor long-term coffee taste; HR to organise training in filling out control chart for coffee taste.	**.0K
3.4	Machine cleaning: Improperly cleaned - Cleaner residue	2	Check for cleaner residue	derry Smith	23 May 15	24 May 2015	23 May 15 24 May Not applicable; never cleaned. See item 3.3 2015	OK
3.5	Machine cleaning: Improperly cleaned - Insufficiently cleaned	2	Check for cleanliness per coffee machine cleanliness Work Instruction 72.4v3	Jerry Smith	23 May 15 24 May 2015	24 May 2015	Coffee machine failed cleanliness test per WI 72.4v3. See item 3.3 for details	■.0K
4.0	Employees							

Figure 19- Close up of a cause-and-effect diagram worksheet.

A prioritization matrix can be used to evaluate multiple potential solutions to the problem. In this example, the team has identified three potential solutions: The team can clean and repair the old machine, buy a new machine, or buy an expensive new machine. They want to avoid high costs, but do not want to spend too much time and they want something with long-term value so the prioritization matrix shown in Figure 20 is used to find the ideal solution.

Factors to Consider	Weighted Value	Option 1 Current Machine	Option 2 New Machine A	Option 3 New Machine B
Costs	10	6 (10x6= <u>60</u>)	3 (10x3= <u>30</u>)	1 (10x10= <u>10</u>)
Time to implement	2	1(2x1= <u>2</u>)	3 (2x3= <u>6</u>)	3 (2x3= <u>6</u>)
Ease of implementation	6	1 (6x1= <u>6</u>)	6 (6x6=3 <u>6</u>)	6 (6x6= <u>36</u>)
Long-term value	8	1 (8x1= <u>8</u>)	3 (8x3= <u>24</u>)	6 (8x6= <u>48</u>)
	Total:	76	96	100
	%:	50.7	64.0	66.7
Degree of fu	ulfillment: 1 = r	not at all, 3 = fair, 6 =	complete fulfillme	nt

Figure 20- Prioritization matrix for improvement options.

CONCLUSIONS

There is no one right quality tool for every job so quality tools should be selected based upon what needs to be accomplished. Information from one tool can be used to continue using a different tool. Actions items resulting from a cause-and-effect diagram should be entered into a tracking list. This assists the team leader in tracking the status of items, makes it easier to ensure action items are completed, and is also useful for reporting the result of action items.

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Design Thinking and QFD: two faces of the same coin?

Patrícia Moura e Sá

Faculty of Economics, University of Coimbra

Affiliated Researcher at CICP

pmourasa@fe.uc.pt

ABSTRACT

Purpose - Organisations put considerable efforts into developing innovative products and services, capable of delivering value to customers and users. The existence of "wicked problems" calls for the creation of multidisciplinary teams and to the early incorporation of users' feedback. A wide range of methodologies and tools have been developed to guide the design of (new) solutions with the purpose of making the process as effective and efficient as possible. Among those, Quality Function Deployment (QFD) and Design Thinking (DT) are particularly relevant. The aim of this paper is to explore possible connections and overlaps between DT and QFD.

Design/Methodology/Approach – Based on a critical review of the literature, this paper compares the two approaches by analysing their core principles, main stages and associated tools.

Findings - Many similarities exist in what concerns the customer-centric approach and the way creativity is embedded in the whole design process. Yet, if, on one hand DT is more in line with the dynamic and interactive nature of value creation, QFD is more robust in terms of quality planning, feasibility assessment and documentation.

Originality/Value – A considerable body of the literature on innovation presents case studies describing the application of methodologies to develop new products/services, but very few studies discuss the interaction that might exist between different approaches. Understanding how some methodologies and tools can be combined is of major importance to organisations that want to develop their own projects.

Keywords: QFD, Design Thinking, Innovation

Paper type: General review

INTRODUCTION

Taking into account the importance of regularly developing new products/services and introducing new solutions to address emerging problems and to remain competitive, individuals, organisations and countries have been particularly interested in studying innovation processes and better understanding why certain projects succeed, whereas so many others fail. Reducing the risks of failure and development costs, while improving time-to-market performance, have been major concerns for decades. Within such period, several approaches and methodologies have been proposed. Due to their importance, in practical and academic terms, this paper is focused on two of them: Quality Function Deployment (QFD) and Design Thinking (DT).

In general terms, any new product/service development project aims to design a solution to a problem that has been identified based on information collected from potential users/customers. The quality of such information is critical. For example, faulty assessment of customer preferences will result in incorrect product attributes and likely lead to product failure. Moreover, organisations have long been forced to recognise that customers do not buy product/service features, but rather the functionalities and benefits associated with them (Beckman and Barry, 2007). This fact has at least two important consequences: first, organisations need to understand how value is created and, second, within their commercialisation strategies, they need to effectively communicate such benefits rather than stressing the features and specifications of a given product/service. Thus, the classic 'technology-push view', according to which organisations start with solutions and then place those solutions in the market to see whether or not there is a need to be addressed, has been replaced by a 'market-in approach' (Beckman and Barry, 2007).

Broadly, the development of any new product/service involves four major stages: (1) understanding customer's needs; (2) arriving at the final concept of the design; (3) define the major characteristics of the new product/service; and (4) analyse and improve the performance and usage profile of the new product/service. Yet, considerable differences exist in the way this broad process is carried out.

As more complex problems arise, a wider set of competencies is necessary to arrive at a good solution. Therefore, new product/service design has become a project of interdisciplinary teams. In order to be successful, these teams need to apply methodologies and tools that assist them in their creativity processes, ensure that they keep focused on the problems and document the whole design.

The aim of this paper is to explore possible connections and overlaps between DT and QFD in order to propose a certain degree of integration that makes the new product/service development process as effective and efficient as possible, reducing the time-to-market, associated costs and risks of failure.

The remainder of the paper is structured as follows. In the next section, based on the literature review, QFD and DT are described. Then, by critically reflecting upon each methodology, the main strengths and shortcomings of each approach are discussed. Finally, in the conclusion some implications are derived on how to combine them to better take advantage of their relative advantages.

QFD AND DT IN BRIEF

Quality Function Deployment (QFD) Essentials

QFD is a methodology used for translating customer requirements into appropriate technical requirements across each stage of product development (Rogers and Salustri, 2009). Everything starts with the Voice of the Customer (VOC) and product specifications derive from customer needs rather than from the feelings of the firm technicians or marketers. Therefore, considerable effort is put in collecting the VOC, usually by means of qualitative methods, such as non-structured interviews, and other observational techniques. The QFD approach recognises the importance of observing the customers in their own environment ("diving into the aquarium").

In order to ensure that the VOC guides the whole process and that decisions on the new product/service are consistent with each other and adequately deployed, a series of different matrices is used throughout QFD. The House of Quality (HoQ) is the central matrix of the QFD methodology. It helps to translate requirements into product/service/process specifications (Hauser and Causing, 1988). The HoQ simultaneously addresses the following questions (Sá and Sá, 2014):

- WHAT does the customer want?
- What is the RELATIVE IMPORTANCE of each customer requirement?
- HOW can the product/service respond to customer requirements?
- How does each product/service feature RELATE TO others?

The answers to these questions are given in the various "rooms" of the HoQ (see Figure 1), namely:

- Room 1 Customer Requirements (obtained through open interviews and observational techniques and translated into a technical language)
- Room 2 Product/Service Features (characteristics that the product/service must have to satisfy customer requirements)
- Room 3 Relationships Matrix (which evaluates how each Product/Service Feature affects each Customer Requirement based on expert engineering experience, customer responses and tabulated data from statistical studies or controlled experiments)
- Room 4 (Roof) Relationships among Features (which analyses the impact (positive or negative) that Product/Service Features have on each other and, thus, helps to understand which features must be improved/changed in parallel in order to have a net positive effect on the overall design)
- Room 5 Competitive Analysis (customer evaluations of competitors in relation to the new product/service that is under development)
- Room 6 Technical Importance
- Room 7 Features Planning
- Room 8 Target Values (Specifications)

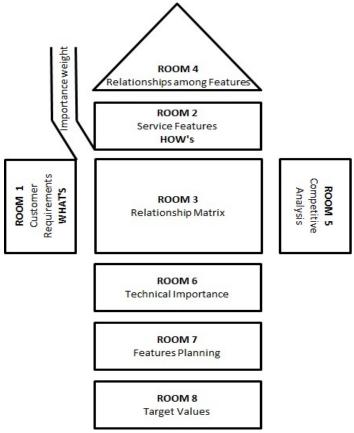


Figure 1 – House of Quality (HoQ)

Associated with QFD, several tools can be applied. For instance, to understand how each requirement affects customer satisfaction the Kano survey can be used. In fact, as the Kano model proposes the relationship between the performance of product/service attributes and customer satisfaction is non-linear, and therefore it is important to classify them as "must-be", "one-dimensional", "attractive" and "neutral" (Tontini et al., 2013). "Must-be" attributes are related with the basic functions of the product/service and, consequently, must be integrated into the new design. On the other hand, "attractive" attributes are unexpected features, which, if absent, do not lead to dissatisfaction, but, if included in the new design, can cause customer delight. Having one or two attractive attributes in the new product/service is essential to differentiate it and to develop a competitive advantage. The attributes classification is based on the way the customer reacts to presence/absence of a given attribute and therefore for each attribute the Kano survey has two questions. At the concept development stage, Pugh methodology (Pugh, 1996) can be useful to make emerge a concept that, by means of an iterative process, successively combines competing ideas, in order to exploit their relative advantages and obtain in the end a 'winner concept'.

By means of a good documentation system, QFD facilitates coordination and communication, highlights interrelationships and creates a common quality focus across all functions (Smith et al., 2007)

The application of QFD is expected to contribute to (Terninko, 1997, cited in Rogers and Salustri, 2009): shorter development times, fewer engineering changes, high customer satisfaction, improved product manufacturability and a language shared among the various functions.

Design thinking: concept and origins

Design Thinking has become an academic and scientific subject of study due to the overwhelming success of two schools: the d.school at Stanford University (US) and the D-School at Potsdam (Germany).

There is not a unique definition of design thinking, since its meaning varies according to the context where it is applied. Yet, briefly, design thinking can be defined as "how designers go about thinking and doing things" (Kimbell, 2009, cited in Edman, 2009).

Although the origins of 'design thinking' go back to the architecture and arts field in the 1960s, its use has become rather popular in the management field, especially from the late 1990s on, being regarded as an excellent way to be creative and innovate (Johansson-Sköldberg et al., 2013) in a broad spectrum of contexts, from developing a new piece of furniture to creating public policies. As Brown (2009) highlights, design principles have been applied not just to physical products, but also to consumer experiences, to production and interaction processes, and to improvements that make existing products more appealing or functional. Indeed, according to Simon (1996, cited in Edman, 2009), "everyone designs who devises courses of action aimed at changing existing situations into preferred ones". In such cases, designers are expected to understand not only the technical aspects of a given problem, but also a wide range of social, economic and psychological impacts of the design decisions proposed. Consequently, as Brown (2008) highlights, designers, who formerly were associated with making selected ideas aesthetically attractive and more desirable to consumers (performing basically late-stage addons), have in the twenty first century moved to the core of the process, creating ideas that better meet consumers' needs and desires (having, thus, a strategic role). Thus, DT is a constructive and experimental approach that incorporates consumer insights in depth and rapid prototyping aimed at finding effective solutions to complex problems (Brown and Wyatt, 2010).

The appropriation of the term by the management field is a result of the growing interest of managers for the world of the designers and their way of thinking when creating artefacts, objects and projects. Some case studies - such is the case of the IDEO in particular - raised particular interest among managers and researchers. In fact, the characteristics of a design thinker have great potential of driving successful innovative solutions to many managerial problems, by assuring a focus on actual needs and problems, encouraging creativity and fostering good communication across a range of disciplines. Such characteristics have been summarised by Razzouk and Shute (2012) and include: human- and environment- centred concern, ability to visualise, predisposition toward multifunctionality, systemic vision, ability to use language as a tool, affinity for teamwork, and avoiding the necessity of choice (since they search for new configurations that combine best attributes of different alternatives). Brown (2008) adds some other features to this picture, such as: attention to detail ("great design thinkers observe the world in minute detail; they notice things that others do not and use their insights to inspire innovation" (Brown, 2008:3)), integrative thinking (as an alternative to simple analytical processes), experimentalism ("design thinkers pose questions and explore constraints in creative ways that proceed in entirely new directions" (Brown, 2008:3), and collaboration with other disciplines. As Beckman and Barry (2007) stress, DT calls, at different stages, for the application of different learning styles, which combine at various degrees concrete experience, abstract conceptualisation, reflective observation and active experimentation.

Among the DT meanings closely associated with the management field one is particularly interesting for the purpose of the current paper – design thinking as problem solving activity (Buchanan, 1992, cited in Johansson-Sköldberg et al., 2013). In fact, Buchanan's paper calls attention to the importance of overcoming the split between the problem definition and the problem solution stages when wicked problems are to be addressed. Due to their complexity, wicked problems call for high levels of creativity and, both to formulate and to solve them, it is necessary to identify the views of all those involved. When transposed to the management field, DT has also different meanings. One of the most appealing ones is associated with Roger Martin, Dean of the Rotman School of Business at the University of Toronto, who argues that design thinking is an essential management skill based on "an ongoing cycle of generating ideas (abduction), predicting consequences (deduction), testing, and generalising (induction)" (Johansson-Sköldberg et al., 2013: 128).

Design Thinking: Stages, Methods and Critical Success Factors

The whole design thinking process is managed by an interdisciplinary project team that incorporates multiple perspectives and works collaboratively, making use of fluid communication tools.

The design thinking process is often iterative and comprises three main spaces (DT prefers the use of the term 'spaces' rather than that of 'stages' to stress that there is some overlapping and steps are not always taken sequentially) (Brown, 2009):

- Inspiration (when a problem or opportunity is identified);
 Innovation must be based on users' experiences/problems. During this stage, the team must get an insight into how people actually use things or experience situations. This requires empathy so that team members experience things as customers do rather than looking at them as simply subjects. Making use of ethnographic observational techniques, the team must inhabit the user's perspective and feel what that person feels. A key purpose is to elicit and listen to stories and that is more likely to happen when the observer is naïve and asks probing questions.
- 2. Ideation (when ideas are generated and tested);
 - The team goes through a process of synthesis in which they distil what they saw and heard into insights that can lead to solutions or opportunities for change. It is necessary to make sense of the data collected, framing and reframing it to identify patterns and develop a focus on what is most important to the customer/user (Beckman and Barry, 2007). The main goal is to come up with a new way to see the problem which in turn will allow the team to come up with new solutions.
 - At this stage, it is important to use first "divergent thinking" (questioning assumptions and generating many different alternatives to the present reality) and next "convergent thinking" (sorting options and deciding which is best). Analysis and synthesis need also to be applied to understand patterns. The process is likely to be iterative, with the team moving back and forth, as the options are examined in practice and new ones emerge. An attitude of experimentation and openness to risk are essential in this regard.
 - Value propositions (that describe the tangible benefits that customers will derive from using a product or service) are an outcome of this stage and provide a very high-level specification for the design of the new product/service.
- 3. Implementation (when the innovation moves from the project room to the market).

Within these three stages five major steps can be identified (see Figure 2):

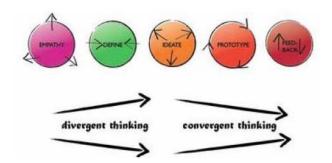


Figure 2 – Design Thinking – Steps (Brown, 2009)

- Empathy: to obtain information on the users and the overall situation that needs to be addressed by getting into closer contact with them;
- Define: to characterise a typical user (persona) to whom the solution is going to be designed;
- Ideate: to generate as many ideas/alternatives as possible;
- Prototype: to build basic prototypes of the most promising ideas;
- Feedback: to learn from the users' reactions to the prototypes.

The design thinking process must take into account three main constraints (Brown, 2009):

- Feasibility (what can be done);
- Viability (what can be done successfully)
- Desirability (what people want or will come to want)

Wrapping up these constraints, Brown (2008: 2) affirms that DT "is a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity".

Associated with the design thinking process are four major cognitive operations (Razzouk and Shute, 2012): generation, exploration, comparison and selection. As the authors note, the first two widen a problem space whereas the last two do the opposite.

A multitude of techniques and methods are recommended when carrying out design thinking projects. Some of the most popular include:

- Persona profiles (including physical, psychological and sociological description of potential users, based on what was actually observed);
- Story-telling (stories put "ideas into context and give them meaning" and narratives can help "create multiple touchpoints" along the user's experiential timeline; later on the process, as Brown and Wyatt (2010: 35) explain, "storytelling, particularly through multimedia, helps communicate the solution to a diverse set of stakeholders inside and outside of the organization, particularly across language and cultural barriers");
- Customer journey maps (oriented graphs that describe the journey of a user by representing the different touchpoints that characterise his/her interaction with the service);

- Experience blueprints (multidimensional diagrams that build on the persona and journey by layering on elements of the ecosystem (people, processes, technology, and data) responsible for making interactions);
- Role-playing (some actors, the sample users or the designers themselves perform a hypothetical service experience)
- Mind maps (visual representations that show multidirectional connections);
- Brainstorming (taking one provocative question at a time, the group may generate hundreds of ideas ranging from the absurd to the obvious. Each idea can be written on a Post-it note and shared with the team. Visual representations of concepts are encouraged as this generally helps others understand complex ideas);
- Prototypes: As Brown (2008:3) puts it, the goal of prototyping is "to learn about the strengths and weaknesses of the idea and to identity new directions that further prototypes might take". Through prototyping, the design thinking process seeks to uncover unforeseen implementation challenges and unintended consequences in order to have more reliable long-term success. Prototypes facilitate communication by making ideas tangible and should be as simple and inexpensive as possible at early stages, just enough to get useful feedback and see if something is viable);

DT naturally comprises costs and risks. Observing the user in the natural environment of usage requires time and financial resources. Moreover, the competency and skills necessary to capture relevant data are not easy to find. Usually, organisations that apply DT reward risk taking and do not demonise failure. Staff training in the tools of design thinking and partnerships with clients are also important.

DISCUSSION: COMPARISON OF KEY CONCEPTS AND PRINCIPLES OF QFD AND DT

Based on the literature review conducted it is possible to find similarities and differences between QFD and DT. Looking at the way each methodology regards the design process, the level of users' involvement, the nature of the project team and the embedded problem solving approach, Table 1 summarises the results of such comparison.

Table 1 – QFD and DT features in comparison

	QFD	DT
View of the design process	Concurrent engineering: some design activities can occur at the same time (parallel); the process is iterative	Problem formulation and solution go hand in hand rather than as sequential steps; the process is iterative and continual refinement is pursued.
User-centred design (both understand and integrate end-user data during the design process)	Listens to customer needs early in the process; observational techniques "diving into the aquarium"	Human-centred design ethos; observational techniques and empathic design: not only listening to customer needs and expectations, but also experiencing the products/services from the

		customers' perspective. Tends to consider all who will be affected by the product/service (not only the customer/final user)
Nature of the project team	Functional representation: design, manufacturing, marketing, financial and other functions are integrated; users may be part of the team	Interdisciplinary project team to work collaboratively. Members are expected to have different personality types and backgrounds.
Participation of users in the project team	Users can be part of the engineering team and are at least involved in determining requirements (HQ-R1) and evaluating the project in comparison to other competitors offerings (HQ-R5)	Users can be involved throughout the entire design process or during certain phases, such as determining requirements and testing. The more the user becomes an active part of the entire design process the closer we are of co-design.
Focus	Both B2C and B2B projects	THE USER is typically the end-user; not much emphasis on B2B projects
Problem solving approach	Except for the earlier stages of VOC collection, where methods are rather open and creative, the process calls for a quite structured and rational reasoning.	The whole design process calls for creativity, as well as for human intuition and emotion.

QFD and DT share a view of the design process that fights the traditional step-by-step, sequential approach. QFD uses the idea of concurrent engineering to call attention to the importance of developing some tasks in parallel, both to speed up the process and to integrate simultaneously the expertise of different functions when taking some decisions. In DT, as Brown (2008: 4) highlights, "the design process is best described metaphorically as a system of spaces rather than a predefined series of orderly steps. The spaces demarcate different sorts of related activities that together form the continuum of innovation". Both QFD and DT assume that the process is iterative, but DT goes to the point of assuming that problem formulation and solution inform each other. Also, the idea of successive refinement is clearer in DT.

Although both QFD and DT are user-centred design approaches, valuing data gathered through direct observation in close contact with customers in the user's natural setting, DT ranks higher in this regard since it incorporates empathic design. Empathic design, as pointed out by Seshadri et al. (2014), allows the designer to identify with the challenges of the end-user. Both methodologies acknowledge the superiority of direct observational techniques, considering that observing the user and the customisation done by her/him during his/her regular routines is essential to gather information about intangible attributes of a product and unarticulated user

needs. The use of ethnographic techniques, which are best suited to capture the meaning-based needs (Beckman and Barry, 2007), is more extensive in DT. Users' involvement in testing is more explicit in DT, while it is supposed to occur in both cases. Even if, similarly, users are asked to evaluate the proposed solutions and provide feedback. DT is a better enabler of co-design.

The nature of the project team is identical: it should be diverse to incorporate a wide range of perspectives and improve the quality and consistency of decisions. While QFD mentions the importance of having cross-functional teams, DT potentially has a more open view, by stressing the importance of involving people with very different skills, ways of thinking and experiences (independently of their belonging to a particular department/function/area). Thus, DT advocates not only functional representation, but essentially different learning styles representation (Beckman and Barry, 2007). The innovation process can clearly benefit from the involvement of people that take in and transform information quite differently.

In what the problem solving approach is concerned, significant differences exist. The QFD approach is considerably more linear and well-structured. The sequence of matrices calls for a logical reasoning often based on deductive, causal-effect links. On the hand, according to Brown and Wyatt (2010), in DT the whole innovation process is deeply human, since it relies on people ability to be intuitive, to recognise patterns and to construct ideas that have functional and emotional meaning.

Table 2 and Table 3 highlight the relative advantages of each approach over the other.

Table 2 – Major Strengths of DT (in comparison to QFD)

	QFD (-)	DT (+)
Idea of value creation	Value creation is not explicitly addressed; value is regarded as being linked to customer assessment of the product/service characteristics in relation to competitors (benchmarking).	The need to understand how use value is created is crucial; the value in use perspective is more explicitly captured and, consequently, a greater effort is put in understanding how value is created (it does not derive directly from the product/service features, but from the way the user makes use of them).
Concept generation stage and selection of the winner concept	Concept selection tends to follow a logical approach, where alternative concepts are rated against a set of criteria based on the product/service imperatives. Pugh methodology is complex and not clearly grounded on users' preferences.	There is room for more intuitive techniques. Extensive use of users' feedback. A comprehensive approach to test the concept with the users is suggested.
Testing	Apart from internal testing procedures to assess	Testing is much more interactive. Prototypes are

compatibility among features	tested in real-context
(HoQ R4), prior to full scale	situations by means of role-
production the customer	playing and other techniques.
evaluates the	
product/service	
characteristics in relation to	
competitors (benchmarking –	
HoQ R5).	

Table 3 – Major Strengths of QFD (in comparison to DT)

Table 5 – Major Strengths of QFD (III comparison to DT)							
	QFD (+)	DT (-)					
Documentation system	QFD system of matrices	A set of pictures, graphics					
	provides a process for	and transcriptions are					
	planning	recorded and kept. However,					
	and for formally recognising	they are not integrated and it					
	and managing trade-offs	is difficult to keep track of the					
	between product/service	path followed to arrive at the					
	elements.	solution or how decisions					
		were taken.					
Guidance on how to go from	The set of matrices proposed	The DT 'toolbox' is very rich					
the prototype to full-scale	facilitates the process of	up to the stage when the					
production/provision	establishing adequate	value propositions for the new					
	controlling and monitoring	product/service are					
	procedures. The deployment	identified, but not much					
	process promotes	assistance is given on how					
	consistency and alignment.	they guide the remaining					
		activities in the innovation					
		process, especially on how to					
		conduct the implementation					
		stage.					

Given the relative advantages of each methodology, it is interesting to find ways to combine them, especially by applying them at different stages of the new product/service development process.

CONCLUSIONS

As the life-cycle of the products/services shortened, competition increased and the nature of the problems become more complex, designing new products and services in line with users' needs, as quickly and as efficiently as possible has emerged as a major topic in the management literature. As a response to these concerns, several methodologies were proposed and various successful case studies of their implementation reported. Yet, most papers present the potentialities of given approach without exploring its possible integrations with other tools that might be already in place in some organisations. The current paper, explores the possibilities of combining two of the most popular new product/service development approaches: QFD and DT.

By carefully analysing their principles, stages and associated tools it is possible to conclude that each of them has its own strengths and weaknesses. In fact, DT offers more guidelines on how to capture the users' views on the problem to be addressed and, by proposing a more comprehensive approach to test with the users the concept to be developed, makes it easier for an organisation to find a strategy to work "hand-in-hand" with their users throughout the product/service development process. QFD is also based on a customer empathy principle, but tends to overestimate the possibility of making the customer an active member of the QFD team, especially when end-users are at stake. On the contrary, by comparison with DT, QFD facilitates more the transition from prototype to full-scale production/service provision by going a step further in what process and control planning is concerned. Integrating QFD deployment matrices at the later steps of DT can lead to better results.

Thus, DT should be preferably used at the earlier stages of the development process, especially when interaction with users is particularly critical, whereas QFD is stronger at later stages, after the product/service concept has been chosen and production/delivering processes need to be designed in order to prepare full scale implementation. QFD can benefit from the lessons given by DT in what concept and prototype testing is concerned, integrating tools that call for users' involvement at these critical stages. Innovation demands experimentation and DT is clearly ahead in this regard.

A final note of caution must be made. In spite of the strong arguments in favour of listening to users' needs and expectations when developing new products and services, stressed both in QFD and DT, as well as the importance of replacing solutions imposed from the top with solutions that bubble from bellow when the organisation works closely with the clients and customers, it is important to acknowledge some limitations of these approaches. In fact, users are often inexperienced in imagining and articulating possible innovation for new products and services. Even if empathic design tries to overcome these limitations, it is clear that sometimes radical innovations come from the expertise and creativity of R&D teams. What, in any case, cannot be neglected is the importance of putting ideas into test to understand how they can be converted in value as perceived by those who use the products and services that result from innovation processes.

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Simultaneous integration: a case study of an SME

Llonch, M.1) and Bernardo, M.2)

¹⁾ Llonch Clima, SL, Bernart Metge, 40, 08100 Mollet del Vallès (Spain)

² Department of Business, Universitat de Barcelona, Av. Diagonal, 690, 08034 Barcelona (Spain)

ABSTRACT

Purpose — The aim of this paper is to analyze the simultaneous implementation of an integrated management system in a small and medium size enterprise.

Design/methodology/approach – Based on a case study, the paper presents and analyzes the implementation of the ISO 9001 and ISO 14001 management system standards. The organization analyzed is a small and medium size company of the heating and air conditioning sector that had no management systems implemented and decided to implement an integrated management system based on both function-specific management system standards and also achieving the separated certification. For the case, the management systems' manager and the consultant provided information about the decision-making, the implementation and certification and the overall satisfaction of the processes.

Findings — The results show that a simultaneous integration is possible and it is more effective than implementing the management system standards sequentially. A cost analysis is also provided to evidence the improvement of the organization's efficiency. The certificates for both management system standards were also achieved. These findings help in confirming theoretical statement posed in the literature of the integration of management systems: integration strategy, methodology and level. The organization values this integrated implementation as very positive internally and externally, as this is one of the first organizations of the sector implementing the ISO 9001 and ISO 14001.

Originality/value - Although studies analyzing empirically the integration of management systems have been widely published in recent years, this paper provides evidence that those organizations implementing integration later than others, can learn from the beginners' experience.

Keywords: management system integration, ISO 9001, ISO 14001, small and medium size enterprise.

Paper type: Research paper

INTRODUCTION

In recent years the studies analyzing the implementation and integration of management systems (MSs) have increased. This is because of the success in the implementation and certification of the quality MS ISO 9001 and the environmental MS ISO 14001. According to the last available data (ISO, 2015), the growth rate of certifications for both MS standards (MSSs) is positive although this rate is becoming lower than in previous years (ISO, 2015).

As it has been discussed in previous studies, organizations can have multiple function-specific MSs implemented and it is necessary to define the best strategy to manage all them in the most efficient way (Beckmerhagen et al., 2003; Bernardo et al., 2009). This strategy is proven to be the integration of these MSs into a single and more effective and efficient MS, the integrated MS (IMS), that aims to satisfy all the organization's stakeholders (Karapetrovic and Willborn, 1998a; Beckmerhagen et al., 2003).

The existing literature about the process of MSs integration is wide, analyzing mainly the aspects of the process (Douglas and Glen, 2000; Salomone, 2008; Bernardo et al., 2009; Gianni and Gotzamani, 2015). General consensus has been achieved for all the process aspects except in one: the integration methodology. There is not a common and widely applied methodology or model that the organizations can follow in order to ensure a successful process and several possibilities have been proposed (AENOR, 2005; Karapetrovic, 2005; de Oliveira, 2013). This aspect is also related to the sequence in which these MSs have been implemented, i.e., the sequence of implementation can condition the integration methodology applied and both aspects can also condition the integration level (Bernardo et al., 2012a). There is scarce literature relating these three aspects of the process empirically and thus, the aim of this paper is to analyze the simultaneous implementation of an integrated management system in a small and medium size enterprise.

The contribution of this paper is to be one of the first empirical studies demonstrating that implementing an IMS is possible and it is profitable for the organization in terms of efficiency gained. The latter is showed based on the cost analysis of the implementation and maintenance.

LITERATURE REVIEW

The MSs integration process has been widely analyzed in the literature. It is accepted that the main aspects of this process are (Bernardo et al., 2012a; Almeida et al., 2014; Domingues et al., 2015): integration strategy, integration methodology, integration level, integration of internal and external audits and benefits and difficulties. All they are described below.

The *integration strategy* refers to the sequence that the organization has followed to implement the multiple MSs. The most cited and applied strategies were defined in Karapetrovic and Willborn (1998a), who proposed three possibilities considering the implementation of two MSs: (a) to establish first the quality MS and then the environmental MS, (b) to establish first the environmental MS and then the quality MS, and (c) to establish both MSs simultaneously. Empirical studies show that the most followed is the first strategy (Douglas and Glen, 2000; Santos et al., 2011) and the second is applied, normally, for sector demands (Bernardo et al., 2011a). The third possibility, i.e., implementing both MSs at the same time, is the least applied but it was found to be the one leading to a higher integration level (Bernardo et al., 2012a). Lavodová (2004) proposed two different strategies considering quality, environment and health and safety MSs: (a) 'step-by-step', in which the MSs are implemented sequentially and then integrated, and (b) simultaneous implementation, in which the MSs are implemented integratedly. The sequential or the simultaneous implementation of MSs is important in this aspect but also the number of MSs implemented, as it has been proved that as more MSs are implemented, more difficulties to integrate are encountered (Bernardo et al., 2012b).

Regarding the *integration methodology*, several proposals have been published and thus, no consensus has been met in this aspect of the process. It refers to the model or tools used to integrate. There are two different sources of methodologies: normalization bodies and the academia. Guidelines have been proposed by normalization bodies, such as AENOR (2005) and BSI (2012). Although an international and certifiable MSS does not exist, it does at the national level and ISO published a manual in which some tips to integrate are presented (ISO, 2008). To summarize them, the majority of guidelines propose to start integrating the common elements and then continue with those more function-specific.

Regarding the academia proposals, several can also be found. For example, Karapetrovic (2005) proposed three different models: (a) 'initial', in which the IMS model is one of the MSs models; (b) 'combined', in which the IMS model is a combination of all MSs models, and (c) 'complacent', in which the IMS model is created in order to accept the different models of all MSs integrated. Karapetrovic et al. (2006) proposed four main tools: (a) process map, as the IMS model could be the same as the ISO 9001 model; (b) PDCA model, as the IMS model could be the same of the ISO 14001 model; (c) common elements, which refers to first integrate the common elements of all the MSs and then the function-specific elements, and (d) an own model, which refers to the creation of an own model that best fits within each organization, de Oliveira (2013) proposed the integration in three main stages: (a) 'planning', in which elements such as external consulting, study of interrelations among standards and integration team and plan are considered; (b) 'development', in which elements such as human resources, documentation and communication and customers are considered, and (c) 'control and improvement', in which elements such as customers' perception of IMS key elements, audits and improvement of IMS are considered. Rebelo et al. (2014) proposed a model to improve the competitiveness and added value of the organizations in which several MSs could be integrated. Finally, the support of information technologies in the process has also been positively highlighted (Pho and Tambo, 2014).

The *integration level* refers to the degree of integration achieved in the process, i.e., the level of integration of the IMS. Although several degrees have been defined (see e.g., Karapetrovic et al., 2006; Salomone, 2008; Bernardo et al., 2009), the most used are three (Karapetrovic, 2002): (a) not integrated, meaning that MSs are managed as separate systems; (b) partially integrated, meaning that some elements of the MSs are managed as a single system and the rest of elements are managed separately, and (c) fully integrated, meaning that all the elements of the MSs are managed as a single MS. Empirical studies evidence that the great majority of organizations tend to fully integrate their MSs (Bernardo et al., 2009; Abad et al., 2014).

Another important aspect of the integration process is the *integration level of audits* both internal and external (Karapetrovic and Willborn, 1998b; Kraus and Grosskopft, 2008). This aspect has been analyzed (Karapetrovic et al., 2006) considering the auditors' team, if it is the same for all norms or different depending on the MS; the audit time, if the audits are performed simultaneously or at different moments of time; the audit plan and report, if they are the same for all MSs or different for each of them; and the opportunities to improve, if they are for the IMS or for each MS. The studies show that in the great majority of organizations, the integration level of internal audits is higher than the externals (Bernardo et al., 2010, 2011b; Simon et al., 2011), as the latter are not controlled or do not depend on the organization's will as the former do.

The last aspect mainly analyzed for the integration of MSs process are the *benefits and difficulties*. Conceptual and empirical studies allow summarizing as the main benefit the improvement of organization's efficiency (Zeng et al., 2011; Bernardo et al., 2015); while the main difficulties are related to the lack of resources (Zeng et al., 2007; Gianni and Gotzamani, 2015).

Once the process of implementation has finished, other aspects have been analyzed, such as the experience managing the IMS (Bernardo et al., 2013) and the comparison among countries (Simon and Douglas, 2013).

Also, it has been also related to other practices such as customer satisfaction (Simon and Pentji Yaya, 2012), innovation performance (Bernardo, 2014) and organizations' performance (de Oliveira, 2013; Ferrón Vílchez and Darnall, 2014; González et al., 2014; Bernardo and Castán Farrero, 2015). The organization's size has also been discussed as a conditioning factor for the integration because the small and medium enterprises are more flexible than large, although they have more resources available (Karapetrovic, 2003; de Oliveira, 2013).

Thus, the research question that can be posed once the process is explained is the following: Can an organization implement the ISO 9001 and the ISO 14001 integratedly? In other words, can an organization that has no experience in managing MSs implement directly as its first MS an IMS?

RESEARCH METODOLOGHY

In order to answer the abovementioned research question a case study of a single organization was done. The characteristics of the organization are provided in the next section.

To apply this methodology, observation of the implementation process and documentation analysis was done and then, in order to reinforce the case, two brief interviews were also realized to gather top management's and external consultant's opinion (Yin, 2009). Because of the relationship of one author with the organization, a very detailed implementation process can be presented. The questions in the interview ere based on knowing the level of the interviewees' satisfaction with the process as well as their forecasted proposal for future maintenance of the IMS.

The implementation started in July 2014 and finished in April 2015. All the documentation and observation were analyzed by the authors simultaneously during the implementation and certification processes.

Although analyzing a single case could be a limitation (see also Shah, 2011; Dobele et al., 2014; Shapiro and Naughton, 2015; Richter and Arndt, 2016) knowing in depth the implementation and certification of the MSs could only be done in one organization.

The description of the organization as well as the implementation process, are presented next.

RESULTS

This section is divided in two subsections. The first explains the characteristics of the organization. In the second, the implementation process, auditing and maintenance of the integrated management system is explained.

The characteristics of the organization

The organization analyzed is a family business with 10 employees. Its activities are related to the construction sector, specifically of heating and air conditioning. It is located in Mollet del Vallès, in Barcelona (north of Spain).

It has more than 800 clients that can be classified into 5 main types: public administration, construction companies, engineering, neighborhood associations and other institutions such as hospitality or religious organizations.

The organization had no MSs implemented before and decided to implement an integrated management system based on both function-specific management system standards and also achieving the certificate for each one. The motivation to implement the IMS is both internal and external. The former is based on the

organizational culture, as it implements the continuous improvement and also has environmental concern; the implication of the top management is very high. The latter is because the organization wants to be able to adapt to a dynamic environment and also because of the competitive advantage that this practice can provide.

For the case, the MSs manager and the consultant provided information about the decision-making and the implementation and certification processes.

The implementation process of the IMS

The implementation of both standards, ISO 9001 and ISO 14001 was decided to be integrated although the certification was done individually. Below, three main aspects are presented: (1) the implementation process, (2) the costs of implementation and maintenance, and (3) the top management's and the external consultant's opinion about the process.

(1) Implementation process

The implementation process started on July 2014 and ended in April 2015. For the implementation an external consultant was hired. The process was divided into 8 phases that are shown, together with the time required in each one, in figure 1:

- First stage: beginning of implementation

In the first stage, a working team was created. It was made up with two people: the purchasing and logistics manager, and the human resources manager.

During July, the external consultant had meetings with the top management and created the process map. As a result of this, the requirement 7.3 of design and development of the ISO 9001 was excluded because the technical manager adapts the design to each customer. In addition, the documentation was created and consisted on the quality and environment manual, the quality and environment policy, procedures, working instructions and records.

Another decision made in this stage was that all the implementation was going to be managed electronically because of productivity and sustainability.

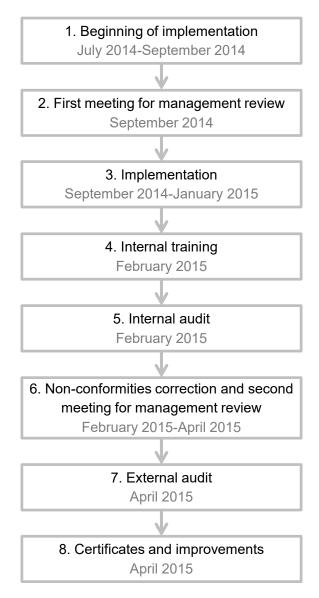


Figure 1 – Implementation process

Second stage: first meeting for management review

In the meeting both the indicators and the additional aims of the IMS were set. The external consultant took also part on this meeting.

Third stage: implementation

In this stage the signaling and evaluation of indicators was done. A calibrating evaluation was also required.

- Fourth stage: internal training

Two internal meetings were done. One was to present and give the welcome manual to all the members of the organization, and the other was to train the employees in the health and safety emergency plan.

- Fifth stage: internal audit

The external consultant performed this stage. 4 non-conformities were detected and improvement actions were also reported. The internal auditor was very satisfied with the work done by the organization.

Sixth stage: non-conformities correction and second meeting for management review

Corrective actions were applied to amend the 4 non-conformities. The comments reported for improvement were considered in the second meeting for management review.

- Seventh stage: external audit

This audit was done in two stages. The first was the meeting to plan the audit in which a brief review of part of the documentation was done and improvement actions were reported. Also, the audit day was determined. In the second stage the external auditor reviewed all the documentation and visited a maintenance site.

The result of this stage was very positive because none non-conformities were detected and 5 opportunities to improve were reported. The certificates for both MSSs could be requested.

- Eight stage: certificates and improvements

In this last stage the certificates application was done. The organization was committed to continue improving the IMS.

(2) Cost analysis

Once the implementation and certification finished, the organization analyzed the costs of the IMS. They are presented in relative numbers as the organization wanted to keep this information anonymous. Table 1 presents the costs of implementation. The total deviation is positive as real costs were lower than the estimated costs.

Table 1 – Cost analysis of the implementation

	QMS	EMS	Expected cost (%)	Real cost (%)	Dev. (%)
External costs					
Engineering services	Х	Χ	0	3.47	-54.70
External audit	Χ	Χ	13.93	14.74	0
Consultant services	Χ	Χ	16.39	14.45	45.58
Activity supplier 1: calibrate	Χ		0	0.06	-0.89
Activity supplier 2: calibrate	Χ		0	0.15	-2.40
Activity supplier 3: calibrate	Χ		0	0.17	-2.73
Calibration laboratory	Χ		0	2	-31.56
Waste annual fee		Χ	1.37	1.04	6.38
Tools for managing waste		Χ	0.55	0.42	2.56
Activity supplier 4: emergency plan		Χ	0	0.04	-0.68
Other costs	Χ	Χ	2.46	1.44	18.23
Internal costs					
Working hours QE responsible 1	Χ	Χ	32.79	34.07	9.54
Working hours QE responsible 2	Χ	Χ	13.66	10.22	66.73
Working hours general manager	Χ	Χ	8.20	6.82	29.15
Working hours technical manager	Χ	Χ	5.46	5.65	2.03
Working hours logistics manager	Χ	Χ	2.19	2.08	12.76
Working hours waste management	Χ	Χ	1.37	1.73	-4.56
Other costs	X	Χ	1.64	1.44	4.56

Total	100	100	100

Source: the company

The external costs contributing more to the deviation were the engineering services and the calibrating laboratory. The external consultant real cost was lower than the expected as well as other costs. Regarding the internal costs, the most important costs were of personnel.

Table 2. Cost analysis forecast

	QMS	EMS	2015	2016	2017
Expected external costs					
External audit	Χ	Χ	0	19.19	19.19
Consultant services	Χ	Χ	0	8.20	8.20
Waste annual fee		Χ	0	3.54	3.54
Other costs	Χ	Χ	2.36	2.95	2.95
Expected internal costs					
Working hours QE responsible 1	Χ	Χ	3.95	15.74	15.74
Working hours QE responsible 2	Χ	Χ	15.79	10.67	10.67
Working hours general manager	Χ	Χ	28.10	17.42	17.42
Working hours technical manager	Χ	Χ	15.52	12.83	12.83
Working hours logistics manager	Χ	Χ	4.29	5.31	5.31
Other costs	Χ	Χ	3	3.94	3.94
Total			100	100	100

Source: the company

The organization was also considering the maintenance costs. Table 2 shows a forecast for 3 years. The two meetings for management review were established and other tasks were also taken into account. For example, in 2015 the amount of working hours of the people responsible of the IMS was reduced. In 2016 and 2017 this reduction in management time will continue.

(3) Participants' opinion

It was also important to gather the opinion of the main characters of the process: the top management and the external consultant.

For the top management, the IMS is considered as an investment that allowed improving some organizational aspects, highlighting the documentation, easing the internal management. The positive value is also for the commitment and implication of all the members of the organization. Quality has been easily applied because of the way of working that the organization had but the environment management was new. Thus, the implementation and certification of the ISO 14001 has been considered important for the organization.

The external consultant's opinion can be defined into 6 main strengths:

- The commitment and implication with the IMS of all employees
- The effort done
- Employees' training
- Warehouse management
- Budget planning according to the working operations
- Internal program control, accreditations and legal compliance

Thus, the consultant was very satisfied with all the work done and the behavior of the employees. She forecasted that the working team has knowledge enough to internalize the IMS.

CONCLUSIONS

The aim of this paper was to analyze the simultaneous implementation of an integrated management system in a small and medium size enterprise. The single case study presented allows posing the following conclusions, although they should be taken with caution because a single case was realized.

First, the results show that a simultaneous integration is possible and more effective than implementing the management system standards sequentially. The organization decided to implement directly the IMS mainly for internal motivations and also because the experience of the external consultant helped them to learn from previous practices, implementing both MSs, ISO 9001 and ISO 14001, at the same time and as a single system. In terms of the integration of MSs process, the sequence of implementing these two MSs is simultaneous, the methodology used is based on common elements analysis and the level of the IMS is the highest as all the elements are managed as a single MS. Thus, it could be stated that this organization has implemented a single MS and its process of implementation could be compared with other processes done in organizations implementing one MS, for example, the ISO 9001 or the ISO 14001. These results evidence that the lessons learned help in improving and enhancing the implementation of IMS, making it a dynamic and adaptive process worthy to apply within organizations.

It can also be said that the IMS is more effective and efficient because the organization is one of the first in the sector in which it operates to implement and certify these MSs, taking advantage of being the leaders in this case. However, on the other side, implementing these MSs at this moment, when a great amount of organizations have both MSs certified worldwide, make them to also take profit of being the laggards and learning from best previous practices, such as using information technologies to manage the IMS. Empirically, this efficiency is measured on the cost analysis that demonstrates the low cost needed to implement and maintain the IMS.

Regarding the organization's size, being a small company owned and in which two generations of the same family are working allows saying that the size could enhance the integration process. In fact, the employees' commitment becomes more important than the resources availability, as the former has been highlighted as an important factor to succeed and the latter has not been mentioned.

Related to this, an internal and an external person of the organization have valued the process. In both cases the opinion is very positive ensuring the continuous improvement of the IMS.

Thus, these findings help in confirming theoretical statement posed in the literature of the integration of management systems, as it is the integration strategy, methodology and level. Thus, managers of those organizations not integrating their MSs, have evidence that this could be done and it is worthy to be done. Also, it evidences that implementing an IMS is an efficient practice.

In this process, the only aspect that could be valued as less positive is the need to certify both MSSs separately. It could be predicted that if the IMS could be certifiable, probably more organizations would decide to integrate their MSs becoming more efficient and this improvement in individual efficiency could also be extrapolated to an improvement in the country's global efficiency. This last statement could be the main governmental implication and thus, promoting the integration of MSs providing different sources of funding.

Finally, the main limitations of this study are the sample size, as only one organization has been analyzed, and the location, as the organization is Spanish and this country has been ranked in the top 5 countries in ISO

9001 and ISO 14001 for a long time. Comparing this case to other organizations integrating their MSs could be done in future research as well as analyzing them in different countries to detect similarities. An additional future research proposal would be to analyze the integration process form the resource based view (RBV) perspective as it provides competitive advantage to the implementing organizations.

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The process of internalization of quality standards

Tarí, J.J., Pereira-Moliner, J., Molina-Azorín, José F. and López-Gamero, M.D.

Department of Business Management, University of Alicante, Alicante, SPAIN

ABSTRACT

Purpose: There is limited research examining the impact of internalization on performance and the drivers that could play a role in this relationship. The aim of this study is to analyze which drivers may impact internalization and the relationship between internalization and performance.

Design/methodology/approach: The paper identifies hypotheses which are tested applying structural equations models. A structured questionnaire was sent to 725 quality certified firms in the tourism industry. 287 completed questionnaires were received.

Findings: The results show that the hypotheses are supported and that internal drivers are the only ones capable of significantly explaining internalization (daily practices and continuous improvement) of quality standards. Continuous improvement explains significantly all performance variables and daily practices explain employee results and society impacts. In addition, some organizations focusing on external drivers can move to internal drivers and then increase their internalization levels.

Originality/value: This study makes a double contribution to the literature on quality management. Firstly, it expands the results of previous studies on quality standards and internalization in tourist firms. Secondly, it expands the results from previous studies on internalization which have focused on analyzing its effects on operational and business results by including customer, employee and society results.

Keywords: Quality management standards, internalization, quality certificate, performance.

INTRODUCTION

Most of the previous works on quality certification have assumed a homogeneous adoption of the ISO 9001 standard, measuring it as a dichotomic variable (Sharma, 2005; Zaramdini, 2007; Benner and Veloso, 2008). Other studies have gone beyond and analyzed a heterogeneous adoption (internalization) of quality standards (Naveh and Marcus, 2005; Nair and Prajogo, 2009; Boiral, 2011), that is, they have considered that those firms implementing a quality standard (e.g. the ISO 9001 standard), may develop its requirements in different ways (Nair and Prajogo, 2009; Boiral, 2011). This means some organizations can adopt the quality standard in a symbolic way while others might implement it in depth.

More work is needed in order to shed light on the process of internalization (Nair and Prajogo, 2009; Heras-Saizarbitoria and Boiral, 2013). Whereas research in operations management has reinforced our understanding of the relationship between quality certification and outcomes (Singels et al., 2001; Terziovski et al., 2003; Singh et al., 2006; Lo and Chang, 2007; Magd, 2008), there is still scarce research on the effects of internalization on the various dimensions of performance and the drivers that can influence internalization. There are no studies on the effects of the internalization of quality standards on other dimensions of performance beyond operational and business performance, such as customer and employee results and social impact. Besides, such studies have seldom focused on the tourist industry.

The aim of this study is to analyze which drivers may impact internalization and the relationship between internalization and performance. The paper applies structural equations models to test these relationships in quality certified firms in the tourism industry. This study contributes to the literature on quality management by expanding the results of previous studies on quality standards and internalization in tourist organizations. Also, it expands the results from previous studies on internalization which have focused on analyzing its effects on operational and business results by including customer, employee and society results.

LITERATURE REVIEW

The literature has examined internal and external drivers to internalize a quality standard. Both types of drivers can have an influence on internalization of quality standards and on performance. Regarding the influence upon internalization, studies on this topic have shown different positions. Firstly, internal and external drivers have an influence upon the level of implementation of the quality standard requirement (Boiral and Roy, 2007; Nair and Prajogo, 2009). Secondly, internal drivers are more important than external ones (Prajogo, 2011). In this context, other authors have pointed out that internal drivers mediate the relationship between external drivers and the degree of implementation of a quality standard, such as ISO 9001 (Jang and Lin, 2008); that internal drivers have a positive moderating influence; and that external drivers have a negative moderating effect, that is, the greater the concern for external drivers, the lower the connection between internalization and organizational results (Prajogo, 2011). This indicates that internal and external drivers exert an influence upon the internalization level, and that they could play a mediating and/or moderating role.

Besides, other studies have shown that a concern for the reasons for certification may also influence performance. For instance, the more important the internal and external drivers, the greater the benefits (Boiral and Roy, 2007). Although both types of drivers may have an influence on benefits, some studies also indicate that internal drivers are more important (Boiral and Roy, 2007; Martínez-Costa et al., 2008). Also, when internal and external drivers are of little importance, bureaucracy problems may appear (Boiral and Roy 2007). In this context, Prajogo (2011) has pointed out that external drivers do not lead to benefits. These results indicate that, in general, internal drivers have a greater influence upon internalization and performance, and that the effects of external drivers are not so clear.

Alongside the reasons for certification, studies on internalization have also analyzed other drivers which might be considered in the future in order to explain other factors that can facilitate internalization. These other internal or external drivers are the following:

- Quality culture. A proactive quality-oriented culture reduces those behaviors reluctant to implement a
 quality standard. This quality awareness may reduce the barriers to implementation of a quality
 standard and lead the organization to create a culture facilitating the internalization of quality
 practices (Briscoe et al., 2005).
- Leadership. Leadership plays an important role and influences other practices (Nair, 2006; Tarí et al., 2007; Molina-Azorín et al., 2009; Kim et al., 2012; Gómez Gómez et al., 2015). This may lead the organization to develop quality practices in a more advanced way, which as the literature has pointed out, leads to improved results.
- Training. Firms which train their employees to a greater extent may find it easier to implement and integrate quality standard practices into their daily routines (Naveh and Marcus, 2005).
- Frequency of audits by customers. Such audits by customers may lead the firm to internalize the quality standard to a greater extent (Christmann and Taylor, 2006).
- Innovative environment. Firms faced with more dynamic environments are more likely to invest in creating a quality culture (Briscoe et al., 2005).
- System coordination with suppliers and customers. Coordinating the system with suppliers and customers increases the level of internalization (Briscoe et al., 2005; Naveh and Marcus, 2005).

This review indicates that internal drivers (for instance, a quality culture or leadership) and external ones (for instance, social pressure) may influence the level of internalization, and that there might be a connection between external and internal drivers. Based on these previous studies about internalization, internal and external drivers may have an influence on internalization (Briscoe et al., 2005; Naveh and Marcus, 2005). Besides, these studies on internalization examined internalization using one or several constructs. For instance, Naveh and Marcus (2004, 2005) used 4 constructs (2 of them could be considered internalization drivers), Briscoe et al. (2005) 2 constructs and Christmann and Taylor (2006), Nair and Prajogo (2009), Prajogo (2011), Tarí et al. (2013), Allur et al. (2014) and Atasaven et al. (2014), a construct consisting of several items. In this respect, on the basis of the work by Naveh and Marcus (2005), two constructs may be identified in order to measure internalization: daily practices and continuous improvement. In addition, one dimension may lead to the another one. Accordingly, the following hypotheses are proposed:

- H1.1. External drivers have positive effects on daily practices.
- H1.2. External drivers have positive effects on continuous improvement.
- H2.1. Internal drivers have positive effects on daily practices.
- H2.2. Internal drivers have positive effects on continuous improvement.
- H3. External drivers have positive effects on internal drivers.
- H4. Daily practices have positive effects on continuous improvement.

Studies show that the higher the internalization level, the greater the performance (Briscoe et al., 2005; Naveh and Marcus, 2005). The studies have focused on the effects of internalization processes on operation and business performance. In this regard, some of these studies have included some item related to customer or people results in the operation performance construct. Accordingly, it can be said that internalization of quality standards may lead to improved operational performance, for instance, in employee results (Allur et al., 2014; Ataseven et al., 2014) and customer results (Arauz and Suzuki, 2004; Psomas et al., 2013). Internalization means that employees apply the requirements of a quality standard to a higher extent. For instance, employees receive more training on quality and may become more involved, receive better information on

their tasks in order to perform them more efficiently, are more familiar with the quality policy, goals and documents, and may use customer information to a greater extent in order to improve quality. All this may help the organization to have better trained and motivated employees, and to better adjust to its customers' needs and expectations. This makes it possible, therefore, to improve customer results (customer satisfaction, fewer complaints, fidelity, etc.) and employee results (employee satisfaction, motivation, productivity, etc.). On the basis of this literature, the following hypotheses are proposed:

- H5.1. Daily practices have positive effects on customer results.
- H5.2. Continuous improvement has positive effects on customer results.
- H6.1. Daily practices have positive effects on employee results.
- H6.2. Continuous improvement has positive effects on employee results.

Quality management might also have some influence on environmental results, because organizations concerned about quality may reduce waste, which may in turn reduce their environmental impact. Similarly, product and process design may include environmental criteria in order to reduce the environmental footprint (Klassen and McLaughlin 1993; Handfield et al. 2001). This indicates that quality concerns may have an influence upon environmental results.

Regarding quality standards, some studies have pointed out that quality standards may have positive effects on other stakeholders, beyond employees and customers, such as, for instance, the authorities (Posinska et al., 2002). Therefore, and considering that various contributions have pointed out that quality practices facilitate the development of environmental practices (Curkovic, 2003) and socially responsible practices (Withanachchi et al., 2007), it may be suggested that higher internalization might lead to greater commitment to the environment and other social issues. These ideas make it possible to formulate the following hypotheses:

- H7.1. Daily practices have positive effects on society results.
- H7.2. Continuous improvement has positive effects on society results.

Finally, the literature appears to show that, the greater the internalization level, the better the operational and business results (Briscoe et al., 2005; Naveh and Marcus, 2005; Jang and Lin, 2008). These ideas suggest that internalization leads to improvements such as, for instance, improved quality and innovation (Nair and Prajogo, 2009), which in turn may create a more open culture that may increase sales and market share (Huarng et al., 1999; Naveh and Marcus, 2005; Nair and Prajogo, 2009). These ideas indicate that internalization may improve business results. Nevertheless, the studies on internalization have not examined the relationships between customer, employee and society results on business performance. In this regard, various works on quality management (e.g. EFQM model) have pointed out that customer, employee and society results improve business results. On the basis of the findings of other works on quality management in general, and the EFQM model in particular, it may be considered that customer, employee and society results lead to improved business results (Eskilden et al., 2000; Heras et al., 2012; Gómez Gómez et al., 2015). These ideas indicate that:

- H8. Customer results have positive effects on business performance.
- H9. Employee results have positive effects on business performance.

H10. Society impact has positive effects on business performance.

STUDY METHOD

Population and sample

The population is formed by the tourist subsectors in Spain with a greater proportion of organizations with the ICTE's "Q" quality certificate (ICTE is the Spanish Tourism Quality Institute which belongs to the Ministry of Industry, Energy and Tourism). The population of this study includes all hotels, travel agencies, restaurants, and country houses in Spain with a quality certificate (725 organizations). It was decided to study the whole population by means of a structured questionnaire with closed questions, which was sent in three waves between October 2014 and January 2015 by e-mail and by post. For the distribution of the questionnaire, support was received from the ICTE (Spanish Tourism Quality Institute), who also distributed the questionnaire among its members by e-mail. The questionnaire was addressed to the quality manager of each tourism organization.

Before the questionnaire was sent in its final format, a pre-test was done by three persons responsible for tourist organizations, representatives of different tourist sub-sectors (two hotel managers and one restaurant manager) and a consultant specializing in quality management.

Finally, a total of 287 filled-in questionnaires were received. Table 1 shows the absolute and relative frequencies of each sub-sector, both in the sample and in the population studied.

Sub-sector	Sample	Population
	(Frequency %)	(Frequency %)
Hotels	170 (42.7%)	415 (45.7%)
Travel agencies	20 (5%)	37 (4.1%)
Restaurants	54 (13.6%)	179 (19.7%)

Table 1. Absolute and relative frequencies of each sub-sector in the sample and in the population

The non-response bias was checked and the analyses showed that the sample is not affected by any non-response bias problems, which means that this group of organizations that participated in this study can be considered as representative of the population. Furthermore, the presence of common method variance was checked.

35 (8.8%)

94 (10.3%)

Variables

Country houses

External and internal drivers. Managers had to evaluate to what extent the following aspects had influenced the decision to implement the ICTE's Q certificate, in a Likert-type opinion scale, between 1 and 7 (1 if this aspect had no influence, 7 if it had a key influence). In order to measure internal and external drivers, a number of items have been identified (Table 2) from the literature review.

Internalization. In order to measure this variable, two constructs have been used (see Table 2). The construct "daily practices", consisting of 5 items, from the studies by Briscoe et al. (2005), Naveh and Marcus (2005) and Christmann and Taylor (2006), and the construct "continuous improvement" (5 items) from Naveh and Marcus (2005), Briscoe et al. (2005) and Nair and Prajogo (2009). The managers had to assess, within a 1-7 Likert scale, if their organization had adopted each practice (1=never carried out, 7=always carried out).

Customer results. A variable was used consisting of five items in order to measure the effects of internalization on the 5 customer results identified. Each item was measured with a Likert scale, from 1 (no impact) to 7 (very high impact) (Table 2). In order to identify these items, we used studies which had measured the results criteria in excellence models, such as customer, employee, society and key results (Curkovic et al., 2000; Tarí et al., 2007; Bou-Llusar et al., 2009) and specific studies on tourism (Deng et al., 2013).

Employee results. Scale consisting of six items (Table 2) of employee results on the basis of studies on quality (Curkovic et al., 2000; Tarí et al., 2007; Bou-Llusar et al., 2009) and specific studies on tourism (Yeh, 2013). The quality manager had to assess the impact of the application of the quality standard requirements on these employee results within a 1-7 point scale (1=no impact; 7=very high impact).

Table 2. Measurement model validation

	Scale items	Loadings (item	Composite reliability	AVE >0.5
		reliability >0.707)	>0.7	
External di	rivers		0.844	0.645
•	Give confidence to customers	0.815		
•	Improve public image	0.738		
•	Protection and care of the environment	0.851		
Internal dr	ivers		0.872	0.533
•	Management commitment	0.660		
	Quality culture existing continuous improvement in the organization	0.739		
	Written documentation of the work methods in the organization	0.753		
	Desire to organize and formalize in writing the working methods	0.756		
	Need for collaboration with suppliers / intermediaries	0.681		
	Innovativeness of the organization	0.784		
	tion – Daily practices	0.704	0.897	0.686
	The documents created for certification are used in daily practice	0.853	0.037	0.000
	• •	0.882		
	The quality system becomes part of daily work routines	0.002		
	All employees are trained in the notions of total quality and the requirements of the	0.720		
, ,	standard	0.730		
	The quality policy and the quality system procedures are updated in order to adapt	0.000		
tnem 1	to daily organizational practices	0.839		
	de la Contra de		0.050	0.700
	tion – Continuous improvement	0.067	0.950	0.793
	The development of the quality system makes it possible to introduce new	0.867		
	vement practices			
	The quality standard has led the organization to discover improvement opportunities	0.878		
	Investing time and resources in the quality standard is a starting point towards the			
	nentation of other more advanced practices	0.883		
	Investing time and resources in the quality standard helps to reflect on the way work is			
done i	n the firm and improve our work	0.900		
•	Investing time and resources in the quality standard is seen as an opportunity to			
innova	te in our organization	0.922		
Customer i	results	0.322	0.936	0.746
	Increased customer satisfaction	0.903	0.500	0.7 10
	Increased quality of service	0.798		
	Increased customer loyalty	0.930		
	Increased valuations in web 2.0 and social networks	0.872		
	Reduced customer complaints	0.837		
Employee i		0.037	0.952	0.768
	Increased employee satisfaction	0.900	0.932	0.708
	, ,			
	Increased employee motivation	0.888		
	Increased employee productivity	0.904		
	Improving working conditions of employees	0.882		
	Reduced absenteeism of employees	0.834		
	Reduction of employee complaints	0.849	0.555	
Society imp		0.000	0.938	0.834
	Increased environmental protection (reduction of resource consumption, pollution	0.902		
reduct	,	0.655		
	Improving the ethical behavior of the organization	0.923		
	Increased levels of prevention of risks to health and safety (risk reduction accidents,	0.915		
etc.)				_
-	erformance		0.949	0.825
	Increased market share	0.926		
	Increased sales	0.941		
•	Increased profitability	0.948		
•	Cost reduction	0.811	1	

Society results. The variable used consisted of three items (Table 2) based on quality management studies and specific studies on tourism (Tarí et al., 2007; Bou-Llusar et al., 2009; Kim et al., 2014). The managers

assessed, within a 1-7 point scale, whether there had been no impact or such impact had been a very high one.

Business performance. This is a construct consisting of 4 items, based on the contributions by Tarí et al. (2007) and Bou-Llusar et al. (2009). A measurement was made of the degree of impact of the application of the quality standard requirements (1=no impact; 7= very high impact) on these four results, using a 7-point scale (Table 2).

RESULTS

The hypotheses are tested applying structural equations models from the partial least squares approach means of the SmartPLS 3 software (Ringle, Wende & Will, 2005). All the constructs are considered as reflective variables. Item reliability, composite reliability and discriminant validity were checked (Fornell-Larcker criterion, cross loadings, HTMT ratio) to validate the measurement model (do Valle & Assaker, 2015) as Tables 2 and 3 show.

Table 3. Discriminant validity based on the Fornell-Larcker criterion for tourist firms

	External drivers	Internal drivers	Daily practices	Continuous improvement	Customer results	Employee results	Society results	Business performance
External drivers	(0.803)	_	_	_	_	_	_	_
Internal drivers	0.585	(0.730)	_	_	_	_	_	_
Daily practices	0.274	0.404	(0.828)	_		_	_	_
Continuous improvement	0.348	0.517	0.621	(0.882)	_	_	_	_
Customer results	0.488	0.500	0.366	0.514	(0.864)	_	_	-
Employee results	0.368	0.540	0.474	0.599	0.733	(0.876)	_	_
Society results	0.445	0.532	0.464	0.580	0.663	0.718	(0.913)	_
Business performance	0.416	0.432	0.370	0.529	0.763	0.687	0.620	(0.908)

Diagonal values (in brackets and bold type) are the AVE square roots. The rest of values in the matrix are the correlations between the construct. In order to test discriminant validity, diagonal values must be higher than the rest.

The hypotheses test appears in Figure 1 and Table 4, which shows R^2 , β , and the t-values after applying a bootstrap test with 5000 subsamples to evaluate the structural model. Figure 1 and Table 4 show that most of the hypotheses are supported. Hypotheses 2, 3, 4, 6, 7, 8, 9 and 10 are fully supported and H5 is partially supported. Hypothesis 1 is the only one that is not supported.

From Figure 1, it may be observed that external drivers do not account from any internalization level (daily practices and continuous improvement) in a significant manner. External drivers have a significant influence upon internal ones, and internal ones significantly account for the levels of internalization. This indicates that tourist firms that implement and certify Q exclusively due to external drivers will not succeed in internalizing the Q requirements. However, if they succeed, on the basis of such external drivers, in creating an enhanced interest in internal aspects, this is when they may improve their level of internalizations. Internal drivers do have a positive influence on internalization.

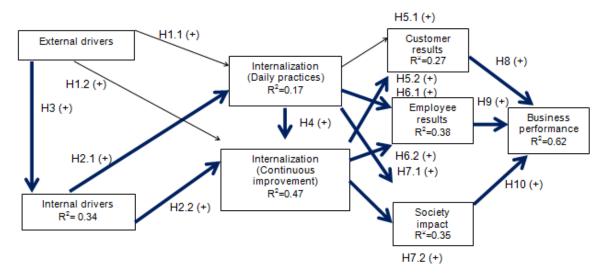


Figure 1. Results of the structural model

Table 4. Significance analysis of the structural model

Hypotheses	β	t-value	Sign.	Is the hypothesis verified?
H1.1 External drivers → Daily practices	0.057	0.825	0.205 (NS)	No
H1.2 External drivers → Cont. improvement	0.041	0.691	0.045 (NS)	No
H2.1 Internal drivers → Daily practices	0.371	5.680	0.000***	Yes
H2.2 Internal drivers → Cont. improvement	0.295	4.056	0.000***	Yes
H3 External drivers → Internal drivers	0.585	14.357	0.000***	Yes
H4 Daily practices → Cont. improvement	0.491	8.750	0.000***	Yes
H5.1 Daily practices → Customer results	0.077	1.033	0.151 (NS)	No
H5.2 Cont. Improvement → Customer results	0.466	6.423	0.000***	Yes
H6.1 Daily practices → Employee results	0.166	2.367	0.009**	Yes
H6.2 Cont. improvement → Employee results	0.496	7.672	0.000***	Yes
H7.1 Daily practices → Society impacts	0.169	1.894	0.029*	Yes
H7.2 Cont. improvement → Society impacts	0.475	5.503	0.000***	Yes
H8 Customer results → Business performance	0.527	9.577	0.000***	Yes
H9 Employee results → Business performance	0.220	4.219	0.000***	Yes
H10 Society impacts → Business performance	0.112	1.885	0.030*	Yes

*** p \leq 0.001; ** 0.001 < p \leq 0.01; * 0.01 < p \leq 0.05; † 0.05 < p \leq 0.10 (based on $t_{\tiny{10001, 9099}}$ one-tailed test) $t_{\tiny{p.001, 9099}}$ = +/- 3.092; $t_{\tiny{p.01, 9099}}$ = +/- 2.327; $t_{\tiny{p.05, 9099}}$ = +/- 1.282 Good-of-fitness model - SRMR = 0.06<0.8

In the same way, Figure 1 also shows that firms first adopt daily practices and then can move to continuous improvement. There is a relationship between both dimensions of internalization. Similarly, internalization has positive effects on customer, employee and society results which lead to business performance. In this context, continuous improvement is more important to improve results than daily practices. Daily practices impact only on employee and society results and continuous improvement has a positive effect on all performance dimensions.

CONCLUSIONS

The paper shows that internal drivers are the only ones capable of significantly explaining daily practices. In addition, some organizations focusing on external drivers can move to internal drivers and then increase their internalization levels. Second, the implementation of a quality standard may be carried out in different ways.

Some firms may show a greater commitment to the quality standard requirements, while others may be less committed, or even concern themselves only with the certificate; this may lead to either an in-depth or to a token implementation of the quality standard requirements. In this respect, daily practices have positive effects on continuous improvement. Third, a greater level of internalization makes it possible to improve the organization's management system. Such positive effects may lead to improvements in customer, employee and society results, which lead to business performance. Continuous improvement explains significantly all performance variables and daily practices explain employee results and society impacts. These studies supplement the previous literature on internalization, which has pointed out the positive effects on operational and business results (Naveh and Marcus, 2005; Nair and Prajogo, 2009) expanding these results to tourism firms.

On the basis of these results, a number of implications may be derived for managers in the tourist industry. Firstly, managers must consider the importance of internal drivers to internalize quality standards and then improve performance. Secondly, daily practices facilitate the adoption of the quality system requirements and may influence employee and society results. However, if these organizations really wish to improve their results, they must make an effort to ensure that these daily practices lead to continuous improvement, which is what will make it possible to increase the possibility of improved customer, employee and society results. These impacts may also lead to business performance. Consequently, managers and tourism planners have to reinforce the investment into practices related with continuous improvement (Figure 1) because they are the only ones capable of significantly explaining customer results.

Finally, a limitation of this study lies in the fact that it has analyzed the responses by the quality manager in various certified tourist firms at a given moment in time. Regarding future lines of research, firstly, existing knowledge could be expanded through more qualitative studies based on interviews with various managers and employees, and even other stakeholders, in order to become familiar with different perceptions of the standard and better understand the quality culture associated with the quality standard. Secondly, this type of study could be performed both on quality standards and environmental ones, which is also interesting considering the similarities between these standards and the fact that many firms have integrated quality and environmental systems. Thirdly, it may also be necessary to continue examining internalization levels and the way each level of internalization may lead to a different business result, even through longitudinal studies. Lastly, the analysis is limited to the field of tourism industry. Future studies should be extended to other important sectors in the fields of services and/or manufacture, and enlarged to international level.

ACKNOWLEDGEMENTS

This work has been carried out as part of research project ECO2012-36316, funded by the Spanish Government. The authors thank and acknowledge the support received.

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Integration of Social Topics in Quality Management Curricula

Simon, A.

Autonomous University of Barcelona Business Department, Edifici B - Campus de la UAB 08193 Bellaterra (Cerdanyola del Vallès) - Barcelona - Spain Alexandra.simon@uab.cat

ABSTRACT

Purpose- The main objective of this paper is to analyze whether and how social topics have been included in Quality Management (QM) programs in higher education. Based on a literature review on the topic, this research also aims to propose how social topics could be included in QM curricula.

Design/methodology/approach- The papers draws on the literature review to propose a model and a methodology to include social topics in QM programs. The model is based on a three-step approach for integrating QM with other areas in the organization which also have an impact on society.

Findings- The model proposes that first QM students should learn the basic approaches and tools in QM. Then, a systems approach should be used to explain how the different interrelated areas and actors of an organization have an impact on society. Finally, students should be able to understand how supply chain management requires internal alignment between all the areas and how decisions related to the supply chain impact not only the internal performance of the organization but also have social impacts.

Originality/value- This is one of the first contributions to study the introduction of social topics in QM in higher education. The main contribution is the proposal of a model to teach and include these issues in a QM university program.

Keywords: Quality Management, Social topics, Higher Education, Teaching model.

Paper type: Research paper

INTRODUCTION

The amount of attention given to social topics in the curricula of higher education Management programs has increased in recent years with an emphasis to "ethical" and "environmental" aspects. Furthermore, businesses need a corresponding ability to implement effective Corporate Social Responsibility (CSR) strategies, thus students need to be provided with the appropriate values, competencies and abilities to achieve such goal.

Quality Management (QM) is a sub discipline of the Management Science. It aims to define, set, control and improve the effectiveness of an organization within its scope and limitations. In general, research on the challenges for QM have included topics such as the lack of top management commitment, issues related to resource access, to employee involvement, cultural issues, etc. However, social issues are usually not considered as a major challenge in an efficient and successful QM implementation (Van Wessenhove, 2008). However, quality managers should be concerned about how social issues are included in their QM systems and especially they should be aware on how to integrate sustainability, human resources or health and safety issues into their QM system. Thus, including social topics in QM curricula is relevant for students who will have a professional career in QM, especially given the trend of the integration of QM systems with other systems of the organization such an Environmental Management System (EMS) or an Occupational Health and Safety Management System (OH&SMS), among others (Bernardo et al., 2009; Simon et al., 2011; 2012).

This paper addresses the fundamental concepts and principles related to the inclusion and coverage of the topics of ethics, corporate social responsibility, and sustainability in QM related university courses. Likewise, a literature review is developed to understand whether and how social topics are included in QM curricula. The main objective is to understand whether there is a trend toward the inclusion of sustainability-related topics in QM courses, whether there is an interest in these topics by university students and how higher education institutions can cover one or more of these topics in their QM curricula as well as which methodology can be used to teach these topics.

The main contribution of this work stems from its emphasis on ethics, CSR, and sustainability as distinct topics included in QM curricula. Another contribution of this work stems from its focus on the issue of the integration of these topics into the core course offerings for QM students. Integration has received recent attention from researchers and continues to be of interest to practitioners who are concerned about the integration of QM systems with other areas of the organization such as the environment, health and safety, etc. Thus, the main objective of this paper is to analyze how QM courses can integrate these topics and a systems approach is provided for such purpose.

New topics in Quality Management

QM is an area that traditionally has focused on the coordinated activities that organizations use to direct, control, and coordinate quality. These activities include quality planning, control and assurance to achieve continuous improvement. It is based on the integrated management of operations allowing a proper optimization of resources and increased efficiency in responding to customer needs (Dale, 1999). Achieving these goals requires a comprehensive analysis of the companies' operations in order to define the strategy to implement the solution best suited to the characteristics of each company. However, the global economy has led to a radical change in QM and the perception of the importance of this area. QM has become a key competitive factor, from a strategic and integrated point of view and has incorporated new concepts and management methods, such for example Total Quality Management or lean production. However, the latter are not the only challenges that QM faces. The integration of QM with new fields related to the social economy, the environment and sustainability are presented as objectives to be achieved in the near future (Kleindorf et al., 2005). Some of these new areas to be integrated with the QM field include:

1) Environmental Sustainability

Often seen as a source of competitive advantage for many companies, the definition of sustainable development depends on its applications in various fields (Hult 2011). Hart and Milstein (2003) defined sustainable development as a process to achieve inclusive, connected, equitable, prudent and safe human development, while Huang and Rust (2011) focused on the quality of the environment and conservation of natural resources. Other authors define sustainability as a trio of issues including economic viability, respect for the environment and social responsibility (Johnson 2009) or more simply: people, planet and profit (Norman and MacDonald, 2004; Markley Rountree and Koernig 2015).

QM includes the task of creating long-term strategies for suppliers, customers and employees to recognize the impact of the organization in the social, cultural and economic fields. Many companies have adopted "green" or environmentally friendly strategies in their operations and Quality Management System (QMS) as part of a focus on sustainability. These strategies seek to eliminate waste and focus the attention of the company to minimize the negative effects on the environment that reduce consumer welfare premises. The development of business policies that promote transparency are also part of the approach towards sustainability.

2) Social Responsibility

In many ways, social responsibility is related to sustainability, but this function specifically examines how the business is involved with their local community. Many companies choose to engage in activities with nonprofit organizations to sponsor local sports teams or volunteering in local schools. The QM area has the challenge to analyze how their processes and operations can be integrated with this facet of the company.

3) Corporate Reporting

Many operations and/or QM directors are responsible for preparing the corporate reports, including the collection of performance data of the processes of the organization, the communication of this information to stakeholders of the company and the management of the audits of the social and environmental practices in the organization. Using these reports allows the company to evaluate the viability and long-term sustainability of the company and its impact on the environment and society.

LITERATURE REVIEW

Teaching social topics in Management courses

Sustainable development, social impact or ethics have been important issues in research for decades, however, higher education institutions continue to struggle to find appropriate teaching strategies for incorporating these topics into their curricula.

In 2002, the United Nations General Assembly adopted a resolution naming the years 2005 to 2014 the "Decade of Education for Sustainable Development" (DESD 2005- 2014). This educational initiative calls for a reorientation of education towards goals more focused on the development of people, skills and values that support sustainable behavior, viable employment and a better quality of life (UNESCO, 2005). In addition, the initiative asks for educational programs that provide students with the information and motivation to solve global problems innovatively. It is expected that this educational initiative "generates and promotes behavioral change to create a more sustainable future in terms of environmental integrity, economic viability and a just society for present and future generations" (UNESCO 2005, p. 6). The stress of these objectives is primarily for the need for universities to develop students' social awareness and skills in sustainability.

Currently there is a significant number of studies that answer the question of whether and how social and ethical aspects in business related subjects can be taught and whether students are interested in learning

them (Evans et al, 2006; Christensen et al, 2008; Prado-Lorenzo et al., 2008, Kletz, 2009; Alonso-Almeida et al., 2015).

In fact, the amount of attention given to social topics in general and especially CSR in the curricula of various university programs varies widely (Matten and Moon, 2004; Evans et al., 2006). The study of Matten and Moon (2004) provided a review of how to teach CSR in higher education institutions in Europe and found that some, but not all business schools were taking initiatives in field of CSR, sustainability and environmental ethics to include them in their programs. The study concluded that the main drivers of these initiatives had been promoted by "individual" members of the faculty, but that the introduction of these issues had not been done in a planned or systematic way. For his part, Evans et al. (2006) analyzed over 200 MBA programs and found some institutional support for the inclusion of social and ethical issues in their curricula.

In recent years, many university programs, and in particular most of the more prestigious MBAs, have incorporated the concept of CSR in their courses, either alone or in combination with the study of ethics and sustainability related issues (Jones et al., 2007; Christensen et al., 2008; Wright and Bennett 2011). However, some authors consider it necessary to give more importance to this issue through the inclusion of these topics in education programs at undergraduate level (Gaa and Thorne, 2004; Bampton and Maclagan, 2005; Block and Cwik, 2007; Orlitzky and Moon, 2008; Jallow, 2010; Wright and Bennett, 2011).

According Fen Tseng et al. (2010), a well-designed higher education should include social and e aspects and this could help students delve into the ideas of ethics and sustainability, internalize these concepts and to enable them to have the knowledge and to find the skills necessary for employment in today's organizations, thus improving greatly their employability.

The Integration of Social Topics in QM Curricula

Globally, more and more companies and organizations are expected to behave ethically and socially responsibly. Their leaders must have the skills and abilities to address a number of issues including equity, sustainability and ethics (Pesonen, 2003; Young and Nagpal, 2013). Usually these areas fall under the OM or the QM manager responsibility. Thus, it is of vital importance to include social, ethical and environmental and sustainability topics in OM and QM curricula. Therefore, the education sector is considered to play a critical role in preparing the next generation of leaders, both through research on social issues and sustainability issues and through the inclusion of these topics in their educational and training programs (Kolondinsky et al., 2010). Education in economics and business in particular has been criticized for being too focused on the ethics of personal advantage (Owen, 2007; Kolondinsky et al., 2010). Education in social responsibility, on the other hand, focuses on the concepts outlined above and requires a deep understanding of students' opinions and values (Kolondinsky et al., 2010; Leveson Lynne, 2014).

Companies value the need for sustainable design processes within their areas of operations to reduce the environmental and social impacts of their products and processes. The need for companies to meet these imperative to respond to changes in the expectations of society obliges universities to redesign their Operations Management (OM) and/or QM curricula accordingly (Borin and Metcalf, 2010). The challenge is to provide opportunities for students to master the traditional concepts of management in general and QM in particular, and at the same time, incorporating new concepts and strategies to cope with these new challenges related to sustainability and society. This approach is in line with the topic of Integrated Management Systems (Bernardo et al., 2009; Simon et al., 2011; 2012) and it is essential for building fundamental skills that business graduates in general and Quality Managers in particular need to succeed in a wide range of organizations, from profit enterprises to social and government organizations (Bridges and Wilhelm 2008).

Despite the need to develop a QM curriculum oriented towards greater sustainability for the next generation of students, business programs in general and OM or QM programs in particular have traditionally been slow to embrace changes. The levels of knowledge and understanding of social issues and sustainability by students is low, especially at undergraduate level, largely because textbooks and classroom materials are still published without significant information on the subject (Wilhelm and Bridges, 2008; Stubbs and Cocklin, 2008).

One of the major problems with the integration of social and sustainability issues in business (Bosselmann, 2001; Haigh, 2005; Reid, 2002) and QM programs is the lack of knowledge and widespread confusion about how to do this integration and what teaching methods should be used to teach these questions. Perhaps the question is broader and becomes whether teachers want to teach QM and include issues about sustainable development and the impact on social change as well as change the educational goals and methods to achieve the inclusion of these issues in the business (McKeown, 2006) and QM subject programs.

As far as this research has been able to find, although the inclusion of social issues in Management curricula has been widely studied, the teaching of such topics in the different Management sub-disciplines, such as QM (but also other very relevant sub-disciplines such as Operations Management), has not been investigated. Thus, due to the high impact that these areas have on society, this study aims to analyze how to embrace social topics in QM programs.

PROPOSED THEORETICAL MODEL

This section proposes a methodology and a model to include social topics in QM curricula. To ensure the inclusion of social and sustainability topics in QM programs, the following aspects, based on the above literature review performed on the new challenges for QM, should be considered:

- 1. Introduce skills and competences that allow students develop internal strategies to improve operations with continuous improvement processes related to sustainability, such as the involvement of employees, reducing waste, reducing energy consumption and control emissions.
- 2. Introduce skills and competences that allow students develop strategies to improve the management of external aspects of the organization such as the topics related to supply chain management, especially in the choice of materials and processes used.
- 3. Introduce skills and competences that allow students develop internal strategies for making investments related to reducing the use of chemical pollutants during manufacturing, the development of substitutes for non-renewable energy, and the redesign of products with less content of raw materials and consuming less energy during their production and their use.
- 4. Introduce skills and competences that allow students develop strategies for the development of sustainable products, processes and supply chains in the long term that reduce impacts on the environment and improve health and safety at work. This can be included with a teaching approach focused on IMS.

One of the main aspects when dealing with social topics in QM education is CSR. CSR deals with the environment, the workplace and society. It also deals with energy efficiency, supply chain metrics, supplier engagement, reduced waste, and a strong focus on customer value, which, in the quality world, would be viewed are old challenges put in a new context.

Different scholars suggest that quality management practices facilitate the development of environmental management (Curkovic, 2003), require ethical behavior (McAdam and Leonard, 2003), need a stakeholder focus, and may facilitate the development of activities that are socially responsible (Withanachchi et al., 2007). Like CSR, quality also has a strong focus on people, not just in terms of customer satisfaction, but related to the quality of working life and employee satisfaction (Tarí, 2011).

The two disciplines also share several important concepts:

- Making hidden costs visible: From a quality perspective, hidden costs related to wasted materials, wasted energy, distracted employees, dissatisfied customers, and poorly performing products.
 Similarly, CSR might use lifecycle approaches to highlight costs buried deep in the value chain, like supplier and consumer energy use for the manufacture and operation of products.
- Corporate governance: In quality, senior management holds complete responsibility for quality problems; likewise, CSR success is directly related to CEO commitment.
- Empowerment: "Quality at the source" refers to an approach in which workers are given the authority to stop a production line if there is a quality problem or offer a customer an on-the-spot refund if the service is not satisfactory. Empowerment is also a primary pillar in promoting supply chain sustainability. The promotion of an informed, participatory workplace helps ensure fair working conditions.
- From reactive to proactive: In quality, prevention and continuous improvement are more effective than inspection. And in sustainability, supply chain monitoring approaches used alone fail to address root causes for social and environmental challenges.
- Internal alignment: According to the total quality approach, each department views other departments as internal customers, causing barriers to fall. This kind of cross-functional approach is useful in identifying and managing CSR issues. Both quality and sustainability, therefore, encourage internal collaboration both vertically (from the CEO level to the factory floor) and horizontally (across departmental areas).

There are more signs of the quality and CSR disciplines converging, for example with the publication of the ISO 26000 standard for Guidance on Social Responsibility. The international standard encourages companies to make a voluntary commitment to social responsibility and provides common guidance on concepts, definitions, and methods for evaluating those efforts. ISO 26000 defines social responsibility as the responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behavior that:

- Contributes to sustainable development, including health and the welfare of society;
- Takes into account the expectations of stakeholders;
- Is in compliance with applicable law and consistent with international norms of behavior; and
- Is integrated throughout the organization and practiced in its relationships.

ISO 26000 is an interesting standard for companies that implemented other ISO frameworks such as ISO 9001 for QM or ISO 14001 for Environmental Management (EM), among others. All these standards share the same basic principles and thus, can be easily integrated (Karapetrovic et al., 2006).

Given that both QM, EM and CSR employ a systems approach and share the same principles and values, encouraging QM students to adopt this same approach seems a good teaching methodology.

Thus, taking the systems approach into considerations, this paper proposes a three-step approach to including social and sustainability topics in QM courses, which is represented in Figure 1 below.

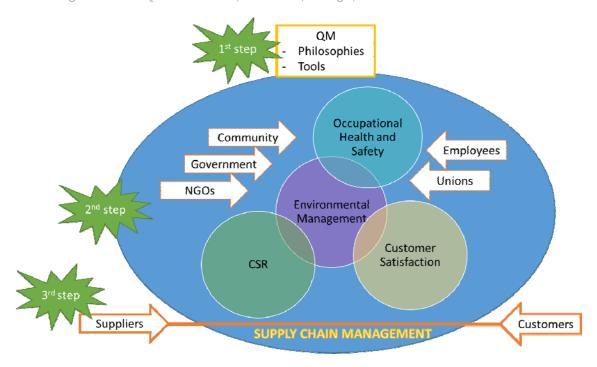


Figure 1 – Model for teaching social topics in QM.

The model proposes that QM students can begin studying the classic quality approaches and then advance naturally towards the integration of these with social and sustainability issues in order to understand the impact of the operations of the company on the different actors in the supply chain. The model includes the following steps:

- 1. Become familiar with the common QM tools (cause-and-effect diagrams, check sheets, control charts, histograms, scatter diagrams, flowcharts, etc.) and approaches (JIT, Lean, TQM, etc.) with an eye toward how to apply these to social and environmental issues. There are opportunities to create social value from existing quality methods.
- 2. Introduce an integrated management systems approach explaining how existing departments in a company such as HR, CSR, and quality are looking at similar issues with very different approaches and how different internal (employees, managers) and external actors (suppliers, customers, government, etc.) have a role in the different areas.
- 3. Understand how supply chain management requires internal alignment between all the departments in the organization and also with external stakeholders, and how decisions related to the supply chain impact not only the internal performance of the organization but also have environmental and social impacts.

To follow the model, it is important to take into account that at the intersection between many quality management approaches such as JIT, Lean, SQC or Six Sigma, there are many topics that also relate to social impacts and sustainability and which should be integrated into the quality paradigms taught in QM courses. Some examples include:

- Organizational values: when teaching socials topics related to QM, it is vital to think about the organization's core values as they relate to the five pillars of total quality: customer focus, leadership and management commitment, employee empowerment and quality culture, supplier partnership and continuous process improvement. These are values that CSR encompasses as well.
- Worker empowerment: in the QM framework, employees are expected to seek, identify, and correct quality problems. Workers are empowered by instilling quality management approaches and are

provided incentives and rewards for identifying quality problems for both internal and external customers. For CSR, inclusive models for ensuring the rights of workers in global supply chains include secure communication channels, robust grievance systems, and worker education and skills development. These are common attributes for ensuring fair working conditions in the supply chain.

- Governance: QM uses control frameworks to build systems that lead to more informed senior accountability. For CSR, partnerships with quality departments to include CSR considerations, emphasizing the "perceived quality" element of "design quality" aspects, is important.
- Health and safety: both QM and CSR are concerned with fostering a safe and healthy work environment.
- Environmental sustainability: aiming towards the improvement of environmental performance mainly in the areas of pollution control and waste minimization is an objective for both QM and CSR.

CONCLUSIONS

The QM discipline has undergone major changes in recent years with the introduction of innovations such as Total Quality Management (TQM), Just-In-Time (JIT), Business Process Reengineering (BPR), or time based competition (TBC) philosophies that must be integrated into the strategy of the company, which imply profound changes in how businesses organize their processes and operate in an increasingly globalized world. These changes involve a series of social and environmental impacts that the companies have to face.

Many companies are interested to include these social aspects in their operations and to relate their QMS to environmental and social issues. To do this they need employees trained in these questions. That is why this study has raised the need for effective educational models and tools to help implement social, ethical and sustainability topics in educational programs of higher education institutions and especially in courses designed to train future business leaders, and more particularly, operations and quality managers (Vega, 2003).

Therefore, the conclusion of this study has been to expand the perspective of QM university programs to include social and sustainability issues both in teaching and research. This research proposes a three-step approach to include social topics in QM teaching. To be competitive, higher education QM programs should significantly accelerate the scope and pace of integration of sustainability and social aspects (Van Wessenhove, 2008).

As a first theoretical approximation to the proposal of a model for including social topics in QM curricula, this paper has several limitations. First, quantitative elements to give a general idea of the numerical importance of the problem addressed are not presented in this paper and need to be developed. Second, a more accurate comparison of how social topics are included Quality Management programs in higher education with other European Countries would be desirable. Finally, the view of the actors in the labor market should also be taken into account.

For future research, taking into account the limitations mentioned above, a thorough review of the higher education QM programs should be performed, to acquire knowledge on the spread of social issues in QM university programs as well as how they are taught and thus be able to propose a methodology on how to improve the inclusion and teaching of social topics in QM. Also, some empirical research about the topic needs to be developed.

ACKNOWLEDGEMENTS

The author disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: (a) Spanish Ministry of Science and Innovation ECO2013-46954-C3-2-R Research Funding; (b) Autonomous Government of Catalonia 2014 SGR 868 Research funding.

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Knowing the element "Integration and Process Management" on Sugarcane Supply Chain

Palota, P.H.¹⁾ and Martins, M.F.²⁾

¹⁾ IFSP – Instituto Federal de Educação, Ciência e Tecnologia de São Paulo, Catanduva, São Paulo, Brasil

²⁾ UFSCar – Universidade Federal de São Carlos, São Carlos, São Paulo, Brasil

ABSTRACT

Purpose - The main objective of this work is to know the element "Integration and Process Management" applied to the production sugarcane chain.

Design/methodology/approach - This study uses a qualitative and investigative approach of multiple cases applied to a Developer of New Varieties of Cultivars, two Sugarcane Growers, two Mills and two Mill Groups in a sugarcane chain of *São Paulo* State – Brazil.

Findings - The field research returned some gaps regarding with the main practices of the element, "Integration and Process Management" from the theory of SCQM in the chain of production of sugarcane, such as: There is not the establishment of the culture of preventive actions and of the continues improvement. Lack of a more effective integration, where some shared joint actions as audits, practices of incentives, performance measures and targets, are not virtually shared with suppliers and clients. There is predominance of the Departmental Organizational Structure with integration virtually non-existent among companies' departments.

Research limitations/implications — The case study's interviews were applied to a specific region - $S\~{ao}$ *Paulo* State in Brazil. The findings of this study are limited to the case of the sugarcane chain, so can not be generalized.

Originality/value — This paper identifies some gaps regarding to the main practices of the element "Integration and Process Management" applied to sugarcane supply chain. The integration in this chain can be improved if its agents take actions in order to fill these gaps.

Keywords: Supply Chain Quality Management; Process Management; Integration; Sugarcane Chain.

Paper type: Case Study.

INTRODUCTION

Flynn and Flynn (2005) suggest that quality objectives should be added to the objectives of the (SC) and argue that the performance of the SC must be built on the based on quality. The integration of the Supply Chain Management (SCM) and Quality Management (QM), which defines the basis of the theory of Supply Chain Quality Management (SCQM), is considered very important for obtaining a better quality because they are interrelated (Rashid and Aslan, 2012).

One of the key elements addressed from the theory of (SCQM) is the "integration and process management". Gotzamani and Tsiotras (2001) state that the integration and process management is the most important contribution in the implementation of ISO 9001. Robinson and Malhotra (2005) show that this issue is related to the extent of processes to supply chain level, where process improvement is made in conjunction with partners in the chain through greater interaction with suppliers and customers. The Statistical Process Control (SPC) provides means to monitor the process and provide information to help in troubleshooting. The process management can reduce variation through practices such as stabilization of production programs and a suited preventive maintenance of equipment (Kaynak, 2003).

The three main facilitators of integration among the partners of a SC are transparent information systems, multi-functional collaboration and collaborative planning through SC (Mentzer et al, 2000; Monczka et al, 1998).

With the advent of open markets, globalization and the prices of its main products are linked to commodity exchange and futures, the chain of production of sugarcane need to be competitive in each of the chain agents, minimizing production costs to overcome the current debt.

For this, the more appropriate for the coordination / integration of production of sugarcane, the better the flow of information among its agents, minors should be the cost of production and the transactions in the chain for greater efficiency and better quality of sugarcane. Bezuidenhout et al (2012) state that there is a lack of cooperation / integration in many of the producing regions of sugarcane and that are few researchers from sugarcane available in the literature in order to explore the knowledge of collaboration/integration in this Supply Chain (SC).

In order to attend the statement of Bezuidenhout et al (2012), this work has, as a main objective, to know the element, "Integration and Process Management", when applied to the production sugarcane chain. Starting from an empirical study of multiple cases on the main agents of this chain, which are Developer of New Varieties of Cultivars, Growers and Mills.

RESEARCH METODOLOGHY

The method of this research is the case study, once a given phenomenon is investigated within a real context through in-depth analysis of the object of analysis.

The conduct of the case study involves some sequential steps as (Forza, 2002; Croom, 2005)

- Define a Conceptual Framework Theory: At this stage, it is developed a mapping of literature; propositions is delineated and the border is delimited.
- Plan the cases: It is selected the unit(s) of analysis and the contacts; the means for the collection and analysis of data are chosen; It is developed the research protocol and set up the means of control of research.

- Driving Test Pilot: At this stage, the application procedures is tested the data quality is checked and the necessary adjustments are made.
- Collect the data: came in contact with the cases interviewed; the data is recorded.
- Analyse the data: At this stage, a narrative is produced, the data is reduced and causality is identified.
- Generate Report: For this final step, the theoretical implications are drawn and a structure for replication is came up.

This study uses a qualitative and investigative approach of multiple case study in order to know the main practices of one of the element of SCQM theory, "Integration and Process Management", for some selected cases of a sugarcane supply chain. To meet this goal, it was analysed seven cases: Developer of New Varieties of Cultivars; two Growers of sugarcane (called: Grower A and Grower B); two Mills (called: Mill A and Mill B) and two Groups of Mills (called: Mill Group A and Mill Group B.

The first step of this work was to understand the origin and the main elements that make up the theory of SCQM. The second step was to identify the main practices of the element, "Integration and Process Management", in order to assist in preparing the fieldwork script.

The third step was to identify the contacts in the companies that opened the doors to the field research. This was the main criterion used. Among the companies that offered opening, it was chosen those, except in the case of the grower A and Developer of New Varieties of Cultivars, which had some kind of implemented quality management system.

The field research was mainly focused on knowing the element "integration and process management" applied to the chain of production of sugarcane, selected for field research.

It was established dual cases for the units of analyses of Sugarcane Growers, Mill and Mill Groups due to the greater complexity that involves these units in the author's view. The dual cases enable data crosses through comparative analyses in order to identify differences and similarities of the practices of the element "Integration and Process Management" from the theory of SCQM.

The fourth step was to create research roadmaps based on the main practices of the element "Integration and Process Management" that belongs to the theory of SCQM.

The criterion for the selection of interviewed was established considering persons who have knowledge related to quality and the various production processes of each unit of analysis. Follow the planning for interviews of each units of analyses: Developer of New Varieties of Cultivars (Executive Director); Grower A and Grower B (Owners); Mill Group A (Production Manager); Mill Group B (Quality Manager); Mill A (Quality Supervisor and Industrial Director); Mill B (Quality Supervisor).

The fifth step was carry out the interviews with the contacts of the research planning of each unit of analysis of the SC.

The last steps were to analyse the results and to accomplish the research report.

RESULTS

This topic shows the origin and the main elements that make up the theory of SCQM, followed by a synthesis and an analysis of the results found in field research cases.

Theoretical Background

QM and SCM are extensively researched by the literature, but very few studies exist examining them together (Robinson and Malhotra, 2005). The ultimate goal of them is the achievement of continuous improvement of the organization's performance and the consequent customer satisfaction. The union of the forces, the joint

application of these concepts, would bring greater results compared the application of managements in an isolated manner (Ramos et al, 2007). The authors show through Figure 1 common areas of these managements.

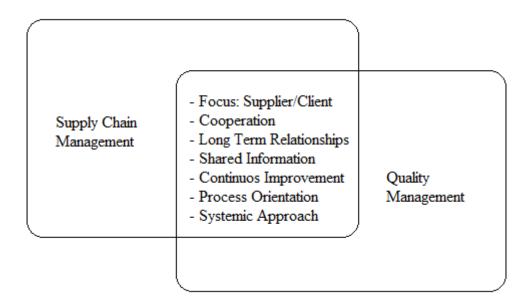


Figure 1 - Overlapping the fields of managements (Ramos et al, 2007).

Many companies today are embracing the concepts involved in the supply chain (SC) as a strategy for your business, creating a new challenge for the management of quality, where much attention has been given to the supply chain management (SCM) and very little to their interaction with the quality management (Mahdiraji et al, 2012).

For Robinson and Malhotra (2005), quality practices should migrate from traditional concept, which has the product as focus and more intra-organizational, to a more open and broad inter-organizational mindset in SC involving suppliers, customers and other partners of the SC. An effective system of quality management (QM) is of fundamental importance for the supply of products and higher quality services for customers (Zu and Kaynak, 2012), where the construction of such a structure, it is more complicated to perform the implementation of an appropriate QM within a single organization.

Given this new scenario, Kaynak and Hartley (2008) suggest that managers must have a vision focused on managing the SC. Flynn and Flynn (2005) suggest that quality objectives should be added to the objectives of the SC and argue that the performance of the SC must be built based on quality. To Flynn and Flynn (2005), there is a strong relationship between quality management practices and performance measures established in the supply chain and, when managers identify this relationship, they will be able to achieve more benefits and gains in process management.

The integration between SCM and QM is considered very important for obtaining a better quality because both are interrelated (Rashid and Aslan, 2012). However, for this to happen, various companies that make up the SC should develop practices that are interconnected and based on collaboration, communication and participatory integration in quality improvement processes across SC in order to supply products and services with the quality required by the customer (Sun and Ni, 2012). Sun and Ni (2012) also concluded that a lack of integration between partners through SC could affect the quality practices and the performance of the manufacturer. Quality is not obtained only by the manufacturer, but by the contribution of all the links' agents that make part of SC that are involved with the product or service as well.

Lin, Kuei and Chai (2013) identified some elements of SCQM, such as integration and management process; Structure and Strategy for Quality; Focus on Consumer and Market; Management Relationship with Suppliers; Innovation and product design; People management; Data and Quality Reports and Quality Tools.

Integration and Process Management

Organizations need to review and improve processes continuously in order to reduce errors (Chow, Lui, 2003). The process control is critical to the success of SC and can be achieved through performance measurement of SC (Gunasekaran et al., 2004).

A synchronous connection between different processes and / or operations is considered critical for efficient SC (Robinson and Malhotra, 2005). A subject much discussed by researchers is the close interaction between customers and suppliers by coordinating working practices as extend customer limits and supplier (Salvador et al, 2001; Romano and Vinelli, 2001; Singer et al, 2003). Beamon and Ware (1998) supports the goal of that quality initiatives can not be static and located, but must interact and synchronize with the entire network of SC companies. The integration of processes with suppliers is an important aspect of SCM (Robinson and Malhotra, 2005).

The traditional view of management companies is functional/departmental structure that has the advantages of being easy to assign tasks and charge responsibilities due a clear division of tasks. The other advantage is in favouring specialization, technical competence and specific knowledge for each area. However, this view tends to favour specific departments of the company over to a more holistic view of the organization, to foster the appearance of departmental barriers, not to favour the learning of all and not be guided to external customer (Toledo et al, 2013). Other barriers to the management of SC fall on the management complexity or misalignments of the processes, structures and culture of companies (Park and Ungson, 2001).

The theoretical research lead to the application of some practices from the element of "Integration and Process Management" as follow on the Table 1.

Table 1- Main Practices related to the Element "Integration and Process Management".

Practices	Authors			
Control and Improve Continuously the Processes.	Chow and Lui (2003); Gunasekaran et al.			
	(2004); Flynn and Flynn (2005); Park and			
	Ungson (2001).			
Coordinate/Integrate/Synchronize the different	Robinson and Malhotra (2005); Salvador et al			
Processes Extend to Clients and Suppliers.	(2001); Romano e Vinelli (2001); Singer et al.			
	(2003); Beamon and Ware (1998); Segars et al			
	(2001); Mehra et al (2001); Ahire and Dreyfus,			
	(2000).			
Manage Internal Processes in an Independent	Toledo et al (2013); Robinson and Malhotra			
Way (Multifunctional Structure).	(2005); Park and Ungson (2001).			

Case Study

The main objective of this work is to know the element "Integration and Process Management" applied to the chain of production of sugarcane in order to identify the main gaps in the practice of this element the "light" theory (SCQM). For achieving this, an investigation of the main practices of the element "Integration and Process Management" was made as (Table 1) by means of the execution of interviews in the main agents of the production chain of sugarcane. It was investigated two producers of sugarcane, two mills, two groups of mills and a developer of new varieties of Cultivars.

The following questions were used in the field interviews for each case:

- There are criteria for managing and controlling production processes.
- Deviations are formalized, measured, monitored and communicated to managers, suppliers and clients in order to accomplish the corrective and preventive actions and process improvements.
- The organizational structure of the company is departmental or multifunctional.
- There is collaboration / integration between departments of the companies.
- The responsibilities, gains, losses, performance measures and the goals are shared within the company and with suppliers and clients.

A - Developer of New Varieties of Cultivars

The Developer has the main objective to make genetic improvement of sugarcane, producing new cultivars with agronomic, industrial and energy characteristics for commercial planting in order to increase the efficiency and competitiveness of the energy sector in agro self-sustainable and renewable system.

The cultivar Developer team consists of about 142 researchers, 83 technicians and 21 experimental stations. It is responsible for supplying 65% in area of varieties of sugarcane that are cultivated in Brazil, which represents about 9 million hectares.

It is experienced about 2,000,000 clones a year, in various stages of selection and environments of sugarcane regions of Brazil.

Commercial varieties with genetics and phytosanitary purity of early, medium and late ripening are developed in order to embrace the total period of harvest that goes from the beginning of April to November of each year.

Table 2 shows a summary of findings in the case regarding the main practices of the element "Integration and Process Management".

Table 2 - The main finding practices on the case of developer of new varieties of cultivars.				
Practices:	Findings			
Control and Improve Continuously the	Production processes without specification. Deviation			
Processes.	treated without a preventive culture.			
Coordinate/Integrate/Synchronize the different Processes Extend to Clients and Suppliers.	There is no sharing of responsibilities, gains, losses, performance measures and goals with suppliers and clients.			
Manage Internal Processes in an				
Independent Way (Multifunctional	Departmental Structure without Integration.			
Structure).				

A.1 - Case Analysis - Developer of New Varieties of Cultivars

The processes do not have specifications. The lack of appropriate standards for releasing new varieties inhibits the improvement process on the development of new varieties of cultivars.

There is no integration between suppliers, farmers and the Developer of New cultivars Varieties in order to obtain improvements in the development of cultivars that add greater value to farms in producing sugarcane. Relationships require greater integration between its agents, as each agent looks for its own needs of an isolated/non-integrated manner.

Internal processes are governed by a departmental organizational structure, which do not help integration.

B - Growers

The Grower of sugarcane A plants about 72 hectares per year and produces about 25,000 tons per year. The producer has no internal and external certification.

The Grower B plants about 8,600 hectares of sugarcane per year, with approximately 5% of its own land, and produces approximately 600,000 tons of sugarcane per year. The producer is certified as a supplier of a large plant, located in the central region of the *São Paulo* State. The Grower is audited by three annual external audits: one of the mill (first layer client) and Coca-Cola and Nestle (second layer clients).

Table 3 shows a summary of the return of the field interview regarding the main practical element "Integration and Management by Process" in Growers.

Table 3 - The main finding practices on the case of growers.

Dunation	Findings				
Practices:	Grower A	Grower B The sugarcane production processes are formalized and monitored. Predominance of corrective actions. Lack of actions for continuous improvement.			
Control and Improve Continuously the Processes.	Production processes are not specified. Corrective actions are sporadic. Lack of actions for continuous improvement.				
Coordinate/Integrate/ Synchronize the different Processes Extend to Clients and Suppliers.	There is no sharing of information with suppliers and clients.	There is no sharing of information with suppliers.			
	Lack of joint actions for troubleshooting.	Lack of joint actions for troubleshooting with suppliers.			
Manage Internal Processes in an Independent Way (Multifunctional Structure).	Family / Departmental organizational structure. Polyvalence of activities in the different processes.	The organizational structure is multifunctional. There is sharing of information among the company' departments.			

B.1 - Case Analysis (Growers A and B)

Grower B has a multifunctional organizational structure in his processes and has a structure and strategy to quality implemented, which passes through audits of the first layer of clients (mill) and the second layer. Grower A has a family/departmental structure and do not have production processes specified, controlled and monitored for taking corrective actions for deviations, although there is not the dissemination of a preventive culture.

Both Grower A and B do not share information with their suppliers in order to take joint actions to improve the quality of sugarcane produced in order to gain farm productivity. Once they do not make use of performance indicators to assess the quality of their suppliers, do not practice quality audits on suppliers and do not practice any kind of incentive to their suppliers.

Grower A seeks for meeting the minimum requirements for the supply of sugarcane to your client with a basic internal management to the industry's activity without integration with its links both upstream as downstream of the farm. While Grower B seeks for sharing information with his client in order to keep the sugarcane quality.

C - Mill Groups

Mill Group A has four plants of industrial production units of sugar and ethanol in four different municipalities of São Paulo - Brazil. The unit belonging to the respondent has a milling capacity of 11 million tons per year, producing daily 750,000 litres of ethanol and 1,900 tons of sugar.

Mill Group B produces about 2.1 billion litres of ethanol and 4.1 million tons of sugar per year. Group B invests in renewable energy sources using by-products of sugarcane (bagasse and straw) to produce second-generation ethanol (ethanol produced from raw material cellulose from by-products of sugarcane - bagasse and biomass).

Table 4 shows a summary of the return of the field interview regarding the main practical element "Integration and Management by Process" in Mill Groups.

Table 4 - The main finding practices on the case of mill groups.

	Findings			
Practices:	Group Mill A	Group Mill B		
Control and Improve Continuously the Processes.	The sugarcane production processes are formalized and monitored.	The sugarcane production processes are formalized and monitored.		
	Only sporadic corrective actions. Lack of actions for continuous improvement.	Predominance of corrective actions. Lack of actions for continuous improvement.		
Coordinate/Integrate/ Synchronize the different Processes Extend to Clients and Suppliers.	There is no sharing of information with suppliers and clients.	There is sharing of information with suppliers and clients.		
	Lack of joint actions for troubleshooting.	Joint actions for troubleshooting with suppliers and clients.		
Manage Internal Processes in an Independent Way (Multifunctional Structure).	Multifunctional organizational structure. Polyvalence of activities in the different processes.	The organizational structure is multifunctional. There is sharing of information among the group mill' departments.		

C.1 - Case Analysis - Mills (Groups A and B)

The groups of mills A and B have multifunctional structure and strategic to quality defined with an establishment of a planning for quality with long-term targets set. The processes are specified, formalized, controlled and monitored in order to take corrective actions for deviations, however there is not the dissemination of a preventive culture for continuous improvement.

A differential of group B, when compared with group A, is the sharing of joint actions with suppliers and clients in order to solve problems for improving the quality, efficiency and productivity of sugarcane supplied. Once

Group B uses performance indicators to assess the quality of their suppliers, practice quality audits on suppliers and practice incentive to their suppliers as training and technical assistance.

D - Mills

The Mill A was the pioneer in the production of sugar in the northwest of São Paulo State and its mission is to produce sugar, ethanol, electricity and yeast for the domestic and foreign markets. Currently, it processes 2,300 tons of sugarcane per year, with capacity to process up to 2600 tons and produces 150,000 tons of sugar per year.

The Mill B's mission is to produce sugar for the domestic and foreign markets, and to produce ethanol and electricity for domestic market. Currently, it processes 4.5 million tons of sugarcane per year, but its capacity is to process up to 5.5 million tons. Currently, it produces 400,000 tonnes of sugar per year.

Table 5 shows a summary of the return of the field interview regarding the main practical element "Integration and Management by Process" in Mills.

Table 5 - The main finding practices on the case of mills

		Findings			
Practices:	Mill A	Mill B			
Control and Improve	Standard Operating Process (SOP).	Standard Operating Process (SOP).			
Control and Improve Continuously the Processes.	There is monitoring for corrective actions. Lack of actions for continuous improvement.	There is monitoring for corrective actions. Lack of actions for continuous improvement.			
Coordinate/Integrate/ Synchronize the different Processes Extend to Clients and Suppliers.	There is no sharing of responsibilities and information with suppliers. There is sharing of responsibilities and information with clients.	There is no sharing of responsibilities and information with suppliers and clients.			
Manage Internal Processes in an Independent Way (Multifunctional Structure).	Organizational structure is Departmental. Reduction of barriers by reducing human resources.	Organizational structure is Departmental. Reduction of barriers by the proximity of familiar management.			

D.1 - Case Analysis – Mills (A and B)

The mills A and B have departmental organizational structure and strategic for quality defined, but without the establishment of long-term targets set. The processes are specified, formalized, controlled and monitored for taking corrective actions for deviations; however, there is not the dissemination of a preventive culture for continuous improvement.

Both mills have relationship problems with suppliers with a predominance of relationships marked as being purely commercial in which there is not exchange of information in order to shared joint actions that could

provide improvements in quality and efficiency. There is not a management of the data related to suppliers with the establishment of goal and a planning of actions to reach it.

AKNOWLEDGEMENTS

The authors thank the Institutions that supported this research.

CONCLUSIONS

The main objective of this study was to know the element, "Integration and Process Management", applied to the production chain of sugarcane through an empirical study of multiple cases in the main agents of this chain.

The field research returned some gaps relations with the main practices of the element, "Integration and Business Process Management" from the theory of SCQM in the chain of production of sugarcane, such as:

- Regarding with the practice of "Control and Improve Continuously Processes", was observed that any deviation of the production processes of sugarcane, from the development of new varieties of cultivars to the processing of sugarcane in the mills, are treated correctively. There is not the establishment of the culture of preventive actions and of the continues improvement.
- Related to the practice, "Coordinate / Integrate / Synchronize different Processes with Extension to Clients and Suppliers", the responsibilities, gains, losses, performance measures and targets are not virtually shared with suppliers and clients in the links of agents selected for this research.
- While for the practice, "Manage Internal Processes in an Independent Way (Multifunctional Structure)." showed that there is a predominance of the Departmental Structure with integration virtually non-existent. Although the need to reduce human resources, fostered by the crisis in the sector, has helped in breaking down departmental barriers.

The predominance of a functional/departmental structure of management, on the organizations investigated, do not favour the learning of all and is not guided to external customer.

The missing of a more effective integration with extension to clients and suppliers can render less efficient the working practices on the sugarcane supply chain. Some shared joint actions, like: audits on suppliers, use of performance indicators to assess the quality of the suppliers and the quality of products on clients, practices of incentives to suppliers and the incentives from the clients to production can improve the integration and the efficiency among the agents of the sugarcane SC.

The integration of processes involving the production chain of sugarcane would be improved if actions were taken towards to fill the findings gaps in this field of research.

This work is limited to a specific region - São Paulo State in Brazil.

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The experience on management systems certification as an enabler for social responsibility external assessment

Aguilar Rosado, N.¹⁾, Bernardo, M.¹⁾ and Tarí, J.J.²⁾

Department of Business, Universitat de Barcelona, Av. Diagonal, 690, 08034 Barcelona (Spain)

²⁾ Department of Business Management, University of Alicante, Campus de San Vicente del Raspeig, Ap. 99, 03080 Alicante (Spain)

ABSTRACT

Purpose - The aim of this paper is twofold. Firstly, to propose an external assessment model for the United Nations Global Compact (UNGC) based on a literature review. Secondly, to test the acceptance of the model using a sample of organizations of the Spanish UNGC Network.

Design/methodology/approach – A literature review search has been conducted for the first aim and 36 papers were analyzed in-depth. For the second aim, 74 valid questionnaires were analyzed to know the level of acceptance and importance of the model proposed by the Spanish UNGC Network organizations.

Findings – A model proposal based on the Communication of Progress external assessment has been presented. Its empirical test shows that organizations of the sample present a higher level of acceptance of the model, but no differences between organizations with certified and not-certified management systems (MSs) have been found. The main advantages of the model are to improve UNGC transparency and compliance, eliminating criticisms about the lack of credibility. However, despite the model implementation is voluntary; it implies some costs to involved parties. Implications for organizations, United Nations and governments are proposed based on these findings.

Originality/value –This work contains one of the first models proposing a detailed UNGC reporting verification process and tests its acceptance empirically.

Keywords: corporate social responsibility, external assessment, Global Compact, model, management system certification.

Type of paper: Research paper

INTRODUCTION

The United Nations (UN) determines that companies, as the main driver of globalization, can help ensuring the growth of markets, commerce, technology and finance, so that both economies and worldwide societies benefit from them (UNGC, 2014a), and also share technological advances and good management practices to safeguard the interests of consumers and users (ISO, 2014), such as Social Responsibility (SR).

According to the Commission of the European Communities (2001), corporate social responsibility (CSR) can be defined as "a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis" (see Dahlsrud, 2008, for an indepth analysis of the concept definitions).

According to Aras and Crowther (2008), the main reason why companies have chosen to participate in CSR is not just competition. Customer expectation goes beyond product costs, focusing on quality, an adequate production process and the environment. However, the image improvement remains an important factor (Arevalo et al., 2013). More and more, CSR is important for organizations and is considered as a strategic aspect for a future sustainability (Lacy and Hayward, 2011).

There are several tools companies can implement to manage CSR but one of the most implemented is the United Nations Global Compact (UNGC). According to the available data, in 2011, more than 10,000 organizations in 145 countries signed the Global Compact (UNGC, 2012). Although a variety of aspects could be analyzed regarding this tool, e.g., the implementation, stakeholders' involvement and benefits (Thérien and Pouliot, 2006; Cetindamar and Husoy, 2007; Perez-Batres et al., 2012; Arevalo et al., 2013; Ortas et al., 2015), one that has been discussed in the literature is organizations' compliance with the tool.

In this regards, organizations have pressure to adopt CSR and this could lead to a conditioned commitment and in some developed countries, to hypocrisy in the adoption (Lim and Tsutsui, 2012). Focusing on the UNGC, Garayar Erro and Calvo Sánchez (2012) state that although the Global Compact (GC) is a voluntary tool, it has several criticisms, being the lack of transparency in compliance, as it is based on a self-assessment report, as well as the lack of an external assessment proving the participants' commitment, the focus of criticism (see e.g., Kell, 2005; Thérien and Pouliot, 2006; Heras-Saizarbitoria et al., 2013).

Taking into account the aforementioned, the aim of this paper is twofold. Firstly to propose, through a literature review, an external assessment model for the UNGC. Secondly to test the acceptance of the model proposed using a sample of organizations of the Spanish UNGC Network. Although several studies have claimed for the need of external assessment, this is, to the best of authors' knowledge, one of the first papers proposing a model for this assessment.

LITERATURE REVIEW

The UNGC, promoted in 1999 by Kofi Annan, is an "a strategic policy initiative for businesses that are committed to aligning their operations and strategies with ten universally accepted principles in the areas of human rights, labor, environment and anti-corruption. By doing so, business, as a primary driver of globalization, can help ensure that markets, commerce, technology and finance advance in ways that benefit economies and societies everywhere" (UNGC, 2014a).

It is an initiative with the support and participation of multinational companies, global trade associations and civil society organizations (Cetindamar and Husoy, 2007). Since then, the UNGC has become an international network

of organizations, which contribute to dialogue, learning and projects that give practical meaning to the Ten Principles of the GC (Kell, 2005) grouped into four main dimensions: human rights, labor rights, environment and anti-corruption (UNGC, 2014a). The initiative seeks to combine the best properties of the UN, such as moral authority and convening power; with the private sector's solution-finding strengths, and the expertise and capacities of a range of key stakeholders.

According to the literature review, the UNGC is not a regulatory instrument, so it does not exercise oversight functions, does not impose criteria and evaluates the behavior or actions of companies (Kell, 2005).

Regarding its assessment, the GC has developed internal and self-assessment tools to measure participant commitment (UNGC, 2014a). It is important for this study to focus on the following tools: 'The Differentiation Program' and 'The UNGC Management Model'.

The Differentiation Program categorizes organizations depending on the development in progress regarding implementation of the ten principles in their organizational practices related to the transparency and disclosure (UNGC, 2014b). The categorization was on three levels, "based on a self-assessment of the COP's content" (UNGC, 2014a): learner, active and advanced. 'GC learner' groups those COPs that are not meeting all the minimum requirements and have 12 months to complete it (the updated version of the UNGC has eliminated this level but it is important to understand the model proposed). 'GC active' groups those COPs meeting all minimum content requirements. 'GC advanced' is built up with those COPs meeting all minimum requirements and providing information on the implementation of the principles into the strategy and operations, taking actions supporting UN goals and regarding sustainable governance and leadership (UNGC, 2014a). The absence of this annual communication would result in removing the organization from the active participants list (UNGC, 2014a).

The Global Compact Management Model seeks to support the efforts of organizations to include corporate sustainability through the integration of the GC commitment into their culture and practices. The model guides companies through the process of formally committing to, assessing, defining, implementing, measuring, and communicating a corporate sustainability strategy based on the GC and its principles. It is important to mention that this is a dynamic and continuous process designed to assist companies in achieving higher levels of performance over time (UNGC, 2014c).

Although the program proposes an assessment, the existing literature discusses the fact that the program has not an external monitoring. For example, Kell (2005) argues that the GC is a "bluewash" and to ensure its future, the program should improve accountability and transparency, internalized and diffuse the principles and increase collaboration, among other actions. Nason (2008) forecasted a threaten future if the admission process does not change and no performance requirements are determined. The author recommends increasing the quality of participants and not the quantity to avoid failure (see also, Garayar Erro and Calvo Sánchez, 2012). Arevalo and Aravind (2010) analyze the adoption of principles during a crisis period concluding that organizations should have a proactive approach in order to avoid "bluewashing" behaviors. More recently, Prakash Sheti and Schepers (2014) argue that the UNGC is more focused on increasing the number of participants and is dependent of large companies. There is no assurance of self-reports of voluntary compliance that leads to decrease credibility. The authors state that if there is no change that could enhance verifiable transparency, the program should disappear. On the contrary, Garsten and Jacobsson (2011) discussed that the simplicity of formal accountability, such an audit, is not able to capture the complexity of ethics.

Rasche (2009) argued that the UNGC is a supplement to missing regulations and not a compliance mechanism although verification could be achieved by, e.g., developing indicators. He proposed that managing growth and diversity, including financial markets and strengthening accountability, the GC development could be improved. In order to sanction not compliance, the adherence process should be modified and this is something that the UN is

not going to accept, thus, the program should be considered as a learning network to include the ten principles into organizations' activities and an accountability standard of common terminology. Rasche and Gilbert (2012) classified the UNGC as a multiactor, multilevel and network based governance tool. To improve its implementation, the authors suggest, among others, that higher performers' organizations should be rewarded and that benchmarking should be done through external parties. Rasche et al. (2013) propose different stages to impact assessment of the GC, although it cannot be measured in isolation. According to them, first a representative panel of participants should be asked and then apply case-based qualitative methods to search for changes in practices done.

Arevalo and Fallon (2008) claim for a realistic assessment to gain credibility as the self-assessment and membership fees are not helping the participants in achieving greater efficiency, accountability and effectiveness. Janney et al. (2009) conclude that COPs transparency is different based on stakeholders' interest. Failing to complete them is seen as negative by the market, thus, organization can create transparency by improving the quality of information and third-party affiliation. In the same line of reporting, Berliner and Prakash (2014) argued that the UNGC has a design problem as the COP is not monitored by external stakeholders. Thus, organizations are not complying with the program and this is not improving their CSR performance (similar conclusions are from Rasche and Waddock, 2014). An additional aspect to consider is that according to Runhaar and Lafferty (2009), in certain sectors the impact of UNGC is marginal because is not industry-specific and is not stimulating to perform better as COPs are not assessed. One of the ways proposed by the authors to use GC to develop strategy is having a proactive attitude in reporting.

Williams (2014) valued the GC as a work in progress that brings together business and civil society for sustainable economy. Berliner and Prakash (2015) also conclude that the UNGC should be the first step to a more robust program. According to these authors, in the current version, the participants are more focused on the benefits gained by the membership (Berliner and Prakash, 2012) than on fulfilling the obligations and thus, their motivation to comply decreases. Thus, an optimal monitoring is needed to avoid the program being considered as a "bluewashing" tool. Carasco and Singh (2008) are in favor of regulation but the participants' different views of obligations are a barrier, as commented also in Haack and Scherer (2014), who differentiate between two CSR initiatives: "strict fathers" and "natural parents". The former refers to the discipline, a single authority controlling and punishing noncompliance that could mean difficulties to adopt the initiative limiting the participants and hindering innovation and learning. The later refers to moral governance based on empathy that allows learning and more participation, although the commitment can be hypocrite in the beginning.

Some authors, like García and Rodríguez (2009), Rasche and Kell (2010) and Balzarova and Castka (2012), highlighted that having experience managing other management systems (MSs) can help in adopting new systems. In addition, organizations that implement MSs such as ISO 9001 and ISO 14001, could easily implement CSR practices (Tarí, 2011).

According to the abovementioned, two research questions can be posed:

RQ1: Can a model that could propose an external assessment of UNGC compliance based on COPs verification be created?

RQ2: Have the organizations with implemented and certified MSs a higher willingness to accept the external evaluation model?

METHODOLOGY

The first aim of this work has been achieved thorough a literature review. The review was conducted using three databases: Web of Knowledge, Emerald Insight and Scopus. In order to avoid missing any paper analyzing a UNGC external assessment, UNGC was the only key word used for the search. The inclusion criteria were only analyzing papers published in peer review journals both empirical and theoretical. The aim was to analyze the assessment but also other factors that could condition it, such as the reasons for the implementation, benefits, advantages and disadvantages and models for the assessment. Regarding the exclusion criteria, books, reviews, press, conference proceedings or not available papers were not analyzed. 176 papers were obtained and after reading the abstracts, 81 papers were analyzed more in-depth. After discarding duplicity and focusing on those papers based on the topic searched, 36 papers were considered for the final revision.

The second aim's methodology was a structured survey. It was sent to the Spanish UNGC participant organizations in February 2014. At this date, the total of participants was 2,876 organizations. The contact information was obtained building a data base founded on the published name list of organizations participating on the Spanish UNGC web site (www.pactomundial.org) and manually searched each web site using internet search engines, then accessing to them, obtaining 477 contact information data, which was this work's population, while the final sample was 74 valid responses (16% response rate). Data analysis was performed by using crosstabs, which allowed analyzing the relationship between two qualitative variables (Coenders et al., 2009). A p-value of 10% has been accepted as significant for all the analyses.

RESULTS

This section is divided into the model proposal presentation and the empirical testing for its acceptance.

A proposal of an external assessment model for the UNGC

The model proposed follows Wilenius (2005)'s requirements to adopt CSR practices within an organization and the GC Management Model, and it is based on the model suggested by Franceschini et al. (2011). According to Wilenius (2005), organizations need to (1) make a commitment (through an annual report), (2) specify objectives to achieve, and (3) implement a management system containing indicators that allow stakeholders to observe social responsibility organizational behavior. UNGC meets Wilenius (2005) steps 1 and 2 in order to be adopted by an organization. However, is step 3 the one not applied but necessary in the process of joining the GC. Regarding GC Management Model, the UNGC suggests the external assessment is voluntary and the model proposed in this paper (figure 1) is modifying this GC Management Model to include an external assessment within the "Measure" section.

Thus the model proposed may increase the UNGC reliability and verification of the information published by participating organizations in the COPs. The model proposed is based on an existing model proposed by Franceschini et al. (2011). Their model pretended to be an "incentive model" for the "autonomous growth of diffusion and credibility of the ISO 9000 national quality certification system" (Franceschini et al., 2011). The proposal considered as main characters the certified organizations and certification bodies, and defined the process each agent needs to perform in order to be active in the certification system. The present proposal for the UNGC external assessment adapts Franceschini et al. (2011)'s model for organizations and bases the compliance on the COPs verification through a third-party. The starting point is the presentation of the COP after the first year of adhesion (COP₁) and this report should be externally assessed.

If the COP₁ assessment determines compliance, participant will upgrade to GC Active level (right side of figure 1). One year later, the organization needs to disclose COP₂ and it will also be externally assessed. If the result of the assessment is positive, the organization will upgrade to GC Advanced level and this proofs commitment enough that jointly with the continuous improvement within the organization, the following COP (COP₃) will be presented after three years. This process will be repeated if the external assessment of the specific COP is positive. If one COP is negatively assessed, the organization will return to the GC Active level and follow the appropriate steps to improve. During this period, internal self-assessment should be performed at least once a year. However, if the external assessment results in noncompliance of the COP₂, the organization would have to return to the Learner Platform to meet the requirements and comply with the external assessment again.

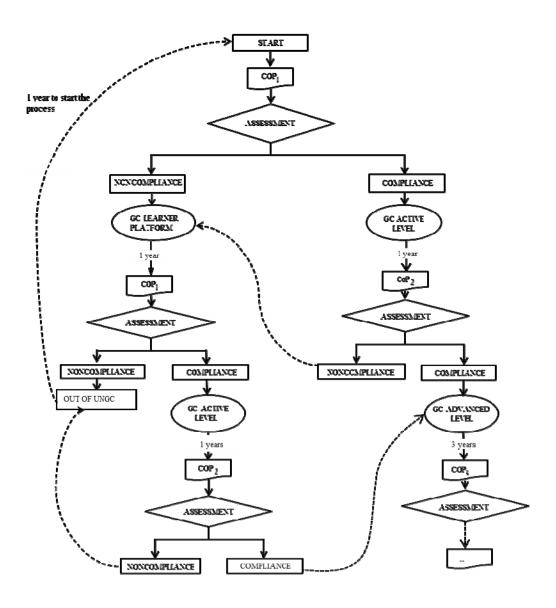


Figure 1. Differentiation program modification

Source: Own elaboration adapted by Franceschini et al. (2011)

On the other hand (left side of figure 1), if the assessment of COP₁ determines noncompliance, participants will be classified into the Learner Platform for a year. After this period of time, the organization will present again COP₁, and the external assessment will be performed. If COP₁ is conformance, the organization will be upgraded to the Active level for a year and after this period, it has to present COP₂. If COP₂ assessment is positive, the organization will be upgraded to the Advanced level and will be evaluated every three years (during this period, internal self-assessment should be performed at least once a year). If the COP₂ does not comply with the assessment, the organization will have to leave the UNGC for a year because is the second noncompliance since adhesion.

On the contrary, if COP₁ does not meet the requirements, it will be the second time with a noncompliance and the organization will have to leave the UNGC for a year. After this period of time, the organization can present a new application.

Empirical test for the model acceptance

Results of the empirical test of the model acceptance are presented in table 1. According to them, although the great majority of organizations accepts the model, there are no significant differences between those organizations with MSs and those without MSs implemented and certified. However, the results are interpreted in order to shed some light on the participants' opinion about UNGC external assessment.

In order to analyze the relationship, two variables are used. First MSs already implemented and certified in the participant organizations. Most of these organizations have implemented the ISO 9001 or its combination with ISO 14001 (there have not been detected any organization that only has ISO 14001). Because the aim was to differentiate between certified and non-certified organizations, it was decided to split this variable into two categories: (1) organizations that have implemented MSs and (2) organizations that have not.

The second variable is related to the participants' willing to implement the proposed model. In order to obtain detailed information, organizations where asked to evaluate specific mechanisms: internal and external assessment, third-party validation, valid assessment for 3 years, corrective actions, and suspending participation when non-complying.

Participants valued first the acceptance of the model (Yes/No) and then the importance of each mechanism using a 1-5 Likert scale (where 1 means "not important" and 5 "very important"). In order to ease the presentation of the results, 3 categories were created: 1) 'not important', built up with categories 1 and 2; 2) 'important, considering category 3, and 3) 'very important', built up with categories 4 and 5.

Table 1 summarizes the results. As commented previously, all participants value positively the model proposed and in all mechanisms the acceptance is higher than the non-acceptance. Regarding the importance given to each of these mechanisms, all of them are valued as 'very important' with more than 50% of the answers; it is only lower, 42.55% in the third-party validation.

Focusing on the relationship of having MSs implemented and certified, there only are significant differences between certified and non-certified companies regarding one mechanism, i.e., suspending participation when organizations are not complying with the UNGC requirements.

More specifically, organizations consider the *internal assessment* as positive although no difference between the 2 groups of companies is found. The internal assessment is part on the UNGC current model, thus it is expected that organizations accept this part of the model. Regarding the importance of this mechanism, as said, those organizations that have implemented MSs established a higher evaluation (30.91% as 'important' and 45.45% as 'very important').

The second mechanism, the *external assessment*, is accepted by 61.22% of the sample. For this reason, regardless if organizations have implemented a MS or not, there is a high willingness to conduct an external assessment. This means that organizations consider that an external assessment would validate the commitment to the UNGC ten principles. This acceptance has no differences depending on the group of companies, thus this result can be interpreted as positive because regardless the organizations' experience with MS implementation and certification, the proposed model could be implemented. However, those organizations with MSs are valuing the mechanism higher than those that do not have MSs. It is noteworthy that those organizations that have valued the external assessment as 'not important' have implemented a MS. This result would mean that, although these organizations are used to external assessment, they do not consider it important, maybe because of the easiness of it compliance or because they believe it does not improve UNGC participation. Further research would be needed to better understand this response.

Table 1. Empirical results of the acceptance of the model proposed

Internal assessment (%)									
				, ,	l				
MS imple- mentation		Yes	No	Total	Not imp.	Important	Very imp.	Total	
(%)	Yes	66.67	13.73	80	7.27	30.91	45.45	83.64	
(70)	No	20	0	20	0	3.64	12.73	16.36	
	Total	86.27	13.73	100	7.27	34.55	58.18	100	
	$\chi^2 = 2.03$	5; df=1; S	Sig.=0.15	4	$\chi^2 = 1.996$; d	χ ² =1.996; df =2; Sig.=0.374			
		Extern	al asses	sment (%)				
MS imple-		Yes	No	Total	Not imp.	Important	Very imp.	Total	
mentation	Yes	48.98	30.61	79.59	24	18	44	86	
(%)	No	12.24	8.16	20.41	4	4	6	14	
	Total	61.22	38.78	100	28	22	50	100	
	χ =0.008; df =1; Sig.=0.929 χ =0.244; df =2; Sig.=0.885								
		Third-p	arty val	idation of	UNGC parti	cipation (%)			
MS imple-		Yes	No	Total	Not imp.	Important	Very imp.	Total	
mentation	Yes	51.16	32.56	83.72	17.02	36.1	34.04	87.23	
(%)	No	13.95	2.33	16.28	2.13	2.13	8.51	12.77	
	Total	65.12	34.88	100	19.15	38.3	42.55	100	
	χ ² =1.56	52; df =1;	Sig.=0.2	11	χ²=1.802; d	f =2; Sig.=0.40	16		
	1 22	Valid a	ssessmo	ent for a 3	year period	I (%)			
MS imple-		Yes	No	Total	Not imp.	Important	Very imp.	Total	
mentation	Yes	68.75	12.5	81.25	5.88	27.45	50.98	84.31	
(%)	No	14.58	4.17	18.75	3.92	3.92	7.84	15.69	
	Total	83.33	16.67	100	9.80	31.37	58.82	100	
	γ²=0.240	6; df =1; :	Sig.=0.62	20	χ²=2.483; df	=2; Sig.=0.289	9		
	1 70	Correc	tive act	ions (%)	<u> </u>				
MS imple-		Yes	No	Total	Not imp.	Important	Very imp.	Total	
mentation	Yes	71.43	8.16	79.59	7.41	25.93	50	83.33	
(%)	No	20.41	0	20.41	0	5.56	11.11	16.67	
	Total	91.84	8.16	100	7.41	31.48	61.11	100	
		7; df =1;				=2; Sig.=0.648	l.		
	170=2.				1	complying (%			
MS imple-		Yes	No	Total	Not imp.	Important	Very imp.	Total	
mentation	Yes	75.56	4.44	80	2.13	25.53	55.32	82.98	
(%)	No	17.78	2.22	20	6.38	0	10.64	17.02	
	Total	93.33	6.67	100	8.51	25.53	65.96	100	
	i otai	55.55	0.07	100	0.51	20.00	00.50	100	

Regarding the *third-party validation*, there are no differences between the two groups of organizations. 65.12% of organizations agree with the proposal. This reveals that external assessment would be a good indicator to enhance UNGC credibility at stakeholder's opinion. These organizations value as "important" and "very important" this mechanism, having a higher importance for organizations with MSs. This could enhance stakeholders' confidence according to the organizations activities and reducing criticisms of UNGC initiative as a "bluewashing" tool, among others. It has not been discussed in any case how assessments should be performed, but considering the aim of ensuring the information veracity, it could be proposed using COP as an assessment starting point, due it is available on line. Thus the initial assessment could be performed without visiting the organization which would decrease costs, comparing it with MSs certification budgets.

Regarding the time period of *valid assessment*, proposed in 3 years as for the MSSs certification, the 83.33% of participants value this mechanism as positive, with higher values for those organizations with MSs. Some of these would not accept the 3 years period assessment validation. Due this period is the same as the MSs certification, this disagreement could indicate whether the period is too short and could be related to costs problems, or that it is too long, and in case of non-compliance, there should be frequent assessments. In order to have more information, further research is needed.

However, more than half of organizations value the proposal as 'very important', this could indicate an acceptance of the proposed model. This valuation could be either positive because this would not imply an annual cost to comply with the model, while the negative part would be organizations decision about not improving UNGC activities and wait until next the assessment. The same scenario occurs in organizations certified with other MSs, this way; implementation and internalization are once more important issues to be analyzed in the future.

If organizations are not complying at the first moment of the assessment, they would have the possibility of implementing *corrective actions*. Nearly 92% of the sample believes that implementing corrective actions is positive for UNGC and 71.43% of them had implemented a MS. A remarkable fact is that organizations who have not implemented MSs have the same opinion. This means that negative opinions (even though they are a minority) belongs to organizations that already have implemented a MS.

The last mechanism is related to the punishment that organizations will have if they are *not complying* repeatedly. The organizations' opinion about temporary suspension is positive for the 93.33% of the participants. Again, no differences are found between groups. This result could be interpreted as a demand from the organizations to differentiate between those who fulfill compliance and those that do not. This could probably mean that complying organizations would have a higher willingness to accept the model; although it would be necessary to ask these organizations what kind of "punishment" or recognition would they expect (future research). Only for this relation there is a significant difference between certified and non-certified companies. That is, companies with a MS consider as 'important' and 'very important' suspending the organizations participation for one year in case of non-compliance. This could help to increase the initiative credibility to stakeholders.

CONCLUSIONS

The aim of this paper is twofold. Firstly to propose, through a literature review, an external assessment model for the UNGC. Secondly, to test the acceptance of the model using a sample of organizations of the Spanish UNGC Network. The study results allow, although with caution, to pose the following conclusions.

First, a model for the external assessment has been proposed. The model is based on an existing model (Franceschini et al., 2011) that aimed to incentive the certification process of ISO 9001 standard for both organizations and certification bodies. The main difference between both models is that for the GC external assessment, the focus is on organizations' performance and the certification bodies should only train their employees and accredit their expertise. This means that the implementation of this model, although it would take time, would be less costly to implement compared to Franceschini et al., (2011)'s.

Second, the model proposes an external assessment by a third-party and this has advantages and disadvantages. According to the existing literature, the model could eliminate or at least reduce, the "bluewashing" perception of the model discussed by Kell (2005), Arevalo and Fallon (2008), Arevalo and Aravind (2010) and Berliner and Prakash (2014, 2015). In the same line, the quality and credibility of an assured report will increase as well as transparency of disclosure (Janney et al., 2009; Bacco and Mele, 2011; Prakash Sheti and Schepers, 2014; Rasche and Waddock, 2014), organizations will have the opportunity to learn from best practices (Rasche and Gilbert, 2012) and take profit of the improvement of CSR performance (Berliner and Prakash, 2014). Reports can be based on the Communication on Progress (COP) as currently as it is well-known by the stakeholders (Janney et al. 2009) and it has been valued as a useful tool for the integrated reporting.

The regulatory form of this model could be seen as positive because it will add a barrier to entry and this could reduce the number of participants and thus, increasing its quality and commitment (Nason, 2008; Prakash Sheti and Schepers, 2014). However, the negative effects are a difficult acceptance of the change by the UN and the difficulty to achieve an agreement of the regulation (Carasco and Singh, 2008). To overcome this limitation, the model could be implemented first as a pilot test and once its acceptance and compliance is demonstrated, modify the program accordingly. A first attempt of this pilot test has been done as the second aim of this study, as the model acceptance has been tested in a sample of Spanish organizations participating in the national UNGC network. According to the results obtained, the level of acceptance of the model is very high among the organizations of the sample and no differences were found if these organizations have or not MSs already implemented and certified.

Regarding the implications, for organizations implementing the model will be costly, but they will be able to demonstrate their credibility and transparency to their stakeholders, improving its relationships because they are truthfully. For the UN and related institutions, the model means a change that should be seen as positive for a sustainable future of the program. Discussion with the affected parties should be established.

The main limitation of the model, a part from its implementation, is that it is not proposing how the COPs will be assessed, i.e., how the content of the report will be verified. In order to solve this weakness, it is proposed to follow Rasche et al. (2013)'s recommendations to define the

requirements to be met. The recommendation is that this assessment should be as easier as possible to ensure compliance.

Finally, future research will focus on analyzing, more in-depth, the acceptance and compliance with the model.

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Reasons of relations between the constructs perceived quality, trust, and loyalty in virtual learning environment

Curth, M.

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ABSTRACT

Purpose: The educational segment is considered one of the most important sectors to the society, which is found to be competitive and in constant growing. Thus, understanding the relationship formation process among companies (educational companies) and clients (students) become valuable to the success of this kind of organization, and this is the objective of this paper. More specifically, the reasons that make the relations between trust, perceived quality, and loyalty being developed and becoming solid were analyzed. **Methodology:** Through an exploratory study of a quality nature, individual interviews were performed, deeply in the educational sector, involving experts of the area (managers and coordinators), professors, and students. **Findings:** The results revealed that, for the relation between perceived quality and loyalty, the main reasons were feeling of being accepted, motivation (stimulus), and credibility. On the relationship between trust and loyalty, it was found as reasons transparency, commitment about the client/student towards the college, and reflex of the learning as the result of the course and the good faith.

Originality: At the end of the paper, the conclusions about the contributions of the study to the development of the relational marketing theory are presented, as well as the manager implications, which contribute with the managers of the colleges so that it could be used in actions that stimulate the interest of the clients/students.

Keywords: Perceived Quality, Trust, Loyalty, Virtual Education.

Paper type: Research paper

1 INTRODUCTION

Loyalty is seen as a relevant factor for competitiveness and financial health of an organization. However, so that there is a long-term relationship between the company and the clients, aspects influencing loyalty must be taken into account, as in the case of quality and trust perceived by the clients. However, the service sector lacks the understanding of the reasons of these relationships, as in the case of educational market.

In the higher education, the concern with the competitiveness is observed because of the rise in the number of institutions. Data from the Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (National Institute of Educational Studies and Research Anísio Teixeira, INEP, 2012) showed that an increasing number of small institutions entered the market, thus making the demand, which was directed to more traditional, large Higher Education Institutions (HEI), with university status, to be shared between university centers, faculties, etc. Similarly, there was an increase in the number of distance courses (INEP, 2012).

Therefore, the concern regarding the marketing is now frequent among the university managers. It is in that moment that knowing how the loyalty of the student is made is now important in the context of high education, thus making maintain the students already enrolled or attract them (Kotler and Fox, 1994).

Thus, studies are carried out aiming to better understanding how the long-term relationships are established in the exchanging scenarios. These studies proposed models where the formation of loyalty starts to be significantly influenced from constructs, such as: clients' satisfaction (Taylor and Hunter, 2003; Harris and Goode, 2004), perceived quality (Aydin and Özer, 2005), commitment (Morgan and Hunt, 1994; Garbarino and Johnson, 1999; Prado and Santos, 2004), trust (Sirdeshmukh et al., 2002; Agustin and Singh, 2005; Ahu, 2005), and the perceived value (Zeithaml, 1988; Sirdeshmukh et al., 2002). Therefore, some studies focused on the relationships between HEI and their students, specifically trying to understand the relationships between perceived quality, trust, commitment, and loyalty with their students (Tinto, 1975; Morgan and Hunt, 1994; Hennig-Thurau and Klee, 1997; Hennig-Thurau et al., 2001; Bergamo, 2008).

However, no study investigated the reasons of each relationship of the constructs: perceived quality, trust, and loyalty in HEI with distance courses - this is the objective of the study.

2 THEORETICAL BACKGROUND

2.1 Perceived quality

The perceived quality is an import loyalty construct, mainly in the service sector (Santos et al., 2010). For Anderson et al. (1994), perceived quality can be considered as an assessment of the company's performance by the consumers, with such performance tending to positively influence the attitudes and behavioral intentions of the client in relation to the supplier. In connection with the statement above, the delivery of services is considered essential for the success and survival of the strategies in competitive environments (Daukins and Reichheld, 1990). Therefore, the perceived quality of the service influences positively the behavior of choice of the client. Thus, it will determine the continuity and the degree of intensity of the relationship with the organization (Hennig-Thurau et al., 2001).

According to Hennig-Thurau, Langer, and Hansen (2001), the peculiar characteristics of the education sector, such as great involvement and cognitive skills, make the quality perception the most appropriate

because it is also influenced by the client's ability to perceive the potential benefits of a product/service after it is acquired.

Thus, the study of Boulding et al. (1993) adapted the model of quality in services (SERVQUAL) for HEI. The authors found as result a strong connection between the service quality and behavioral intentions, including the report of positive issues about the university, planning the financial contributions after the course is concluded, besides helping with the *placement* of the university student.

Based on the issues stated above, Guimarães (2005) reports that the students contribute decisively to the service and consequently to their own satisfaction. Therefore, one of the challenges for the education institutions is to develop a quality culture among their students.

2.2 Trust

Trust is seen in many studies as an essential component for the relationships to be successful (Berry and Parasuraman, 1995; Moorman et al., 1993), while being essential so that the relationship has a long-term status and consequently to be retained (Ganesan, 1994; Garbarino and Johnson, 1999).

According to Castro et al. (2007), trust refers to the expectation that someone complies with their obligations or performs with the expected results. Similarly, Grönroos (2003) defines trust as the expectation from one party that the other will behave in a predicting manner in a given situation. In the same line, Morgan and Hunt (1994) report that trust is an important factor when developing marketing relationships and only exists when one of the parties believes that the other is just and deserves credibility. These authors include the attributes consistency, competence, honesty, responsibility, good faith, and integrity of the partners.

Regarding the influence of trust and loyalty, Sirdeshmukh et al. (2002) point that there is a reciprocity relationship between trust and loyalty, since the more the company searches the trust of the client, the more this client will be loyal to the company.

In the educational context, the construct trust is based on the previous experiences that each student has with professors and professionals connected with the educational process. At this point, the following topics are also addressed; perceived security topics regarding the professors when teaching the a lesson, exams corresponding what is taught in class, up-to-date, conferences, and lectures given by the teaching staff, besides charisma and proximity, making trust an important predictor of loyalty (Bergamo, 2008).

2.4 Loyalty

According to Oliver (1999), in the 1990s, loyalty started to be considered as a strategic tool and part of the company discussions, mainly in order to guarantee a basis for loyal clients. The author defines the construct loyalty as a deep and consistent commitment in terms of future repurchase of a product or preferred service, thus generating repeated purchases from the same brand, despite situational influences and marketing efforts to cause a change in behavior or search another brand. Larán and Espinoza (2004) state that the repeated purchase cannot be considered as a synonym of loyalty because it can be related to other aspects, such as: price, convenience, or event loyalty to several brands simultaneously.

In the educational context, the loyalty of the student is a key objective of private HEI, which financially supported by the enrollment fee. Keeping the student means having a solid and predictable financial basis for future activities of the HEI (Kotler and Fox, 1994). According to Hennig-Thurau et al. (2002), loyalty results from multiple inter-related constructs. Therefore, they suggest a holistic approach to their explanation because a single construct is not enough to explain loyalty.

3 RESEARCH METHOD

In order to meet the objective proposed in this study, a qualitative, exploratory research was chosen because it is the adequate method when there is the need to understand phenomena in complex social contexts (Malhotra, 2006).

The sample included 25 respondents who accepted to participate in the research and met the established criteria. These respondents were divided as follows: experts (managers/coordinators of the institution), students (clients), and professors of the institutions.

At first, the qualification criteria for the respondents were defined. In the case of the managers of educational institutions, they should present the following characteristics: a) have worked for more than one year (two semesters) in the coordination of the institution; b) belong to an institution registered at the Ministry of Education and Culture (MEC); c) long to an institution that offers distance learning courses for more than one year (two semesters).

The students/clients chosen should have the following characteristics to be part of this study: a) to be properly registered and to be in compliance with the institution; b) to have all the resources for the satisfactory development of a discipline in the distance modality (computer, broadband internet, etc.); c) to have completed more than one discipline in the distance education modality.

The professors who were chosen to participate in the research should present the following characteristics: a) have taught in more than one discipline in the distance education; b) have been an employee of the in the institution for at least one semester; c) have training linked to the area of the discipline (graduation, specialization, master degree).

The subjects of the research were found in nine HEI: seven of them are private and two are supported by the federal government. The distribution of the interviewees between private and federal HEI was characterized for having 17 interviewees in private institutions and 8 in publish institutions.

In this study, the semi-structured model of interview were used since it helps to rebuild subjective theories, as the interviewee has a complex reservation of knowledge about the topic studied (Flick, 2009). The questions of the semi-structured model of interview were divided into four blocks, each one referring to the reasons of the relationships of the constructs: perceived quality and loyalty, trust and loyalty, and commitment and loyalty, respectively.

The data collection used the in-depth individual research method, where the researcher plays an important role since their attitude influences the data collection (Flick, 2009). To determine the total number of interviews to be made in each group, the criterion of response saturation of the interviews (Miles and Hubermann, 1994).

Aiming at improving the evaluation of the interviews during the analysis, they were recorded and the audio was transcribed (Flick, 2009). The interviews lasted approximately 1 hour. In order to transform the data collected in the educational segment in research results, content analysis procedures were used to systematize, categorize, and make the analysis of the interviews possible (Yin, 2005). The procedure used for the research was the thematic codification where the groups studied derive from the research question, thus they were defined *a priori* (Flick, 2009).

Once the data collection is concluded, the analysis consisted in triangulating the data collected from the interviews. The process of triangulation used the interviews with managers/specialists, professors, students/clients of HEI and bibliographic revision.

4 RESULTS OF THE REASONS OF THE RELATIONSHIPS BETWEEN PERCEIVED QUALITY, TRUST, COMMITMENT, AND LOYALTY

4.1 Perceived quality and loyalty: emotional background of the student

According to Boulding et al. (1993), the level of sentimental attachment is higher when the perceived quality is above the wanted levels. Thus, some of the reasons of the relationship between perceived quality and loyalty emphasized by all the interviewed groups are related to emotional factors. Among the reasons found, *the feeling of being accepted* is highlighted, as it is shown in the reports below.

Manager 8: "It (loyalty) emerges when the student feels accepted in the course, in the Virtual Learning Environment (VLE), in the group of peers who interact with him/her in the environment." (Manager 8)

Professor 7: "I believe that the student that perceives quality feels happier and accepted, and this is one of the greatest struggles of the distance education."

Student 6: "One of the factors that I saw that made me see quality was being contacted by the course coordinators, the people who created (developed) the course [...]. I felt more accepted, closer to the decision makers [...]"

Parasuraman et al. (1985) report that most services are produced and consumed simultaneously. Usually the quality assessment is made when the service is being delivery and interaction between client and the contact staff of the service provider company.

Other reason found in the groups of the interview, which was mentioned the most by the group of professors and also related with emotional aspects, is the *motivation (stimulus)*, as it is exemplified in the reports below.

Manager 4: "The quality perceived by the student regarding what the institutions offers stimulates, motivates, and makes the student to persist. At the college, we were shaping the students, we improved the structure, the teaching staff, etc. In the end, the students were even more dedicated."

Professor 8: "When the student perceives quality in the environment (VLE), what there is inside and in the teaching staff, this student is willing to stay. The student is encouraged to stay."

Student 4: "I think the quality is perceived when we (students) perceive the result [...] in the disciplines that did not have this (result), I lost my interest."

The responses of the students/clients do not fully converge with the responses of other actors interviewed, with the students/guests mentioning the motivation to continue with the results/applications they find in everyday situations as the main reason for the perceived quality to take their loyalty with the HEI. Thus, the incongruity between the responses of the actors involved can lead to a misplaced delivery of values by managers and professors to clients/students, which may be related to a possible increase of students dropping out in the distance academic environment.

4.1.1 Perceived quality and loyalty: credibility of the distance education from the student's part

One of the reasons found in the report of the groups analyzed is related with the *credibility* of distance education. Therefore, it was emphasized that the practices of the institution influence positively the fact of the student believe of not in the distance education.

Professor 3: "One of the reasons I see is the credibility given to courses in the distance mode. The students can see the tutor. If they (students) do not perceive quality, the distance education is discredited."

Manager 1: "The perceived quality generates credibility. If the person (student) perceives the structure, the professors, and the content to have quality, this person believes. And this credit is not only to the institutions, but also in the distance education."

Student 1: "The changes made after the requests made us (the students) to develop a greater perception of quality for the course. These changes made us even believe in the distance education."

The group of interviewed managers, as the one with the professors, emphasizes the relevance of the credibility not only regarding the institution, but also for the proposition of the distance education as a whole.

The group of students/clients emphasized the improvements requested that were made. However, the improvements requested were not related to the issues reported by the interviewees from the other groups. They pointed their reports to the credibility given by the student/client during the relationship with the institution and with the development of this relationship.

4.2 Trust and loyalty: transparency between those involved

According to Sirdeshmukh et al. (2002), the relationship between trust and loyalty is explained by the reciprocity of arguments, that is, when the providers act so that the trust of the consumer is built, the perceived risk with the provider of a specific service is probably reduced, enabling the consumer to make trusting predictions about the future behaviors of the supplier. Thus, the *transparency* among the involved is one of the reasons of the relationship between trust and loyalty that was highlighted in the reports of the groups interviewed and was considered by the respondents as important for the reciprocity of arguments and perception of justice by the student to occur, as shown in the reports below.

Manager 6: "The institution is responsible for the synergy in all services it enables to the student. It is through this synergy, a transparency relationship with the student is developed, making him/her to stay in the institution [...]."

Professor 6: "Less 'spaces' between professor and student generates transparency and reciprocity. I feel them closer. I had reports that they feel better this way, as they spent much time without contacting the institution in a synchronic manner."

Student 5: "In the course, I feel that the communication between the students and the people that created the course is very good. We had reported things we did not like and they were readily solved. [...] provides a greater interactivity and transparency between all those involved."

The managers reported that transparency would be one of the reasons that makes the student/client perceive the institution differently. However, the synergy pointed by one of the interviewed managers has as a starting point the management of people and internal processes of the HEI.

Professors showed examples where their communication with the students in different formats simultaneously enabled greater transparency, making the relationship between those involved more trusting.

According the report of the student, the fact they have, or do not have, a better communication among the ones involved enabled the student to stay in the course longer. Other issue to be emphasized addresses the "shortening" of the educational chart that enables a better communication between those involved, because students/clients could have easy access and the communication they search for in several moments.

4.2.1 Trust and loyalty: commitment with the relationship

Morgan and Hunt (1994) state that trust and commitment are central to relationship marketing studies since they increase cooperation among the partners, reduce the risks of exchanging for alternative partners, and minimize the perception of risk due to the reduction of opportunism actions by partners. *Commitment* in the relationship emerges between the institution and the student as a reason in the relationship between trust and loyalty, mentioned by respondents as a result of reciprocity in the practices of the institution or professors and students, thus shown as follows:

Manager 8: "The commitment and involvement of the student have to be much deeper for this proposal of education. The students that stay, the loyal ones, we were not able to observe this in detail."

Professor 4: "When the student gets involved, is committed, s/he will surely stay until the end of the course. [...] it also includes the practices of the institution, such as: extension courses, internal events, polls."

Student 9: "[...] when I have professors that seemed more committed, I felt I wanted to do the same. And I also had professors who did not have the same attitude. When this happened, I just did what was requested, I would not go beyond that. Honestly, I really did not like the tutor's lack of commitment [...]."

The commitment developed by the student after observing the same commitment of the ones involved was evident in the report of daily examples given by the interviewees. These examples emphasize the relevance of the commitment of the action from both the professors and different levels of the organization. According to Konrath et al. (2009), the students that starts a distance learning course is someone who must be committed, disciplined, and organized with their time and work space so that they are successful in their learning.

According to Doney and Cannon (1997), the performance of the provider regarding the factors common to their function, such as delivery, price/cost, service, and benefits can change the future of the transactions, since the competitors can supply the same potentialities. Having the factors connected to the performance and benefits of the relationship based on experience as premises, it was observed that a specific group (professors) stressed situations linked to experiences related to student reports that highlighted *positive* points related to learning. These issues are addressed below.

Professor 1: "[...] a student told me she was more confident in her own capacity after the discipline was over. I felt confident regarding what I have learnt."

The reports exposed by the group of professors mention situations based on experiences prior to the development of disciplines or the courses, having the students/clients as example. The group emphasized that the loyalty patters were kept because the students perceive the reflections from the experience they had that resulted in learning.

4.2.3 Trust and loyalty: influence of the benevolence

According to Agustin and Singh (2005), trust is represented by the confidential belief of a client that a seller will deliver the services to which s/he was promised. When it comes to belief in the delivery, the subjects responded that the *good faith* from the institution would be one of the reasons of the relationship between trust and loyalty.

Manager 5: "When the course sells something that is does not have, or something that is known to be changed soon, the fact of acting in bad faith regarding what was offered makes the student to not become loyal to the institution."

The reports of the managers emphasize the need for the HEI to develop the reasons linked with trust not only on the students but also on the society as a whole. Related to this, Santos and Fernandes (2006) point out that the uncertainty about the actions of the other party are sources of risk, contributing to the non continuity of loyalty, which is evident in the reports of the managers.

Professor 8: "[...] you have to believe so that this would happen. You have to have faith in this relationship. When this happens, the student stays until the end of the course."

For the interviewed professors, the reason good faith is already marked with the exchange of information of students/clients with the HEI. However, the students/clients exchange much information in the virtual environment and enroll in courses where they do not have contact with the professors or with the physical part of the institution. An example would be the educational institutions with pulverized poles in different regions without having their own location.

Student 2: "Not all students know where to search information about the institution or the professors. [...] there are colleges for distance education that are not recognized by the Ministry of Education."

The answers from the group of students complete the answers of the previous groups. As highlighted by the last group, not all students/clients know where to search information about the institutions or the professors. Related with the above, Morgan and Hunt (1994) include the attributes consistency, competence, honesty, responsibility, good faith, and integrity of the partners.

5 CONCLUSION

Among the reasons found that lead to the relationship between perceived quality and loyalty, feeling of being accepted, motivation, and credibility are presented as results, with these being common in all the researched groups. Among the reasons found, the reason related to the feeling of being accepted was highlighted by all groups and with a significant amount of quotes. They concluded homogeneously that students must be accepted, and for this to happen, the higher education institution with distance course should develop activities for students to have the feeling of being accepted. Thus, the relevance of the professors and the tutors is acknowledged. Related to this and the quality elements, the follow is highlighted: the quality of the content, the level of training of the professor, the involvement of actors in the teaching and learning process and the implementation of the course. However, the level of sentimental attachment is higher when the perceived quality is higher, leading to favorable intentions related to the institution (Hennig-Thurau et al., 2001).

Another reason related with emotional factors is the motivation (stimulus), which was highlighted by all groups, but the group of professors and students were the ones who mentioned it the most. They converged their answers to the sense that, when the student perceives quality is still loyal to the institutions because of the motivation or stimulus, making these students to become more involved with the institution. Thus, the perceived quality and with emotional commitment are the greatest influences of the loyalty of the student (Hennig-Thurau et al., 2001).

The last reason pointed by the groups relating perceived quality and loyalty addresses credibility. The reason credibility, as the other reasons of the relationship between perceived quality and loyalty, was also mentioned by the groups, but the professors mentioned this topic more times. Related to this, Retamal et al. (2009) point out that aspects associated with the key factors for the successful implementation of the course refer to the credibility of professors and supporting the use of Virtual Learning Environment (VLE), dropouts of students, the acceptability of the course by the students and the provision of student support services.

When it comes to the reasons of the relationship between trust and loyalty, the reasons found were: transparency, commitment, reflex of the learning as a result and benevolence (good faith). In this sense, the transparency was emphasized more times in the reports of professors, but it was also mentioned by other groups of interviewees. The groups agreed in their answers when pointing out that transparency is related with constant communication between students and coordinators/professors, providing synergy as the course progresses. Similarly, Sirdeshmukh et al. (2002) highlight that the relationship between trust and loyalty is explained by the reciprocity of arguments, that is, when the providers act so that the trust of the consumer is built, the perceived risk with the supplier of a specific service is probably reduced, enabling the consumer to make trusting prediction about behaviors of the supplier in the future.

The reason connected to commitment were more mentioned by the group related with professors, who reported that the trust of the students makes them to commitment and consequently to be loyal. Similarly, the other groups developed the same discourse, but the group of students added the involvement in their report. For Konrath et al. (2009), the student that enters the distance education setting is someone who also must have commitment, discipline, and organization of his/her time and work space.

One of the reasons found in the report is related with the reflection of the learning resulting from the course. Unlike with the other reasons, only one group mentioned this reason, which is the group of professors. They pointed out a number of examples of students, who realized some sort of result after the learning and reported to the professors. In the same sense, Franco (2002) emphasizes that learning results from a building process founded on the connections made by the subject from their previous knowledge with their actions, which were caused not by the means, but by the interaction of this subject with their environment. Thus, the subject builds the knowledge that gives him/her a higher power to interfere with the environment to which s/he belongs.

The last reason found in the reports of the interviewed subjects about the relationship between trust and loyalty is related with the influence of good faith. Thus, the reason was reported by the groups. However, the group that emphasized this reason was the group of professors who reported that the existence of good faith is essential for the loyalty to occur. Similarly, managers and students reported that the institution must act with credibility in order to withhold their clients/students. In line with the statement above, Moorman et al. (1993) claim that the less the consumer knows about a product or a service, the more s/he will trust the company, that is, trust would act as a reducing factor of the risk and vulnerability of the relationships, thus contributing for the feeling of building loyalty.

Finally, the limitations of this study are acknowledged, but the topic related to the reasons of the relationships proposed is not over. However, the reasons found can be considered relevant to understand the topic and for future research, whether in the segment where it was developed or in other type of segment.

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Service quality study in property and casualty insurance market using the Quality Function Deployment methodology

Jordi Escayola Mansilla and Jesús Tricás Preckler

IQS School of Management, Universitat Ramon Llull, Barcelona, Spain.

ABSTRACT

Purpose – The aim of this project is to study the dimensions of service quality in non-life insurance business, applying the Quality Function Deployment (QFD) methodology in the Spanish insurance market. In order to apply this known method (not used in insurance so far), we have interviewed more than 300 insurance customers (mainly car and household insurance) and 17 insurance experts – which include company directors, researchers, public institutions members, private institution members and consultancy directors of the insurance field.

Design/methodology/approach - We have tested 21 quality items taken from recent previous studies, adapted to the Spanish insurance market and reviewed by insurance experts and market research professors. These items represent the WHAT's of the QFD methodology. We have studied their correlation with 21 HOW's items, obtained by interviewing a certain amount of insurance experts.

Findings — Conclusions show the dimensions of service quality which have more impact on insurance customers, as well as the actions companies should take in order to improve these dimensions in order to satisfy their customers' requirements and become more competitive and successful.

Originality/value - Taking advantage of this research, insurance companies can develop their business and focus their actions on what is more efficient in the long term, increase the customer satisfaction and loyalty – which is very important in this kind of business–, and they can also ensure post-purchase intentions. This research represents the first QFD analysis in the European insurance market.

Keywords: Property and casualty, Quality Function Deployment, Insurance, Service Quality.

Paper type: Research paper.

1. INTRODUCTION

Companies use aggressive marketing strategies to attract new customers and increase market share at the expense of competitors; and/or defensive strategies, to protect products and markets from their competition by maximizing customer retention under certain cost constraints (Ennew and Binks, 1996; Roberts, 2005). Small increases in the customer retention rate can generate considerable improvement in profitability as the cost of attracting new customers is higher than the cost of attracting new customers (Lombardi, 2005). In insurance, high retention rates are closely related with the economic performance of companies (Diacon and O'Brien, 2002). A large number of insurers consider retention to be the most important determinant of economic success (Moore and Santomero, 1999).

As it usually happens in other industries, the selling cost of an insurance policy is not recovered unless the policy is renewed for at least three or four years (Zeithaml *et al.*, 1996). Loyalty is in essential in insurance business, Shlesinger and Graf von der Shulenburg (1993) suggested that corporate image and service quality influence the customers' decisions to choose insurers and affect the price customers are prepared to pay for a policy. A moderating variable between service quality/customer satisfaction and economic performance is loyalty (Tsoukatos and Rand, 2006). Loyalty is the extent to which customers wish to keep their relationship with a supplier, and usually results from how much they believe that the value they receive from this supplier is higher compared to what they would receive from others.

Not all insurance products have the same characteristics, and it is easy to identify differences between life, health, and property and casualty insurance products and services. In property and casualty insurance, the longer customers remain with a company the less likely they are to submit claims (Peppers and Rogers, 2014). According to the points stated above, customers become more profitable across time. The industry considers that understanding customer behavior after the initial purchase will help insurers to maintain longer customer-insurer relationships (Harrison, 2003).

Despite the importance of the Spanish insurance industry, it has been the object of scant attention in business research literature.

It is important to take into consideration the high competition in the insurance market – especially in the property and casualty insurance products, which are based on the features of competitive markets (Joskow, 1973).

Because of the fact that an insurance is usually characterized by a substantial delay between purchase and use, many of its features are not immediately evident. In most cases, customers will not be fully informed about and aware of the exact features of their insurance policy before they actually need to use it, i.e. file a claim. The most important reason to purchase an insurance is the amendment of damages – which may or may not occur in the duration of an insurance contract (Wells and Stafford, 1997; Anderson and Skogh, 2003). This makes the claim settlement procedure the most critical incident of insurances. Only then customers can actually assess the value of the service they bought some time ago. This distinguishes insurance from the majority of services, for which production and consumption occur simultaneously (Zeithaml *et al.*, 1988). As a logical consequence, it is important to take into account that not all customers are going to suffer a claim.

According to Toran (1993), quality should form the basis of all activities involved in the insurance industry, because customers want higher quality service through responsive agents with better contact and personalized communications from the insurer. Accurate transactions and quickly solved problems are also services expected by customers (Pointek, 1992).

Taylor (2001), in his study on service recovery analysis in insurance industry, noted that quality of service and customer satisfaction and loyalty are fundamental for the survival of insurers. He further stated that the development of close relationships with customers, high-quality after-sales services, and good relationships with customers can lead to very positive results for the insurers.

King (1992) extracted four important insurance quality factors. These factors are: financial stability of the company, reputation of the insurer, agent integrity, and quality of information and guidance from the agent. Curiously, some researchers define insurance quality as the insurers' willingness to compensate sincere customers (Anderson and Skogh, 2003). Others confuse quality and generosity, the latter being insurers' readiness to compensate for more than a court would order (Roos, 1981). Insurers' tendency not to adequately perform regarding their customers' perceptions of quality creates problems to them, as the markets are extremely competitive and continuously become more so (Taylor, 2001).

We have not found previous published studies on using Quality Function Deployment in any European market. Despite the global influence of the insurance sector, not a significant number of previous research studies has been focused on found relationships between customer expectations and the insurance company's actions.

The particular characteristics of the insurance business reflect that it is crucial to improve the service quality perception, and this research proposes the application of QFD in order to improve the insurance service. As a result, customer satisfaction and loyalty will increase by discovering which are the most important HOW's in order to achieve the customers' expectations. Those are the main objectives of this research.

The secondary objective is to analyze the importance of service quality dimensions in the Spanish property and casualty insurance market by studying the importance of the WHAT's.

In addition, some improvements in the property and casualty insurance sector –service quality and retention—would have a strong impact in the results of the insurance companies, and customers would be provided with better and more efficient service according to their expectations.

2. LITERATURE REVIEW

2.1 The voice of the customer

Applying the QFD methodology implies obtaining information about WHAT are the customer's expectations. In order to obtain this information, we will use *the voice of the customer* (VOC) as the WHAT's for the QFD structure.

Traditionally, customer voices have been considered a critical resource for firms (Lee *et al.,* 2000). This is because VOC includes expectations related to customer needs and requirements, and these expectations can help firms to improve their products or services.

Research on VOC started developing based on Parasuraman's research. He stated that VOC can be collected from customer recognition and customer surveys, and emphasized the importance the VOC collection method (Parasuraman *et al.*, 1988). They proposed to use VOC as input to Quality Function Deployment (QFD), in order to formalize the process of listening to the customer.

A generally accepted point of view is that VOC should be considered as a gift to help firms develop new products or services that meet the needs of their customers (Barlow and Moller, 2008; Denove and Power, 2007). Walker and Baker (2000) stated that one of the crucial elements of insurance quality is understanding of customers' expectations, for instance by VOC, because their expectations serve as standards against which service performance is measured.

Moreover, it is important to maintain contact with realistic and current customer expectations, because they are dynamic and highly influenced by other factors (Ghobadian *et al.*, 1993). According to Gans (2002), if an organization does not understand customer expectations, any required actions taken to improve the quality of the products and services cannot succeed.

In this particular study, we take as a reference the items obtained in a previous research studying the Greek insurance market (Tsoukatosand and Rand, 2006) which was based on a previous study in Greek and Kenyan market (Tsoukatos *et al.*, 2004), and adapt it to the Spanish insurance market based on the opinions of insurance experts and market research expert professors. Interviewees represent an important set of the insurance sectors (insurance companies, brokers, academics and public institutions).

2.2 Quality Function Deployment (QFD)

QFD is a tool to achieve customer needs, through which one can design or improve services and products according to the requirements of customers. "Quality Function Deployment" is a translation from Japanese: "him shitsu" (quality), "kinou" (function), and "ten kai" (development).

Researchers such as Sullivan (1986), Hauser and Clausing (1988), Zairi and Youssef (1995), Chan and Wu (2002), and Terninko (1995) have discussed on the benefits of QFD.

QFD is probably the most important management tool developed to assure quality in new or improved products and services. It is an important aspect because product and service development implies an increase in sales (Krishnan and Ulrich, 2001). In fact, both production and service industries could use its benefits, expected by research literature on implementation of QFD (Cristiano *et al.*, 2000). QFD is a very interesting tool to obtain relationships between elements in strategic planning, which are necessary for organizations. Devadasan *et al.*, (2006) affirm that by using QFD companies would reduce time spent designing products, and Franceschini (2001) defends using QFD in order to improve products according to customer needs.

QFD is used in various fields for determining customer needs (Stratton, 1989), for developing priorities (Han *et al.*, 1998), formulating annual policies (Philips *et al.*, 1994), benchmarking (Pfohl and Ester, 1999), and environmental decision making (Berglund, 1993).

As a result, we conclude QFD is a useful tool in order to study how companies could improve their product/service quality according to the customer's expectations and the technical aspects of the insurance product/service.

With that goal, the traditional process of QFD has been adapted to enable the construction of Insurance Service Quality Function Deployment (hereinafter ISQFD), which consists of sections detailed below:

Section 1: the WHAT's, consisting of a list of corporate clients' expectations in relation to their external legal advisers, as well as the relative importance to corporate clients of each of the identified expectations (weight of the WHAT's).

Section 2: the HOW's, consisting of the resources an insurance company needs to improve in order to satisfy the WHAT's (client's expectations).

Section 3: The Relationship matrix, providing a mapping of the level of impact of each of the HOW's (insurance company resources) regarding each of the WHAT's (client's expectations).

Section 4: The Contribution values, identifying the influence of each of the HOW's in the overall corporate client satisfaction with regard to their insurance service. The resources obtaining the highest contribution values are critical for competitive quality and hence represent strategic quality resources.

Section 5: The Roof. This matrix is designed to show the impact of each one of the resources on the rest. It is a bidirectional impact, where the interdependence between the resources is determined. This section provides relevant information on the way in which insurance companies enhance relevant resources by interlinking them with other resources, and hence with regard to the dominant logic in a particular company or industry.

3. RESEARCH METHODOLOGY

A deductive method has been used, as previous studies have served as a theoretical base to develop this research

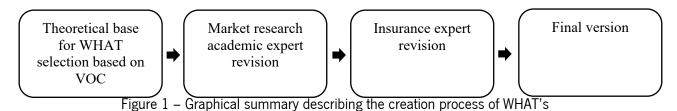
This research is focused on the construction of the first matrix in the QFD structure, which analyze the relationship between WHAT's and HOW's and in the construction of the roof.

During development of the research, and in particular during the process of obtaining the key points to construct the QFD matrix, quantitative and qualitative research methodologies were used. On the one hand, to construct the set of WHAT's and HOW's, interviews with different insurance experts were the qualitative part of the research. On the other hand, information obtained by surveys (weights of the WHAT's) constitutes the quantitative part of the research.

3.1 Creation of the WHAT's set

As introduced previously, the WHAT's of QFD in this research are based on the Tsoukatos and Rand (2006) research and have been adapted to the Spanish insurance market. We decided to include 21 items as well as "Price" and "Solvency margin", because if we take into consideration the recent economic crisis, price should have a strong importance in customer's responses. As a result, customers provided answers in 5-point Likert scales for each of the 22 service attributes in the survey. In order to obtain the final 21 WHAT's, we grouped similar concepts in order to make the survey as short as possible, while maintaining the diversity of concepts. It is important to adjust the items used in the WHAT's (voice of the customer), because as Furrer *et al.*, (2000) established, the importance of SERVQUAL (Parasuraman *et al.*, 1988) dimensions –the primary theoretical basis of this research and the basis of GIQUAL scale– vary across people from different cultural backgrounds. Because of this, it is crucial to obtain realistic and time-consistent items which measure the real service quality dimensions of the insurance service.

It is a regular trend for companies to conduct customer satisfaction surveys to know their customers' point of view. Improvements on the basis of such surveys are usually considered to be enhancements in the competitive position of the firm, which ultimately result in better offerings and better customer service (Frank and Enkawa, 2007).



Finally, some differences but not significant changes in regard to the original GIQUAL scale were obtained. The final set of items to be analyzed were: "Technological development of the insurance company", "Image of the insurance company", "Personal image and presence of employees", "Advertising", "Price", "Compliance with agreed contract", "Products which satisfy customer needs", "Contracts with understandable service conditions", "Interest in solving the problems", "Clear documents presenting no errors or ambiguities", "Information about when services requested by customers are to be carried out", "Speed and efficiency of the service", "Willingness to help and respond to customers", "Confidence inspired in the customer", "Adequate time for solving the claims", "Courtesy", "Adequate knowledge of the employees", "Personalized service", "Opening hours", "Defending the interests of the client and acting in good faith", "Understanding of the specific needs of the customer".

Despite the initial set of WHAT's was obtained in order to analyze other insurance market, according to the opinions of different insurance experts, we can ensure the final set is adequate to analyze service quality items

in the Spanish insurance market. Some elements of the initial WHAT's list (Tsoukatos and Rand, 2006) were not considered, others were grouped and the "Price" was included according to the experts' opinions.

The weights of WHAT's were obtained by a set of 305 surveys completed by insurance customers. The majority of them were completed online using *Surveymonkey* software. As a pretest, two insurance experts and a reduced number of customers were interviewed in order to detect inconsistencies or potential improvements. Data were collected between February and June 2016.

In the sample, 40% of the customers required the services of the insurance company in the previous two years before completing the questionnaire.

3.2 Creation of the HOW's set

In order to obtain the HOW's, we interviewed different insurance experts with relevant influence and experience in the Spanish insurance sector. After one-hour interviews, we grouped the concepts discussed and selected those which appear more frequently. In addition, we included the concept "Knowledge of the market", because we thought it could be important in order to understand what is happening and what direct competitors are doing.

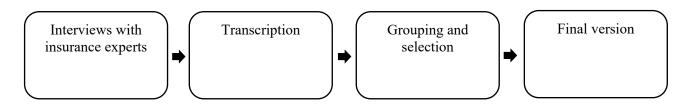


Figure 2 – Graphical summary describing the creation process of the HOW's.

An interesting point to take into consideration is the similarity between the interviews with experts. They agreed substantially in their opinions regarding the possible actions an insurance company could take in order to obtain better satisfaction results.

The final set of HOW's were the following¹: "Product offering", "Technology", "Call center service", "Pricing systems", "Marketing and advertisements", "Solvency margin", "Underwriting processes", "Documents and conditions", "Additional services offering", "Knowledge of the market", "Training of employees", "Professionals", "Working environment", "Knowledge about the insured risk", "Relationship with brokers", "Active communication with customers", "Claims management", "Risk management", "Coordination between departments", "Orientation to the customer", "Integrity of employees".

3.3 Construction of the QFD Matrix

After obtaining the WHAT's and HOW's, the QFD matrix was constructed according to the results obtained and tested through 17 interviews to insurant experts (CEO's, directors, technical mangers, business area managers, brokers, researchers, members of the public institutions...). Two interviews were used as a pretest, which concluded that the questionnaire was clearly understood matrix did not present significant errors, so no modifications were made. Data were collected between March and September 2016.

During the interviews, experts completed the matrix and we observed a relative consistency in the answers. In general, and as previous analysis showed, there is certain uniformity and equality in opinions. During the interviews, experts had to evaluate the correlation between each WHAT and each HOW as follows:

- 0: no correlation at all
- 1: low correlation

¹ By chance the same number was obtained in the WHAT's and HOW's set.

- 3: medium correlation
- 9: high correlation.

3.4 Construction of the Roof

During the interviews designed to obtain the QFD matrix, insurance experts were asked about the correlation between HOW's. In this case, they had to provide us about with their opinion regarding the correlation between elements manageable by insurance companies. Due to the fact that the QFD matrix exercise is high in intensity and time-consuming, we decide to reduce the complexity of the roof by asking experts whether they found a correlation or not. The results were obtained as follows:

- 0: no correlation
- 1: positive correlation

The possibility of including negative correlations was not considered in order to simplify the analysis. Data were collected between March and September 2016 simultaneously with the QFD matrix's results.

4. RESULTS

4.1 Importance of the WHAT's

In this section, results show which are the most important service quality items (WHAT's) for insurance customers. According to the results of the survey, the majority of items are highly valued, and it is difficult to remark a subset of items as significantly more important than others. This implies that item selection was successful.

Results in Figure 3 clearly show that items with less importance are: advertising, personal image of employees, and technological development of the insurance company. Probably, customers are expressing the fact that these features do not reflect the "essence" or the fundamentals of a property and casualty insurance contract, which is to provide customers with a solution according to previous contract conditions. All these items reflect the effort of insurance companies to transmit a comfortable and interesting image of the services offered. However, in the end, these particular items do not contribute to improve the quality of the service.

In contrast, it is very clear that customers perceive that the following items have a high degree of importance: speed and efficiency of the service, interest in solving the problems, and compliance with the contract. Taking into consideration the potential importance of insured risks in the property and casualty insurance business, it seems logical that customers are interested in obtaining ethical, clear, and fast solutions if required.

Surprisingly, items such as "Price", "Courtesy" and "Products which satisfy customer needs", which a priori seem to be crucial for the quality in insurance business, are not highly evaluated. However, it is important to remark that in the past few years, due to the economic crisis, prices of the majority of insurance products in Spain have decreased. This probably has a strong effect in the perception of price, which is not considered to be a significant item by customers.

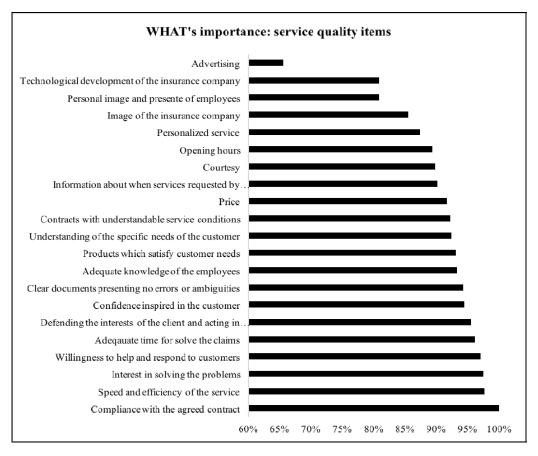


Figure 3 – Results of the normalized importance of the WHAT's.

4.2 QFD matrix

The highlighted results are those considered significant – with an average higher or equal to 8, and a standard deviation less or equal to 2.5. Taking into consideration the sample size of experts (17 interviewed insurance experts), consisting results were obtained using this scale. It is important to consider that figures only have been highlighted as significant if there is strong evidence that this relationship exists, based on expert opinions.

Some potential improvements with remarkable impact on insurance company image were very significant in terms of global contribution. It seems clear that if companies improve the most demanded HOW's, such as "active communication with customers" and "orientation to the customer", the image of the insurer would improve.

By improving orientation to the customer, experts can expect an important effect in all concepts related to customer support, advertisement, and the image of the company – which is important due to the nature of the business. Investments in active communication with customers would improve the customer's feeling of being understood by insurance companies, the perception of personalized service, and the insurer's image.

An interesting point to take into account is the high correlation between "Technology" and the efficiency and speed of the service, which is critical in order to solve the overwhelming majority of claims in some property and casualty insurance business lines. Investment in "Claims management" is expected to improve the image of the insurance company, the commitment with the customer, and the efficiency of the service.

"Integrity of employees", as expected, has a strong correlation with corporate image and with transmitting security to customers. It probably is a required condition for other concepts, and if it is not highly correlated with other customer requirements it is because it has been "taken for granted".

According to the opinions of the experts interviewed, by improving "Solvency margin" and "Underwriting processes" companies should expect no significant improvements in service quality perception.

Investing in "Training of employees" is expected to generate soft changes in some particular service quality items, but not significant enough to be considered crucial. Only efficiency of the service and knowledge of employees would increase significantly.

WHAT/HOW	Importance	UNIT	Products on offer	Technology	Call center service	Pricing systems	Marketing and advertisements	Solvency margin	Underwriting processes	Documents and conditions	Additional services offering	Knowledge of the market	Training of employees	Professionals	Working environment	Knowledge about the insured risk	Relationship with brokers	Active communication with customers	Claims management	Risk management	Coordination between departments	Orientation to the customer	Integrity of employees
Technological development of	81%	AVER.	2,2	9,0	1,9	4,6	1,8	2,4	5,6	1,9	1,0	0,8	2,0	2,6	0,6	2,2	2,5	4,6	5,2	4,6	1,6	3,4	0,2
the insurance company. Image of the insurance		DESV. AVER.	<i>3,4</i> 7,1	<i>0,0</i> 5,8	<i>3,4</i> 8,6	<i>2,9</i> 1,9	<i>3,5</i> 8,6	<i>3,4</i> 6,1	<i>3,3</i> 4,8	<i>3,5</i> 5,3	<i>2,3</i> 7,4	1,3 4,7	<i>3,0</i> 7,8	<i>3,3</i> 5,7	<i>1,2</i> 4,9	<i>3,4</i> 3,8	<i>3,4</i> 6,0	<i>3,5</i> 8,1	<i>3,4</i> 8,3	<i>3,4</i> 3,9	<i>2,9</i> 5,1	<i>3,5</i> 8,3	<i>0,7</i> 8,3
company.	85%	DESV.	3,0	3,4	1,5	3,5	1,5	3,9	3,4	3,5	2,9	3,6	2,7	4,0	3,8	3,8	3,6	2,4	2,0	3,7	4,0	2,0	2,0
Personal image and presence of employees.	81%	AVER. DESV.	2,1 3,5	1,5 <i>3.0</i>	4,1	0,3 <i>0,8</i>	3,8 <i>4.1</i>	0,2 <i>0,8</i>	0,8 <i>2,3</i>	0,9 <i>2,3</i>	2,0 3,5	0,6 <i>1.2</i>	7,9 <i>2,4</i>	3,7 <i>4,2</i>	8,3 <i>2,0</i>	0,4 1.0	3,0 <i>4.1</i>	3,0 <i>3,6</i>	2,0 3,5	0,8 <i>2,3</i>	3,0 <i>4,1</i>	3,5 <i>3,9</i>	5,8 <i>4,1</i>
	CEN'	AVER.	1,8	1,1	4,0 1,2	1,6	9,0	1,4	0,5	2,3 1,2	3,5	2,9	1,4	<i>4,∠</i> 0,2	1,2	0,5	2,9	3,8	0,9	0,9	4, I 1,1	8,3	1,3
Advertising.	65%	DESV.	2,3	1,5	2,4	3,0	0,0	3,0	1,2	3,0	3,6	4,1	3,0	0,7	3,0	1,0	4,1	4,2	2,3	2,3	3,0	2,0	3,0
Price.	92%	AVER. DESV.	3,2 3,5	4,0	0,3 <i>0,8</i>	8,6 1.5	1,1 <i>2,3</i>	3,1 <i>3,6</i>	3,5 <i>4,3</i>	1,1 <i>3,0</i>	1,7 <i>3,0</i>	3,8 4,1	0,9 <i>2,3</i>	0,5 <i>1,0</i>	0,2 <i>0,7</i>	3,1 4.0	2,1 <i>3,4</i>	1,7 <i>3,0</i>	2,7 <i>3,8</i>	3,2 <i>3,6</i>	1,9 <i>3,5</i>	2,4 <i>3,9</i>	0,2 <i>0,8</i>
Compliance with the agreed	1000/	AVER.	1,1	0,8	2,1	0,4	0,7	1,2	0,9	2,9	0,8	0,6	2,5	3,5	0,9	3,5	1,8	2,3	9,0	2,2	2,2	3,4	8,3
contract.	100%	DESV.	2,3	2,3	3,5	1,0	2,2	2,4	2,3	3,7	2,3	2,2	3,8	4,3	2,3	4,2	3,5	3,4	0,0	3,4	3,9	4,0	2,0
Products which satisfy customer	93%	AVER.	8,6	1,1	1,6	2,2	3,2	0,4	3,9	2,8	7,9 <i>2.4</i>	8,3 <i>2.0</i>	2,0	0,1	0,8	7,6	5,4	7,2	1,3	1,9	2,3	8,6	0,3
needs. Contracts with understandable		DESV. AVER.	1,5 3,5	<i>2,4</i> 0,2	3,5 1,5	3,5 0,9	4,0 1,4	1,0 0,2	<i>4,0</i> 2,2	<i>4, 1</i> 8, 1	1,9	1,8	3,5 1,6	<i>0,2</i> 0,2	<i>2,3</i> 0,7	2,6 2,1	<i>4,0</i> 2,2	<i>2,8</i> 2,0	<i>3,0</i> 0,9	<i>3,0</i> 0,8	3,9 1,1	1,5 3,5	0,8 1,2
service conditions	92%	DESV.	3,9	0,7	3,0	2,3	3,0	0,7	3,4	2,5	3,5	3,5	3,0	0,8	2,3	3,5	, 3,4	3,0	2,3	2,3	2,4	4,3	3,0
Interest in solving the problems.	97%	AVER.	2,7	1,1	7,2	0,7	0,8	0,4	1,9	1,1	5,8	1,7	4,6	4,4	3,2	2,1	3,5	3,9	8,3	1,3	2,7	8,3	2,1
		DESV. AVER.	<i>3,7</i> 0,8	<i>3,0</i> 7,8	<i>2,8</i> 5,8	<i>2,3</i> 0,2	2,3 0,1	1,0 0,1	<i>3,5</i> 3,5	<i>3,0</i> 0.7	<i>4,0</i> 0,1	<i>3,0</i> 0,9	<i>3,5</i> 2,6	<i>3,7</i> 8,3	<i>3,5</i> 3,4	<i>3,5</i> 0,9	<i>3,9</i> 3,5	4, 1 3,5	<i>2,0</i> 8,6	<i>2,4</i> 1,2	<i>3,8</i> 7,6	<i>2,0</i> 4,8	<i>3,5</i> 1,4
Adequate time for solve the claims.	96%	DESV.	2,2	2,7	3,1	0,8	0,3	0,3	3,9	2,3	0,2	2,2	3,8	2,0	3,9	2,2	3,9	3,9	1,5	2,3	2,6	4,3	3,0
Clear documents presenting no	94%	AVER.	4,5	0,7	0,7	0,3	1,1	0,1	3,8	9,0	0,9	1,7	1,3	0,1	0,1	2,2	1,0	2,4	1,6	0,8	1,7	4,6	1,3
errors or ambiguities. Information about when service		DESV. AVER.	<i>4,5</i> 0,9	<i>2,3</i> 3,5	<i>2,3</i> 7,2	0,8	3,0 1,2	<i>0,2</i> 0,1	<i>3,2</i> 1,8	<i>0,0</i> 1,6	<i>2,3</i> 1,8	3,0 1,4	<i>3,0</i> 2,0	<i>0,3</i> 3,5	<i>0,3</i> 1,5	3,4 1,2	<i>2,3</i> 2,5	<i>3,4</i> 8,3	<i>3,0</i> 4,9	2,2 1,5	<i>3,0</i> 2,2	<i>3,5</i> 5,8	<i>3,0</i> 0,8
requested by customers are to	90%		•			,	-			-	-	•				-							
be carried out.		DESV.	2,3	3,9	2,8	0,3	3,0	0,2	3,5	3,0	3,5	3,0	3,5	3,9	3,0	3,0	3,4	2,0	3,2	2,4	2,9	3,1	2,3
Speed and efficiency of the service.	98%	AVER. DESV.	1,5 <i>3,0</i>	8,3 <i>2,0</i>	7,6 <i>2,6</i>	1,1 <i>3,0</i>	0,4 <i>1,0</i>	0,2 <i>0,8</i>	5,5 3,6	0,5 <i>2,2</i>	1,7 <i>3,0</i>	1,6 <i>3,0</i>	8,6 1,5	7,2 <i>2,8</i>	7,2 2,8	1,2 <i>2,3</i>	7,5 <i>2,9</i>	5,5 <i>3,0</i>	8,6 <i>1,5</i>	3,5 4,3	7,6 <i>2,6</i>	7,9 <i>2,4</i>	1,5 <i>3,0</i>
Willingness to help and respond	97%	AVER.	3,3	1,5	7,2	0,1	1,8	0,6	3,4	2,5	4,1	1,1	4,2	2,9	3,7	2,7	2,6	8,3	3,4	1,4	2,2	8,3	2,7
to customers.	2770	DESV.	3,9	3,0	2,8	0,2	3,0	2,2	3,9	3,3	3,9	2,3	4,3	3,7	4,1	3,8	3,3	2,0	3,9	2,3	3,4	2,0	3,8
Inspire confidence to the customer.	94%	AVER. DESV.	4,0 <i>3,0</i>	1,3 3.0	4,6 3,5	1,8 <i>3,0</i>	7,6 <i>2,6</i>	5,2 4,3	4,9 <i>3,2</i>	4,6 <i>2,9</i>	4,9 <i>3,2</i>	2,3 3,4	7,9 <i>2,4</i>	3,6 <i>3,8</i>	5,0 4.0	2,8 <i>3,7</i>	4,3 <i>3,2</i>	8,3 <i>2.0</i>	7,6 <i>2,6</i>	3,1 <i>3,6</i>	2,0 <i>3,4</i>	7,1 <i>3,2</i>	7,9 <i>2,4</i>
Courtesy.	90%	AVER.	0,8	1,2	8,6	0,2	0,9	0,1	4,4	0,5	1,8	0,6	7,9	4,2	4,9	0,6	3,2	5,1	3,2	1,2	1,1	7,2	1,5
	20/0	DESV.	1,3	3,0	1,5	0,7	2,3	0,2	3,7	2,2	3,0	2,2	2,4	3,8	4,1	2,2	<i>3,6</i>	4,3	3,6	2,3	2,3	2,8	3,0
Adequate knowledge of the employees	93%	AVER. DESV.	1,3 <i>2,3</i>	1,4 <i>3,0</i>	2,0 <i>3,0</i>	0,7 <i>2,3</i>	0,6 2,2	1,2 <i>3,0</i>	2,0 3,5	0,8 <i>2,3</i>	1,2 <i>3,0</i>	7,2 2,8	8,6 <i>1,5</i>	4,9 <i>3,7</i>	2,8 <i>3,3</i>	8,5 <i>1,9</i>	3,5 <i>3,9</i>	2,9 <i>3,7</i>	1,6 <i>3,0</i>	2,4 <i>3,4</i>	1,7 <i>3,0</i>	4,3 <i>3,3</i>	1,6 3,0
Personalized service.	87%	AVER.	1,6	2,1	7,2	0,7	1,1	0,1	3,2	0,5	3,1	1,0	5,2	3,9	2,5	1,2	8,2	8,6	3,9	1,4	1,3	8,3	0,5
r ersonalizeu service.	0//0	DESV.	3,0	3,5	2,8	2,3	2,4	0,2	4,0	2,2	3,6	2,3	3,9	3,6	3,3	2,3	2,4	1,5	3,1	2,4	3,0	2,0	2,2
Opening hours.	89%	AVER. DESV.	0,3 <i>0,8</i>	3,2 <i>3,1</i>	8,6 <i>1,5</i>	0,1 <i>0,2</i>	0,5 <i>2,2</i>	0,1 <i>0,2</i>	0,6 <i>1,0</i>	0,5 2,2	1,6 <i>3,0</i>	0,8 <i>2,3</i>	1,4 <i>2,4</i>	1,4 <i>2,4</i>	1,1 <i>2,3</i>	0,6 2,2	1,9 <i>3,0</i>	2,4 <i>3,4</i>	1,8 <i>3,0</i>	0,4 <i>0,8</i>	0,6 2,2	7,5 <i>2,9</i>	0,2 <i>0,7</i>
Defending the interests of the	0.00	AVER.	1,2		1,2	0,2	0,9	0,2	0,9	1,8	1,1	1,6	3,9	2,4	0,5	1,4	2,7	2,8	2,1	1,3	0,5	8,3	8,6
client and acting in good faith.	96%	DESV.	2,3	2,2	2,3	0,8	2,3	0,8	2,3	3,0	2,3	3,5	4,1	3,4	1,2	3,0	3,8	3,7	3,5	2,4	2,2	2,0	1,5
Understanding of the specific needs of the customer.	92%	AVER.	8,3	2,2 3,5	2,4 <i>3,4</i>	1,3 <i>2,4</i>	3,2 <i>3,5</i>	0,5 2,2	3,1 <i>3,1</i>	1,6	8,3 <i>2.0</i>	7,6	7,9	3,4	1,2 <i>2,9</i>	7,2 <i>2,8</i>	7,2	8,3 <i>2.0</i>	2,2 3,4	1,7 <i>2,9</i>	1,3	7,9 <i>2,4</i>	1,9
necus of the custoffler.		DESV.	2,0	3,3	3,4	∠,4	3,5	۷,۷	3,1	3,0	2,0	2,6	2,4	3,0	2,9	∠,ŏ	2,8	2,0	3,4	2,9	2,9	2,4	3,0
Contributions			55	52	84	25	43	21	56	46	56	48	84	62	50	52	70	93	82	36	47	119	53
Contributions Relative			4%	4%	7%	2%	3%	2%	5%	4%	5%	4%	7%	5%	4%	4%	6%	8%	7%	3%	4%	10%	4%

Figure 4 – Results of ISQFD.

An interesting result shows that by improving "Pricing systems", customers would only perceive improvements in the price. A similar situation appeared when experts were required to find correlations with improving "Work environment", which would only have an impact on the image of the employees.

4.3 Contribution of the HOW's

An important starting point in order to understand the results of the QFD analysis are contribution values. As discussed, these show the general contributions of the actions a company can improve (HOW's) in the set of service quality items (WHAT's).

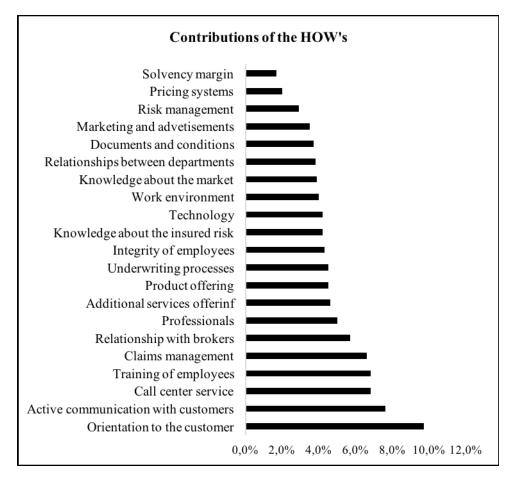


Figure 5 – Contribution values.

According to the results obtained in the Figure 5, it is very clear that customer orientation, "Active communication with the customer", "Training of the employees" and "Call center service" and "Claims management" (both have direct implication in the relationship with the customer) are the most important elements insurance companies should improve in order to obtain better global results in service quality.

On the other hand, "Solvency margin", "Pricing systems" and "Risk management", are clearly far away from customer service quality perception. Curiously, insurance companies provide these areas with high technical resources, and according to the results, they have no direct impact on customer satisfaction.

Results are consistent with recent trends in Spanish insurance market, which are strongly focused on customer.

Probably, customers are taking for granted the solvency margin of insurance companies.

4.4 Results of the Roof

The Roof in QFD tries to analyze common correlations between future actions in order to improve service quality. It is a useful tool to discover HOW's, which can indirectly help improve the WHAT's which do not stand out in the main QFD matrix.

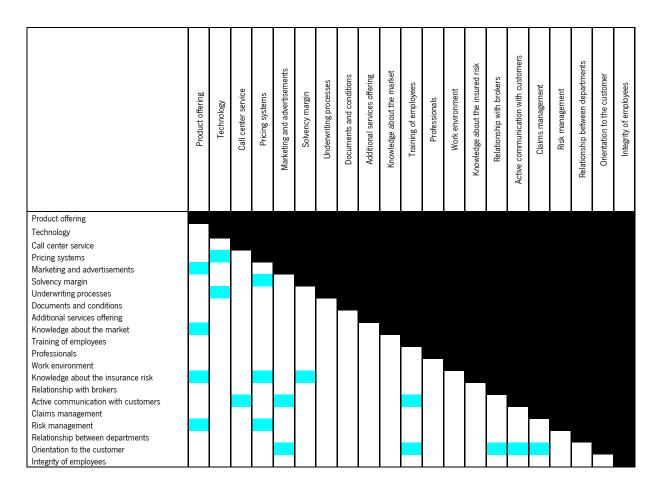


Figure 6 – Results of the Roof.

Results in Figure 6 show the combination of HOW's between which 75% or more of interviewed insurance experts agree that there is a correlation.

Of course, "Knowledge about the market", "Relationship between departments" in insurance companies (which is going to be reflected in shared knowledge), and "Marketing" have a correlation with "Product offering" because of communication and knowledge.

Improvements in technology have an impact in pricing systems and underwriting processes. It is a well-known reality that, in the previous years, the insurance sector has improved underwriting processes and pricing systems significantly thanks to technology.

As discussed in previous analysis, customer orientation is important in order to satisfy customers. Its correlations with efforts in advertisement, training of the employees, communication, relationship with brokers and claims management imply that insurance companies could increase customer orientation by improving the traditional points of the insurance business, such as relationship with the distribution channel and claims management.

6. CONCLUSIONS

This study makes some important contributions to the academic literature. First, the ISQFD has been developed for the first time by the European insurance market. Second, it has been proved QFD is an important tool in order to analyze service quality in property and casualty insurance.

According to the results obtained by the application of the ISQFD in this study, we can conclude that "Orientation to the customer", "Active communication with the customer" and "Training of the employees" are the most important HOW's, and all of them are related to service rather than the insurance product itself.

According to the results obtained, by making investments to improve customer orientation, active communication with the customer, training of the employees, call center service, and claims management, insurance companies should expect to improve customer satisfaction and, as a result, customer loyalty.

Training of the employees is essential in order to improve customer orientation and communication with the customer, which are two crucial points to achieve an optimal service quality in property and casualty insurance business.

Price is not a significant aspect for customers. By improving pricing systems, which in property and casualty insurance are usually very sophisticated, nothing more than price would be affected. We did not expect that result, because during the recent years, Spain's financial situation has forced some insurers to reduce prices in property and casualty business – especially in new business production.

According to the results obtained in this research, an important point to take into account is the high level of importance of the majority of WHAT's analyzed. As a conclusion, insurance customers have high expectations of a full service, and there are no significant differences in customer preferences or expectations. This phenomenon demonstrates the continuous pressure insurance companies are under in order to maintain their products and services in levels of quality which are high enough to satisfy their customers.

"Compliance with agreed contract", "Interest in solving the problems", "Speed and efficiency of the service", "Willingness to help and respond to customers", are the most important expectations (WHAT's) for insurance customers in the Spanish market. We can conclude customers want to obtain an efficient service in an insurance company which provides them with honesty and professionalism.

This study has some limitations that should be considered when interpreting our research findings. Despite the number of interviewed experts is acceptable, more completed questionnaires will improve the study. However, because the sample did not represent any specific company, we can ensure results are not biased. Some of the implications of this research are:

- Provide insurance researchers with a consistent tool (QFD), never used before in the Spanish insurance market, in order to analyze service quality in insurance.
- Determine empirical basis where insurance researchers will focus future investigations in order to analyze other importance insurance products or lines of business such as life insurance by the application of the QFD methodology.
- Provide a set of business actions in order to improve service quality combining the opinions of insurance experts and customers experience.

Taking into consideration the findings of this research, future researches will focus on the important service characteristics for insurance customers in order to find additional results.

These research intends to show the significant aspects on which insurance companies should focus their investments in order to improve service quality and competitiveness – and, as a result, their sales and customer retention. We found evidence to prove that the most important points are related to service provision. Evidence also shows that the insurance company activities which are more highly evaluated by customers are those focused on customer orientation, and those which provide employees with knowledge and abilities in order to efficiently interact with customers.

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Employees Satisfaction and Quality Management in Human Resources: a Study in Spanish Thermal Centre

Del Río-Rama, M.C.,1) Álvarez-García, J.2) and Bredis, K.3)

¹⁾ University of Vigo, <u>delrio@uvigo.es</u>

²⁾ University of Extremadura, <u>pepealvarez@unex.es</u>

³⁾ University of Extremadura, <u>cristinabredis@hotmail.com</u>

ABSTRACT

Purpose- Labour satisfaction of the employees with their job affect quality of a service that is provided to a client so it is a very important aspect that must be managed by executives of organizations. The organizational climate is a key for a company's success, and its regular analysis can help to improve those aspects where the organization is not so effective. The aim of this study is to identify/to evaluate current labour satisfaction of the employees to analyse strengths and weaknesses of the labour conditions that will allow us to suggest some improvement actions to the managers and determine whether the proposed scale based on the EFQM model is a valid measurement scale for measuring job satisfaction in organizations.

Design/methodology/approach- A descriptive analysis was used as methodology, and a questionnaire was sent to 55 employees of the Thermal Centre with the aim to collect data; the response rate was of a 76.36% (42 employees). The measuring instrument was tested and validated.

Findings- The obtained results show areas with possibilities of improvement are training, internal communication, knowledge and identification of objectives and organization and change management and the areas that need to improve their work conditions are perception of the executives and salary.

Originality/value- By detect the dimension's strengths and weaknesses of the labour conditions he has to take into account and so, to work with them the executive manager of the Thermal Centre with the aim improve labour climate that indirect way influence on clients through the quality of services.

Keywords EFQM, Human Resources, Labour Satisfaction, Organizational Climate, Thermal Centre

Paper type Research paper

INTRODUCTION

Labour satisfaction of the employees with their job and their labour environment, called Organizational Climate, is a very important aspect that must be managed by the enterprises' executives. It is defined as a number of features that determine a company, that differentiate it from others, and that affect in many cases the employees' behavior, as well as their motivation or satisfaction. Several researches have shown that satisfaction affects productivity, level of absenteeism and employees' rotation (Clegg 1983; Akerlof et al. 1988), aspects that also affect quality of a service that is provided to a client (Flynn 2005). Therefore, organizational climate is a key for a company's success, and its regular analysis can help to improve those aspects where the organization is not so effective.

Considering all this, it is highly important to measure labour satisfaction in enterprises, because it helps to understand experiences or expectations of an employee that affect in an indirect way a client and, as a consequence, the quality of services that are provided to them. Therefore, measuring of satisfaction with job's conditions allows to find out which aspects should be worked out to improve labour environment.

Taking into account all these points, the aim of this research is to determine the level of current labour satisfaction of the employees of a Thermal Centre1, so strengths and weaknesses of labour conditions can be analyzed, and it will allow to suggest some ways of improvement to the executives and determine whether the proposed scale based on the EFQM model is a valid measurement scale for measuring job satisfaction in organizations.

The chosen for this research Thermal Centre is managed with a quality management system (QMS) based on a standard UNE 186001:2009 (Themal resorts) and UNE 182001:2008 (Tourist hotels and apartments), so it has a Q Mark for Tourist Quality. Therefore, we have decided to use a quality approach to analyse labour satisfaction, basing on a tool of the Total Quality Management (EFQM Model) that allows an enterprise to evaluate itself regarding 9 criteria, being human resources management and results on persons two of them. The first criterion, human resources management, evaluates the way an enterprise manages and use knowledge and potential of its employees, and the second one, results on persons, measures the results that have been got in relation to its staff. According to Robles-García et al. (2005, p.127), to measure these results, "it is necessary to have some measures of perception that could show aspects related to motivation and satisfaction. In short, measuring of organizational climate". Definitively, this model is considered as very suitable for measuring the labor satisfaction as it includes all the aspects that in the literature are related to job satisfaction (working conditions, training, promotion and career development, recognition, remuneration, command-partner relationship, participation, organization and change management, work environment, communication, knowledge and identification with objectives and perception of direction).

To reach this objective, the article has been organized in five parts. After the introduction where the theme is set in a context and the objective is laid out, the second part develops a theoretical framework where a concept of labour satisfaction, the factors that form it and its consequences, relation between both satisfaction and quality and satisfaction and productivity, and the way to measure it are explained. Empirical research that allows us to achieve the article's goal is set out in the third part. In the fourth one, the collected data are analysed, and finally the most important conclusions originated by this analysis are introduced.

¹ Lopes et al. (201, p. 127) defines it as "that installation that has mineral hot springs water declared of public utility, medical care and adequate installation to carry out the treatments prescribed." The Thermal Centre has facilities where treatments are performed with mineral hot spring water and facilities where termalist is housed.

LITERATURE REVIEW

Labour satisfaction

Empiric literature has been gone through to demarcate a concept of labour satisfaction, and we can determine that it is "a quite wide term, and there are many definitions of it and many variables that are included in it" (Castro et al. 2009, p.107). In this revision, we have been verified that there are two groups of labour satisfaction: the one that is focused on emotional state and feelings and the other one that is considered to be a generalized attitude towards a job (Chiang 2013, p. 42-43). So, Barraza and Ortega (2009, p.1) define it as "an attitude that an employee shows towards its job, and this attitude is based on beliefs and values that the employee develops doing its job, and that will influence in a significant way on his behavior and his results", Andresen et al. (2007, p. 719): "an emotional pleasant or positive state produced by the work experience; this state can be achieved by satisfying some individual requirements through a job", and for Lee and Chang (2008, p. 733) it is "a general attitude that an individual has towards his job".

Considering the literature revised for this research, labour satisfaction is a negative or positive attitude that an employee has doing his work (Feldman and Arnold 1995; Robbins 2004). The attitude that depends on a number of factors as an economic one, academic training, relationship with the colleagues, work conditions, labour climate, etc., that according to the theory by Herberg (1968) can be grouped in two factors: intrinsic factors or motivational ones, and extrinsic ones or those of hygiene.

The first one includes "personal development, responsibility, recognition, the work itself, strengths and aims" meanwhile the second one refers to "company's policy, salary, interpersonal relationships, private life, status and safety" (Herbert 1968).

The theory of two factors or the theory by Herzberg (1959) is one of the main explanatory theories of the labour satisfaction, and it forms part of the so called "*Theories of content and cause*" together with the theories by Maslow (1954), the ERG theory by Alderfer (1969) and the one by McClelland (1961) called the learned needs theory. These theories are in charge of analyzing both the motivations that lead people to work and the factors and elements that influence and impact on their interest on working. Another aspect of explanatory theories on labour satisfaction is formed by the "*Process Theories*" that "*pretend to show the way the labour behaviour is strengthened, managed and carried out*" Campbell et al. (1970).

Consequences of labour satisfaction

Labour satisfaction is closely related to people's behavior in their workplace that basically affects the employee and the company. In this way, Gamero (2003, p. 9-13) makes a recompilation of consequences originated from labour satisfaction according to an individual scale (physical and mental health, longevity, escape or retreat attitudes, life satisfaction) and an organizational one (neglect, absenteeism, protest activities, productivity, civic behavior in the company, counterproductive work).

Many researchers corroborate these consequences, in other words, a relationship between labour satisfaction and behaviour of an employee. Álvarez (2004, p. 105) affirms "there are many researches that have confirmed that loyalty of an employee towards his enterprise, his productivity, his level of absenteeism and his labour rotation depend a lot on the level of his labour satisfaction". Other researchers as Mangione and Quinn (1975) and Clegg (1983) claim that there is a positive relationship between labour satisfaction and productivity and a negative one between satisfaction and labour absenteeism, and McEvoy and Cascio (1985) and Akerlof et al. (1988) say that there is a negative relationship between labour satisfaction of an employee and his neglect. On the other hand, Rogers et al., (1994) and Fosam et al. (1998) say that there is a positive relationship between the employees' satisfaction and the clients' satisfaction in the service sector.

Productivity is highly related to labour satisfaction. Productivity is defined as "a way that a system of operations or proceedings of an enterprise function" (Chiang, 2013, p. 44). The researches carried out

between the 50th and the 60th claim that there is a positive relationship between productivity and labour satisfaction through the following phrase: "A happy employee is a productive employee", meanwhile 30 years later they still define it positive but not so much. Other studies say that productivity leads to satisfaction, but not vice versa; a higher productivity leads to economic, social and psychological rewards that produces higher level of satisfaction for an employee, if he considers these awards to be appropriate (Chiang and Ojeda 2013, p. 45).

However, not all the employees are satisfied with their job or the enterprise where they work, so their dissatisfaction must be taken into account as well. In this sense, according to Locke (1976), labour dissatisfaction is defined as a negative emotional response towards the job that finally affects labour values of the employee, frustrating or ignoring them.

Labour satisfaction versus quality

Labour satisfaction and quality are two related concepts. In this sense, a model of the European Foundation for Quality Management (EFQM) considers people to be one of the most essential points for the development of an enterprise, so it belongs to the second and the seventh criteria of the nine that exist grouped in two categories: Facilitating agents and Results. This model refers to the employees in the following sense: "excellent enterprises value the persons that work for them and create a culture that allows to get all the personal goals and those of the enterprise in the most profitable for both parts way. They develop people's abilities and encourage justice and equality. They care about the employees, communicate with them, reward and appreciate them, so the employees are motivated, their commitment with the company increases, and they use their abilities and knowledge for the enterprise's benefit". (Guide Review of managing people, p. 8).

Given the fact that people's behavior is basic for providing of services of high quality, because they have a direct contact with clients, it can be said that the service's quality and the image of the enterprise depends on the employees. In addition, if we consider the previous paragraph that say that the employees' behavior depends on their labour satisfaction, it becomes a highly important aspect to be taken into account by the managers of any enterprise that would like to provide a quality service. According to Yee et al. (2008) the satisfied employees work better and try to provide a service of higher quality (Loveman 1998; Silvestro and Cross 2000).

In this sense, an argument that "the employee's satisfaction improves the quality of a service" is based on the theory of the equity of social exchanges (Blau 1964; Organ 1977); this theory makes reference to the fact that when managers of an enterprise offer appropriate work conditions that make the employees feel more satisfied, they tend to "correspond" appropriately through their efforts doing their work, a reciprocal fact between a company and an employee that leads to the quality of services; it means that the employees' satisfaction has a positive effect on the quality of services (Wayne et al. 1997; Flynn 2005).

According to Snipes et al. (2005), the researches on labour satisfaction and quality of services are the most studied phenomenon in the literature on organizational behavior. Several researches find out that labour satisfaction influences positively on the quality of services (Yoon et al. 2001; Hartline and Ferrell 1996). According to Heskett et al. (1994) quoted by (Snipes et al. 2005, p. 1331), "financial efficiency of an enterprise arises from the clients' satisfaction that in turn arises from the employees' efficiency that in turn arises from the employees' satisfaction".

Taking into account everything told previously, labour satisfaction and quality of services are closely related. An employee works better and provides a higher level of quality to the services, if he is motivated and rewarded by his supervisors that makes him feel more satisfied in the company. According to Zeithaml and Bitner (2000), quality of services depends directly on the impression that the employees cause to the clients.

Tools to measure labour satisfaction

There are several ways to measure labour satisfaction, for example, those quoted by Meliá and Peiró (1989). On one hand, there are global measures and on the other hand, there are specific aspects.

According to Harpaz (1983), there are other ways of measuring of labour satisfaction, as, for example, direct and indirect methods. The direct ones, or those based on the European model of EFQM management (Osakidetza/ Servicio Vasco de Salud, 2001:33) are to facilitate the process of the EFQM self-evaluation. These methods allow to collect information on attitudes of the interviewed people in relation to the work dimensions; the interviewed persons answer according to a scale offered for each item of the questionnaire.

The indirect, or traditional, methods are based on the information of the attitudes of the interviewed people that is more precise that the one of the direct methods; they have a number of disadvantages as subjectivity of interpretation and difficulty of quantification of the answers. There are several kinds of indirect methods, as:

- Minessota Satisfaction Questionnaire- MSQ (Weiss et al. 1967) that has as its basis the theory of adaptation to work.
- Job Diagnostic Survey- JDS (Hackman and Oldham 1979) that was developed to observe the effects of different characteristics of work on individuals.
- Job Satisfaction Survey- JSS (Mueller and McCloskey 1990) tries to measure satisfaction through nine subscales apart from global satisfaction.
- Job Descriptive Index- JDI (Smith et al. 1969) tries to measure work through five dimensions related with it.
- Questionnaire S4/82 (Meliá et al. 1986) allows to evaluate satisfaction with supervision and involvement in the enterprise; with physical environment; with material service; with remuneration, basic service and job safety; with interpersonal relationships and intrinsic satisfaction with a job.
- Job in General Scale- JIG (Ironson et al. 1989) allows to evaluate general satisfaction of an employee, being its second goal to measure some dimensions of job.
- Multidimensional scale of job satisfaction (Shouksmith et al. 1990) contains salary, opportunity of promotion, relationship with the colleagues and job conditions.
- Overall Job Satisfaction (Warr et al. 1979).

METHODOLOGY

Universe and field of study

The employees of a Thermal Centre in Spain have formed population of this study. The Thermal Centre has facilities where treatments are performed with mineral hot spring water and in the same building there is a 4 stars hotel with 105 rooms that also has a restaurant, a coffee-shop and an 18 hole golf course. The Thermal Centre has 55 employees both permanent and seasonal that belong to eight departments. It is the only one Spanish Thermal Centre that has three Q (hotel, thermal resort and golf course) awarded by the Spanish Tourist Quality Institute of the Tourism Ministry.

Questionnaire and measurement

The questionnaire has two different parts. The first one gets the information that allows us to define the profile of the interviewed persons (socio-demographic and labour), and the second one evaluates the labour satisfaction of the employees. A measuring tool is an adaptation of the questionnaire used by Osakidetza/Servicio Vasco de Salud (2001, p. 10), that deals with areas recommended by the EFQM Model and that takes into account all the aspects included in the personal criterion (Facilitative Agents) and in the criterion of the personal results. The employees were also asked about environmental policy and impact.

All the employees of the Thermal Centre have marked their level of satisfaction with 13 dimensions identified in the EFQM model linked with the employees' satisfaction plus environmental aspect. These aspects are

labour conditions, training, promotion and professional development, recognition, payment, organization and change management, labour climate, internal communication, knowledge and identification with objectives, perception of the executives and environmental policy and impact. A question on general perception of the level of satisfaction has been also made, so the questionnaire has 38 items. A Liker scale has been used, being 1 very unsatisfied and 5 very satisfied.

For the distribution of the questionnaire among the employees, an HR department of the Thermal Centre has been got in touch with asking for their collaboration and their permission to hand over the questionnaire to all the employees. The questionnaire was collected guaranteeing the anonymity of the respondent to avoid the bias the answers. It was handed over the 6th of March, and it was picked up 20 days later. The response index is a 76.36% that means 42 of the 55 employees. The sampling error is 7.50 for the level of confidence of 95% Z= 1.96 p=q=0.5.

Validation of the measurement scale

The current study used SPSS 19.0 to validation of the measurement scale using exploratory factor analysis (EFA). The psychometric properties of the scales (reliability, validity and dimensionality) are analyzed (Anderson and Gerbing, 1988); the item-total correlation of each of the proposed scales is observed (recommended minimum value 0.3 by Nurosis, 1993) and Cronbach's Alpha was verified (greater than 0.7 according to Nunnally, 1979). To check the unidimensionality, an EFA was conducted with varimax rotation (Bagozi and Baumgartner, 1994) that allows us to determine which observable variables loaded on which latent variables: explained variance (must be greater than 50%) and factor loading (loadings lower than 0.3 are considered significant according to Hair et al, 1999).

Table 1- Results of the Exploratory Factor Analysis (EFA)

Factors Identified and number of items	Cronbrach´s Alpha	Items eliminated	% Explained Information
Relationship with supervisors (6 items)-RS	0.920		71.75%
Involvement (2 items)-l	0.780		82.00%
Received recognition (1 items)-RR	-	_	_
Environmental policy and impact (3 items)-EPI	0.974	_	95.13%
Promotion and professional development (3 items)-PPD	0.879		80.77%
Labour climate (2 items)-LC	0.601		71.45%
Training (3 items)-T	0.949	Do not delete	90.91%
Internal communication (3 items)-IC	0.899	any item	83.52%
Knowledge and identification of objectives (2 items)-KIO	0.954		95.63%
Organization and change management (3 items)-OCM	0.770		70.23%
Work conditions (4 items)-WC	0.907		79.33%
Perception of executives (2 items)-PE	0.958	-	96.10%
Salary (2 items)-S	0.773	-	81.63%
General perception (2 items)-GP	0.699		77.33%

Source: Authors' own data

The results show that measuring instrument of reliability shows that all items have an item-total correlation above the recommended 0.3 minimum and the Cronbach Alpha in all scales is greater than 0.7, which indicates adequate internal consistency (table 1). With regard to unidimensionality analysis, their results did not lead to removal of any item; in all cases the factor loadings are greater than 0.5 and the accumulated percentage of explained variance is greater than 50% in each of the scales.

With regard to the content validity of the scales it is based on the literature review for the design of the scales; they were taken as reference the EFQM Model and the work performed by Osakidetza/ Servicio Vasco de

Salud (2001), García-Pozo et al. (2010), Pérez-Ciordia et al. (2012), Robles-García et al. (2015). Convergent validity implies that the same measured phenomenon of several independent forms leads to similar results and the reliability of the measurement scale through the coefficient Cronbach's alpha reflects the degree of cohesion among the items on the scale and is therefore an indirect indicator of convergent validity.

We analyze the correlations between different scales and particularly with general perception (table 2). In all cases there is correlation, but it not significant in the relationship between relationship with supervisors with knowledge and identification of objectives and labour climate; involvement with labour climate. We can see that there is a correlation between all the scales used to measure job satisfaction with general perception.

Table 2- Pearson correlation between scales

		RS	ı	EPI	PPD	LC	T	IC	KIO	ОСМ	wc	PE	S
RS	r	1	.685**	.315*	.355*	.265	.421**	.450**	.277	.546**	.402**	.367*	.388*
ı	r	.685**	1	.315*	.514**	.297	.529**	.615**	.480**	.599**	.465**	589**	.444**
EPI	r	.315*	.413**	1	.738**	.593**	.799**	.746**	.592**	.597**	.759**	.678**	.573**
PPD	r	.355*	.514**	.738**	1	.659**	.841**	.886**	.676**	.739**	.814**	.816**	.743**
LC	r	.265	.297	.593**	.659**	1	.735**	.788**	.540**	.749**	.805**	.800**	.806**
Т	r	.421**	.529**	.799**	.841**	.735**	1	.867**	.725**	.789**	.913**	.864**	.770**
IC	r	.450**	.615**	.746**	.886**	.788**	.867**	1	.654**	.815*	.815**	.874**	.791**
KIO	r	.277	.480**	.592**	.676**	.540**	.725**	.654**	1	.813**	.802**	.751**	.654**
ОСМ	r	.546**	.599**	.597**	.739**	.749**	.789**	.815**	.813**	1	.842**	.859**	.774**
WC	r	.402**	.465**	.759**	.814**	.805**	.913**	.815**	.802**	.842**	1	859**	.801**
PE	r	.367*	.589**	.678**	.816**	.800**	.864**	.874**	.751**	.859**	.859**	1	.815**
S	r	.388*	.444**	.573**	.743**	.806**	.770**	.791**	.654**	.774**	.801**	.815**	1
GP	r	.323*	.482**	.752**	.875**	.703**	.862**	.840**	.770**	.779**	.810**	.829**	.719**

r = Pearson correlation; ** correlation significant at 0.01; * correlation significant at 0.05

Source: Authors' own data

DATA ANALYSIS

We have started to analyze the data observing the profile of the employees who answered the questionnaire. They belong to all the departments of the Thermal Centre, having the cleaning department the highest rate of answers (26.19% of the total), being 62% women and 38% men. Regarding the educational level, a 16.67% of them are licensed, and a 9.52% have professional training. An 81% of them (34 employees) are permanent, and a 19% are seasonal; the shifts are rotating. The data show that a 40% of the employees have been working in the enterprise for 5-8 years, and a 15% - for more than 8 years.

To analyse labour satisfaction of the interviewed employees we have measured their level of labour satisfaction with all the job dimensions that we have taken into account, and it has been compared with the level of general perception. The table 3 shows the average and standard deviation of each dimension. An analysis of reliability has been done as well; it studies internal consistency of each tool of measuring. For this aim a Cronbach's alpha has been used that evaluates internal consistency of the scale through an average correlation of each variable with the rest of the scale. All the scales are over the minimum recommended value of 0.7 (Nunnally 1979).

The best valued dimensions, it means, those where the employees have a higher level of satisfaction, are: their relationship with supervisors, possibility to participate in the improvement process and decision making in their work area that the company gives them, and recognition of their work that the employees receive from their supervisors; all of them are the dimensions that have obtained an average of more than 4 points (being 4 "satisfied"). To the contrary, the less valued dimensions are the level of satisfaction with the salary, with perception of the executives related to the decision making and receptivity to the employees' demands and the work conditions; all of them valued with more than 3,70 in average (being 3 not satisfied neither unsatisfied).

The employees have been asked to value "a general perception of the level of satisfaction" that allows to compare the deviation between the valued level of satisfaction taking into account each dimension and general perception valued in a general way. An average of 4.09 has been obtained, if we take into account an addition of the averages obtained from each of the 13 valued aspects and an average of 4.26 in the case of general perception, the deviation is 0.15 in favour of general perception. As a conclusion, we can say that the employees are satisfied with the company.

Taking into account standard deviation, we can conclude that both average standard deviation of the studied aspects and the one of general perception are practically the same: 0.12 and 0.10. Therefore, variability between the collected data in general is uniform.

Table 3- Studied aspects

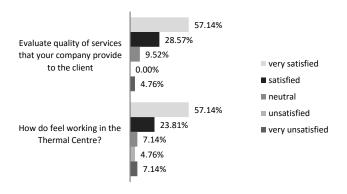
Level of satisfaction with	Average*	Standard deviation	Cronbach's α
Relationship with supervisors	4.50	0.10	0.920
Involvement	4.45	0.00	0.780
Received recognition	4.31	0.00	-
Environmental policy and impact	4.17	0.10	0.974
Promotion and professional development	4.13	0.10	0.879
Labour climate	4.11	0.36	0.601
Training	4.08	0.05	0.949
Internal communication	4.02	0.05	0.899
Knowledge and identification of objectives	4.01	0.08	0.954
Organization and change management	3.94	0.36	0.770
Work conditions	3.86	0.22	0.907
Perception of executives	3.79	0.07	0.958
Salary	3.75	0.05	0.773
All the previous dimensions	4.09	0.12	_
Level of satisfaction general perception	4.26	0.10	0.699

^{* 1:} Very unsatisfied; 2: unsatisfied; 3: Not satisfied neither unsatisfied; 4: Satisfied; 5: Very satisfied

Source: Authors' own data

Regarding general perception of labour satisfaction (graphic 1), a 57.14% said that they were very satisfied both with the quality of services that they offer to their clients and with the way they feel working in this company.

Graphic 1- Level of satisfaction general perception



Source: Authors' own data

With the aim to determine the areas to be improved, each studied work aspect is analysed to evaluate labour satisfaction separately, taking into account the items that are used to measure the level of satisfaction.

Level of satisfaction with work conditions and training

The employees are not satisfied neither unsatisfied with their work conditions with an average of 3.86 in general terms, being the best valued item safety conditions (4.05) and the less valued with an average of 3.55 is the way their company obey the agreement/regulations/labour laws. We can also see that a 76.19% of the employees are satisfied or very satisfied, being only a 7.04% those who are not.

Table 4- Work conditions and training

	Average	Satisfied or very satisfied	Neutral	Unsatisfied or very unsatisfied
Level of satisfa	ction WORK C	ONDITIONS		
Safety conditions	4.05	76.19%	16.67%	7.04%
Physical and environmental conditions	3.95	73.81%	16.67%	9.52%
Working timetable	3.90	64.28%	28.57%	35.72%
The way their company obey the	3.55	59.52%	16.67%	23.81%
agreement/regulations/labour laws				
Level of satis	sfaction with	ΓRAINING		
Opportunities of training for professional development	4.12	83.34%	9.52%	7.14%
Received training for professional development	4.10	80.96%	11.9%	7.14%
Response to requests for training	4.02	78.90%	14.29%	6.81%

Source: Authors' own data

Regarding the dimension of training, we can say that the employees are satisfied with it with the average of 4.08. The Table 4 shows the averages of the items that we have used to measure the training aspect; the scoring is very homogeneous being more than 4 points (satisfied) for all the items.

Level of satisfaction with promotion and professional development, received recognition and salary

The level of satisfaction with promotion and professional development has an average of 4.13 and has more than 4 points in three items used for measuring. As we can see in the table 4, an 83.33% of the employees are very satisfied or satisfied with their job and the level of use of their professional abilities; a 76.19% of them are very satisfied or satisfied with the expectations of promotion or professional development. In this last item, a percentage of the employees that say that are unsatisfied is the highest one (23.81%).

Table 5- Promotion and professional development, received recognition and salary

	Average	Satisfied or very satisfied	Neutral	Unsatisfied or very unsatisfied							
Level of satisfaction with promotion and professional development											
Satisfaction with their job	4.21	83.33%	7.14%	16.77%							
Level of use of professional abilities	4.17	83.43%	9.52%	16.57%							
Satisfaction with the expectations of promotion or professional development	4.02	76.19%	14.29%	23.81%							
Level of sa	tisfaction with	n received recogn	ition								
Recognition of well done job by the supervisors	4.31	83.33%	14.29%	2.38%							
Leve	el of satisfact	ion with salary									

Salary in relation to the rest of aspects	3.79	64.28%	21.43%	35.72%
Salary in relation with the done job	3.71	66.67%	16.67%	33.33%

Source: Authors' own data

Speaking about the recognition of the employees by the superiors for a well-done job, the average is 4.31, so they are satisfied. An 83.33% of the interviewed employees are very satisfied or satisfied and only 2.38% of them say that they are unsatisfied with this recognition.

Salary is one of the lowest valued aspects by the employees of this company with an average of 3.75 points; it is very close to 4 points that means "satisfied". Both the salary paid to the employee and the rest of the aspects have an average of 3.71 and 3.79 points respectively. It means neutral labour satisfaction, not satisfied neither unsatisfied with the mentioned items (Table 5). A percentage of the employees who say that they are unsatisfied or very unsatisfied is very high (35.72% and 33.33% respectively).

Level of satisfaction with supervisors and involvement

Relationship with supervisors is the best-valued dimension having 4.50 points as an average (Table 6). If we observe valuation of the items separately, the employees have a higher level of satisfaction with supervision by their bosses and with an ability of their direct supervisor to practice their organizational functions with an average of 4.60 in both cases; none of the employees said that they were unsatisfied with this relationship. Observing the percentage of the collected data, we can see that a 90% of the interviewed employees are very satisfied or satisfied with the relationship with their supervisors taking into account all the analyzed items but an item that measures orientation and support received from their direct supervisor for a work practice (83.33%).

Table 6- Relationship with supervisors, involvement, and organization and change management

	Average	Satisfied or very satisfied	Neutral	Unsatisfied or very unsatisfied
Level of satisfaction with the re	lationship w	ith superviso	ors	
Supervision exercised over you	4.60	95.24%	4.76%	_
Ability of your direct supervisor to practice his organizational functions	4.60	95.24%	4.76%	_
Evaluation of professional relationship with your direct supervisor	4.57	90.48%	9.52%	_
Personal treatment received by your direct supervisor	4.48	90.48%	9.52%	_
The way your direct supervisor judges your tasks	4.40	95.24%	9.52%	_
Orientation and support received by your direct supervisor for your work practice	4.38	83.33%	16.67%	_
Level of satisfaction	with involve	ment		
Possibilities to be involved in the process of improvement of your job	4.45	90.48%	9.52%	_
Frequency of request by your supervisor to take part in decision making that can affect your labour area	4.45	88.09%	11.90%	_
Level of satisfaction with organiza	tion and cha	ange manage	ment	
Work organization in your labour area	4.36	90.48%	9.52%	_
Level of knowledge on structure, functional areas and activities of the Thermal Centre	3.81	61.90%	28.57%	9.53%
Coordination between several areas	3.67	52.38%	35.71%	11.91%

Source: Authors' own data

The dimension of involvement as well as relationship with the supervisors is highly valued by the employees with an average of 4.45 points. The Table 5 shows that the employees are very satisfied both with the frequency of requests by their supervisors to take part in decision making about projects that affect their job and possibilities to take part in the process of improvement of functioning of their job; speaking about percentages, 88.09% and 90.48% of the employees respectively.

Organization and change management with an average of 3.94 points allow us to say that the employees are not satisfied neither unsatisfied with job organization in their area (4.36), but not with coordination between other work areas (3.67) neither with a level of knowledge on functional areas, activities of the Thermal Centre and its structure with an average of 3.81 points (Table 6). In both items a percentage of satisfied or very satisfied employees is of 61.90% and 52.38% respectively

Level of satisfaction with labour climate, internal communications, and knowledge and identification of objectives

Average evaluation of labour climate is 4.11, so it allows us to say that the employees are satisfied. They are satisfied with relationship between the colleagues of the same area (4.48), and they are neutral (not satisfied neither unsatisfied) valuating relationships between the colleagues in different areas; in this case a percentage of unsatisfied employees is high (15.06% - Table 7).

Global average in internal communication is 4.02 points. The main part of the interviewed employees says that they are very satisfied or satisfied with internal communication in the company, especially with the fact that they are informed about decisions made by the executives of the Thermal Centre and that they have information enough to develop their job in a correct way; speaking about percentages, a 78.59% and 73.81% of the employees respectively. An 80.95% of them say that they are satisfied or very satisfies with repercussion of suggestions/contributions done to improve their labourr area (Table 6).

Table 7- Labour climate, internal communications, and knowledge and identification of objectives

	Average	Satisfied or very satisfied	Neutral	Unsatisfied or very unsatisfied
Level of satisfaction with	h labour clir	nate		
Relationship between the colleagues and labour atmosphere in your labour area	4.48	88.01%	7.14%	4.76%
Relationship between the colleagues and labour atmosphere between different areas	3.74	75.42%	9.52%	15.06%
Level of satisfaction with into	ernal comm	unication		
Information about decisions made by the executives that affect an employee	4.07	78.57%	9.52%	11.91%
Repercussion of suggestions/contributions done for the labour area improvement	4.00	80.95%	11.90%	7.15%
Information received for a correct work practice	3,98	73.81%	16.67%	9.52%
Level of satisfaction with knowledge a	nd identific	ation of objecti	ves	
Level of knowledge about objectives, projects and results	4.07	73,81%	23.81%	2.38%
Appropriateness of goals and plans of your labour area	3.95	69.04%	26.19%	4.77%

Source: Authors' own data

Achievement of goals is an essential point for any company that basically depends on the employees, so they have to be informed about them and about the result as well, either positive or negative. Table 7 shows that the employees of the Thermal Centre are satisfied with their level of knowledge of objectives, projects and results (73.91%), but they are neutral (3.95 in average) speaking about the level of adjunction of plans and

projects to each labour area, so a percentage of satisfied or very satisfied employees decreases (69.04%). A 26.19% of the employees are not sure about the effectiveness of the projects and plans, and 4.77% shows clearly their dissatisfaction.

Level of satisfaction with perception of the executives and environmental policy and impact

The executives of the company have a very important role for the enterprise, because they decide which kind of work has to be done, when and in which way. There is a number of the employees that are not satisfied neither with the decisions that are made by the executives nor with receptiveness of them towards the problems of the employees. A percentage of these employees is 11.91 and 16.66 respectively.

Table 8- Perception of executives, policy and environmental impact

	Average	Satisfied or very satisfied	Neutral	Unsatisfied or very unsatisfied
Level of satisfaction with per	ception of th	e executives		
Receptiveness of the executive towards problems/demands of the employees	3.83	69.04%	19.05%	11.91%
Appropriateness of decisions made by the executives	3.74	69.05%	14.29%	16.66%
Level of satisfaction with envir	onmental pol	icy and impact	1	
Importance of program of environmental management	4.24	78.57%	14.29%	7.14%
Level of implication with the program of environmental management	4.21	83.33%	9.52%	7.15%
Adequacy of environmental policy	4.05	76.19%	16.67%	7.14%

Source: Authors' own data

Environmental policy exists in the Thermal Centre as well. It is executed through the managers that promise to have a responsible attitude towards the environment, and to require other employees and companies and/or persons working for it to have it as well. Taking into account the answers of the interviewed employees (4 points in average), we can say that the employees are satisfied with environmental policy and impact of the company with an average higher than 4 in three analyzed items (Table 8).

Finally, we want to find out is there are any difference between the level of satisfaction of the employees dependent on the employees' sex (16 men and 26 women) and kind of contract (34 permanent employees and 8 seasonal). A t-test has been done; it has helped us to compare the averages of both groups at the same time. First of all, we have proved the equality of variances using Levene's test, because these two groups have different size so we could do a normality test.

Table 9- Statistic tests of comparison of the averages according to sex and kind of contract

Level of satisfaction with	Levene	's test	t-te	est	٥.	Leven	e's test	t-	test	٥.
	F	Sig. t		Sig.	Sig	F	Sig.	t	Sig.	Sig.
Relationship with the superiors	0.371	0.546	-0.986	0.330	>0.05	2.926	0.095	0.022	0.982	>0.05
Involvement	0.001	0.981	-1.973	0.055	>0.05	3.081	0.087	1.022	0.313	>0.05
Received recognition	0.533	0.470	-0.761	0.451	>0.05	0.204	0.654	0.228	0.821	>0.05
Environmental policy and impact	10.397	0.003*	-2.161	0.044	<0.05	6.846	0.012*	1.562	0.0157	>0.05
Promotion and professional development	15.400	0.000*	-2.644	0.016	<0.05	6.695	0.013*	0.764	0.467	>0.05
Labour climate	42.947	0.000*	3.670	0.002	<0.05	1.408	0.242	0.824	0.415	>0.05

Training	4.174	0.048*	-3.416	0.003	<0.05	5.934	0.019*	1.138	0.287	>0.05
Internal communication	6.693	0.013*	-3.077	0.006	<0.05	4.191	0.047*	0.812	0.439	>0.05
Knowledge and identification of objectives	1.039	0.314	-2.038	0.048	<0.05	3.047	0.089	2.284	0.028	<0.05
Organization and change management	1.549	0.221	-3.821	0.000	<0.05	1.178	0.284	1.527	0.135	>0.05
Work conditions	0,097	0.347	-2.934	0,006	<0.05	5.600	0.023*	0.977	0.357	>0.05
Perception of the executives	7.508	0.009*	-4.081	0.001	<0.05	0.955	0.334	1.092	0.281	>0.05
Salary	4.320	0.044*	-3.896	0.001	<0.05	0.425	0.518	1.251	0.218	>0.05
General perception	11.887	0.001*	-2.406	0.027	<0.05	22.303	0.000*	1.398	0.202	>0.05

^{*} As there are some differences of variances, a Kruskal-Wallis test has been used (a chi-squared test). Sig. < 0.05 means that the differences are significant. Sig. > 0.05 means that the differences are not significant.

Source: Authors' own data

As for the Levene's test, we can observe that there are several dimensions that do not have homogeneity of variances, so finally the Kruskal-Wallis test is applied. In the sex analysis we can see that the hypothesis of equality is denied in several dimensions (sig. <0.05) because there are significant differences, and we can say that there is an association between a dependent variable (sex) and the independent one (dimension). In the contract analysis, we cannot deny the hypothesis of equality of the variances with the exception of "level of satisfaction with knowledge and identification of objectives" where we can say that there are significant differences between permanent and seasonal employees.

We have also analyzed a matrix of correlations of the dimension of labour satisfaction that belong to a quality of service questions. The data reveal that there is a significant Pearson product-moment correlation (r) between satisfaction and quality of service dimensions in exception with "relationship with your supervisors" dimension (r=0.237, sig. 0.130) and "involvement" (r=0.280, sig. 0.073).

CONCLUSIONS

The main contribution of this study is the validation of the proposed scale, the results show that the scale is reliable and valid for use by the thermal centers as a tool to measure job satisfaction. This scale basis using the EFQM model is very new and has been used in health services (Osakidetza/ Servicio Vasco de Salud, 2001; García-Pozo et al., 2010; Pérez-Ciordia et al., 2012; Robles-García et al., 2015) but it had not been validated statistically.

A second contribution of this work and not least important, on one hand, to obtain a global evaluation of satisfaction of the employees, and on the other hand, to detect weaknesses of each dimension or factors belonging to it; it would help us to give to the executive manager of the Thermal Centre the dimensions that he has to take into account and to work with them, that are the weaknesses detected by this research, so he could improve labour climate that in an indirect way influence on clients through the quality of services.

Speaking about labour satisfaction, if we take into account the results of this research we can say that the employees of this enterprise are satisfied with their organizational climate with an average of 4.09 (average of dimensions) and 4.26 (general perception) respectively. Following the strategy offered in the book of evaluation and improvement of satisfaction of personas working in enterprises that provide services (Osakidetza/ Servicio Vasco de Salud 2001), considering that excellent areas have more than 43% of satisfied employees, strong ones (41-43%), with possibilities of improvement (39-41%) and those that have to be improved (<39%), the final results are:

- Excellent areas: relationship with supervisors, involvement and received recognition.
- Strong areas: environmental policy and impact, promotion and professional development and labour climate.

- Areas with possibilities of improvement: training, internal communication, knowledge and identification of objectives and organization and change management.
- Finally, the areas that need to improve their work conditions are perception of the executives and salary.

To make improvements in the company, the executives have to delete the weaknesses where the employee feels himself less satisfied; it means, to improve work conditions, perception of the executives and salary, and to keep relationship with supervisors, level of satisfaction with their involvement and with received recognition.

As regards the limitations, the first relates to the study population is restricted to a single company, which prevents comparisons with other environments and situations, or to generalize the findings. A second limitation is related to the cross section thereof; it has been performed in a specific moment in time.

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Implementation of a quality model on a software company in Brazil

Silva, T.A.1, Queiroz, F.C.B.P.2, Queiroz, J.V.3 and Furukava, M.4

- ¹⁾ Federal University of Rio Grande do Norte (Brazil), ticianea3@gmail.com
- ²⁾ Federal University of Rio Grande do Norte (Brazil), fernandacbpereira@gmail.com
 - 3 Federal University of Rio Grande do Norte (Brazil), viegasqueiroz@gmail.com
 - ⁴⁾ Federal University of Rio Grande do Norte (Brazil), furuka2014@gmail.com

ABSTRACT

Purpose – This study was carried out to describe and analyze how the process of implementation of a quality model in a small software industry in Brazil improves its level of development production.

Design/methodology/approach – Based on the literature review of quality models and the needs of the company, the most suitable model was chosen and applied to the situation, being the Brazilian Software Process Improvement (MPS.Br) the chosen one. The process was presented and than applied in the industry, in witch the scenario was described and the before and after were compared.

Findings – The rate of performance was improved among other factors, showing the success of the quality model.

Originality/value – The research considers the applicability of a quality model in the process of software development, which is still limited in literature. The study concentrates on the quality model that suits the needs of the company, improving the development processes and showing what was necessary to implement in order to get the desired results. It also expects to contribute with future references for the companies and enthusiasts who desire to know more about the process.

Keywords: Quality, Certification, Process, MPS.BR, Implementation.

Article classification: Case study.

1. INTRODUTION

The technology area, especially the development of software, demands constant learning and recycling of the professionals viewing the demand from new technology introduced on the market daily. In this scenario of constant innovation is necessity the search of new methods of obtaining results and accompaniment of the market.

The everyday life inside the software development area is know for a great pressure regarding the deadline, cost of operations and the quality of the product. Regardless of the size of the team, many organizations have trouble dealing with those activities. In this scenario many quality models were developed, offering the companies efficient methods in development and maintenance of software.

With the constant search for quality and edge, the organizations have been recurring to the certified software quality models, providing the client with the guarantee that their processes follow a standard to assure a satisfactory result. This certification can be defined as a series of regulations that help to guide the implementation of a quality system and is certified by a third part entity.

This study will describe and discuss the process of implementing and certifying the Brazilian Software Process Improvement, MPS.Br, in a small technology company in Brazil, expecting to gain improvement in the productivity levels as well as getting to know how exactly happens the process of software development.

2. LITERATURE REVIEW

The process of quality achievement goes beyond delivering a product or providing a service within the pre assigned characteristics, according to Ambrozewicz (2003). It covers the global process from the resources used, passing through the controlling of the process, the professional qualification to the consumer service.

Crosby (1990) defines quality as a system that prevents flaws, by making right the first time around. As for Deming (1986) quality means accordance, prevention and continuous improvement. As it is, quality acquires different meanings depending on the clients needs and demands, as the necessities changes, the concept of quality does as well.

Therefore, quality is not an absolute measurement, but a goal to be reached, that is in constant change, in the same pace as the clients necessities develop. (Starke et al, 2012). As for software quality, it contemplates a complex combination of factors that vary according to the different applications and clients who require the software (Pressman, 2005).

According to Rouiller et al. (2003), many models and software quality standards have been proposed through out the years, in the following sections the most used quality models are presented.

2.1.ISO STANDARD

The International Organization for Standardization (ISO) is a non-governmental organization and its existence was motivated by the need of an international reference to regulate the contractual obligations between the supplier and the buyer that focused on the assurance of maintenance and uniformity of the product.

The most recognized models, such as ISO 9001, became know for the quality of the product, closer to the client perspective. According to Cortes e Chiossi (2001), the technological evolution, between other reasons, have elevated the clients minimal standards expectations. In this note the inexistence of problems was left behind as a competitive differential and became a basic requirement accompanied by usability, costumer service and others features.

The ISO standardization has as its disadvantage the applicability, the process of implementation is complex and confusing for newcomers and the certification is bureaucratic which makes following the requirements harder since the software industry is very dynamic and virtual.

2.2.CMMI

The Capability Maturity Model - Integration (CMMI), is an international model for quality in software development, it was created by the Software Engineering Institute (SEI). According to the SEI (2010) organizations from different natures including aerospace industry, financial, software, hardware, automobilist e telecommunications, use CMMI for development processes.

The model contains practices that cover management projects and processes, system and software engineering as well as other supporting processes throughout development and maintenance. It uses professional judgment as well as common sense, as described in the Technical Report released by the SEI, to understand the model CMMI which is divided in six capacity levels as shown:

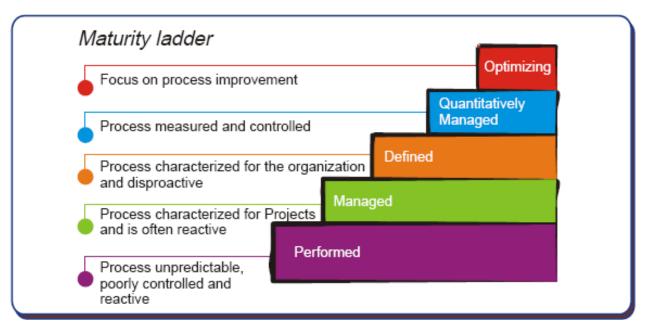


Figure 1 – Maturity Ladder (http://www.qaiglobalservices.com/Minisites/High_Maturity_Leadership/index.asp)

In order to reach each individual level, the organization must satisfy all given goal associated with each process area.

Even with all benefits that CMMI can offer a company, according to Sutherland (2008), there are a few negative points that must be considered, a few being:

- Great cost and time invested in the implementation (high maturity levels) counter interacts with the Brazilian reality;
- Respects the process but ignores the people;
- Does not focus on internal problems;
- Is not business-oriented;
- Ignores technical and organizational structure;
- Focus in internal efficiency and ignores external competitiveness

2.3. IMPROVEMENT OF THE BRAZILIAN SOFTWARE PROCESS

According to the data shown by the Federal Association of Brazilian Informational Technology Industries the amount of Brazilian software industries who carry any type of quality certification makes for only 11,8% of the total in 2014, as for ISO 9000 certification that number comes to 3,9% of the total and CMMI only 3% of these industries, these ones being multinational industries. (Assepro, 2014).

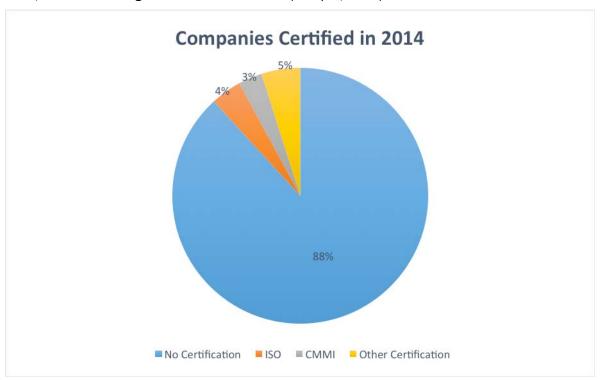


Figure 2 - Companies Certified in 2014

As claimed by Sommerville (2004), throughout the past years, the organizations interests in process improvement has grown. With the growth in technologies development in Brazil, the knowledge about standards and process improvement began to reach all companies, but the certifications available were difficult to become reality, either it financially or methodical, in this scenario the Brazilian market developed the MPS.BR. Created in 2003 by SOFTEX to improve the capacity of software development in Brazil. It had as base two international models for quality the CMMI (Capability Maturity Model Integration) and the ISO International Organization for Standardization), as well as software engineering practices and the necessities of the Brazilian market.

The MPS.BR model was as its advantage an economically viable way for the small industries to reach the benefits of the improving software process in a reasonable window of time. It brought a gain in competition to the national industries.

2.4. STRUCTURE OF THE MODEL

The MPS.BR is an improvement model, it purposes requirements that must be met by the companies as well as a software evaluation process, making it more accessible for small and medium companies to be certified and acquire a quality standard, attending de needs of nation wide businesses.

In this model there are requirements that must be implemented, they are all listed in a guideline of implementation so that the company can be certified in the software development area. This models has different levels of maturity, this being defined as the level of process improvement in which all objectives are attended (ISO/IEC 15504-1, 2004). Each level of maturity is composed by specific areas with specific

requirements that must be met, to each superior level all requirements of the previous levels must be met as well.

All seven levels of maturity in the model are shown ahead:

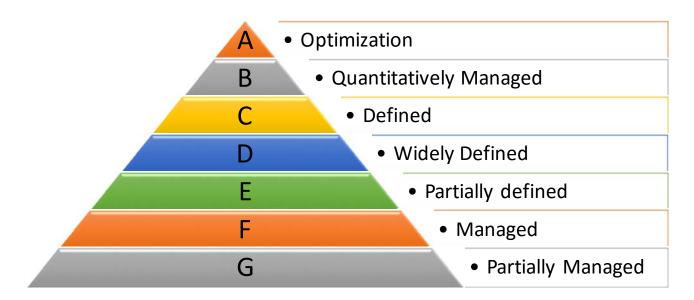


Figure 3 – MPS.BR Maturity Levels (adapted from: http://www.fumsoft.org.br/qualidade/modelo mpsbr)

The first levels is the level G, the more mature one is the level A. Each level shows different control rates in the process and the quality that com be expected from the organization.

A small company usually has a great distress to achieve the first level of maturity since the environment is usually chaotic taking control and having records of production can be very complex, therefore there is a great amount of tools available to help nowadays making the implementation process simpler.

2.4.1. MATURITY LEVEL G

The first maturity level is G (Partially managed) that covers two areas, Requirement management and Project management. This level is composed by the most critical processes in management. Intending to improve project control, the organization must implement supporting processes for software development, those are found in the next level, F (Managed).

Within level G planning, execution and process control must be observed, establishing commitment to fulfill the processes and maintain the visibility to the managers. The two areas defined in this level are: Project Management (GPR) – with the purpose to identify, coordinate and control tasks and recourses, also to provide information about the project, and Requirement Management (GRE) – with the purpose to manage the clients requirements and break those into smaller tasks to be coded, to identify inconsistencies in the product and on the project by knowing the usability of the product.

2.4.2. MATURITY LEVEL F

The second maturity level is the F (Managed), as shown in the following image, this level is composed of the level G areas added with new areas.

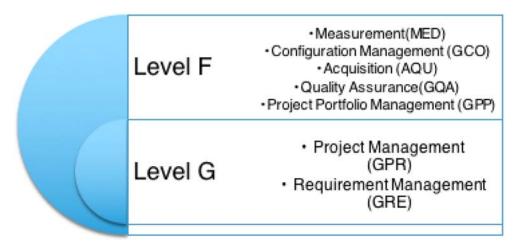


Figure 4 - Level F areas

The areas introduced by level F are:

Quality Assurance (GQA) – to assure that products and processes execution are following the standards stated in the documentation. This supporting area is responsible to maintain control and accordance in the productive process through documentation analysis, it is a critical area for the MPS.BR since it is the company way of keeping everyone's job as it was designed.

Measurement (MED) – to collect, store, analyze and report all data from the development process and the projects, with the measurements is possible to establish indicators and goals to each individual project.

Configuration Management (GCO) – has the purpose to establish and maintain the integrity of all products and projects, this area is responsible to for the security of the archive, giving access to the files, and to track every change in the source-code, the core of the product.

Project Portfolio Management (GPP) – has the purpose to initiate necessary projects in order to meet the strategic objectives of the organization. This area is not necessary for companies who do not work with new projects and only maintain existing products.

Acquisition (AQU) – with purpose to manage de acquisition of products that satisfy the need of the company. This area is necessary for industries who buy part of the system from other suppliers.

3. CASE STUDY

This study took place in a small software company in Brazil that has as its areas:

- Software development: acts in the market developing efficient solutions, making the clients life simpler and gaining financial and operational return.
- Technical Support: provides technical support to the developed products.

The company has 42 employees in several areas, 15 of those in the software development area. The development is divided in three teams, with 4 developers per team, each one responsible for one different product, other than the teams there are also the requirement analyst, who writes all the requisites and work tasks, the development director who acts as the product owner, bringing the clients needs and as support there is the quality analyst (the author of this study), responsible for the documentation and auditing of the processes.

3.1.STUDY SCENARIO

In 2010 the company was certified MPS.BR level G in development, having the two initial areas of process implemented, Requirement Management and Project Management, critical areas for a software project since it makes the work easier, identifying the needs e providing control for each project.

The company has its processes documented, therefore they are outdated since the previous certification, also there is no control over the development process. The improvement and need of change is within the culture of the company and its staff, however there was some changes in the staff and some newcomers do not know who a quality model works. The firm has responsibilities and roles defined and documented, but the responsibilities are still tangled together.

The development area of the company has a low productivity rate, with that a lot of effort goes to waste trying to fix older bugs in the system. Therefore, the directors of the firm decided to invest in the process improvement, using the MPS.BR model, chosen because of its viability since it is implemented gradually and easily applicable in small companies and also is subsidized (by SEBRAE) reducing the costs.

With the intention of planning the activities towards software improvement relating to level F requirements a diagnosis was made with employees who had technical, managerial and administrative knowledge as well as an external consultant. The diagnosis showed the necessary changes to achieve level F and after the current situation of the company the implementation process took place during nine months followed by the certification.

3.2. METHODOLOGY

The implementation happened with the aid of an outside consultant, responsible to prepare an action plan with every requirement necessary to obtain the certification as well as to achieve the improvement in the development process, such as an increase in productivity. Inside the company this process was managed by the development director and by the author of this study, the quality analyst. This process took place in 2014, from January to September.

4. RESULTS

4.1. Implementation

The company obtained a situational diagnosis, showing how it worked and what needed to be done in order to obtain the MPS.BR level F certification, then the implementation started. To achieve the level F was necessary evaluate and implement the needed areas out of the six required, the areas being Measurement (MED), Configuration Management (GCO), Quality Assurance (GQA), Acquisition (AQU), Project Portfolio Management (GPP), Requirement Management (GRE) and Project Management (GPR), the last two were legacy only needing improvement.

After all the required items were implemented the certification was scheduled and it happened with qualified representative licensed by SOFTEX (the organization responsible for the MPS.BR model).

From the implementation of the certification the documentation improved and was renewed, the responsibilities were outlined and limited with each career and the teams performance had a improvement (that could be measured). For each required area results are shown ahead.

4.1.1. Requirement Management

This area had been implemented before, during the level G in which the company was certificated in 2010, but the project management software has changed since then and the new standards were not registered although a pattern was followed since the responsible for all inputs in the system was only one person, the requirement analyst.

In this area was only necessary to document the process done by the analyst in the management system, making the standards available for every company member. There was no necessary change the standards in

how to make changes in the source code since it did not change its location or the information that the code holds.

4.1.2. Project Management

This area had been implemented during the previous certification but was registered in obsolete system, since than the management system changed and all projects documentation were now being registered in a new tool called TFS (Team Foundation Server).

The use of this system made the project management easier, giving access only to the interested people. Each person involved in the project had a profile where the access was limited respecting the need of each individual. But those processes were not documented and had no standardization, each component of the team registered information in the way they wanted, so was necessary to stablish standards and document those, the standards were debated and defined by the director and documented by the quality analyst.

Was also necessary to attribute a responsible for each process in this area, it was then documented. The last thing necessary for this area was the socialization on how to properly use the TFS, since a great part of the people involved in development did not know how to properly use all off its functions.

4.1.3. Configuration Management

This area is important to the development process, is the area that tracks every change made in the product, when it was made, who changed it and is able to change back to a previous state if necessary. It is extremely important when a bug is reported, so this area is critical.

It was then necessary to introduce this area in the organization, defining standards to the names of files, where every alteration should be made and how, folders that should be used, and was also introduced the configuration manager a title attributed to the requirement analyst who had the responsibility to verify the products folders and files as well as the source code to make sure that every alteration has a responsible person.

This process assures the integrity of the product and makes it possible to track the responsible for bugs in the system also been able to identify who is needing training or help with the processes standards.

4.1.4. Quality Assurance

The Quality Assurance was implemented by first hiring a quality analyst, after that was necessary to identify all the processes related to quality, which were then documented during this procedure the execution of the quality processes were happening in parallel.

As a quality process there was mainly the auditing, where was used initially a checklist created by the development director, it was used as a base to the current checklist used in the quality process and is now divided by each instance of the project, Planning, Execution and Closure, the checklist is also divided by the process area. It was then possible to measure each area and work on the ones with the worst performance.

4.1.5. Measurement

The measurement started with the improvement in the measures, possible with the help of team members, who learned that records of hours spent in each task should be done as the standardization.

This area required all data regarding the work tasks, such as how many tasks were done by each team member, the complexity of those, how many hours were spent in each task, how many bugs were corrected, how many nonconformities there were in the project, etc. With the data was possible to create indicators and acceptable levels for each one.

As an example there is the quality checklist, where there is a total amount of requirements and there is the amount of the ones that were met, with the rate of requirements met is obtained the adherence of the

process. There is a limit established of 75% of adherence for the project if the indicator is lower, actions must be taken to make sure that the nonconformities are fixed.

With the measurement is possible to know the development situation in numbers, making it easier to share and comprehend the progress of the projects and the teams. All measurements are available for every development member, and the results of each project are shared at the completion of the project.

4.1.6. Acquisition

The acquisition area is not necessary for companies who develop the entire system, is demanded for the ones who buy systems or modules developed by third parties, since the organization in this study develops all of its products, the area was not implemented.

4.1.7. Project Portfolio Management

The Project Portfolio Management is necessary only for companies who work developing new products for each client, the studied company does not develop unique products, it has three products that are maintained and upgraded, therefore this area was not implemented.

4.2. Certification

The certification process started with the preparation of the company representative, the quality analyst, who went through the Introduction to MPS-Software course (C!-MPS-SW), mandatory to be a part of the certification process.

Was then requested the presence of the evaluators certified by the competent organization, SOFTEX. Approaching the date of the evaluation all documents are compiled, those being the company information listing all the involved in the process, the confidentiality agreement to assure that all information collected during the documentation analysis and interviews are confidential, and a general view about the evaluation days with all the schedules.

In the process four projects are evaluated, two finished ones and two in progress, making it possible to observe the consistency of the evidence. Since there are three products, and therefore three parallel working projects in the studied company, only two were considered for the evaluation, with one finished project and the one which was in progress during the certification.

The evaluation lasted two days, in the first one all evidences were brought up by the two evaluators with the assistance of the company representative, the quality analyst. Since there were no nonconformities, only improvement suggestions, the evaluation was able to proceed in the next day, if any nonconformity was found the process would continue after it was fixed.

The second day of evaluation started with interviews, where all the involved in the projects asked questions, backing up and confirming what was described in the documents of the company, being able to assure that the guidelines were the reality. After this moment and after the conference of all documentation of the implemented areas a meeting with the directors took place, where the they were informed of achieving level F in development. All documents were signed and than the news were socialized with all other members of the company. Therefore the news could only be disclosed to the public after the official publication by SOFTEX.

4.3. Improvements with the MPS.BR model

With the implementation of the model MPS.BR is possible to observe improvement in the access of the companies' documents, where all processes are registered where the newcomers can read and get familiarized with the development process and know all the standards established.

Besides that, was possible to observe an improvement in the individual performance levels as shown in the graphics ahead. The indicator line represents the relation between time spent in the development (in minutes), the amount of points (complexity of the task) and the amount of tasks completed (development work).

The first graph shows the performance levels of one team before the complete implementation process.

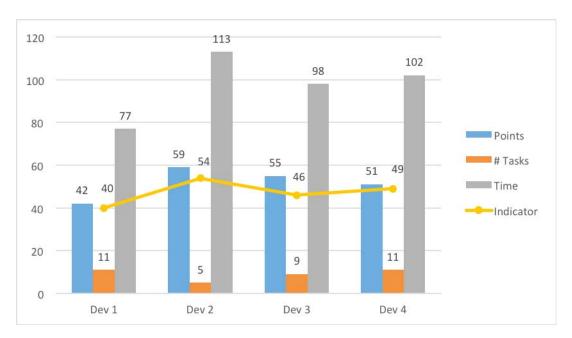


Figure 5- Individual Performance levels – February

The second graph shows the performance in the same team after the certification of the model, where is possible to observe an improvement in the performance rate of all developers, besides that the team is maintaining a balanced level.

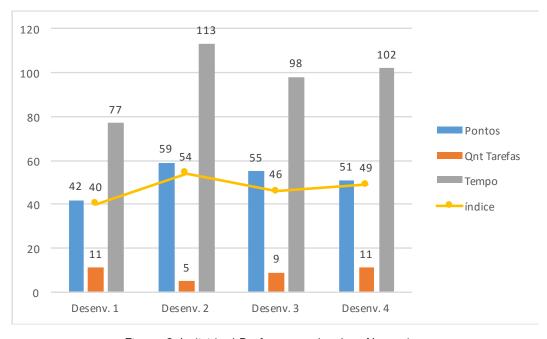


Figure 6- Individual Performance levels – November

After each project is finished all indicators are presented to the teams observing the developers who had a lower level of performance and getting to know why it happened, if it is a problem in understanding the requirements, if it was too complex, if it was a personal reason, since knowing the reason makes it possible

for the others to help someone who is struggling. Also each member wants to know their own performance and to know if they improved, comparing with previous results, in a constant search for improvement, which became culture of the company.

The quality auditions also became culture in the organization, making sure that all stablished process and patterns in documents are followed. There was the performance improvement but also a improvement in the relationship between team members, creating a sharing environment and defined responsibilities, with every task being done in the best way.

With the measurement area, all the decisions of the directors are backed with numbers, being able to create goals and limits for each indicator and being able to act in a problem area before the closure of a project, before the implementation of this area all judgments as to whether there was rework or the need of more work force was made by the directors feeling.

Besides all internal benefits, with the certification there was also external benefits as the higher credibility in the market since the certified company offers a feel of security, it was also used for marketing porpoises and the possibility to attend governmental organizations, that require a certification.

5. CONCLUSIONS

The literature review was indispensable to the conception of this article. The processes of implementation and certification MPS.BR level F were discussed . The initial diagnoses showed that the company addressed in this study needed adjustments and process improvement in the development area, it was the chosen the MPS.BR model of reference to apply all process improvements to meet the requirements of level F. This model was shown to be the best fit for the company, that needed a gradual implementation and is a small company with little resources.

The implementation of the model provided a improvement in the process, allowing a better management in requirement, lowered the projects nonconformities, implemented indicators, audits and standards, there was an increase in performance levels and the process organization, there was also an improvement in the organizations culture, creating a bond and a better relationship between the employees.

The main difficulties during the implementation were: the lack of communication between workers, the poor knowledge of the systems used internally, such as TFS, lack of agreement on stablishing the best way to perform a process (standards) and the concentration of power by the high management.

The institutionalization of the model during the implementation made improvement of the staff through trainings, helping improve and maintain all evidences of the process it also helped the communication between staff members.

With that was possible to observe that the objective of the study was met with a gain in the team members performance levels as well as a more balanced performance levels between team members.

This study is a expirience report that shall help other software companies going through the certification process.

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Applying Design of Experiments in Product Development Process

ARAÚJO JÚNIOR, L.Q.¹⁾, QUEIROZ, F.C.B.P.²⁾, ASSIS, C.F.²⁾, AZEVEDO, W.M.²⁾, QUEIROZ, J.V.²⁾ and FURUKAVA, M.²⁾

¹⁾ Federal University of São Carlos (UFSCar), Brazil

²⁾ Federal University of Rio Grande do Norte (UFRN), Brazil

ABSTRACT

Purpose – The constant changes in production systems has sought to cater largely to the needs of customers. The market, since then, has become increasingly competitive. In this context of seeking a competitive edge to impress customers and keeps them retrospectively, companies has developed new products. The lack of a clear management and a method in the Product Development Process (PDP) may cause the companies are unable to incorporate new technologies that result in significant improvements. The purpose of this article, therefore, is to propose the use of technique Design of Experiments (DoE) in PDP in Small and Medium Enterprise (SME).

Methodology – The study was conducted in an small ice cream artisanal shop. In order to conduct research methodology was elaborated: (1) Design of idea, (2) Listen to voice of customers, (3) Listen to voice of experts, (4) Identificating the parameters of interest; (5) Design of Experiments, (6) Analysis, (7) Optimization; (8) Product Release.

Findings – At the end of the product, it can be said that the use of DoE in PDP provided a successful outcome, with an innovative product on the market and improving aspects of information management within the organization studied. It stands out as positive the company has a great innovation environment, which is characterized by being very open to new and bold ideas. It is suggested the application of this study in other SMEs to improve the management of innovation.

Keywords – Design of Experiments, Product Development Process, Innovation Management, Artisanal Ice Cream Shop.

INTRODUCTION

In recent decades, has been ocurred a exponential progress in market worldwide, mainly caused by requirement of customers for products with higher quality. For this reason, competition between companies has become fierce and the constant pursuit of the "continuous improvement" implies management tools be essential to the success of any organization in the market.

An alternative for industries to survive in the market is the investment in innovation focusing on Research and Development (R&D), where are originated the new technologies that will exceed the needs of customers and provide a competitive edge in the increasingly dynamic market.

By using statistical techniques - which helps to make a more reliable decision - as a experimental planning, companies of any type can purchase the needed gradual knowledge during the process of innovation. In this concept, there are two crucial aspects to be emphasized: the new product development and quality of this product.

In process of developing and launching products is appropriate the managing of production resources. Its necessary identify all the critical factors that affect product quality, so they can be balanced, in order to the decision making be the best possible. So, understand experimentation requires a assessment of innovation process. That is, innovations of products and technologies are not from studies "fast", they are developed in a gradual way in laboratories and organizations with a system for experimentation.

One experiment can be defined as something organized to get results. The organization indicates manipulation of experimental conditions that results, so less confusing as possible, in conclusions of the proposed objectives. As most cases the results are numeric or can be treated numerically, it is possible to use statistical methods (RIBEIRO JR, 2012). The result of experiment tests is the best combination of factors, previously listed in programmed model, that optimized the problem of the response variable in question.

Organizations with focus on product development possess a system of experimentation to help to reduce the number of ideas for continue and improve the group which can become viable products. An fundamental step in the process occurs when an idea or concept becomes a prototype, which can then be tested, discussed, and rated with customers (THOMKE, 2010).

The lack of a clear management and a method in PDP may cause in companies the impossibility to incorporate new technologies that result in significant improvements. It is common do not find SMEs with PDP methodology defined. These companies often development products still based on empirical experience of their employees.

The approach used in this research aims to propose the use of DoE in PDP in SME, more specifically in a small Artisanal Ice Cream Shop, and aimed increasing reliability and, consequently, boost their competitiveness in the market. Corroborating with Antony (2003), which affirms that designed experiments offers a chance to test effects of parameters and this allows to experience a minimum number of tests which provide sufficient information at the same time.

This research is justified due to gap of knowledge that involves the subject Design and Analysis of Experiments within the SMEs in Brazil, and especially its benefits in the process of innovation.

According to Alves (2003), to make an effective monitoring of quality characteristics in a production process, the use of tools statistics becomes necessary to detect, identify and analyze

what are the factors responsible for the variability that affects unpredictably the process. But Corrêa and Corrêa (2006) emphasize that the tools dont solves problem and improve situations; in fact, the function of the tools is support and assist people in making decisions that solve problems and improve situations.

To Kartusa and Kurkus (2013), the prosperity of countries in general, and companies in particular, depends on innovation capacity, evidencing the fact that if the companies dont change what they offer and how to create and proffer their products and services, they run the risk of being overcome by others competitors.

LITERATURE REVIEW

The theoretical framework was the first stage of the work methodology. This stage of the research can be divided into three phases: survey and work consultation on design and product development, design of experiments, and the interface between the above topics and innovation management, encompassing the context of SMEs.

Product Development Management

According to Kaminski (2000), the product is the result of an engineering project, developed and offered to customers in order to meet individual and collective needs. So, design new products and launch them to market quickly is the challenge faced by manufacturers in various sectors (CHASE et al, 2006).

PDP may be defined as a set of activities through whereby be seek, from the needs of the market and possibilities and technological constraints - and considering the competitive strategies and product, achieve the design specifications of a product and its production process, so the manufacting sector be able to produce it. Even more, product development involves the monitoring of the product after launch, and the product discontinuance planning on incorporating market these concepts in the design specification, meeting all the needs of product throughout its life cycle (ROZENFELD et al., 2006).

This article follows the model reference (Figure 1) of Rozenfeld et al (2006), with the restriction in the macro phase "Pos", where this study ended in the Product Launch, not following the product discontinuation.

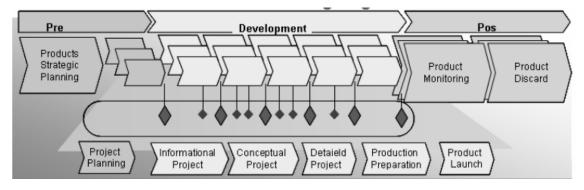


Figure 1 - PDP Model Reference; Source - Rozenfeld et al. (2006)

The new PDP in SME must be structured with special attention, especially in relation the capabilities and resources of the organization, market opportunities and attributes product valued by consumers (MOTTA et al., 2007).

Design of Experiments

An experiment is characterized by the treatments and experimental units to be used, the way treatments are assigned to units, and the responses that are measured (OEHLERT, 2010). More formally, we can define an experiment as a test or series of runs in which purposeful changes are made to the input variables of a process or system so that we may observe and identify the reasons for changes that may be observed in the output response. We may want to determine which input variables are responsible for the observed changes in the response, develop a model relating the response to the important input variables and to use this model for process or system improvement or other decision-making (MONTGOMERY, 2012).

DoE is a method to work efficiency on the systematic planning and development in experimentals projects. Designed experiments provide the ability to test the effects of projects parameters. This allows to experience a minimum number of tests providing sufficient information at the same time (ANTONY, 2003).

In general, experiments are used to study the performance of processes and systems. The process or system can be represented by the model shown in Figure 2.

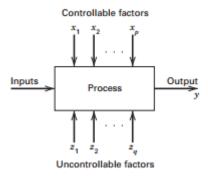


Figure 2 - General model of a process. Source: Montgomery (2012)

The objectives of the experiment may include (MONTGOMERY, 2012):

- 1. Determining which variables are most influential on the response y
- 2. Determining where to set the influential x's so that y is almost always near the desired nominal value
- 3. Determining where to set the influential x's so that variability in y is small
- 4. Determining where to set the influential x's so that the effects of the uncontrollable variables $z1, z2, \ldots, zq$ are minimized.

According Snorradóttira et al. (2011), DoE is useful for screening, optimization testing and system robustness. It has the following benefits: (1) the expansion of possibilities for performance evaluation aligned with the strategy and the market; (2) Optimizes the planning, execution and analysis of an experiment; (3) Encouragement of innovation management in organizations, and the most emphasized, (4) more reliable results: money and time saving.

Integration Innovation Management, Product Development and Experimentation

In particular in PDP, it is often necessary to obtain information on products and processes, in empirically way. At this time, the work of people involved with projects is similar to researchers who need design experiments, collect data and analyze them. (RUFFONI, 2000).

Box and Woodall (2012) indicates that an innovative system can be created using combinations of statistical tools that can add significant value to a business on an ongoing basis.

The importance of studying tools, such as DoE combined with innovation, is due to the fact that innovation is used as competitive positioning. Firms innovate or to defend their competitive or seeking competitive advantage positions. That is, it can have a reactive position and innovate to avoid losing market share or may have strategic position to stand out in the competitive market (OCDE, 2005).

Experimentation is on the core of the ability of each company to innovate. In other words, the systematic testing of ideas is what allows companies to create and improve their products. In fact, no one product can be a product without first having been an idea that has been molded in one way or another, through the testing process. Nowadays, a large development project may require thousands of experiments, all with the same goal: to find out whether the product concept or proposed technical solution is a promise to face a new need or problem, then incorporate this information in the next round of testing for the best product results (THOMKE, 2010).

Experimentation is therefore an essential step in any industrial research program. Seeing research as an interactive problem-solving process, so the faster an organization can accomplish each phase, the faster it should be able to solve problems. The benefits derived from the experimentation does not consist, however, only in speed in problem resolution. Benefits can also arise from the amplitude of the search, which can help break the conceptual inertia, which is reinforced by experience. Inertia in R&D results in part from the fact that the definition of problems for which solutions are sought and recognition of relevant information are themselves often problematic. (WEST, IANSITI, 2003).

RESEARCH METHODOLOGY

Methodological procedures

For the research in question, the researcher used a methodology based on Montgomery (2012) and Ribeiro and Caten (2011). Starting from precepts established by the authors, was structured a methodology that consists seven stages, ranging from the conception of the idea to the product launch. A scheme can be seen in Figure 3:

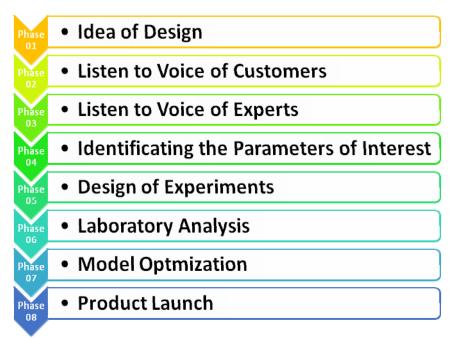


Figure 3 - Methodological Way Structured

The details of the actions of each phase of the methodology will be further explained in the section "Results". The phases 05, 06 and 07 happened concomitantly in the study.

RESULTS

Idea of Design

The search for better life quality has never been so much in evidence in Brazil and in the world as today. Women and men, young and adults, elderly and children seek to lead a healthy life, eating well and maintaining good physical shape.

This search for an esthetically perfect body and the lack of a healthy body culture has led people to use abusively substances that may potentiate the shortest possible time the achieve of perfect body (SOUZA, CENIC, 2014).

In this context arises food supplements, whether to maintain energy during activities or to gain muscle mass, which have always been a great ally of athletes in search for ever better performance.

Food supplements, according to Correa and Navarro (2014), emerged a few decades ago for people who couldn't meet their nutritional needs with feeding, giving more power and energy, so the supplement name.

The concept generation was made from brainstorming between the researcher and the company and some problems could be listed:

- 1. There is a pre-conception of a large part of the population who believes ice cream cant be a healthy food.
- 2. Athletes usually dont eat ice cream when they are dieting.

From the physico-chemical point of view, in general, the ice cream is basically constituted from 10 to 17% fat, 8 to 12% nonfat dry extract, 12 to 17% of sugar or sweetener, 0.2 to 0.5% stabilizers and emulsifiers and 55 to 65% water. Each component contributes in particular aspects of the final product characteristics (QUEIROZ et al., 2009).

Finnaly, from this view, was agreed the ice cream will have a major challenge to have a composition of 0% fat, and high concentration of proteins and carbohydrates.

Listen to Voice of Customers

The customers chosen were subdivided into three categories: sports athletes, gym athletes and street athletes. The focus of research with customers was to understand their nutritional needs. They were randomly chosen eight people.

In general, the respondents seek no fat foods, that, in some way, can help in weight loss, muscle gain and mainly provide energy to before training. But with the restriction of not being very caloric. In addition, respondents also want food without gluten. About flavor, 87.5% of respondents prefer flavors such as chocolate, strawberry or vanilla, claiming it would be more enjoyable and similar to the type of whey protein they consumed. And other 12.5% prefers fruits.

Listen to Voice of Experts

About the specialists was chosen health professionals. Five informal interviews were conducted. Three nutritionists and two physical educators formed the focus group.

The purpose was to understand what should have be in a diet of someone who wants to get a healthier life. Based on the basic premise that the ice cream to be developed would be aimed at a public who does regular exercise, they have raised some important details.

The recommendation was: the whey protein should be the type isolated, because it is tasteless and contains the highest protein percentage. Furthermore, the product should present minimal amounts of carbohydrate and lipid. Lactose-free and gluten is essential for product could meet your goal.

Identificating the Parameters of Interest

Based on the opinion of customer (customers need) and experts (projects requirement), it was made an QFD matrix. It helps started the product conception process for further identification of the parameters of interest.

As first choice, thought about the flavor, assuming the whey protein had no taste (isolated). Analyzing the QFD (Figure 3) realizes the limitation of lipids within the product idea, for this reason was chosen to make an ice cream with fruit to decrease fat (is easiest make a ice cream without lactose if choose a fruit to be the major ingredient), in additional decrease the amount of carbohydrate - assuming that was chosen prepare a product that is not hypercaloric.

Evaluating the fruits with their health benefits and trying to understand the possible acceptance in the ice cream market, it was decided to choose the orange.

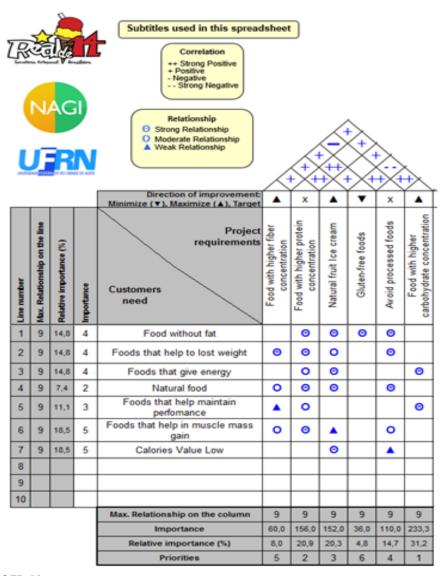


Figure 3 - QFD Matrix

The QFD matrix can draw the following conclusions: The objective of the project would be to develop a product without gluten, lactose, with the lowest percentage of fat as possible and that it was a rich source of protein and carbohydrates.

Design of Experiments

The components experiments are:

- 1. Variable response: Ice Cream Whey Orange.
- 2. Predictor variables (factors):

a. Base: soy milk or water

b. Water: Water Concentration

c. Protein: Protein Concentration

First Test of Experiments

As a first step of the experiment, it was necessary to determine whether the base of the ice cream: soy milk or water. For this reason, was chose initially to conduct an experiment by varying a single factor: the base. The procedure used is based on the revenue of two ice cream fruits, one being water-based and the other using soy milk.

As a note, the use of soy is because isn't contain milk protein (lactose), which would considerably increase the percentage of fat in the product composition. The proportions of whey followed a pre-established pattern between the researcher and the ice cream makers, according to the feelings of each other on the best amount according to recipe used.

Considering the high price of whey protein, was been agreed between the company and the researcher use the pulp of orange in experimental tests, trying cheapen the ice cream. At this stage, there were two repetitions to reduce the statistical error of weighing of the ingredients.

After the experiments were realized the first sensory analysis, the parameters were odor, flavor, texture and look of ice cream. Both samples passed the odor test.

Were noticed in the two samples used water-based, texture and visual samples were reproved. Regarding flavor, the final product got a little taste of orange, which leads to hypotheses: the orange concentration is low or combination with whey protein failed. About texture, the ice cream wasn't creamy, it was with a cracked appearance, like a açaí, which influenced the visual.

About the samples which were used on the basis of soy, it can be pointed out that the flavor has passed the test. The ice cream was creamier, but still not acceptable, thus the visual was not yet validated. For this reason, the base chosen for the tests was based on soy.

Second Test of Experiments

With the decision of the first stage experiments with the ice cream base would be soy milk, start now to the second round. As taste of ice cream had not been good in any of the tests, it was decided to try put natural orange juice to improve the taste - because was being used the fruit pulp - and to increase fiber intake in the new ice cream.

With this, the new factors were:

a. Water: Water Concentrationb. Fiber: Fiber Concentration

c. Protein: Protein Concentration

In this round, the concepts of full factorial experiment were used. To determine the number of tests, it has to n^r , where n is the number of levels in each factor and f is the number of factors. Considering that remain three factors (protein, fiber and water) and that each factor has two levels (in respect of confidentiality rules, will be used nomenclatures + (plus) and - (minus)), thus, the number of performed treatments were $2^3 = 8$ treatments, as can be seen in the table follow.

Table 1 - Experimentation framework of Test 2

TREATMENT	A	В	С	ABC	SENSORY TESTS	REASON
1	-	-	-	-	DISAPPROVED	TASTE, TEXTURE AND VISUAL
2	+	-	-	+	DISAPPROVED	TEXTURE AND VISUAL
3	-	+	-	+	APPROVED	
4	+	+	-	-	APPROVED	
5	-	-	+	+	DISAPPROVED	VISUAL AND TASTE
6	+	-	+	-	DISAPPROVED	TEXTURE AND TASTE
7	-	+	+	-	APPROVED	
8	+	+	+	+	APPROVED	

Subtitle:

A-Water Concentration

B-Fiber Concentration

C-Protein Concentration

The project 2* is used generally to make the screening of the factors that impact the response variable, and therefore useful in the early stages of experimental work, when usually it has many factors to be investigated (MONTGOMERY, 2012).

Treatments 1, 2, 5 and 6 were failed in the first sensory tests conducted by the research team. The main problems have occurred in that aspect of the first round of experiments: texture and look, beyond the orange flavor, that had not gotten the best combination with the other ingredients. The samples 3, 4, 7 and 8, obtained a satisfactory result.

To solver the questions about which sample should be used on the laboratory tests, there were three repetitions in each one approved in this round of tests. After the repetitions, were realized the same sensory analysis and the sample chosen for subsequent analysis was the number eight. The decisive factor was that the ice cream yielded more (it was produced a greater amount of kilos) and hasn't lost any of the properties, according to the blind test performed by all employees of the organization.

The results found in chemical composition tests failed to support the research hypothesis, it was found a high concentration of lipids and a regular percentage of protein. Furthermore, creaminess and texture of the product were the lowest with aspects of sensory analysis. Even missing the tests from the ashes and the carbohydrate, the researcher found a better finished the experiments, considering mainly the results of proteins and lipids, making a new change in the levels of selected factors.

Third test of experiments

The idea of this round was to try to find another combination that optimize the final product. Therefore, was made another changes. It was chosen to insert the green banana biomass to improve product consistency, as well as to increase the percentage of fibers.

Analyzing the reliability of components, it was chosen to keep the whey protein used in the first test, because it had been recommended by health professionals and didn't find contraindications in INMETRO.

Therefore, again performed a factorial experiment, with the same factors of the second round of experiments, only changing the pulp for fruit. With the already defined formula, this round of

experimentation was simpler than the previous one. She had the same number of repetitions, as can be seen in the table below.

Table 2 - Experimentation framework of Test 3

TREATMENT	A	В	С	ABC	SENSORY TESTS	REASON
1	-	-	-	-	DISAPPROVED	TASTE, TEXTURE AND VISUAL
2	+	-	-	+	DISAPPROVED	TEXTURE AND VISUAL
3	-	+	-	+	DISAPPROVED	TEXTURE
4	+	+	-	-	APPROVED	
5	-	-	+	+	DISAPPROVED	TEXTURE AND TASTE
6	+	-	+	-	DISAPPROVED	TEXTURE AND VISUAL
7	-	+	+	-	APPROVED	
8	+	+	+	+	APPROVED	

Subtitle:

A-Water Concentration

B-Fiber Concentration

C-Protein Concentration

The ice cream with fruit juice was better than that of pulp in all sensory tests, especially in taste and creaminess. The addition of green banana biomass was a very good adjustment to complete the composition of the product.

Physico-Chemical Analysis

It Was realized tests mandatory by COVISA to determine if the ice cream is or is not fit for human consumption. Considering the importance of the test, it was chosen by the researcher in a licensed laboratory of Natal and the sample was considered satisfactory. The report is found in Annex 1.

Bromatologic Analysis

After the physical-chemical analysis, a new round of chemical composition analysis in the ice cream was made. The methodology recommended by Instituto Adolfo Lutz (2008) for edible ices was used for the analysis.

Three tests were conducted on each of the 3 stages of ice cream manufacturing process (Freezing, Free Cooling, Cooling) to reduce the statistical error. All the tests are showed in Appendix 1.

Product Launch

The participants that composed the focus group (athlets and health professionals) were again called and was applied to sensory analysis regarding ice cream, showed in Table 3.

Table 3 – Compilation of Sensory Analysis Results

	Color	Appearance	Odor	Flavor	Texture/Consistency	Interaction
1	5	4	3	4	3	4
2	4	4	5	3	3	5
3	5	4	5	5	5	4
4	4	4	5	5	3	5
5	4	5	4	5	4	5
6	3	5	5	5	5	3
7	5	4	4	5	4	5
8	5	3	5	5	5	5
9	4	4	4	5	5	5
10	5	3	5	4	5	3
11	5	5	5	5	4	5
12	5	4	5	5	4	5
13	4	3	5	5	5	5
μ	4.4615385	4	4.6153846	4.6923077	4.2307692	4.5384615
σ	0.6343239	0.6793662	0.624926	0.6056929	0.7994081	0.7457969

The main positive points showed were the flavor, where they highlighted the "softness" of ice cream; odor, where they pointed out that the smell of the fruit is present and the interaction between the elements. This last point was the one who had the best comments. In the group opinion, any mixture with whey protein, e.g., milk shake, has a bad taste. The key point of the ice cream was to make a product that combine a tasty and nutritious food. 70% of respondents pointed out that not even looked like they were eating whey protein.

Regarding questions with the lowest ratings, there is the appearance and consistency / texture. The result was expected by the research team, as were the main complicating points at the time of preparation of the product.

Even with the inclusion of green banana biomass, the aspect of acai continued - even decreasing considerably. For this reason the appearance was the item with the lowest evaluation in the questions. And following the same has the texture / consistency. The final product can be look in Picture 1.



Picture 1 – Ice Cream Whey Orange

As the main observation, customers also pointed out that it could be developed with chocolate or vanilla instead the fruit, with the exception of obtaining characteristics similar to presented.

Overall, the product had an average of 4.4231. The result was considered very good by the research team, which found that the product has achieved all the goals set at the beginning of the project.

DISCUSSIONS

The propose of this article was insert the DoE as a tool to assist in the DPD in SMEs companies, it obtained an positive result for the company's management: the documentation for step-by-step product development, something that had never happened before.

The knowledge management in the ice cream shop was focused on the organization's owners and ice cream man. With this work, the researcher was able to contribute to improvements in this sense: a clearer documentation about the product development process.

About the found facilities, it stands out the company has a great innovation environment, which is characterized by being very open to new and bold ideas. Making an addition in this sense, is a tradition of the company every month launch new flavors. According to customer acceptability, these flavors may or may not be part of the company's portfolio.

The main limiting, it can be highlighted: act with exact measurements and find the ideal texture. Regarding the first, there was a restriction on the employees who did not recognize that an error in the amount of raw material could interfere with important variables of the product as flavor, visual, etc. And the creaminess, such as ice cream was made with a flour (whey protein), and no addition of milk, the creaminess was secured from the addition of green banana biomass, where it acted as an alloy, replacing the fat in ice cream.

As strengths of study, it can be noted that were carried out physico-chemical tests and chemical composition to ensure compliance of food with the rules in Brazil. These types of tests had never been done before on another product of the Organization, representing more credibility in the market.

The chemical composition of the product is as follows:

Table 4 - Centesimal Composition of ice cream

Parameters	Percentage
Humidity	73.6412
Ash	0.4319
Rough fibers ¹	0.4373
Lipids	0.1857
Proteins	10.27
Carbohydrates ²	15.0337
Total Caloric Value	102.8861 kcal

Subtitle:

For determining the Total Calorific Value (TCV), multiply the lipids by 9, proteins and carbohydrates for 4 by 4, resulting in a value of 102.8861 kcal. The TCV was a good result for the search, considering that was low and can replace a meal of an athlete, which usually is somewhere around 130 kcal. With this information, was developed the labeling of the final product, which is shown below:

Table 5 – Ice Cream Nutritional Information

	NUTR	ITIONAL INFORMAT	ΓΙΟΝ	
	Porti	on 100g (01 ice cream b	all)	
	Amount for po	rtion	%	DV (*)
Calories	103 Kcal	432 kJ	5	%
Carbohydrates	15	G	5	%
Proteins	10	G	14	%
Total Fats	0	G	0	%
Saturated Fats	0	G	0	%
Trans Fats	0	G	(**)	%
Food fibers	0	G	2	%
Ash	0	Mg	(**)	%
Humidity	73	%	(**)	%

^(*) Daily Values based on a 2,000 kcal diet or 8,400 kJ. They DV may be higher or lower depending on calorie needs.

To highlight how the product was relevant for the question to be healthy, a search was made in the literature on studies that address on the composition of handmade ice creams.

¹It was not possible to perform the determination of alimentary fiber.

²The actual carbohydrate content is less than this presented.

^(**) DV not established.

With the limitation of work carried out in Brazil in this area, was found three. A compilation of the three and this article to prove how much the ice cream Whey Orange became an innovation in the market was made.

Table 6 - Comparison of chemical composition of artisanal ice creams (values in percentage)

	Pazianotti et al.	SABATINI et al.	VACONDIO et al.	ARAÚJO JÚNIOR
Parameters	(2010)	(2011)	(2013)	(2015)
Total Solids	34.35			31.63
Carbohydrates	23.34	76.6	21.61	15.0337
Lipids	6.9	0.48	5.45	0.1857
Proteins	3.5	4.79	1.66	10.27
Ash	0.66	3.67	0.55	0.4319
Rough Fibers		5.68		0.4373
Humidity			70.73	73.6412
Total Calories (kcal)	169.46	190.7167	142.13	102.8869

It possible characterize several innovative aspects of the research in question. First, no study has all the chemical composition tests showed that this research. Among all these studies, the ice cream Whey Orange was presented the lowest concentration of carbohydrates, lipids, ash, rough fiber and total caloric value, which corroborated the hypothesis that ice cream can be a healthy alternative. Moreover, it had the highest amount of protein of all the ice cream and the highest percentage of water, which makes it healthier.

FINAL CONSIDERATIONS

The research in question had two key assumptions. The first was DoE reduces the uncertainties of PDP; and the second hypothesis was ice cream made based supplements is a viable alternative for athletes.

Faced with these two premises, the present study aimed to propose a methodology for development of new products for these customers, using DoE in a artisanal ice cream shop.

The applied methodology decreased uncertainty of developing a new product, because the steps recommended facilitates the understanding of the factors that made up the product and how they influenced (positively or negatively) the results expected by the research team.

The new method presented significant aspects about the management of knowledge within the organization. In addition, one of the great contributions of the research was that the first time was a validation of an product in relation to bromatologics analysis or chemical composition of the product.

Also in relation to practical difficulties, there is the difficulty of operation with exact measurements in the manufacture of ice cream and for the creaminess of the product, considering that the final product almost had no fat and this is responsible for forming creamy ice cream.

The hypothesis that ice cream could be a healthy alternative for athletes was proved as the chemical composition tests showed the following results: 73.6412% water; 0.1857% lipids;

0.4319% ash; 0.4373% rough fiber; 0.1857% lipids; 10.27% protein and 15.0337% carbohydrates. Considering that no one has the real total of fiber, carbohydrate percentage may be even lower.

It was found that a ball 100 grams of ice cream has approximately 102.8861 kcal, which resulted an excellent power source for athletes. Moreover, it is rich in vitamin C, which helps maintain healthy and active body.

As future developments of this research, it is intended to serve as reference material for other SMEs can use the DoE for PDP in their organizations, making the tool accessible to all researchers and stakeholders.

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Annex 1 - Ice cream Analysis Report



LAUDO DE ANÁLISE DE ALIMENTOS



Data da emissão: 03/11/2014.

DADOS DO SOLICITANTE								
SOLICITANTE: SORVETERIA REAL DE 14								
ENDEREÇO: Avenida Prudente de Morais, 648 - <u>Tirol</u> , Natal - RN, 59020-400								
DADO	OS DA AMOSTRA							
№ DA AMOSTRA: Proc. 135/14 MBAL 118/14	TIPO DE AMOSTRA: SORVETE SABOR WHEY PROTEIN							
DATA ENTRADA LAB.: 23/10/2014	HORA DA ENTRADA: 16:40							
DATA DA FABRICAÇÃO: Não informado	VALIDADE: Não informado							
FINALIDADE DA	CONDIÇÕES DA							
AVALIATIVA	Congelada							
ANÁLISE:	AMOSTRA:							
PROCEDÊNCIA DA	RESP. PELA							
PIPA/RN	O solicitante							
AMOSTRA:	COLETA:							
O	BSERVAÇÕES							

PADRÕES MICROBIOLÓGICOS PARA ALIMENTOS

PARÂMETRO	VMP	UNIDADE	RESULTADO
COLIFORMES A 35°C/g	ND	NMP/g	2,4 x 10 ³
COLIFORMES A 45°C/g	4	NMP/g	< 3
SALMONELLA SPP em 25 g	AUSENTE em 25	UFC/g	AUSENTE
ESTAF. COAG. POSITIVA/g	10 ³	UFC/g	< 3 (OBS1)

CONSIDERAÇÕES

Metodologia: "Tubos Múltiplos - Apha 1999"

Legislações: RDC Nº 12, de 02 de Janeiro de 2001 - Padrões Microbiológicos para Alimentos - ANVISA.

Abreviaturas: VMP - Valor Máximo Permitido; NMP - Número Mais Provável; ND - Não definido pela legislação em vigor.

CONCLUSÕES / OBSERVAÇÕES

OBS1: Tabela ANVISA do Número Mais Provável (NMP) por g ou mL para série de 3 tubos, aonde o nº positivo dos tubos foi 0 0 0, portanto o resultado é expresso como < 3.

A amostra analisada encontra-se SATISFATÓRIA de acordo com os padrões da legislação vigente.

OBSERVAÇÕES: Os resultados obtidos aplicam-se exclusivamente à amostra enviada pelo interessado.

Maurício da Silva Souza - Químico - CRQ 15.100.090

Jamuicio da fila lauge

Responsável Técnico

Data da emissão: 03/11/2014.

Av. Princesa Isabel, 884, Cidade Alta. CEP: 59025-400 CNPJ: 07.243.411/0001-57 - REG. ANVISA № 2647/11 ... CRQ; nº 15.5400249; 152 Região Tel./Fax.: (84) 3201-7348 8102-3735 9644-0694

Appendix 1 – Bromatologic Analysis

• Brix Test (soluble solids)

Table 7 - Comparison of soluble solids in Test 2 and Test 3

	Freezing	Free Cooling	Cooling	Medium
Test 2 (µ)	32.43	35.17	33.03	33.54
Test 3 (µ)	30.83	32.07	31.63	31.51

This result shows the ice cream is more dilute, which becomes logical considering that the amount of water increased without compromising the essential character thereof: flavor.

• C Vitamin (Ascorbic Acid)

Table 8 - Comparison of Vitamin C in Test 2 and Test 3

	Freezing	Free Cooling	Cooling	Medium
Test 2 (µ)	74.64	84.47	90.317	83.1423
Test 3 (µ)	89.6286	90.7121	89.4922	89.9443

The insertion of natural orange improved the vitamin C in ice cream, an improvement of approximately 8.18%, and got a smoother taste.

• Total Sugar

Table 9 - Comparison of Total Sugar Analysis in Test 2 and Test 3

	Freezing	Free Cooling	Cooling	Medium
Test 2 (µ)	36.80833	36.74173	34.61283	36.0543
Test 3 (µ)	21.1758	23.4229	21.9379	22.17887

The concentration of total sugars decreased from 36.0543% to 22.17887%, a very significant result. This test proved that the fruit pulp has more calorie than the fruit.

• Humidity

Table 10 - Results of Humidity in Test 3

	Freezing				Free Cooling				Cooling			
	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result
	Weight	Weight	Weight	(%)	Weight	Weight	Weight	(%)	Weight	Weight	Weight	(%)
A 1	69.682	71.0357	5.130	73.6121	49.336	50.7640	5.093	71.962	50.787	52.1711	5.154	73.1451
A 2	66.646	67.9853	5.075	73.6099	77.738	79.1457	5.091	72.349	60.835	62.1931	5.074	73.2341
A 3	45.866	47.224	5.019	72.9428	64.321	65.8570	5.064	69.668	79.101	80.4028	5.114	74.5444
μ				73.3883				71.326				73.6412
σ				0.3150				1.1831				0.6397

This shows the percentage of water was on average of 72.7853%, a good result for the experiment.

Ash

Table 11 - Results of Ah in Test 3

		Fre	ezing			Free	Cooling		Cooling			
-	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result
	Weight	Weight	Weight		Weight	Weight	Weight		Weight	Weight	Weight	
A 1	28.9215	28.9302	3.2764	0.2655	24.9126	24.9243	3.1719	0.3689	28.1608	28.1747	3.1713	0.4383
A 2	28.8267	28.8394	3.0036	0.4228	27.3147	27.3285	3.1828	0.4336	30.2986	30.3119	3.1068	0.4281
A 3	26.7350	26.7482	3.1179	0.4234	28.9940	29.0073	3.1526	0.4219	26.7623	26.7762	3.2378	0.4293
μ				0.3706				0.4081		l		0.4319
σ				0.0743				0.0281				0.0045

There are no problems about the value be 0.4035%. Gray is the quantity of mineral. Among these minerals, can be highlight magnesium, cobalt, manganese and iron. The daily amount of carbohydrate intake of these minerals to the body of an athlete no need be large.

Rough Fibers

It wasn't found a partnership that could realized the alimentary fiber test, so it was chosen to calculate the rough fibers (Table 12) for more precise value of calorie. Even with an statistical error in the calculation, because the alimentary fiber is the union of the soluble fiber more insoluble (rough), was choosed this situation. For this reason, the obtained value represents only a portion of the fiber.

Table 12 - Results of Rough Fibers in Test 3

		Fre	ezing			Free	Cooling		Cooling			
	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result
	Weight	Weight	Weight		Weight	Weight	Weight		Weight	Weight	Weight	
A 1	1.2249	1.2314	1.0176	0.6388	1.2583	1.2635	0.9988	0.5206	1.2778	1.2820	1.0099	0.4159
A 2	1.2517	1.2582	1.0294	0.6314	1.2557	1.2609	1.0051	0.5174	1.2628	1.2670	1.0046	0.4181
A 3	1.2335	1.2399	1.0172	0.6292	1.2168	1.2210	1.0075	0.4169	1.2278	1.2326	1.0040	0.4781
μ		<u> </u>	I	0.6331		I	I	0.4849		1		0.4373
σ				0.0041	1			0.0481				0.0288

Lipids

Table 13 - Results of Lipids in Test 3

	Freezing					Free	Cooling		Cooling			
-	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result	Balloon	Final	Sample	Result
	Weight	Weight	Weight		Weight	Weight	Weight		Weight	Weight	Weight	
A 1	103.4667	103.4829	5.1597	0.3140	106.5960	106.6129	5.0360	0.3356	103.9924	104.0023	5.1066	0.1939
A 2	108.0411	108.0601	5.0904	0.3733	123.4101	123.4173	5.0298	0.1431	105.0804	105.0910	5.3483	0.1982
A 3	109.0491	109.0687	5.3219	0.3683	106.4906	106.4986	5.0282	0.1591	110.0603	110.0693	5.4524	0.1651
μ				0.3518				0.2126				0.1857
σ				0.0268				0.0872				0.0147

The results were very satisfactory because was achieved, with statistical rounding, get the initial purpose: to make ice cream without fat.

Table 14 - Comparison of Lipids in Test 2 and Test 3

	Freezing	Free Cooling	Cooling	Medium
Test 2 (μ)	0.94	0.74	1.06	0.9133
Test 3 (µ)	0.358	0.2126	0.1857	0.252

The exchange of fruit pulp for fruit resulted in a lower percentage of lipids.

Carbohydrates

The percentage of carbohydrates is found by the difference of the sum of the percentage moisture, ash, fiber, lipids and proteins in relation to one hundred (100).

It was found as a result of the following results:

a) Humidity: 73.6412%

b) Ashes: 0.4319%c) Fibers: 0.4373%d) Lipids: 0.1859%

e) Protein: 10.27%

Thus, is the value of 15.0337%. The fact that as was calculated with rough fiber and not tottaly, the percentage of fibers is outdated. For this reason it is believed that the actual percentage of carbohydrates is much smaller than that shown by this study. In percentage of carbohydrates, 21.9379% is the total sugar. This represents that in an ice cream ball 100 grams, has only 3,298 grams of sugar. A significant result for the study.

Using simulation for balancing a line of power plugs

Ramos, A.L.1, Ferreira, J.V.1 and Santos, S.T.2

¹⁾ GOVCOPP / DEGEIT, University of Aveiro, Campo de Santiago, 3810-193 Aveiro, Portugal

² DEGEIT, University of Aveiro, Campo de Santiago, 3810-193 Aveiro, Portugal

ABSTRACT

Purpose - This paper presents a simulation study carried out to analyse a balancing solution for a line of power plugs. This line is used in the classroom (course of Advanced Simulation in the master programme of Management and Industrial Engineering, University of Aveiro, Portugal) as a lean living lab to illustrate the utilization of Lean Manufacturing tools.

Design/methodology/approach - The curricular unit is based on an experiential approach that involves, in the first part, the utilization of simulation games and, in the second part, the development of computer simulation models. The work uses a discrete-event simulation (DES) approach to analyse the assembly line of power plugs in order to increase its throughput and overall productivity. The study involved the comparison of two design alternatives for the assembly line and the selection of the best scenario for a given set of performance measures.

Findings - The use of simulation allows the students to make a more comprehensive analysis of the line and to identify factors that could improve the efficiency of the system. Thus, simulation is a valuable tool to evaluate different line configurations through the comparison of several key performance indicators supporting the decision-making process.

Originality/value - The pedagogical practices used in the course of Advanced Simulation of the master programme are innovative and the exploitation of a modelling technique such as simulation is certainly a successful approach to promote visual, interactive and problem-based learning strategies, and to bridge the gap between academia and industry by guiding industrial engineering students through the resolution of real industry (and service) problems using simulation models.

Keywords: Decision-making, Line balancing, Pedagogical practices, Simulation.

Paper type: Case study.

INTRODUCTION

Lean Manufacturing is a comprehensive philosophy for structuring, operating, controlling, managing and continuously improving industrial production systems. Continuous improvement, inherent to lean thinking, is a recurring concept in business environment, allowing the companies to have a better knowledge of their processes and an increasing capacity to fine-tune the operations creating value and reducing waste.

The companies decide to implement lean tools based on a combination of faith in the lean philosophy, experiences of others who had previously adopted those principles, and general rules of thumb on anticipated benefits. Although, such faith-based justification is insufficient to convince many managers to adopt lean concepts (Detty and Yingling, 2000). To support the lean implementation it is important to quantify the potential gains. Simulation tools can be used to estimate the possible benefits that companies can potentially achieve with lean practices.

Regarding the education/teaching aspect, due to the dynamic, computer-based, visual, and problem-solving nature of simulation, the simulation courses have been used, in the last years, to implement new learning approaches focused on the client (the student) and focused on active learning/experiential practices based on real problem-solving. Sometimes, the simulations are linked to gaming scenarios with rules and competition. Several simulation games have already started to appear in the literature, mostly focusing on lean tools (Badurdeen et al., 2010; Silva et al., 2013). Simulation-based educational products have a great value in education providing an excellent way to visualize and experience a practical scenario and to reinforce the theoretical aspects discussed in the classroom (Siddiqui et al., 2008; Pasin and Giroux, 2011).

This work presents a combined approach of lean practices and simulation tools in order to evaluate a given system and quantify the potential benefits of adopting such practices. The simulation study was carried out in an active learning classroom context and the main objective was to evaluate a balancing solution for a power plugs' assembly line.

The paper is organized as following: section 2 presents the Advanced Simulation's classroom experience highlighting the use of simulation; section 3 describes the simulation study carried out to evaluate a line balancing solution and section 4 provides some major conclusions of the work.

ACTIVE LEARNING CLASSROOM

The pedagogical practices used in the course of Advanced Simulation of the master Programme in Management and Industrial Engineering of University of Aveiro (Portugal) are innovative and clearly promote the linkage between education, research and business environment. The curricular unit is based on an experiential approach that involves, in the first part, the utilization of simulation games and, in the second part, the development of computer simulation models. In the first part, the course has the valuable collaboration of a consulting company from Aveiro region (VLM Consulting) that has a unique connection with the business environment and a considerable experience in the application of lean tools. The company and the university team use educational games (serious games) in the classroom living lab to simulate the application of lean tools (e.g., VSM, line balancing, Kanban system, 5 S's) to a power plugs' assembly line. These educational games, where students are active participating elements, strongly promote active learning based on experimentation.

In the second part of the course, the students develop simulation models, using the software Arena®, for diverse real systems. Since these students are taking their business internships, whenever possible, they are incited to bring real problems to the classroom and find a simulation-based solution/improvement to those problems. The use of simulation allows the students to make a more comprehensive analysis of the systems and to identify factors that could improve their efficiency. Thus, simulation is a valuable tool to evaluate different configurations through the comparison of several key performance indicators supporting the decision-making process.

In this case study, the student developed a simulation study to analyze the assembly line used during the gaming phase in order to explore it in a more comprehensive way and find solutions to increase the throughput and the overall productivity of the line.

SIMULATION MODEL FOR LINE BALANCING

The main purpose of the simulation study was to find a balanced configuration for the power plugs' assembly line used in the lean living lab. The first step was to develop a model for the existing configuration (the one used in the first iteration of the game) and then test other balancing configurations to improve the line throughput and overall productivity. The study involved the comparison of design alternatives for the assembly line and the selection of the best scenario for a given set of performance measures such as the throughput of the line, the work-in-process inventory levels and the utilization of resources.

Power plugs' assembly line

The system-in-analysis in this study was an assembly line of power plugs more specifically, the BS 1363 three-pin (Type G) plug, represented in Figure 1.

The line has 5 workstations to assemble 13 parts into a finished product. The line assembles three different models of the plug corresponding to three different fuse colors.



Figure 1 – Power plug BS 1363 (Type G).

The first workstation performs the following tasks: i) hold the male cover and insert the cable clamp on the two parallel holes, ii) insert a screw and rotate it lightly by hand and repeat the process for the other bolt in the opposite hole, and iii) tighten the two screws with the screwdriver. In the second workstation the operator only places the fuse in the fuse holder and places it in the respective container, to distinguish the fuse color. The third workstation performs the following tasks: i) place the fuse pin in the male cover, ii) introduce a simple pin in the male cover, and iii) add to central rectangular hole the central pin. In the fourth workstation the operator: i) places the fuse (from workstation 2) together with the male cover so that the two grooves are aligned in the same level, ii) places the female cover, and iii) tightens the central screw. In the last workstation, the operator: i) loads the paper label, ii) takes the plastic bag and opens it, iii) places the assembled power plug inside the bag and closes it, and iv) labels the bag according to fuse color.

Base simulation model

In recent years, a lot of research in how to develop a simulation study has been made and it is possible to conclude that the required steps to achieve the best results include problem formulation, conceptual

modelling and data collection, operational modelling, verification and validation (V&V), experimentation, and output analysis (Kelton et al., 2010).

In developing the simulation model for the assembly line particular care was taken to model the process as close to reality as possible (as performed during the game in the classroom). In this stage it was necessary to determine which data would be necessary to use in the model and if the needed inputs were available. The availability of data for the processing times of the tasks involved in the assembly process allowed the fitting of proper distributions to these data. The distributions and its parameters were selected using the Arena's software module Input Analyzer (Figure 2). The distributions obtained were analyzed trough visual inspecting, square error value and p-value, in order to guarantee a "good" fit.

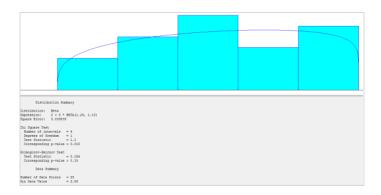


Figure 2 – Fitting values to a standard distribution using the Input Analyser.

In this base model, the assembly line works in a push system and each worker has to get the parts they need to their tasks in the central raw material warehouse. This *muda* operation was modelled using a triangular distribution. As neither maintenance procedures nor equipment failures influence significantly the regular operation of the system, these were ignored.

This base model was used to: i) allow for a better understanding of the actual system, ii) identify critical aspects and opportunities for improvement, and iii) test lean solutions in order to improve the productivity of the system-in-analysis. The run parameters of the model were defined as following: a) replication length: 1 day of operation (8 hours); b) number of replications: 10 (the number of replications was determined through a trial-and-error approach until 95% confidence intervals were reasonable).

The operational model was developed using several modules from Arena templates and it was developed an animation model illustrating the dynamic behavior of resources, routings and buffers.

The model was verified and validated (V&V) using different techniques such as animation, internal validity, predictive validation, structured walkthrough, and examination of model traces. The animation and the comparison of predicted performance measures with the known behavior of the line during the classroom game were the dominant techniques employed.

After the execution of the model the average line throughput was about 800 power plugs and the results evidenced a clear bottleneck in workstation 1 with a utilization rate rounding a mean value of 90% and the waiting time in queue exhibiting a mean value of approximately 4 minutes. The workstation 3 has the lowest utilization rate (about 33%) and no inventory in queue.

The results, as expected, reveal a clear unbalanced solution for the assembly line. So it was clear that one of the most imperative actions referred to balancing the line by levelling the workload across all workstations.

Balancing the assembly line

To balance the assembly line the student used the theoretical concepts learned in the course of Operations Management and also used intuitive graphical tools such as precedence diagrams and Yamazumi charts (Figure 3).

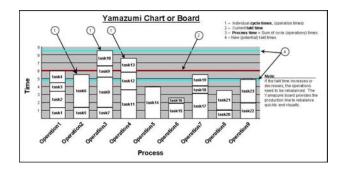


Figure 3 – Yamazumi chart to help the line balancing process.

The student proposed a new line configuration with a different assignment of tasks to the workstations and the reduction of one workstation (workstation 2 and workstation 3 were merged). The proposed assembly line has 4 workstations, with an average cycle time for each workstation of, respectively, 31.9, 17.7, 28.7 and 19.6 seconds. So, the new configuration was simulated and the average throughput rounded the 880 power plugs (an increase of 80 power plugs in a working day) with less one person. This means that the productivity of the assembly line was clearly improved. The workstation 1 stills the bottleneck of the system but the utilization rates of the different workstation are now more balanced (rounding the interval 75%-90%).

By grouping the workstations 2 and 3, the assembly line was more balanced (Figure 4), smoothing the production levels of the different workstations and increasing the overall throughput.

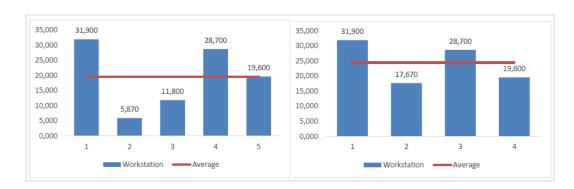


Figure 4 – Balancing the workload of the assembly line workstations: left side – initial configuration; right side – new solution.

The major benefits of the proposed solution were the reduction of one person in the assembly line (reducing labor costs), the increasing in the amount of power plugs produced, the increasing in the average utilization rates of the resources in the line, and the decreasing of the utilized working space.

The student also proposed other suggestions to improve the efficiency of the line that are being studied such as: the implementation of a pull system, using a just-in-time philosophy and the creation of a Kanban system to control the material flow only allowing the production when needed.

CONCLUSIONS

The pedagogical practices used in the course of Advanced Simulation of the master programme are innovative and the exploitation of a modelling technique such as simulation is certainly a successful approach to promote visual, interactive and problem-based learning strategies, and to bridge the gap between academia and industry by guiding industrial engineering students through the resolution of real industry (and service) problems using simulation models. As observed in the classroom, simulation is a powerful tool to analyze, in a dynamic way, a given system and to test different scenarios aiming to improve the performance of that system.

Using this active learning approach, the students are deeply involved in the learning process and use their own real world business experiences as input for the simulation projects. The companies can also see the benefits of using simulation techniques to design and analyze their manufacturing/service systems.

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Maturity and integration in management systems. Organizational sustainability

Escobar Rivera, D.1) and Simon Villar, A.2)

Department of Business Organization, University of Girona, M. Aurelia Capmany 61, E17071 Girona, Spain. Tel.9728480. Mail: dalilis.escobar@gmail.com

² Edifici B – Campus de la UAB, 08193 Bellaterra (Cerdanyola del Vallès), Autonomous University of Barcelona, Spain. Mail: Alexandra.simon@uab.cat.

ABSTRACT

In the current business environment, management systems show a complex and integrated nature from the perspective of a substantial group of internal and external variables. The evolution of the company over time-directed through the philosophy of management systems- promotes the relationship between three cardinal elements: the level of integration, maturity and sustainability. In terms of proportionality and on the basis of diversity of each system, the company will be more sustainable as it reaches higher levels of maturity.

Consequently, the management system not only contributes to the maintenance of the levels reached in terms of their effectiveness and compliance, but becomes an instrument for improvement. The integration of processes and the maturity level, has been recognized in several studies as a central variable in the integrated management systems, along with others such as the strategy adopted, the implementation process and motivation. Therefore, a link between those three elements towards organizational sustainability, favors the effectiveness of the evaluation to the objectives, as well as the satisfaction and more recently, customer delight.

This paper addresses the fundamental concepts and principles related to the link between level of integration and maturity of the management system and the sustainability of the organization. It also includes analysis of various models available in the literature focused on these elements so as to identify the contact points where that concurrence is exposed to express it in the form of a model.

Keywords: management system, maturity, level of integration, sustainability.

Paper type: Research paper

INTRODUCTION

Management requirements in organizations increases according to their needs; this aspect marks a coeval trend towards maintaining business sustainability and compliance with existing legislation; from an internal perspective, based on the requirements of the management system. As well as from an external perspective, from legislation, regulations and environment. In this sense report published by ISO (2014) independently to address the growth rates reported generally in the standardization around 3%, with a high incidence of standards such as ISO 50001: 2011 for energy management and others as the standard ISO 22000:2005 for food management; highlights the inclusion of standard ISO 22301:2014 for business continuity. This one specifically begins to be implemented globally, and has in its first year of publication, 1765 certifications (ISO, 2014) with good forecast for next stages; due to the concern of organizations to protect themselves in a dynamic environment of crisis.

The application of standards whose objectives are focused on the future of organizations, as well as customer delight, for example technical standards UNE-CENT/TS 1668: 2015, for excellence in service and creating exceptional experiences the customers -like fundamental object in the organizational management output indicates interest in the discussion about sustainability means in practical terms and within the organizational context versus the challenges. Sustainability is a long-term commitment and varies over time because of an organization that also changes, although not as fast as the environment, therefore it must be continuously monitored and managed. The management system for its part, enables organizations regularly reconsider the definition of the challenges for sustainability and work from this perspective.

Organizational management is not only the administration of the aspects that directly affect their sustainability, but the main objective is to generate profits and services to meet the needs of customers involved in the business. In trying to reach that goal, the organization matures, since the execution of processes at the different levels and the management system is integrated; for responding effectively and efficiently to the fulfillment of the objectives. This maturity and integration can be measured through levels or degrees, depending on a group of variables that describes the experience followed by the organization.

In the same way to achieve higher levels of maturity and integration, the organization faces many challenges as a risky environment and market instability. In short, the satisfaction of needs, as well as organizational sustainability are influenced by the availability, quantity and quality of human resources, materials and information. In literature several studies about the importance and role of resources are reflected; starting from the consideration of the theory of resources and capabilities, initiated by the contributions of (Penrose, 1959), (Andrews, 1977) and (Amit and Schoemaker, 1993) among others. Both theories looking specify how a company creates competitive advantages from identifying resources and their form of exploitation which determines their capabilities. According to Fong Reynoso (2011) the theory of resources and capabilities could be considered as a theory of competitive advantage, also the conditions that enable preserve it in time (Barney, 1991). Therefore the characteristics that have the resources and their relationship with the company, bearing in obtaining sustainable competitive advantages.

Customer satisfaction and organizational sustainability is influenced also by the integration of processes and organizational maturity from an evolutionary point of view. Organizations and therefore their administration, have changed their structure and paradigms increasingly often, moving from rigid structures to new forms of flexible organization that have proven to be more efficient than traditional models. Moving on from the classical theories represented by authors such as Fayol and Taylor to a contemporary approach (Nava Villarreal, 2013). If the organization wants to achieve to be sustainable, it requires efficient tools that facilitate their management process and a clear vision of the factors that influence their maintenance through management system; because its integrative orientation provides a better possibility to see causal relations between decisions, actions and results.

This article aims to introduce an analysis of the link between level of maturity and degree of integration of the processes in the management system, with organizational sustainability; providing a model to explain its

interaction in this context. Their main value is in the systematization and link between these elements; located in a theoretical model; to support the elements that define the organization focused on achieving a future based not only in the satisfaction of the customers but delighting them, while taking into account other stakeholders and interact responsibly with the environment. This article is in itself a new proposal from the object being addressed.

LITERATURE REVIEW

Standardized systems based on the model of the International Organization for Standardization (ISO) have a model based on the management cycle management approach; so that the philosophy of planning, organizing, directing and controlling (Isaac Godinez, 2004), is enhanced (Beltramo et al., 2012). To achieve the effectiveness of these models, it is essential that the leadership of the organization be formally compromised and that this commitment is translated into practice in the allocation of the necessary resources. These models can be integrated, which means the applying of the principles of management approach advocated by the theory of business management processes. The idea is to manage the set of processes that are established in the organization specific way that could be understood from a global and balanced perspective; for maximum effectiveness and organizational efficiency, customer satisfaction and society.

In the same way the process approach allows the implementation and completion of the systemic nature of management; on the basis of process variables over time, either because of internal or external factors that adapt according to changing customer requirements and other relevant stakeholders, as well as market conditions. Furthermore the process approach is one of the management principles established by international standards, which is expressed in models and guidelines for integration as the PASS 99: 2006 and UNE 66177: 2005 and defended by authors like (Zaratiegui, 1999), (Llanez Font, 2015) and (Teixeira Domingues, 2013). Hence the degree of integration of the system will be given a certain extent, from the individuality of the processes that integrate and management.

Maturity level of organization

The maturity level in the organizational context, is addressed in the literature as a way to improve the effectiveness of organizations, and is currently and an essential tool in the evaluation of capacity (Jia et al., 2011) and (Saco, 2008) cited by (Teixeira Domingues, 2013). In an article published by (Domingues et al, 2014) a summary of the concepts in this regard provided by authors like (Anderson and Jessen 2003) and (Sen et al., 2011) is presented, among others about the maturity term.

(Paulk et al., 1994) identified the characteristics that distinguish the immature organizations, marked by adhoc procedures, from the mature ones, which make disciplined use of project management methodologies (Barssaneti, 2011), in concordance with (Teixeira Domingues, 2013) «While the maturity concept concerns with one or more relevant items to the studied object described as key process agents (KPAs), the capability concept relates with just one of those items». Some examples of capability definitions are (Van Loon, 2004) and (Valdes et al., 2011).

(Teixeira Dominguez, 2013) conducts an analysis of maturity models and makes clear its measurement from an initial levels from one end of qualitatively or quantitatively state. Each level corresponds to the measurement of certain characteristics that define the object evaluated. Maturity models started from the software industry and is where the greatest contributions reside in this regard; although it has been adapted to different contexts, such as organizational.

Taking as starting point the definitions provided by several authors, including those addressed by (Texeira Domingues, 2013), an analysis cluster was applied using SPSS (version 10.01 of 1999) with the method of hierarchical cluster analysis, distance from Rogers and Tanimoto, the closest neighbor analysis method and

binary measure, to find distinctive features that demonstrate trends among authors. The application of this method allows to obtain a dendrogram (See Figure 1), in which a cut is made in the level 10 for clusters covering the concepts discussed, from the presence or absence of the following features selected from analysis of the literature:

- a) describes the characteristics of a particular object;
- b) is related to the evolution of the organization;
- c) presents a direct relationship with quality items
- d) influences on organizational improvement
- e) is related to the effectiveness
- f) defines the experience of the organization
- g) it presents an explicit development in a timeline
- h) develops an organizational function
- i) defines characteristics of the described object

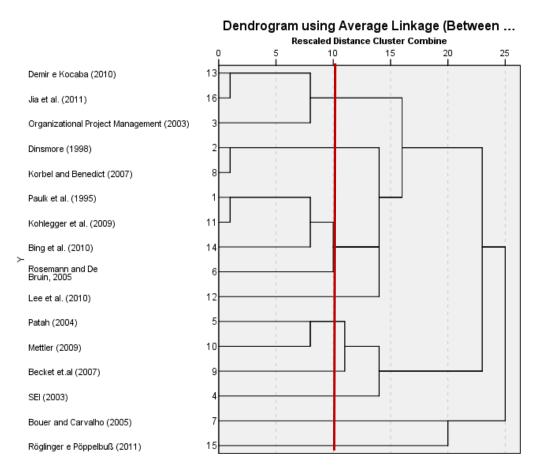


Figure 1 – Dendrogram with cut at level 10, result of cluster analysis between variables

Source: Own elaboration

From the application of the cut at level 10, four groups of concepts represented by several authors are structured; a frequency analysis was applied to these groups, the results of which are depicted in the graph shown in Figure 2. In general in the four groups the authors agree that maturity and the models that explain it

are an expression of an evolutionary growth of the organization, not necessarily associated with a straight timeline; as stated (Bersanetti, 2011). Some authors refer this term from consideration as a state or stage through which the objectives are achieved. These objectives themselves are variables in the timeline and translate into broader demands for business, according to its own progress and to factors such as the impact of market and human resources.

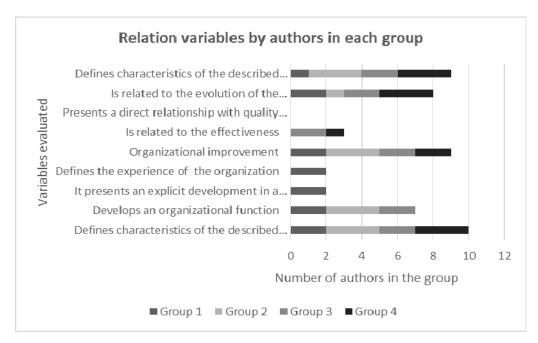


Figure 2 – Variables referenced in the definitions provided by the authors **Source:** Own elaboration

Likewise, the authors assert that maturity models are related to the improvement of the organization. In very small measure -only two of them, the SEI (2003) and (Patah, 2004)- accounting for 22.2% of the authors included in the four groups, associated with quality and effectiveness in achieving objectives. However efficiency, quality and improvement, are consecutive pillars in the management system; if the objectives are not fulfilled in a rational way in the use of resources, it can hardly be said that there is quality product or service, and therefore focus on improving, it will be more difficult. This approach responds to our knowledge to a limited view of the system, their interactions and the impact of their results.

In the context of organizational management, contributions on maturity models are limited, our understanding of a more complete analysis including a suggested model, corresponds to (Domingues et al., 2014). His proposal is based on five levels, concluding on excellence and supported on eight pillars, including the process approach, continuous improvement and mutually beneficial relationships with the suppliers.

In the model, the ascendancy of the organization is clear from certain key indicators at each level and the weight given by the experts consulted each; within this ascent, sustainability is located from level one to two. On these elements the author's state: "concepts such as successful sustainability, macroergonomics, life cycle analysis and management and social responsibility were inserted on the model, reflecting their relevance and contribution to the integrated management systems maturity".

Degree of integration of the management system

The model applied to ISO standards and the implementation of several with different nature to provide at its output internal and external customer satisfaction and quality products or services; while environmental impacts are reduced. These are some of the factors that have led to the search and implementation of

integrated management systems (IMS), as an expression of the existence of synergies between different systems and obtaining benefits from them (Karapetrovic and Willborn, 1998a), (Wilkinson and Dale, 1999), (Douglas and Glen, 2000), (Rocha et al., 2007) and (Karapetrovic and Casadesus, 2009).

At the same degree that the organizations define -since their needs- which of those standards should be integrated; may have different levels in the integration process (Almeida et al, 2014.) determined from empirical studies; through the analysis of its basic characteristics such as: organizational structure, degree of integration of the mandatory procedures and degree of integration of operational processes. Several studies report contributions and propose ways to measure the degree of system integration. (Karapetrovic, 2002) for example, refers to four basic summarizes levels: political, document integration, objectives and goals, as well as the alignment of management tools.

(Bernardo et al, 2008) systematize a group of important studies on the integration of the management system such as: (Seghezzi, 1997) (Wilkinson and Dale, 1999), (Karapetrovic, 2002), (Karapetrovic, and Jonker 2003) and (Pojasek, 2006). This same group of authors expresses "although the differences in the definitions of each level or degree of integration that exist among the models make a completely accurate, yet effective, classification impossible, four such levels that indicate approximately the same degree of integration, from separation or no integration ("level 0") to complete integration ("level 3"), demonstrating the existence of groups of organizations that respond completely to the classification provided by them.

More recently (Almeida et al., 2014) conducted a case study where several organizations are concentrated in two main groups: (1) High Integration Level Organizations (HILO) and Low Integration Level Organizations (LILO); to define critical success factors (CSFs), which correspond to different levels of integration ranging from one to five; in subsequent relationship with the maturity of the system. Among the most important CSFs, study indicates: the financial resources availability, employees involvement and motivation and human resources suitability.

Following the route established by some of the previous studies (Gonzales and Rodriguez, 2011) propose a methodology for determining the level of integration of organizations with management systems through six steps. These include the calculating of four key indicators and can provide suggestions on the way forward for the integration of other standards. The proposal develops standards for quality management, environmental, health and safety at work and internal control (standard focused on Cuba, which is in our opinion one of the main constraints). Other authors like (Karapetrovic and Casadesus, 2009), (Heras et al., 2007) and (Bernardo et al., 2011) have focused on different aspects of systems integration as the influence of the order in which they develops, benefits and difficulties faced in their implementation and their impact on levels of integration. These provide precise conclusions that support the proposal and allow to relate the concepts of maturity and integration management system with organizational sustainability.

Sustainable development of organization

In the opinion of (Kannan et al., 2014) "in a recent survey, approximately 70% of business leaders said that sustainability has a permanent place in their management agendas". The term sustainability is related mostly to the environment and globalized from the United Nations in 1986 as "the satisfaction of the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). In this regard, in different geographic areas to make efforts to implement regional levels. This approach has come to the company as an entity that interacts and directly influences society. In other words an enterprise system with social responsibility in looking for quality but through a balance with the environment to achieve economic benefits.

In the opinion of (Rocha and Searcy, 2012) referring to (Bansal 2005) who demonstrated that both resource-based (Barney, 1991) and institutional (DiMaggio and Powell, 1983) factors influence organizational sustainability, at the corporate level. Accordingly, a company addressing the sustainability concept evidences a

higher maturity level if compared with other company that do not address to this concept (Domingues et al., 2014). Perhaps the most widely-used theoretical framework for explaining organizational sustainability development is stakeholder theory (Freeman, 1984).

Rocha and Searcy (2012) conducted an extensive analysis on sustainable development of the organization from the perspective of integration models in the literature, and affirm the lack of studies on this subject in the same article, they argue like (Karapetrovic and Willborn, 1998b) focuses on the application of systemic approach concentrated on three key elements: goals, processes and resources. In this sense (Rocha et al, 2007) proposes a model about seven aspects: stakeholders, resources, leadership, processes, values, objectives, and results. The same authors in 2012 affirm "additional examples are available in the literature. In any case, all models must be able to accommodate the inclusion of current and new management systems, harmonize differing requirements, and support integrated management systems implementation and improvement" (Rocha and Searcy, 2012).

These authors additionally carried out a first proposal since the benefits of the management system of three pillars or dimensions of sustainable development in the organization (economic, social and environmental), adding a fourth dimension called operational benefits that can assume aspects that remain distant or excluded of the above three dimensions. These dimensions are assumed from the understanding of the management system as a facilitator of adopting a sustainability approach in organizations; since the integration of systems, which share resources for reaching objectives and improving the organization and respond to stakeholders. This aspect also coincides with the criteria of (Ormazabal et al., 2015) when they say that "thanks to the process efficiency, not only does the environmental aspect become visible but also economic issues".

The dimension of economic benefits is based on the reduction in the duplication of policies, procedures and work instructions, decreasing time and operating costs. Several authors, whose contributions relate to the issue of management systems, reaffirm this criterion, and collected in works such as Simon (2012). In the dimension of social benefits, the authors include variables referenced in essence, how the organization is projected and seen from outside; therefore there appear aspects such as increasing transparency and image benefits. The division into two dimensions, social benefits and other environmental benefits, located on the second to the variables that impact from inside the organization as: increased prominence of environmental issues in organizational management and increased emphasis on compliance with applicable regulatory requirements (Rocha and Searcy, 2012).

Finally in the dimension of operational benefits they include those that arise from the actual implementation of the management system, impacting performance and accounting for the business. Accordingly they include: the increased synergy between standardized management systems, reduced audit fatigue and how the standardized management systems relates with the rest of the business (Rocha and Searcy, 2012).

The assessment of organizational performance since models of sustainability is neediness, given its contribution to the planning, decision making, innovation and the future of the companies. It strengthens above the opinion of several authors, with emphasis on (Rocha and Searcy, 2012); this study was the first contribution, according to the literature reviewed in this regard and traces important guidelines for the development of organizational models that consider sustainability in connection to the implementation of management systems.

METHODOLOGY

For the development of the proposal in this paper, theoretical methods and associated tools were used. Within the methods at this level is the analysis and synthesis of information obtained from the literature review and experience of experts and academics interviewed. To develop the analysis, through its decomposition into the elements that comprise it, this method was linked to the use of cluster analysis in SPSS tool in its 10.01 1999

version, to corroborate the variables that most affect sustainability and its relationship with organizational maturity and integration management system, as a result of a synthesis process. The modeling method was also used to structure the Maturity-Integration-Sustainability in Integrated Management Systems (MIS-IMS), making clear the application of a systemic-structural perspective.

RESULTS

Resulting from the analyses previously carried out, a theoretical conception structured as a model is proposed (see figure 4) to explain the relationship between the three elements discussed up to the stage: the integration of the management system, degree of maturity and sustainability of the organization. On its basis the systemic approach by processes and the integrated character are expressed, with emphasis on the administrative or management cycle.

From the study of literature for the development of theoretical framework, the relevance of the systemic nature to constitute the proposal was based; this offers the possibility to explain the object as an integrated whole and its description and interpretation, setting the dialectical relations between its elements. In the same way process approach supports the implementation of systemic approach recommended from authors like (Karapetrovic and Willborn, 2001). Based on this approaches it is considered possibly the processes as the most important and widespread in the management of innovative companies (Zaratiegui, 1999) element. These processes besides provide the basis to adapt to the frequent changes in the environment and the market and therefore influence the work of the organization for sustainable development.

The proposed conception to explain this development and its link with maturity and integration management system is built on premises, understood these as scientific deductions, product of theoretical systematization made about the object; in the case of the proposal developed are premises the following:

- the existence of an integrated management system as the core for the evolution of the organization towards continuous improvement, with at least an average level in the integration of processes and maturity; depending on models or methods used to measure both variables;
- the interest of the organization to develop innovation from processes to comply with the demands of the stakeholders and focus on sustainability;
- the recognition of all stakeholders of the organization.

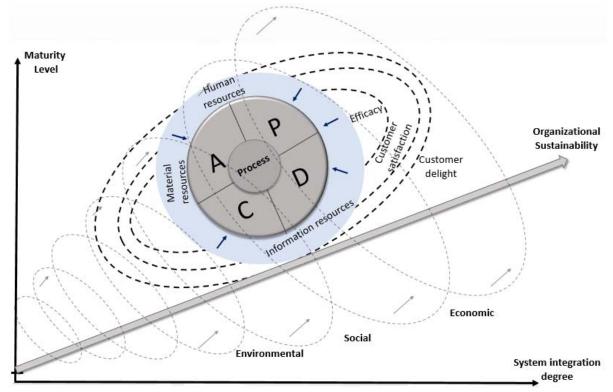


Figure 3 - Model MIS-IMS

Description of structure of the proposed model

The model seen in Figure 3, Maturity-Integration-Sustainability in Integrated Management Systems (MIS-IMS) is supported in two dimensions (spatially) shown since the axes of ordinate and abscissa. The axes of "X" represents the measurement of the degree of integration of the system; this integration can be evaluated in quantitative or qualitative terms. Similarly the axes of "Y", represents the maturity levels of the system; both variables correspond to different models used by each organization and in this case although previously analyzed several proposals made by the authors, their selection and application are available to the company, its characteristics and management system established. So it should not be an impediment, but a flexible element that favors the adaptability of the model.

The initial point of intersection of the two axes, i.e. the point (X1, Y1) although represented by a variety of results, depending on measurement levels used in organizations do not correspond to the origin (0, 0); because to start talking about sustainability and even integration of processes and system maturity, the organization should be distant from an early stage of its implementation. Sustainable development of the organization responds to a mature system behavior to operational level processes.

The core of the integrated sphere, composed of several layers -representing management system- constitute the processes; considering them as a sequence designed to generate a result from an entry, which converge into an outlet and response to customer requirements (Noda Hernandez, 2004) and stakeholders activities. This integrated multiple orientation in relation to the management areas implies (Llanez Font, 2015):

- understand how processes must be managed to obtain products and services that meet all requirements;
- how to embed standardized systems, to identify the influence of the process in respect to areas and determine its purpose, regardless of the type of process, in each case, influence and purpose they will be different, but should always be designed considering object management areas integration.

The management system is built on the basis of administrative cycle known as a manifestation of its systemic character, so, to plan, to organize, to direct and to control the actions developed is established as a need. Consequently, the model establishes three main subsystems, which interact directly into the system, found in

the literature since the proposal of authors like (Krapetrovic and Willborn, 2001) defined as: subsystem processes, resources and objectives.

The processes are executed by specialized personnel whose competence and skills inside their reliability and trustworthiness, therefore find a proper balance in human resources, so as to meet their objectives it is essential from planning. In the processes further resources and authority for the establishment and achievement of objectives take part in it, both materials and information involved, including technological resources. The management of the resources and process approach; are a combination that is affected directly when conditions or characteristics of each one change. In relations with this aspect (Rocha and Searcy, 2012) indicated, the integrated management systems models generally emphasize the importance of skilled human resources that are aware of an assorted array of functions (such as quality, environment and others). Employees are a key stakeholder that must be engaged in collaborative action along the processes mentioned above (Senge et al, 2007) and (Pepper and Wildy, 2008).

These two subsystems incide from a third one, which in this case is represented as the first of three axes: the objectives, represented by efficiency, as scale compliance, which are modified from time to time as "the planet system management" with its layers rotate about these axes. The second axis -more away and dependent on the initial cross- that is, the fulfillment of the objectives is the customer's satisfaction, which include stakeholders of the organization.

While senior management influences the implementation and improvement of the management system, also acquires the responsibility for decision-making; these are carried out by the personnel working in the organization and also expected benefits of a different kind from its commitment. The organization also responds to other stakeholders, related primarily with customers and investors, the environment and society in general. So there is a large group of stakeholders both internally and externally that must be coordinated towards the same goal.

Correspondingly, a direct and necessary orientation towards the customer and its satisfaction not only of their expectations, but the occurrence of exceptional experiences, which are considered distinct concepts (Magnini et al., 2011) and (Wang, 2011) evidence. This last, begins to show a significant relevance; sample of this is the publication of the standard UNE-CENT / TS 16880. Its disclosure is also based on achieving complete customer's satisfaction as an indispensable requirement to win a place in their "mind" and therefore on the market; in juxtaposition besides to organizational sustainability. Therefore, the third axis represents precisely the customer's delight, a factor that is related directly as a sustainable development. If the organization is not able to keep customers close, there is no reason to survive and evolve, this approach implies that delight customers can then interact with their loyalty.

As it has been mentioned, each system can be integrated in different variants and possess a different range in correspondence to the standards that include more quantity of the size that the figure represents increases. Similarly the mass of various planets differs from one to another, as their characteristics and may increase or decrease accordingly (this comparison is not an exact analogy, but a way to expose the concept presented). The system shown in the model, then progresses upward to sustainable development and therefore organizational sustainability, influenced by a growing spiral where the dimensions that explain this variable as (Rocha and Searcy 2012) originate: an economic, financial and environmental dimension; modifiable.

These dimensions are also supported by the foundations of Triple Bottom Line, an accounting framework that incorporates three dimensions of performance: social, environmental and financial (Elkington, 1994). This differs from traditional reporting frameworks as it includes ecological (or environmental) and social measures that can be difficult to assign appropriate means of measurement. The TBL dimensions are also commonly called the three Ps: people, planet and profits. Before Elkington introduced the sustainability concept as "triple bottom line," environmentalists wrestled with measures of, and frameworks for, sustainability (Slaper and Hall, 2011).

The model described enables the establishment of the conceptual framework for explaining the relationship between integration management system, its maturity and organizational sustainability from the analysis of literature developed, its importance and the small number of studies on this investigated. Organizational sustainability is certainly an issue that can occupy an important space for debate in the future to facilitate the confrontation to the current economic framework.

CONCLUSIONS

Sustainability of companies, at international level, is a key issue in the current environment. In this sense the studies referenced in the literature are still limited and even when it comes to addressing sustainability in relation to the management system; therefore, this article is a contribution in the investigation of this topic. It is tackled since the organizational sustainability and the dimensions that define the link with the management system through system integration and maturity level, expression of evolutionarily positive performance of the organization. The limitations analyzed allowed the development of the proposal MIS-IMS model to explain how the organization develops in a sustainable way, linking the variables that explain the construct addressed.

The proposed model is based on the analysis of the theoretical framework, with a focus on processes and systemic nature, to adapt to the changing environment and organization. However, further research is needed to validate the model MIS-IMS and increase from an empirical perspective the demonstrations related to the variables involved and others that could be incorporated.

AKNOWLEDGEMENTS

The authors of this article wish to thank the specialists who were interviewed to gather criteria around the link between these three concepts, especially to Dr. Mariluz Llanez Font. The professors Dr. Martí Casadesús Fa and Dr. Paulo Sampaio, for their support and the opportunity to have their criteria.

The author Alexandra Simon disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: (a) Spanish Ministry of Science and Innovation ECO2013-46954-C3-2-R Research Funding; (b) Autonomous Government of Catalonia 2014 SGR 868 Research funding.

The author Dalilis Escobar Rivera disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: (a) the support of the Secretariat for Universities and Research, from the Department Economy and Knowledge of the Government of Catalonia; (b) European Social Fund.

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Assessing Quality Tools Use in the Wind Power Sector

Castelló, J.1, De Castro, R.1 and Marimon, F.2

¹⁾ Universitat de Girona. EPS - Campus Montilivi, C/ Mª Aurèlia Capmany, 61. Girona 17071 u1923606@campus.ugd.edu; rudi.castro@udg.edu

²⁾ Universitat Internacional de Catalunya. Fac Económicas C/ Immaculada, 22. 08017 Barcelona

fmarimon@uic.es

ABSTRACT

Purpose - This study focuses on the state of quality control management tools and techniques used in the Wind Power (WP) sector.

Design/methodology/approach - Research was carried out in 120 Wind Power sector supply chain companies (component suppliers, wind turbine assemblers, and wind farm operation and maintenance) using the questionnaire method. The companies selected for the study have been implementing a quality management system in accordance with ISO 9001:2008.

Findings - The survey's findings reveal a high level of quality control techniques and tools being used in WP companies. The results show that the tools and techniques most commonly used are internal audits, flowchart diagrams and cost of poor quality. The survey also highlighted some areas for further improvement, such as implementing advanced and complex quality techniques. Furthermore, some managerial implications from this study are also reported at the end.

Research limitations/implications - The study was based on the quality managers', quality engineers', and company mangers' perceptions (subjective data) and neither examined the reasons for not implementing, or the difficulties encountered while implementing, quality tools and techniques.

Practical implications - The specific findings of this research are not only useful for managers who wish to implement a quality management system, but also provide recommendations for improving that implementation as well.

Originality/value - This study provides more detailed knowledge of the usage of the different quality tools and techniques in the WP, especially in ISO 9001 certified companies.

Keywords: Quality tools and techniques, ISO 9001, Wind Power sector

Paper type: Research paper

INTRODUCTION

The roots of total quality management (TQM) can be found in the leaders of the quality management movement: Deming's 14 points and improvement cycle (PDCA), Shewhart's statistical process control (SPC), Juran's quality trilogy (quality planning, control and improvement), Crosby's prevention defects, zero defects and cost of quality, Garvin's quality dimensions, Ishikawa's root cause and effect diagram, and Feigenbaum's three steps to quality (quality leadership, modern quality technology and organizational commitment.) etc.

In the past decades, the importance of TQM has increased considerably, on both a practical and theoretical levels. A number of studies have been carried out to develop a set of key practices for TQM implementation although these do vary from one author to another. Various studies have been carried out to identify those practices.

According to the literature, the elements of TQM can be grouped into two dimensions: the **management system or "soft" elements** (leadership, strategic quality planning, employee management and involvement, supplier management, customer focus, process management, continuous improvement, information and analysis, knowledge and education) and the **technical system or "hard" elements** (quality tools and techniques) (Evans and Lindsay, 1999; Tarí and Sabater; 2004; Tari, 2005; Fotopoulos and Psomas; 2009).

Developing the "soft" elements of TQM successfully is a long term issue and so must be emphasized accordingly in a TQM implementation plan. However, to effectively develop these "soft" management elements they must be supported by the technical "hard" elements of TQM (Zairi and Thiagarajan, 1997).

The technical "hard" elements consist of a set of tools and techniques such as histograms, flow charts, relations diagrams, scatter diagrams, control charts, Pareto analysis, Quality Function Deployment (QFD), Statistical Process Control (SPC) and Design of Experiments (DOE).

Nevertheless, past evidence has shown that TQM has failed in some cases, simply because the factors required for success are not in place (Curry and Kadasah, 2002). A possible reason for TQM not being successful lies in the absence of the use of suitable quality management methods such as tools and techniques (Zhang, 2000; Tarí and Sabater, 2004; Ahmed and Hassan, 2003). Authors such as Tari and Sabater (2004) and Fotopoulos and Psomas (2009) underline that, failure when applying quality tools and techniques is not due to the fact that they are ineffective, but due to a lack of clear understanding as to when, where and how to apply them. Another mistake easily made by companies is that they take each quality tool and technique as being a completely separate, isolated tool for application. The relationships and the sequence of quality tools and techniques are two important aspects that must be taken into consideration for their effective application (Fotopoulos and Psomas; 2009).

Based on these views, it is suggested that a TQM program may only have a positive influence on performance if management focus on the state of application of a number of TQM tools and techniques in their company, i.e., a well-equipped technical system must be established (Sousa and Voss, 2002). Moreover, this technical system, along with other components of TQM, is critical for the survival and continuation of business (Zackrisson et al., 1995).

Bearing in mind the advantages of the TQM tools and techniques and the absence of an empirical study on the use of technical systems in the Wind Power sector, above all in the whole value chain, we proposed carrying out an empirical study on this subject in order to verify to what the usage of different tools and techniques for TQM improvement and their performance are used in the sector.

The purpose of this paper then, is to analyse the level of of quality tools and techniques (TQM hard elements) "use" in the Wind Power (WP) sector. The findings will determine the implementation status (level use) of the quality tools and techniques in firms which have been ISO 9001:2008 certified in the WP supply chain.

The rest of the article is structured as follows: the second section presents the literature review on quality tools and techniques and their use. The third section describes the study's methodology. The fourth section presents the analysis and the respective results. Finally, the results of the research are discussed and final conclusions are presented.

LITERATURE REVIEW

The literature review suggests that there are several differences between quality "tools and techniques". According to McQuater et al. (1995), a single "tool" may be described as a device which has a clear role. It is often narrow in focus and is usually used on its own. Examples of tools are: histograms, Pareto analysis, cause and effect diagrams, control charts, and flowcharts. A "technique", on the other hand, has a wider application than a tool. This often results in a need for more thought, skill and training to use techniques effectively. Techniques can be thought of as a collection of tools. Examples of techniques are: SPC, Benchmarking, Quality Function Deployment (QFD), Failure Mode and Effects Analysis (FMEA), Design of Experiments (DOE), and Six Sigma (DMAIC). For example, statistical process control (SPC) uses a variety of tools such as charts graphs and histograms, as well as other statistical methods, all of which are indispensable for the effective use of this technique (McQuater et al., 1995).

A number of researchers, such as Lam (1996), Ahmed and Hassan (2003), Vouzas (2004), Bamford and Greatbanks (2005), Tari (2005), Alsaleh (2007) and Fotopoulos and Psomas (2009), distinguish quality tools and techniques in terms of ease of understanding and implementation for their users. According to Fotopoulos and Psomas (2009), tools such as flowcharts, check sheets, histograms and brainstorming are supposed to be "simple and basic", while the more complex techniques such as SPC, DOE, Taguchi's methods and QFD are supposed to be "advanced and sophisticated".

Along these lines, Ishikawa (1985), Evans and Lindsay (1999), Dale and McQuater (1998), and Dale (1999) introduce a set of seven tools such as flow charts, Pareto charts, histograms, cause and effect diagrams, brainstorming, run charts and graphs, control charts, and scatter diagrams which are widely accepted and used by organizations.

On the other hand, Deming (1986) emphasized the use of statistical techniques for quality improvement and proposed a PDCA cycle to improve quality in organisation. Ishikawa (1976, 1985) underlined the importance of the cause and effect diagram for problem solving, and quality circles as a way to achieve continuous improvement. In addition, Imai (1986), Dean and Evans (1994), Goetsch and Davis (1997), and Dale (1999), have drawn up a list of tools and techniques for quality improvement.

The review of the literature shows that there have been numerous studies analysing the critical factors for successful quality management tools and techniques implementation. On some occasions tools and techniques do not work exactly as firms had expected when they tried to apply them. According to Kwok and Tummala (1998), failures when applying quality tools and techniques are not due to the fact that they are ineffective, but due to a lack of clear understanding of when, where and how to apply them. Another mistake made by the firms, is to take each quality tool and technique as a completely separate, isolated tool for application. The relationships and the sequence of quality tools and techniques are two important aspects that must be taken into consideration for their effective application (Fotopoulos and Psomas; 2009). Thus, McQuater et al. (1995) underline that tools and techniques require attention in terms of a number of critical success factors, such as management support and commitment, effective, timely and planned training, genuine need to use a tool or technique, defined aims and objectives for use, co-operative environment and backup, and support from improvement facilitators.

In our research, and based on an extensive literature review Isikawa (1985), Imai (1986), McQuarter et. al (1995), Bunney and Dale (1997), Dale and McQuarter (1998), Bamford and Greatbanks,(2005) etc., we have been grouped 25 quality tools and techniques into **three groups** using the following criteria: (i) tools for

consulting and acting proactively (ii) tools for analysing and control (iii) tools for problem solving and improvement. These three groups are based on WP sector experience and to fill the gap we detected during our literature research review.

The main reason that we group the tools and techniques is to cover this gap in the literature, because the earlier studies we mentioned beforehand have all analysed the quality tools and techniques in one and the same package. And, as mentioned earlier, in some cases there is a lack of clear understanding in terms of what, where, when, why, who, what, and how to apply them. The relationships and the sequence of quality tools and techniques have some fundamental aspects that must be taken in consideration for their effective application. In this way, Bramford and Greatbanks (2005) provide guidelines to apply quality tools and techniques in everyday situations.

From the literature review above, it is evident that many researchers have explored the level of use of quality tools and techniques in companies worldwide and with differing quality management status. Nevertheless, we are motivated to explore the "level of use" of quality tools and techniques in companies which have been implementing a quality management system according to ISO 9001:2008 in the WP sector.

We have planned for future research where we will focus on the impact of each factor on results, but this is part of a larger project and will need further research

RESEARCH METODOLOGHY

We present the Research Methodology which consists of conducting a survey with Wind Turbine Suppliers and modelling the collected data with a Component Factor Analysis to better understand the behaviour of these tools in firms in the WP sector.

Questionnaire

In order to achieve our objective and based on the above research question, the research was carried out in WP sector supply chain firms (components suppliers, assemblers, and wind farm operation and maintenance). The data collection method used was that of the questionnaire. The questionnaire's design was based on the literature review of the work of Ishikawa (1985), Imai (1986), Stephens (1997), Bunney and Dale (1997), Dale and McQuarter (1998), Bamford and Greatbanks (2005) and Hagemeger et al. (2006). The questionnaire was initially reviewed by quality managers and academics and a pilot test was performed by quality professionals.

The final version of the questionnaire consisted of two sections. The first section comprised questions regarding a company's profile (company name, respondents and their position within the company, number of employees, main products or services, etc.). The second section collected information about the use and implementation of 25 quality tools and techniques in the WP sector (see Table 1). The questionnaire was answered by quality managers, suppliers quality engineers and company managers. The answers were based on a five-point Likert scale (1 no use – 2 hardly any use – 3 regular use – 4 often used- 5 frequent use).

Sample

The data collection was conducted by the authors in a research project financed by MICINN. The survey was launched in January 2015, and 125 questionnaires were collected, from which only 119 were retained for our analysis. A substantial number of respondents are global players and they have been referred to in the sector's specialized journals such as MAKE Consulting (2013) or BTM Consult (2014). The criterion for selecting the companies that would participate in this study was being ISO 9001:2008 certified.

Method

The analysis starts with an extended descriptive analysis, and the model building was done by an Exploratory Factor Analysis (EFA) using Principal Components Analysis and the Varimax rotation of quality tools, followed by a Confirmatory Factor Analysis (CFA).

RESULTS

Descriptive analysis of tools and techniques

The results of survey are presented in Table 1 and Figure 1. In the table the tools are classified by the proposed groups and ordered by percentage of use. The use and intensity of various quality tools and techniques by the responding companies in the WP sector can be found in Figure 1.

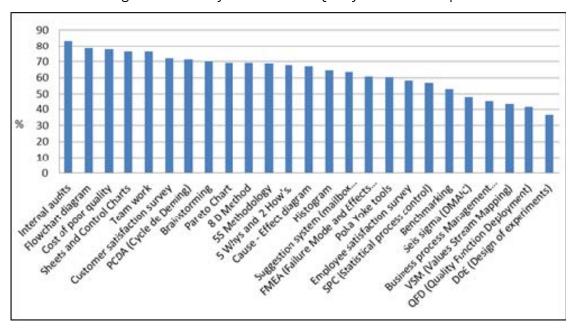


Figure 1 – Intensity of use for each Quality Tool or Technique

The percentage is understood as the mean of answers using the Liker scale (from 1 to 5) out of 5. From the Figure 1 we can observe that internal audits (83%), flowchart diagrams (78%), cost of poor quality (78%), sheets and control charts (76%), and team work (76%) are very popular because they are easier to implement and simple to use. On the other hand, quality tools and techniques such as: Design of Experiments DOE (36%), QFD (42%), VSM (44%), Six Sigma (48%) and BPM (46%), are used less because they are rather more complex quality tools and techniques. The results show that the tools and techniques needing greater knowledge and skills are used less frequently than the tools and techniques requiring a lower knowledge and skill level. These results are also in line with the findings of Fotopoulos and Psomas (2009) and Heras et al. (2011).

Table 1 – Quality tools and techniques in the questionnaire categorised by proposed groups

(i) Tools for acting proactively	Mean	Std. dev	% out of 5
Employee satisfaction survey	2,91	1,22	58
Suggestion system (mailbox suggestions)	3,18	1,69	64
Customer satisfaction survey	3,61	1,68	72
Team work	3,81	1,31	76

Internal audits	4,17	0,75	83
Mean of the group	3,53		71
(ii) Tools for analyzing and control	Mean	Std. dev	% out of 5
QFD (Quality Function Deployment)	2,08	1,28	42
Benchmarking	2,65	1,72	53
SPC (Statistical Process Control)	2,84	1,47	57
Poka Yoke tools	3,03	1,98	61
FMEA (Failure Mode and Effects Analysis)	3,04	1,33	61
Histograms	3,24	1,81	65
Cause - Effect diagrams	3,35	1,26	67
5 Whys and 2 Hows,	3,39	1,53	68
Pareto Chart	3,46	1,56	69
Brainstorming	3,50	1,3	70
Sheets and Control Charts	3,82	1,37	76
Cost of poor quality	3,89	1,52	78
Flowchart diagrams	3,92	1,07	78
Mean of the group	3,19		65
(iii) Tools to improve and for solving problems	Mean	Std. dev	% out of 5
DOE (Design of Experiments)	1,82	0,76	36
VSM (Values Stream Mapping)	2,19	1,17	44
Business process Management (BPM - BPR)	2,29	1,65	46
Six sigma (DMAIC)	2,41	0,99	48
5S Methodology	3,45	1,32	69
8 D Method	3,46	1,37	69
PCDA (Deming cycle)	3,56	1,45	71
Mean of the group	2,74		55

Descriptive analysis of tools and techniques by proposed groups

Descriptive analysis tools and techniques considering the proposed three groups show that the most-used group of tools is the group (i) tools for acting proactively with 71%. One of the main reasons for the "frequent" use and good knowledge of these types of tools and techniques is that some of them are mandatory in the ISO 9001: 2008 standard, as much as implicitly (such as "internal audits" - 83%), as explicitly (such as "customer satisfaction survey" - 72%). On the other hand, other tools and techniques in this group (such as "employee satisfaction survey" - 58% or "suggestion system" - 64%) are used internally to analyse organizational structures, management styles, communication or the work environment. These tools and techniques are different from other groups because they require little investment and little employee training. Usually these tools are qualitative (soft) and do not require any specific statistical knowledge. They are easy to apply and are used by management for making long-term decisions from a qualitative point of view. These tools are usually used for long-term action plans, usually within the company strategic plan framework, or quality management system revisions.

Second, we have tools and techniques in the (ii) tools for analysing and control group and used by 65% in the sector. These types of tools are used for analysing and diagnosing problems faced in daily practice and also in production processes control (for instance "Flowchart diagrams" - 78%, "Brainstorming" - 70%, "Pareto chart" - 69%, "Cause-Effect diagrams" - 67%, "5 Whys and 2 Hows" - 68%). They are designed primarily for analysing and resolving problems that usually appear in daily production work. In this same group we found some tools (such as "FMEA" - 61%, "QFD" - 42% or "Benchmarking" - 53%) to also be commonly used in phases of product development or in advanced quality planning. The results of the study show that they are

known and used "regularly" in the sector. Therefore, we can say that the industry has applied knowledge and problem analysis tools "regularly" but there is still major room for improvement.

With monitoring tools (such as "SPC" - 57%, "Poka Yoke" - 61%, "Sheets and Control Charts" - 76%), we see that they are also well known and used "regularly" by the sector. Regular use of these tools takes place in the monitoring and control of production processes. However, we are surprised by the high use of SPC in this particular sector, since one of the characteristics of the WP sector is the low volume and high variability, and the SPC is more commonly used in high-volume, low variability where processes tend to be more stable.

As in some tools and techniques of group (i), some of the tools and techniques used in group (ii) are mandatory or are implicit in ISO 9001:2008 (i.e. mandatory procedures as "quality records procedure" or specific sections of the standard such as "Analysis of data"). One of the reasons for the "regular" use and good knowledge of these tools is the sense of the sector belonging to a supply chain. These quality tools are known of and introduced into companies by process engineers and manufacturing, as well as managers and quality engineers. However, some of these concepts (such as the "SPC", "FMEA") require initial training by external consultants and internal facilitators, but the rest of them are known and are part of daily practices in the sector.

Finally, we have the tools and techniques which are less used. They belong to the (iii) tools for problem solving and improvement group with a 55% use. These techniques are much more complex to use with respect to the other groups and they are generally techniques that require an excellent knowledge of statistics (such as "Six Sigma" - 48% or "DOE" - 36%) or some knowledge of processes and manufacturing methodologies (such as "VSM" - 44%). All of them tend to be used with the help of external consultants and internal facilitators, who support through a solid knowledge of statistics and develop specific methodologies. The use of these techniques is restricted and generally responds to top management initiatives (Such as "Six Sigma" or "Lean manufacturing" launching programs). On the other hand, also in the group (iii) are 5s (69%), 8D's (69%) and PDCA (71%), which are techniques used for continuous improvement and solving complex problems. Although less complex statistically, these techniques also require the help of external consultants or internal facilitators in order to meet the objectives and as such tend to respond top management programs.

Exploratory Factor Analysis

Intending to validate the grouping of 25 tools and techniques used and learn about their structure, we performed an exploratory factor analysis (EFA) in order to verify that the families raised are homogeneous. In this exploratory analysis, we started from the 25 tools that were initially distributed on 5 factors, but with weights distributed on various factor (Table 2) loadings. Since the goal was to obtain three groupings of tools, data will be iterated until its_simplification. After three iterations looking for loadings higher than 0.5 and that each factor had 3 or more variables involved, the results were validated and passed to the next confirmatory analysis.

Table 2 – Quality tools and techniques in the exploratory Factor Analysis. First iteration, and only loadings > 0.5 are considered.

	0.0 0.0 00110.0				
Quality Tools	F1	F2	F3	F4	F5
Suggestion system (mailbox suggestions)		0.741			
Customer satisfaction survey		0.839			
Internal Audits		0.736			
Brainstorming	0.713				
Flowchart diagram	0.666				
Histogram	0.654				
Cause - Effect diagram	0.755				
Pareto Chart	0.793				

Sheets and Control Charts		0.606			
5 Whys and 2 Hows	0.602				
5S Methodology				0.706	
FMEA (Failure Mode and Effects Analysis)			0.683		
QFD (Quality Function Deployment)					0.689
PCDA (Deming circle)					0.639
8 D Method			0.801		
DOE (Design of Experiments)			0.567		
VSM (Values Stream Mapping)				0,605	

Confirmatory Factor Analysis

Table 3 summarizes the reliability analysis of the three dimensions of perceived quality. The internal reliability of these factors was then assessed and confirmed as the retained indicators exhibited loadings of 0.5 or higher. The internal consistency of the constructs reaffirmed our approach, obtaining values that exceeded the recommended threshold value of 0.7 for both Cronbach's alpha coefficient and composite reliability (CR). The Average Variance Extracted (AVE) also surpassed the cut-off point of 0,5 (Nunnally and Bernstein 1994) for all factors. Results revealed that Cronbach's alpha value did not improve when removing an item; therefore, we decided not to exclude any items.

These results confirmed a linear dependence between the variables and supported our view that the results were sound. Only three factors emerged with eigenvalues greater than one (Kaiser criterion). Looking more closely at the tools included in each factor, the following labels were provided: (1) Tools for acting proactively; (2) Tools for analysing and (3) Tools for improvement and solving problems. Table 3 shows only those items with significant loads; which were the items proposed for the three constructs. The composite reliability and the AVE of the constructs are above the threshold recommended, showing good psychometric values which in turn vouch for internal consistency and reliability.

Table 3 – Confirmatory Factor Analysis. Standardized loads and reliability for each dimension.

CR: Composite reliability: AVF: Average Variance Extracted

CR: Composite reliability; AVE: Average Variance Extracted					
Tools for acting proactively (CR = 0.841 & AVE = 0.799)	F1	F2	F3		
Suggestion system (mailbox suggestions)	0.770				
Customer satisfaction survey	0.847				
Internal Audits	0.779				
Tools for analysing and control					
(CR = 0.856 & AVE = 0.773)					
Brainstorming		0.770			
Flowchart diagram		0.731			
Cause - Effect diagram		0.809			
Pareto Chart		0.781			
Tools to improve and for solving problems					
(CR = 0.767 & AVE = 0.775)					
5S Methodology			0.735		
8 D Method			0.530		
DOE (Design of experiments)			0.668		
VSM (Values Stream Mapping)			0.746		

From the results, we found that the group of families is consistent with the data and is structured in three constructs. Factor 1 (F1) tools for acting proactively, Factor 2 (F2) tools for analysing and control and finally Factor 3 (F3) tools for improvement and solving problems

DISCUSSION

In view of the results, we can say that the WP is a sector that has a high level of use quality management related tools and techniques. One of the main features of the sector is the high technological complexity of the product, the short production runs (low volume) and high variability (constant technological developments) all these considerations involve a constant practice of analysis and problem solving.

Our study shows, at the individual level, that in the use of tools and techniques the level is "acceptable" in the WP industry compared with other sectors referenced in the literature (Ahmed and Hassan, 2003; Lagrosen, Lagrosenand Lagrosen; 2005; Alsaleh, 2007; Fotopoulus and Psomos, 2009; Heras et al, 2009; Talib et al 2013), and where the level of "use" of quality tools and techniques is lower than that of our sector.

We can show that the most used tools in the WP sector are: internal audits (83%), flowchart diagrams (78%), cost of poor quality (78%), sheets and control charts (76%) and team work (76%). Some techniques and tools mentioned as "internal audits", "flowchart diagram", agree with previous studies referenced in the literature such as Tarí and Sabater (2004), Heras et al. (2011) and Talib et al. (2013). But we cannot state the same in terms of intensity of use, since evidence from the WP sector shows a much higher use.

One of the reasons which makes our findings different with respect to other referenced literature (Ahmed and Hassan, 2003; Logrosen and Logrosen, 2005; Fotopoulos and Psomas, 2009) is that these studies have not focused on specific sectors such as in our case.

Apart from that, we note that the tools "less used" in our study are DOE (36%); QFD (41%), VSM (44%), Six Sigma (48%) and BPM (46%). In this sense we are more in line with other referenced literature, despite our use of these tools being somewhat more extended, but we also agree with the work of Heras et al (2011) and Talib et al. (2013), where less use of quality techniques such as DOE, Six Sigma and BPM is evident.

From the point of view of the authors of this article, a high complex technology sector such as WP facilitates the use and development of quality tools and techniques thanks to this highly technological environment. However, when we divide quality tools and techniques into categories in terms of their specific use, as we propose, some variations are observed. With regard to the tools and techniques of the group (F1) "Tools for acting proactively" show that there is a "regular" use (71%) by the population surveyed. One of the reasons for this high impact is because all these tools and techniques associated with this group from part of the ISO 9001: 2008 environment, which implies the use of some tools and techniques derived from some of its procedures or mandatory processes (i.e., internal audits, customer satisfaction, etc.). The third group (F3) is "Tools to improve and solving problems" with 55% use. In this sense, the result is reasonable since, as McQuarter et al., (1995) noticed, there are significant differences in the use of tools and techniques from sector to sector. In this sense Greene (1993) and Tarí and Sabater (2004) point out that the particular situation of each company at all times requires certain tools. Techniques for improving and solving problems such as 8D's, DOE, VSM, QFD, BPM, require commitment and management support for their development, require specific plans, investments in training programs and specific guidance by external consultants in some cases, for training, implementation and development, as well as internal facilitators to support their implementation.

CONCLUSIONS

Quality tools and techniques help organizations to analyse and solve problems by providing methodology required to detect the root causes of problems, 1) developing and planning corrective and preventive required

actions to prevent recurrence of problems 2) validating the efficiency of the solutions, and finally, 3) monitoring the solutions proposed.

According to this, the use of quality tools and techniques improves communication between managers, engineers and operators and they also help operators to understand the processes and distinguish the possible causes of process variation. Moreover, the present study has also evidenced that the ISO 9001: 2008 environment provides a framework for the use of quality tools and techniques. However, it should be noted that the use of quality tools and techniques requires an appropriate environment for their development and it is the responsibility of top management to provide the right environment based on sufficient resources and by leading the program.

To conclude, a point to consider when analysing the results of this study is that the WP sector is considered a high-tech sector and technologists due to product requirements (i.e. 97.5% availability 24 hours a day it is required for wind turbines). It shows that the industry technicians and engineers are used to analysing and solving problems caused by these turbines in daily practice.

PRACTICAL IMPLICATIONS

For managers, this article has some implications. From a practical point of view, the results of this research provide WP sector firms, managers and practitioners with a practical understanding of these tools and techniques for quality improvement.

Therefore, WP sector managers would be better to focus on the less-used quality tools and techniques, and understand clearly as to what design of experiments (DOE); quality function development (QFD), VSM (Values Stream Map), Six Sigma (DMAIC) and business process management (BPM) really mean and implement them accordingly to improve their overall business performance while enhancing quality performance at the same time. If the firms wish to go beyond ISO 9001, they must improve all of these aspects in order to improve their competitiveness.

Firms and their managers should understand that the quality of a product does not only depend on the quality of the process, but also on the quality of the management system and the adoption of key quality tools and techniques. Top management must provide an adequate atmosphere, appropriate resources and training for continuous improvement programs.

Further, the advantages of applying quality tools and techniques should also be understood by practicing managers. Well-designed training sessions and development programmes should be provided to all members of the company so that everyone understands not only the importance of basic and advanced tools and techniques, but also so they are able to apply them.

In other words, managers should encourage employees to use quality tools and techniques in the quest for improvements in whole sector SC.

AKNOWLEDGEMENTS

The authors are grateful for the financial support from the Spanish Ministry of Economy and Competitiveness ECO2013-46954-C3-3-R and from the Autonomous Government of Catalonia 2014 SGR 868.

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Supplier Evaluation Process from the perspective of the Stakeholders

Caran V.1, Krueger J. F.2, Ayres, L. F. 3 and Araujo Jr. A. H4

- ¹⁾ Alumni of the Mackenzie Presbyterian University, Campinas, São Paulo, Brazil
- ²⁾ Alumni of the Mackenzie Presbyterian University, Campinas, São Paulo, Brazil
- ³⁾ Professor of Production Engineering Dept., Mackenzie Presbyterian University, Campinas, Brazil
 - ⁴⁾ Professor of Production Engineering Dept., State University of Rio de Janeiro, RJ, Brazil.

Abstract: The paper deals with a supplier's process management and their performance, and had as an objective to identify stakeholder's perceptions about this management, in an automotive industry in the Metropolitan Region of Campinas, Brazil. The nature of the research is qualitative and was conducted by means of interviews and the results showed that a well stablished suppliers management process contributes to the organization's continuous improvement of products and processes. The company researched has about 800 employees, is a global company, and a world leader in the production of automotive wheels. The research's conclusion showed that in order companies to become more competitive, it is necessary to strengthen the value chain links and create long-term relationships with their suppliers.

Keywords: Supplier management, Supply Chain, Evaluation of Supplier Performance, Processes Management, Stakeholders.

1. Introduction

Handfield and Nichols (1999, 115) addresses that "a supply chain includes a firm's internal functions which include all transformation processes, its upstream suppliers, and its downstream distribution channels reaching the end customers which includes distributors and retailers".

According to Ferguson (2000), the supply chain management involves a collaborative strategy linking cross-enterprise business operations to achieving a shared vision of the market opportunity. This shared vision in automotive industry has been improving the competitive edges, through cost cutting and continuous improvement of quality either the suppliers or the recipients.

Scavarda (2001) points out that a Procurement Department in automotive industries, for a long period, has always been understood as a support area, so that its scope normally was restricted to commercial transactions, which aimed mainly at reducing the purchase price of those products at a required level of quality, to meeting the production demands of such organizations. The supply chain management encompasses all quality management activities associated with the flow and transformation of goods from raw material stage through the end users (finished product) stage along with flow of all information related to quality and materials as well as information flow both up and down the supply chain (FERGUSON, 2000).

In the same direction Urbaniak (2015) emphasizes the importance about the building a long-term partnership with the suppliers, in order to achieve a strong relationship between them.

These strategic procedures allow the firms transform the recurring purchase transactions in a cooperative relationship, which are usually governed by a contract and improve the possibility to developing a higher supplier's commitment to solve, for example, quality problems either in the productions line or in field.

As time went by in Brazil, it became inexorable a market opening, which promoted the production globalization in unimaginable scales, and in such a way that changed dramatically the competitive arena of business, requiring from Procurement Areas/Departments postures differentiated for the performance of their duties and functions.

Campos (1992) emphasizes that a company can't be competitive in isolation, since it is embedded in a chain of buyers and suppliers, where all the companies operating in it, seek to maximize their added value, transferring cost and quality gains, in order to make the chain as a whole much more competitive.

The above outlined context, signals out that changes came over to remain in next years, and so is not enough to provide quality products or services to customers, it is also necessary to develop personalized experiences, creating therefore synergistic products and services that have market acceptance (ALVAREZ; QUEIROZ, 2003).

The above listed authors suggest to make companies more competitive, it is necessary to strengthen the links of the value chains and create long-term relationships with its suppliers.

It is urgent for the strategic moves of the organizations, that the process of qualifying suppliers, to be managed properly, generate competitive advantages for companies. This concern for the integrity of their businesses, with the establishment of lasting partnerships with reputable companies, acting with ethics and social responsibility, in accordance with legal principles and, furthermore, noting the quality and commitment in supplying products and services it is a decisive factor for its perpetuation (OLIVEIRA, 2013).

The objective of this study is to determine the stakeholder's perceptions of the supplier's evaluation process. This paper was derived from a Degree Programme in Business Administration from the Mackenzie University, Campinas campus.

2 Literature review

2.1 Concept of Processes

Conceptualizing processes becomes a hard task as there are a large number of approaches, from different authors, with different visions, which can lead to confusion in the use of this term, in the practical application of that 'constructo'.

So we sought to find in the literature, after extensive review, authors whose concept best suited to the initial objectives intended by the authors of this research. Therefore, the author chosen was Oliveira (2013), who defined process as a set of structured and interrelated activities such as planning, organization, management and evaluation, presents a logical and sequential links between them. The same author recognize that all these activities should be integrated to obtain and preferably surpass the needs and expectations in a balanced way of all stakeholders.

The logic of the choice of the above author's definition, had a decisive factor not only related to the approach by logical sequencing of activities, but also for understanding how to reduce interpersonal conflicts without, however, eliminating those activities, and especially in obtaining focus on the satisfaction of both internal and external customers.

Those statements are reinforced by Arostegui et al (2012) who pointed out that the organizations should be seen like a system and the functional areas depend on each other in order to aggregate value to the entire enterprise.

2.2 Suppliers Performance Evaluation Process

Lysons (2012, 166) simply defines performance measurement "as the quantification or the expression of a quality or attribute in numerical terms", or in another definition of measurement: "The systematic assignment of numerical values (quantitative) or verbal descriptors (qualitative) to the characteristics of objects or individuals; designation of the status of such characteristics". Evaluation also means to acquire information to form judgments for further decision making.

In order to assess supplier performance, more objective according to Cousins et al. (2008), non-financial measures are considered, consisting of information sharing, responsiveness in problem solving, collaboration level, supplier satisfaction, certified suppliers and supply base characteristics. These activities are also closely associated with developing supplier's performance and capabilities, like recognition and awarding, training and education, financial assistance and so on.

Also in this context, Strategic decision-making evaluation of suppliers cannot be only determined by pricing the intrinsic quality of products and services offered. measuring the companies seek partnerships with long-term relationships, which are translated through values and mutual trust. This type of relationship is intended to develop a reciprocal and balanced growth between the relationship, the parties, and during this companies exchange intelligence and information, empowering them to create value for those involved, making them thus more competitive (SILVA; SILVA; BELAN, 2006).

Weber and Current (1993), point out that the primary goal of this process is to decide on the most appropriate supply source, which comes with other important decisions to the company, such as the number of suppliers that will participate in the supply portfolio and the volume of requests to be allocated to each of these suppliers.

According to Urbaniak (2015), the supply chain concept plays a very important role to developing and improving the efficiency and the effectiveness of companies and mainly, based on this approach there is a connection to planning and others functional organizational areas.

Even according to Canto (2004), it is necessary to standardize this supplier's performance evaluation process through the use of metrics that reflect the organization key points in order to achieve its specific objectives. It should be noted however, that by making this kind of management, companies provide the development of the entire value chain making them more robust, i.e., providing more reliable and perennial results.

2.3 Process Management

According to the Business Process Management (BPM) Methodology, Process Management is defined as a systematic approach in order to identifying and managing the organizational process to aim the enterprise desired results, what means in a consistent way and aligned with the strategic goals of the organization.

Paim, et al. (2009) point out that "improving processes is a basic action to respond to the changes that occur in the action environment, to maintain the system productive and competitive".

To above authors, the management process is divided into three groups of tasks that can be understood as planning, organizing and controlling processes, and this includes the measurement of processes considered strategic for the organization, that means a performance indicator system.

With proper management of the processes, managers can evaluate, from appropriate performance metrics of each of the chosen strategic processes, its flaws and gaps, and improvement opportunities. These actions allow to identifying the activities that no longer add value to processes and which are likely to be either eliminated or improved.

3 Methodology

This research can be considered of qualitative and exploratory nature and is related to a case study since it was intended to understand and explain a phenomenon of real life. According to Yin (2010), a case study is significant when researchers plan to obtain information which indicates the importance of contextual issues to understanding the research problem.

A qualitative research is the most suitable to similar studies, due to the fact they provide greater depth on topics, whose knowledge is not yet fully delineated. The qualitative method provides an integrated approach to phenomena, which can be better understood in the context in which they occur, leading to the understanding of relationships dynamics.

The study also used secondary data, obtained both through literature revision and organization data reports collected through interviews made with company's managers. In this research we used semi-structured interviews once it favored dialogue with respondents, deepening important aspects to keeping focus on the research objectives.

For the analysis of data collected we used the Content Analysis Technique, which, according to Bardin (2009, p. 21) corresponds to the consolidation of the data obtained by grouping them into categories. The categorization should take into account the characteristics that are common to each of these elements, allowing a simplification of the raw data in order to facilitate the researchers' conclusions.

In this context, Bardin (2009) warns that to perform a proper categorization and, with that, to be able to generate a set of appropriate categories, the principle of exclusion must be obeyed, i.e, an element chosen for a particular category, necessarily, must not belong to another, such that the intersection between them must be zero.

This analysis allowed the data to be categorized to facilitate not only their consolidation, but their grouping into different categories, which were classified according to the results of the interviews.

3.1 Data of the company studied The company in which the research was drawn up, fancy name "Company X", operates in the automotive segment, and gives emphasis in monitoring and tracking the

supplier's performance process evaluation. These unit, a global company, has about 800 employees and is a world leader in the production of automotive wheels.

3.2 Results of data collecting

The data collection was carried out through semi-structured interviews, with questions prepared by the researchers. The interviews were applied to thirteen employees identified as key persons in the processes, and distributed according to the areas researched: - quality and advanced quality engineering, procurement, logistics, production and tooling department. Concerning the sampling of employees: one of them belonged to the strategic level, ie the manager of the plant, eight to the tactical level, managers and supervisors, and four to the operational level.

Taking into account the considerations made, four categories, were identified from the data consolidation, in accordance to Bardin (2009): Category 1 - Stakeholders in the suppliers performance evaluation process; Category 2 - Suppliers performance evaluation process; Category 3 - Results generated by the suppliers performance evaluation process and Category 4 - Risks inherent to the suppliers evaluation performance.

3.2.1 Categories Identified after analysis of data

Statements from respondents supported the identification of categories, however, due to limited space in this conference paper, the authors decided to highlight only one and the most significant speech of each category.

CATEGORY 1 - STAKEHOLDERS IN THE SUPPLIERS PERFORMANCE EVALUATION PROCESS

E1: [...] We have people from all the company areas: we have people from Engineering, Quality, Advanced Quality, Procurement, Product Engineering, Production [...].

This statement demonstrates the need for linking together all participants, strengthening relations between the areas involved in the process, demonstrating the importance of a systemic vision and a synergy that must exist between them, so that the management of this process adds the necessary value to the whole organization.

It was noted that the stakeholder's mapping could play a very important role, in order to improve the supplier's process management. The need to identifying stakeholders process's reinforce the statement pointed out by Arostegui et al. (2015), which determine the cooperation between functional areas inside the organization.

CATEGORY 2 - SUPPLIERS PERFORMANCE EVALUATION PROCESS

This category relates to the assessment of the performance of suppliers and can be better understood by following statements:

E3: [...] Our procedure of supplier evaluation, and supplier choice starts with the Risk Assessment. The Risk Assessment is a tool that has several issues, from the technical, logistical side, and commercial side, so we can minimize the risk of choosing a vendor that does not have the capacity to provide for the company.

The respondent E3 indicates that the company has a consolidated practice to reduce the risk of acquiring not able third-party products.

According to Arostegui et al (2015) the management's relationships with the suppliers represents the organizational competitive differential and it is considered a key factor to improve and implement successfully the quality management of the organization.

CATEGORY 3 - RESULTS GENERATED BY THE SUPPLIERS PERFORMANCE EVALUATION PROCESS

This category brings information collected, which have relation to the impacts generated by supplier's performance evaluation process from the point of view of the organization. This perception is significant for people to have confidence in what other areas are doing so that the level of supplier's quality can be continuously improved, as understood by the interview below:

E5: [...] The suppliers performance evaluation process helps to take decision, for example, in relation to what suppliers purchase. For example, we have a specific provider, [...] from 2014 onwards we eliminated this supplier because of problems we had with his delivery quality.

And another point, even for decision making, it is important that prices should be negotiated by the Purchasing Department, once if the company don't monitor them, this same company can't give technical support to the Purchasing Department decision making according to Arostegui et al (2012). The good results obtained by the supplier's performance evaluation should be used in order to stablish and consolidate trust between partners. Urbaniak (2015) points out that when the transactions were transformed in a long-term point of view, cooperation can become more productive for both sides.

CATEGORY 4 - RISKS INHERENT TO THE SUPPLIERS PERFORMANCE PROCESS EVALUATION

According to the interviews, it was identified some risks that are inherent to the supplier's performance process evaluation, as noted by the respondent E1, as shown below:

E1: [...] we're trying to reduce supply risks [...] we can't do it with 100% of suppliers [...] we are focusing more on raw material, which constitutes 60% of our product [...].

In the talk of the E1 respondent, we realized the strategy employed by the company regarding the prioritization of activities, opting for raw materials, which is corresponding to 60% of the products content supplied by the company.

Arostegui et al (2012) by citing Gonzalez-Benito and Dale (2001) mention that in spite of the risk, the existence of common and shared objectives and challenges is a huge motivational factor in order to obtain advantage when working with a very small number of suppliers.

3.2.1 Final Considerations

The data obtained allow emphasizing that the management of the supplier evaluation process in the analyzed company has a strategic management and the perception on the part of stakeholders is that it contributes to the management decision-making processes to ensure the quality of the supply of products acquired from third parties.

In the interviews conducted, it is noticed that there are still conditions to process improvements, especially in the strengthening of internal relations between the internal areas that participate in the process and the suppliers making it more robust.

4. Conclusion

We observed in the company studied, that the suppliers performance evaluation process, presents itself as a strategic theme within its supply chain. This reinforces the point of view that the construction of lasting partnerships in the supply system, promotes everlasting competitive advantages, since it has the potential to improving the quality of management for both companies involved in the partnership as suggested by Oliveira (2013).

Each interviewee, in his own way, was aware of the importance of an assessment of supplier performance, showing that they have the perception of the process importance, however with some gaps, reflecting improvement opportunities for those who are directly related to the processes studied. What concerns the areas interested in the suppliers performance evaluation process, such areas have an architecture of indicators, as a way of tracking and monitoring their supplier's performance.

This fact that was appointed by the managers plays an important role as a relevant factor in the decision making of the areas/departments involved, in choosing a suitable and convenient supplier.

In short, we can conclude that the value perception of stakeholders in the process of performance evaluation of suppliers is a positive factor, based and from the analysis of the responses of the respondents who, highlighted the importance of the supplier process evaluation for the organization's continuous

improvement of products and processes, including, their own suppliers. The research allowed us to conclude that in order companies to become more competitive, it is necessary to strengthen the value chain links and create long-term relationships

The results obtained from respondent categorization speech indicated the need to have a structured supplier performance evaluation process and a systemic coverage in organizations. For this process to add value in a balanced manner to its stakeholders is required, a close relationship between the participants areas, avoiding the functional focus on setting goals and challenges, and preventing them to becoming competitors instead of complementary partners, as proposed by Arostegui et al. (2012).

This is the approach normally observed in organizations that do not have this broad vision of the business in which they operate. By establishing the evaluation process and also with the generation of results of qualitative levels of providers, companies can establish a long-term strategy, and thereby reducing supply risks from suppliers according to Urbaniak (2015).

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Relationship between Quality Management Practices and Innovation: The State-of-the-art

Bianchi, R.O. 1) and Sampaio, P. 2)

¹⁾ School of Engineering of Lorena, University of Sao Paulo, Lorena, Brazil

² Department of Production and Systems, University of Minho, Guimarães, Portugal

ABSTRACT

Purpose: The establishment of a knowledge-based economy has recognized innovation as the driver of economic growth and productivity along with quality management which has the potential to enhance operational and financial performance giving companies privileged position on the increasing market competition. However, an issue emanates from the lack of consensus in the literature whether quality management drives or inhibits the innovative capacity of a company. The objective of this literature review is to verify the greater tendency, any possible mediator effect between quality management and innovation and to clarify what has been done so far involving those concepts looking for less explored fields that could serve as a basis for development of future research in this area.

Design/ methodology/ approach: The selected articles were divided into two main groups, those supporting the positive relationship between quality management practices and innovation, and those supporting the negative relationship analyzing both schools of thought in a narrative model.

Findings: It was observed the standpoint supporting the positive relation between quality management and innovation is stronger than the negative one and very few studies deal with the extension of how quality management programs influence the innovative capacity of organizations, becoming then a promising area to explore.

Originality/ value: A clear understanding of the relationship between quality management and innovation allows an organization to properly allocate knowledge and resources to achieve higher business performance.

Key words: Quality management, innovation, mediator effect

Paper type: Literature review

1. Introduction

Many researchers have been intrigued by the role of innovation and quality management (QM) as factors to increase an organization's competitiveness (Schniederjans & Schniederjans, 2015). The positive influence of QM reflects on the company's performance and its role to reach a competitive position is well known worldwide (Kaynak, 2003). However, since a knowledge-based economy has been established, a long-term competitive advantage is built by capacities or intangible resources characterized by its high value and rareness, and difficulty to reproduce (Barney, 1995). Thus, the exclusively adoption of QM is insufficient to achieve business success and the role of what is the most important factor to sustain a competitive position in the current market has changed from quality to innovation (Cooper, 1998; Hoang et al., 2006). Such importance has motivated researchers and practitioners to determine and analyze the responsible agents leading to innovation (Becheikh et al., 2006). Hence, many studies have emerged in order to investigate whether there is a significant and positive effect of QM practices on innovation as well as the relationship between QM and innovation regarding its circumstances and environment (e.g., Kim et al., 2012; Moura et al., 2007; Perdomo-Ortiz et al., 2006; Flynn, 1994).

This paper presents a literature review of the relationship between QM and innovation based on published articles over the last three decades, period which most of the significant studies can be found. A broad analysis permits an arrangement of the studies in two major categories: scholars, whom accept the positive relation between QM and innovation, argue that QM principles and practices are similar those embedded on the concept of innovation, hence, promoting the organizational culture and environment propitious to innovation (e.g., Prajogo and Hong, 2008; López-Mielgo et al., 2009; Roffe, 1998); and on the other hand, scholars who support the negative relation between QM and innovation claiming QM practices induce a narrow-minded thinking due to the requirement of standardization and the adoption of costumer focus which supposedly hinders creativity and consequently hinders innovation (Slater and Narver, 1998). The existence of these two categories is due to QM and innovation being multidimensional implying complexity. Most researchers limit investigation to the impact of QM on innovation directly, when in fact this analysis disserves a direct and indirect approach (Kim et al., 2012; Moreno-Luzon et al., 2013).

As a result, through examining what has been done since late of the 1980s, the objectives of this paper are: to illustrate which is the greater tendency, whether positive or negative; and to identify indirect approaches and mediator effects focusing on the assessment of "how" QM practice can influence innovation. The intention is to clarify possible fields, which are less explored on the literature serving as basis for development of future innovative research contributing to a deeper comprehension on the relation of QM and innovation.

2. Literature review on the relationship between QM and innovation

2.1. Supporting a positive effect.

2.1.1. Some dimensions of Total Quality Management (TQM) positively affect some dimensions of innovation, directly.

Before dividing the multidimensional model of QM among the different practices that comprise it, two structures may be designed to classify them by its essential characteristic and they are: mechanistic, including systematic procedures; and organic referring to unsystematic procedures (Beyer et al., 1997). Hence, there is a positive connection between the innovation and different QM practices, enhancing innovation and the organic side of TQM, which is deeply associated with innovation (e.g., Abrunhosa et al., 2008; Perdomo-Ortiz et al., 2006; Prajogo and Sohal, 2004b). Those efforts are extremely based on human resource where innovation is concentrated meaning people stand up as the most important factor affecting TQM towards innovation (Feng et al., 2006). Perdomo-Ortiz et al. (2009) sustain those practices associated with human resource management

conduct by TQM principles have a positive impact on innovation performance, in such a way motivated employees engaged on training and teamwork are likely to enhance the company's innovation performance. Abrunhosa et al. (2008) also sustain this position when observed supportive people management practices are correlated with high levels of technological innovation. Innovative companies put a greater emphasis on training, customer relations, and direct communication between top management and employees than less innovative firms (Baldwin and Johnson, 1996).

Despite the conclusion of some researchers about existing QM practices being more relevant than others in order to pursue innovation, many others defend the argument that QM practices are of equal importance on the development of innovative performance since they are linked to each other directly or indirectly (e.g., Kim et al., 2012; Benner and Tushman, 2002; Gustafson and Hundt, 1995). Martinez-Costa and Martinez-Lorente (2008), in a study of 451 manufacturing and non-manufacturing companies, argue in favor of the direct relationship between TQM and both process and product innovation, only when TQM is implemented as a system emphasizing equally all the QM practices. Prajogo and Hong (2008) support the positive relationship between product innovation and the adoption of TQM exploring opposite QM practices such as process management and people management. When it comes to incremental innovation and technological innovation, the more a company enhances its efforts in process management, which means mapping routines, improving and standardizing them, the more innovative a company may be, proving systemic QM practices also plays a vital role to promote innovation (Benner and Tushman, 2002). Flynn (1994) supports QM practices may have a positive influence on the speed of product innovation giving a company a competitive advantage. Nevertheless, Lopez-Mielgo et al. (2009) conclude the other side of the coin is also true, meaning a company with a high innovative capacity is likely to implement some TOM elements in order to reduce costs and guarantee profitability of the investments by means of standardization and quality control.

Regarding the direct relationship between certifications of quality management standard such as ISO 9000 and ISO 9001 and its impact on innovation, studies also provide empirical results supporting the adoption of those certifications will improve the innovation performance of the company. While Pekovic and Galia (2009) showed a completely significant and positive association between ISO 9000 and innovation and its ramifications as product and process, Terziovski and Guerrero (2014) support the same association concerning process innovation. For ISO 9001 the results are more concise, Kim et al. (2012), with Canadian companies, and Fernandes et al. (2014), with Portuguese organizations, conclude the certifications have a significant and positive impact on innovation performance.

2.1.2. QM establishes a fertile atmosphere or platform for developing innovation.

Innovation and QM are interconnected in a two-way road. It means QM philosophy embraces the essence of innovation, and the most significant innovations are those which relates to TQM principles, because they occur on the sphere of creating value for customers (Mahesh, 1993). Both QM and innovation possess the same organizational platform, which implies on some similarities such as the pursuit for increasing value and involvement of customers' needs (Llorens et al., 2003; Nowak, 1997). QM is significantly connected with innovation as both are developed on the same organizational environment and strives for common targets. Kanji (1996) sustained the role of TQM as a bridge. The author connected TQM and innovation at the same objective, which is the customer's satisfaction through continuous improvement. Whereas, successful innovation is only obtained if the company is already engaged with TQM principles. In short, companies that seek to become innovative must have the capacity to manage quality in advance (Prajogo and Sohal, 2003). In an attempt to clarify the theory of a fertile pre-atmosphere created by QM, Prajogo and Sohal (2004a) applied a case study with a successful Australian manufacturing company which shifted its strategic management from quality to innovation

due to the changes of business environment. The researchers firstly drew that previous knowledge on QM was fundamental to successfully embody innovation, working as a learning process to all involved in the transitioning and concomitantly with innovation rather than one at the expense of the other. Secondly, the adoption of an innovation management was supported by a flexibility capacity of the company to adjust business environment changes, highlighting at the importance of leadership management regarding new organizational structure and culture. Nonetheless, a customer relationship analysis indicated a redefinition on some TQM principles towards the customer focus philosophy where customers dictated the product and its quality based on their perception. The proposal focus on unperceived needs and exploring new needs and markets as asserted by Slater and Narver (1998). To address those strategies issues, companies should be able to be involved in organizational changes with a certain speed in order to achieve a flexibility posture towards strategy (Nowak, 1997).

When innovation is dealt as a dynamic capability, TQM is understood as a builder of a fertile atmosphere or platform for implementing innovation (Cho and Pucik, 2005; Prajogo and Sohal, 2004a). Perdomo-Ortiz et al. (2006) recognize innovation as a "strategic resource that must be managed", thus, different structures of QM practices work as basis for companies' innovative culture. Innovative capacity and quality are connected directly and indirectly to aim a company's performance such as growth, profitability and market value (Prajogo and Sohal, 2004a). Specifically, on one hand QM isolated is not able to guarantee growth and, on the other hand innovative capacity by itself does not assure profit increase (Cho and Pucik, 2005). Similarly, Santos-Vijande and Álvarez-González (2007) showed that TQM promotes innovativeness and influences positively only administrative innovation while innovativeness has a direct and positive relationship towards technological innovation. These findings sustain the thought that TQM works as a forerunner of innovation capability in such a way it complements each other to build up a competitive advantage.

2.1.3. QM practices positively affect innovation through a mediator effect.

Researchers have inclined to identify the positive relationship between QM and innovation is indirectly and sustained by a mediator effect (e.g., Yusr et al., 2014; Moreno-Luzon et al., 2013; Yusr et al., 2012; Sony and Naik, 2012; Kim et al, 2012; Amir et al., 2012; Prajogo and Sohal, 2003; Bolwijn and Kumpe, 1990). Pérez-Arostegui et al. (2010) showed the indirectly effect of QM on innovation through the role of absorptive capacity, while QM executes the role of the source of information, absorptive capacity would improve a company's leading to innovativeness. Knowledge is the most valuable resource of a company since any innovative activity involves generation and use of knowledge (Melkas et al. 2010). Knowledge management, which includes acquiring, sharing and applying it, when involved with QM practices at problems solving results in innovation (Amir et al., 2012; Hung et al., 2010).

Yusr et al. (2012) argue that management of information, knowledge, skill and resources to address market-related needs, known as marketing capabilities, may also result in innovation. However, the acquirement of information, knowledge, skill and resource comes from QM practices. The good relationship with the customers in a QM philosophy provides the necessary framework for creating value for them, thus, enhancing marketing capabilities and, consequently innovation (Yusr et al. 2014). Nonetheless, independently of how is the mediator between QM and innovation, flexibility posture is crucial to achieve an innovation performance. Bolwijn and Kumpe (1990) conducted a research through large Europeans manufacturing companies to look at the past. The authors concluded that flexibility strategy act as a natural mediator effect between QM and innovation and assert that an innovation management system can only be achieved through a previous knowledge of managing quality. The flexibility may be understood as a cultural change which allows all involved absorbing a new mentality and posture (Moreno-Luzon et al., 2013).

2.2. Supporting a negative effect.

Some academics have concluded that there is no evidence associating QM and innovation (e.g., Silva et al, 2013; Singh and Smith, 2004; Roffe, 1999; Lawton and Parasuraman, 1980). Burdett (1994) states that the philosophy of TQM barely goes further than incremental changes and limits to "do better", whilst innovation inclines more to "do differently". The routine and the repetition involved on QM practices might offer circumstances that constrain the development of creativity and make the problems well-know. An individual would come up with innovative solutions only if the environment could not offer any barrier to creativity and the case were unfamiliar (Glynn, 1996). Ahanotu (1998) argues TQM practices have the potential to limit workers' empowerment in a way that their actions and time are focused only to eliminating waste inhibiting them to engage in significantly innovative opportunities. Even though this continuous improvement may generate a minimum knowledge development, it is attached to a routine and structured task instead of the development of innovative production process and product. Singh and Smith (2004) found no evidence of an association between TQM and innovation, where TQM supposedly works as a supportive platform or to create the propitious environment for innovation. The empirical investigation was directly and the assessment of a TQM practices considered innovation as a whole.

A specific QM practice has been targeted as the main factor to deny the relationship between QM and innovation, referred to as customer satisfaction (Slater and Narver, 1998; Wind and Mahajan, 1997). Kim and Marbougne (1999), in an study of the strategy of successful companies, concluded the customer satisfaction approached from QM does not make part any more to the core of high profitable growth, since it mainly targets existing customer. Said customer's satisfaction addresses only expressed desire from current customer constraining the company's innovative capacity (Slater and Narver, 1998). Wind and Mahajan (1997) believe the customer focus cannot provide more than incremental changes since it deals with current customers and its problems. Yet, the authors do not deny the importance of this QM practice for innovative performance, instead, they claim necessary changes at this type of approach. The also proposed changes on marketing research towards customers' needs and desire, in order to identify beyond the customers' perceptions. A new approach should then be able to access latent needs of current customer as well as new potential markets (Prajogo and Sohal, 2004a; Slater and Narver, 1998). Kim and Marbougne (1999) suggested a different posture characterized by targeting potential buyers in a broad examination of non-customers and being able to expend some existing customer.

3. Methodology

This study consists of a review of empirical and conceptual articles published between 1990 through 2015 about the influence of quality management practices on innovation. Motivation rises from the widely acceptance of TQM as management philosophy capable of giving the competitive advantage in the market to any organization. However, as market conditions have changed the factors to increase organization's competitiveness it has also changed where intangible recourses took the leading position, particularly and specialty, in knowledge and innovation (Prajogo and Sohal, 2001; Bolwijn and Kumpe, 1990). In this regard, the following question could be asked: Does the quality management in organizations influence their innovative capacity?

The multidimensionality behind both concepts does not limit the answer simply to a yes or no, many researchers attempt to clarify that question through the assessment of different practices of QM and diverse aspects of innovation. Then, there were two main objectives in this review: (1) to identify the greater tendency in the literature, if QM influences positively or negatively innovation, (2) as well as any possible mediator between QM and innovation.

Three online databases were used to identify relevant articles published in related journals: Elsevier Science, Emerald Database and ABI Inform Global (ProQuest Direct). The online databases were accessed

through the Integrated Systems of Libraries from University of Sao Paulo (SibiUSP), a virtual collection of academic publications. This selection was conducted in three stages: first, a computerized search was carried out using the following keywords – Relationship between Quality Management and Innovation, Quality Management Practices and Innovation, Quality Management and Innovation, Total Quality Management and Innovation –; second, the purpose was to select researches that establish any link between at least one quality management practice and one type of innovation, thus, an article containing both keyword was considered a potential article to be included on this study. Finally, a deep analysis sought after those associations to understand its nature and the entire concept behind its characteristics and then placed article according to the philosophy of the relationship between the QM practices and innovation. The references of significant articles were also used to collect some studies. It is important to point out TQM was adopted as synonymous of QM, as well as TQM practices and QM practices.

This literature review is divided into two main kinds of articles: those supporting the positive relationship between QM practices and innovation, and those which do not support it or support the negative relationship. The section with articles that argue in favor of the relationship is subdivided into three categories: according some authors, there is a direct influence of QM practices on innovation (1); other group of researchers defend that QM practices cultivate the necessary environment and climate to develop an innovative capacity (2); and another group of academics argue the relationship between QM and innovation is indirect (3). The section which refuses the relationship between QM practices and innovation covers all the arguments in a unique section grouping different arguments.

4. Discussions

The investigation of the impact of QM practices on innovation through a direct view has showed a significant and positive relationship. When isolated, QM practices and different types of innovation are placed directly facing each other and the influence is usually beneficial. Still, QM practices with a behavioral character seem closer to innovation than QM practices with the essence on mechanical methods, due to the similarity of principles between those QM practices and innovation (Schniederjans & Schniederjans, 2015). However, all the QM practices are equally important towards innovative performance and should be enhanced likewise (Schniederjans & Schniederjans, 2015; Kim et al., 2012). QM practices are interconnected to one another, affecting innovation directly and indirectly, because QM is a managerial philosophy which comprises a set of practices in the same framework. Its effective functionality as organizational management is only obtained when all the different QM practices are applied together (Kim et al., 2012).

If the relationship between QM practices and innovation occurs indirectly, it assumes the existence of mediator effect due to a specific QM practice to a dynamic capability. The function of a mediator effect is based on the preparation of an ideal scenario to foster innovation from the benefits of QM and this ideal scenario embraces values related to flexibility and knowledge. The implementation of QM implies on the adoption of opposites purposes: a rigid one originated from a mechanical structure such as control and precision, and a malleable one created by one organic structure such as creativity and risk taking (Moreno-Luzon et al., 2013). This paradoxical culture gives the company the necessary flexibility capacity to intermediate the relationship between QM and innovation (Moreno-Luzon et al., 2013). QM practices also provide a substantial amount of information, a crucial resource for development of innovation considering knowledge management to be behind all kind of innovation process (Pérez-Arostegui et al., 2010). Therefore, the company's ability to recognize the potential of information and explore it with a financial interest is called absorptive capacity, which plays an important role mediating the relationship between QM and innovation (Pérez-Arostegui et al., 2010).

The first possible conclusion after analyzing several studies is a tendency supporting the positive effects of QM practices on innovation. Researchers have showed that different QM practices directly affect different dimensions of innovation (e.g., Abrunhosa et al., 2008; Martinez-Costa and Martinez-Lorente, 2008; Prajogo and Hong, 2008; Feng et al., 2006) and QM practices create a fertile atmosphere or platform for developing innovation (e.g., Santos-Vijande and Álvarez-González, 2007; Cho and Pucik, 2005; Prajogo and Sohal, 2004a; Kanji, 1996), and also the positive effect of QM practices on innovation occurs indirectly regarding a mediator effect (e.g., Yusr et al., 2014; Moreno-Luzon et al., 2013; Yusr et al., 2012; Sony and Naik, 2012; Kim et al, 2012).

Nonetheless, several studies have tended to identify that QM practices do not support innovation and may even negatively affect innovation (e.g., Silva et al, 2013; Singh and Smith, 2004; Roffe, 1999; Lawton and Parasuraman, 1980). Interesting findings have demonstrated that some QM practices limit and inhibit the company's innovative capacity, specially, those related to mechanical structures of QM (Ahanotu, 1998; Glynn, 1996).

5. Implications and Conclusion

The managerial implications suggest companies can establish a learning base through implementation of QM practices, regarding the interdependency among QM practices (Kim et al., 2012). A deeper understanding of each QM practices is necessary, in order to effectively allocate the resources for capability development, allowing the company to achieve a competitive advantage through innovation (Moreno-Luzon et al., 2013). In addition, researchers suggest some reforms on QM practices involving customer focus, stating that the new approach would be able to draw latent desires from current customers and non-customers, differently from the QM perspective (Prajogo and Sohal, 2004a; Slater and Narver, 1998).

Reaching a conclusion, the efforts are concentrated on the investigation whether or not there is a relationship between QM practices and innovation and if it is positive or not. Thus, after observing a tendency to support the positive effects of QM practices on innovation and through reviewing the literature, future researches should investigate this relationship using new perspectives. Based on this literature review, some possible questions might emerge for future investigations such as how QM practices lead to innovation and how QM enhances the innovative capacity of an organization.

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Is the Biosphere certification increasing customers' satisfaction in hotels?

Presas, P.1, Bernardo, M.1 and Hernandez-Vivanco, A.1

Department of Business, Universitat de Barcelona, Av. Diagonal, 690, 08034 Barcelona (Spain)

ABSTRACT

Purpose - The main objective of this paper is to analyze if the customers' satisfaction improves after the achievement of the Biosphere certification, designed for sustainability in touristic companies and destinations.

Design/methodology/approach – A single certified hotel in Barcelona is analyzed. The hotel was certified in June 2015 and information about customers' satisfaction has been gathered from July 2014 to March 2016. Data are from the website Booking.com and the quantitative punctuation as well as customers' comments have been considered. A sample of 649 opinions has been analyzed.

Findings - The results show that the customers' satisfaction does not improve with the certification but the positive comments posed do. The customers' nationality is significant regarding the certification and the word-of-mouth has been found as an important marketing tool for the analyzed hotel. Also, it has to be said that a wider period of time is needed after the certification to analyze its impact.

Originality/value – The study proposed is, to the best of authors' knowledge, one of the first analyzing the Biosphere certification and its impact on hotels..

Keywords: Biosphere certification, customer satisfaction, hotel, Barcelona

Paper type: Research paper

INTRODUCTION

The quality management in the hospitality sector has been widely analyzed in the literature, mainly based on the diffusion of different national and international quality management systems (Casadesús et al., 2010; Alonso-Almeida et al., 2013), but also the impact of quality and environmental management (Tarí et al., 2009, 2010).

One of the most important topics, but not sufficiently analyzed, has been the hotel customer satisfaction. To know which the main aspects are for clients as well as their role in promoting the hotel services is key to provide a quality service (Xie et al., 2014; Heras-Saizarbitoria et al., 2015). Analyzing the customer satisfaction based on the quality management systems that the hotel can have implemented has been attempted to be done in Heras-Saizarbitoria et al. (2015), that compares the customers' satisfaction in two different samples of hotels, those ISO 9001-certified and not-certified. They found no impact of the certification regarding this aspect.

On the other side, in the literature of management systems diffusion it is found that the sectoral management systems are increasing in importance as they fit better with the organization's activities (Llach et al., 2011; Marimon et al., 2011) as well as the increasing importance of the social responsibility practices (Marimon et al., 2012; Llach et al., 2015).

Taking into account the aforementioned, the main objective of this paper is to analyze if the customers' satisfaction improves after the achievement of the Biosphere certification, a sectoral management system of responsible tourism. To the best of the authors' knowledge, this is one of the first studies analyzing this certification and its impact on hotels.

LITERATURE REVIEW

Customer satisfaction

The success of the hotel industry is to achieve customer delight and identify the products and service attributes that influence it, and how this attributes influence higher levels of satisfaction (Albayrak and Caber, 2015). Therefore, the business achievement is satisfying the customers. Customer satisfaction is the ability of the businesses to satisfy their needs, managing their expectations and creating value for them (Dominici and Guzzo, 2010).

However, Kozak (2001) ignores expectations and focus on how the consumers' rate attributes of the specific accommodation, post-consumption appraisal, which influences the guest's experience. This approach is called direct assessment.

Fuchs (2002) and Pearce and Benckendorff (2006), among others, use the benchmarking approach to study the satisfaction, which is built based on a direct comparison among aspects of a hotel performance and its competitors. The rise of online reviews is an opportunity to use benchmarking and direct assessments (Zhou et al., 2014; Heras-Saizarbitoria et al., 2015).

Some authors introduce the relation between the perceived service quality relative to price and the customer acquisition cost to analyse the consumer satisfaction (Matzler et al., 2006). In the hospitality industry, which offers homogeneous services, the competitiveness of the hotels is based on providing high-quality services which will be able to influence and improve the customer satisfaction (Barsky and Labagh, 1992; LeBlanc and Nguyen, 1996), and then increase their profitability (Oh and Parks, 1997).

Magnini et al. (2011), Li et al. (2013) and Dong et al. (2014), among others, analyze a bundle of attributes and items that influence hotel customer satisfaction and the quality of the service perceived, which includes physical and service characteristics (hotel attributes) such as hotel, room, food, location, staff, value/price, security, and other factors, such as consumption emotions (Ladhari et al., 2008). Furthermore, Radojevic et

al. (2015a) found that belonging to a branded hotel chain helps to ensure high level of quality standards and customer satisfaction.

Moreover, the literature shows that the corporate social responsibility (CSR) and the environmental initiatives increase the customer satisfaction (e.g., Lee and Heo, 2009; Luo and Bhattacharya, 2006; Berezan et al., 2013; Gao and Mattila, 2014), by providing added value (López-Gamero et al., 2009). On the other hand, promoting the environmental actions, the hotels could receive accusations of "green washing", doubting the reason for carrying out these practices and their effectiveness, therefore promoting an environmentally friendly image (Chan, 2013a, 2013b; Chong and Verma, 2013; Chun and Giebelhausen, 2012).

Demographical profiles could also influence in the level of satisfaction, for example, the nationality (Kozak, 2001), cultural issues like language and food (Ye et al., 2013), or demographic groups (Radojevic et al., 2015b). But it is not clear how the consumers perceive these initiatives.

The customer satisfaction consequences are the loyalty (Fyall et al., 2003) and the post-behaviors as to revisit, recommendation (mainly, classic or electronic word-of-mouth promotion), and creating market reputation, among others (Matzler et al., 2006; Trusov et al., 2009; Radojevic et al., 2015a). The consequences for the hospitality industry are, for example, to increase the investments, to improve service quality, and to encourage the relationships with customers (Jones et al., 2007).

Online customer reviews are considered as an important element of marketing strategy, which effects on the hotel's online reputation and contribute to its financial performance (Anderson, 2012; Kim et al., 2015; Mauri and Minazzi, 2013; Xie et al., 2014; Radojevic et al., 2015a).

Electronic word-of-mouth (eWOM) is defined by Litvin et al. (2008:461) as "all informal communications directed at consumers through Internet-based technology related to the usage or characteristics of particular goods and services, or their sellers". Several studies explore the eWOM focusing on investigating how online reviews impact on consumer decision making, i.e., to what extent exposure to eWOM affects consumers' attitudes, choice and purchase decisions (Chevalier and Mayzlin, 2006; Sen and Lerman, 2007; Utz, et al., 2012; Vermeulen and Seegers, 2009). They also found that online reviews have a strong effect on perceived trustworthiness for being more unbiased than information provided by the company (Bickart and Schindler, 2001; Smith et al., 2005).

Online reviews improved hotel awareness and the persuasive effect more for lesser-known hotels than for well-known hotels (Vermeulen and Seegers, 2009), i.e., the overall effect of online reviews on hotel consideration was related to the branding of them. As well, these authors suggest that positive reviews have a positive impact on consumer behavior, whereas negative reviews have little impact.

Biosphere certification

The Biosphere certification is a responsible tourism system with the aim of ensuring "compliance with certain requirements concerning the principles of sustainability and the continuous improvement in line with these principles" (RTI, 2016). It was created by the Responsible Tourism Institute (RTI) and it is based on the United Nations 17 Sustainable Development Goals. It is a voluntary and independent Sustainable Tourism Certification (RTI, 2016).

There are 3 types of certifications: for hotels, for tourism destinations and for tour operators. From them, the first one is of the interest of this research. The Biosphere certification for hotels has 5 main sections (RTI, 2016), presented briefly below:

1) *Instruments in a responsible tourism policy*, in which basic management tools are implemented to ensure that the responsible tourism is disseminated (policy, action plan, staff motivation and training plan, responsible marketing, requirements and corrective actions).

- 2) Conservation and improvement of cultural heritage, that seeks to conserve the identity of the destination to benefit the present and future customers (integration in the cultural reality of the destination, participation in the conservation of cultural resources and promotion of visitors' knowledge).
- 3) *Economic and social development of the destination*, in which this socio-economic development should be improved (promotion of the economic and social development of the local community, and responsible attitude with employees).
- 4) *Environmental conservation* refers to the conservation of natural resources, biological diversity and the environment (landscape, biodiversity and soil protection; energy, water, waste, consumption of products and services, atmospheric emission, noise and light pollution management and control).
- 5) Client satisfaction and involvement in the responsible tourism system is related to quality tourism, offering a "tourist product that not only fulfils the basic requirements of quality, but will also be further reaching, involving visitors in the day-to-day situation of the destination, as a result of their enhanced knowledge and awareness" (quality client service, client safety, client's responsible behavior on site, services providing information and awareness about the destination and universal access).

In order to get the certification, an organization should meet, at least, the mandatory requirements and communicate the evidences (RTI, 2016). There are 6 main steps to follow that are shown in figure 1. After the application for the certification, the organizations pay and have access to all the information needed, training and the software available to get certified and manage the system. Once this is achieved, the implementation of the requirements needs to be fulfilled. This part, as well as the others, is also done using the software provided. The information uploaded is then evaluated externally online or in site by an auditor. If the requirements are met and the evaluation is positive, the applicant is certified and has access to the logos and benefits of the certification, that according to the RTI are, among others: analytical benchmarking, publicity on the website, logo usage, appearing in the list of certified entities sent to tour operators and booking pages, online and site audits and broadcasting in social networks and newsletters. The certification is reviewed annually.

Considering the analyzed above, the research question to be posed is if the Biosphere certification improves customer satisfaction in the certified hotel.

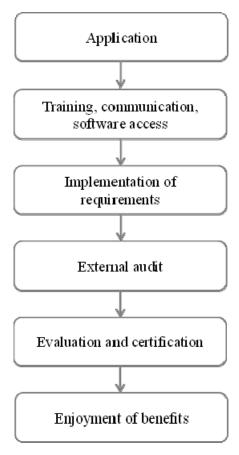


Figure 1 – Certification process

Source: adapted from RTI (2016)

METODOLOGHY

The methodology applied is mixed, i.e., quantitative and qualitative methodologies have been used.

Data gathering

The data are from a single hotel that is the one with the information about the date of the Biosphere certification achievement.

The hotel analyzed is a four star boutique hotel located in Barcelona, owned by a hotel group with hotels in Paris and Buenos Aires. The hotel is certified with the Biosphere Responsible Tourism since June 2015.

Data were obtained from the Booking.com website, the online hotel reservation world leader and the largest consumers' reviews and experience evaluation in booked hotels database (as also used, e.g., in Heras-Saizarbitoria et al., 2015). The Booking.com website is more reliable than other similar websites, because only real guests, who have booked a hotel service, could report a review. The aim is to try to avoid spam opinions and fake reviews that could influence other reviews and/or further reservations (Anderson and Simester, 2014; Jindal et al., 2010). The sample of reviews only comprises Booking.com clients who write reviews after their stay, and does not include customers who have stayed at the hotel using other methods to book their room.

The composition of respondents is categorized by who have travel (couples, singles, families and friends), the purpose of the trip (holidays or business), length of stay, country, language and review date. The data gathered from the hotel is general information about the number of rooms, stars and customers reviews and

score. The review score (general customer satisfaction) from Booking.com website is scored using a Likert scale from 0 to 10 on cleanliness, comfort, location, facilities, staff, value for money and free Wi-Fi (as also used in Heras-Saizarbitoria et al., 2015).

This study thus focuses on consumers' reviews posted between July, 1^{st} 2014 and March 6^{th} 2016 (both included), with a total sample of 649 reviews.

Data analysis

First, the variables used have been:

- 'Punctuation', which is the quantitative variable showing the customers satisfaction level with the hotel and ranks from 0 to 10.
- 'Certification' is a dummy variable in which 0 means not certified (from July 1st 2014 to June 30st 2015) and 1 means certified (from July 1st 2015 to March 6st 2016).
- 'Year', referring to the date of comments posed: 2014, 2015 and 2016.
- 'Nat20', which refers to the countries of origin with 20 or more visitors. 9 countries have been considered (see table 2).
- 'Comments', in which positive and negative comments are considered.

In the *quantitative methodology*, the selected variables for the 649 observations are summarized in table 1.

Moreover, the year and the nationality were selected as control variables. Their values are shown in table 2.

The basic statistics of SAT, POS and NEG show some evidence that of their non-normal distribution, which can be evidenced in figure 2.

In order to analyze the relationships, this article uses a two-stage approach. In the first stage, it is analyzed how the clients' satisfaction varies depending on their positive and negative comments as well as the fact of using the certification. In the second-stage, the aim is to determinate if there is an expected benefit of using the certification in order to improve positive comments, or decrease the negative ones.

Table 1 – Variables summary

Continuous Variables	Abbreviation Mean		Median	Std. Dev.
Punctuation	SAT	8.75	9.2	1.2363
Number of positive comments	POS	0.95	1	1.1264
Number of negative comments	NEG	0.17	0	0.4120
Dummy Variable	Codification	Frequency	%	
Certified or not?	CERT	-	-	
Yes	1	290	44.68	
No	0	359	55.32	

It is to be remembered that the idea of a regression is to obtain a great summary of a dataset, so one way of doing it is by doing several regressions at different percentages in order to get a more complete summary of that information (Mosteller and Tukey, 1977), which is the way Koenker (2005) proposed a new approach of a simultaneous quantile regression which is more useful for obtaining a great summary of data on a specific quantile of study by estimating all parameters simultaneously.

Table 2 – Control Variables

Control Variable	Codification	Frequency	%
Year	Year	-	-
2014	2014	212	32.67%
2015	2015	373	57.47%
2016	2016	64	9.86%
Nationality	Nat20	-	-
Others	0	268	41.29%
Spain	1	47	7.24%
Italy	2	17	2.62%
UK	3	85	13.10%
Germany	4	52	8.01%
Belgium	5	21	3.24%
Australia	6	54	8.32%
USA	7	36	5.55%
France	8	37	5.70%
Switzerland	9	32	4.93%

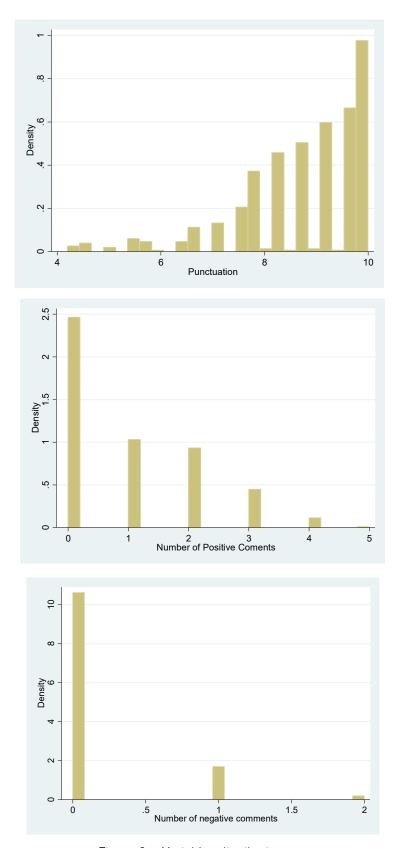


Figure 2 – Variables distributions

In this research, the first aim is to obtain the differences at the median (τ =50) in order to get information on how satisfaction varies depending on the certification and the number of positive and negative comments. This

way, the first stage is calculated by Equation 1, and is to be solved by bootstrapping at 100 subsamples in order to avoid heteroscedasticity:

(Eq. 1)
$$Q_{SAT}(\tau|DP) = \beta_0 + \beta_1 POS + \beta_2 NEG + \beta_3 CERT + \beta_{4f} Year_f + \beta_{5k} Nat20_k$$

where τ is to be tested at quantiles 25, 50 and 75 in order to get a more complete picture of the distribution, f = 2014, 2015 and f = 0.1, 2, ..., 9.

For the second stage, the Mann–Whitney–Wilcoxon test is useful in order to determinate whether using certifications changes the median of the number of positive and negative comments. Moreover, Newson (2006) improved this idea by also providing confidence intervals of what he named the *Harell's C* statistic, which in this study determinates the probability of getting positive or negative comments by having or not the certification.

Regarding the *qualitative methodology*, the participants' comments on different aspects of the hotel to obtain the score, such as cleanliness, comfort, location, facilities, staff, value for money and free Wi-Fi were analyzed (Heras-Saizarbitoria et al., 2015). They were classified into positive and negative comments (used in the previous analysis) and also by the certification aspects, as presented in the results section. These comments help in reinforcing the quantitative results.

RESULTS

This section is divided following the same structure as in the previous section. First, the results from the quantitative analysis are presented and then the qualitative results.

Quantitative results

In the first stage, CERT=0 (i.e., not having a certification), year 2014 and "Other Nationalities" were selected as the reference groups since they are categorical variables. Results indicate that CERT is not directly significant for improving satisfaction (table 3); nonetheless, each positive comment improves significantly the punctuation in 0.4 for those that tend to punctuate at the lower 25^{th} quartile (SAT = 7.9) and in 0.5 for the median (SAT = 8.9), but is does not increase the punctuation for those that already give a high punctuation in the 75^{th} quartile (SAT = 9.6). Also, each negative comment decreases significantly the punctuation, but its effect decreases while the punctuation is higher (-1.25 at τ = 25, -1 at τ = 50 and -0.8 at τ = 75).

As per the control variables, the effect of the year is not significant, but depending on the nationality of the respondents, the punctuation may be higher or lower. USA respondents usually punctuate higher in all the quartiles, while Belgians punctuate higher at $\tau = 25$, Swiss at $\tau = 50$ and English and Australians punctuate higher at $\tau = 75$. Germans and French punctuate lower at $\tau = 75$ and for Spain and Italy there are no significant differences compared to Others (Nat20 = 0).

Table 3 – Coefficients and significances of Quantile Regressions

	τ = 25	$\tau = 50$	τ = 75
Main			
CERT	-3.15e-15 (0.210)	-0.200 (0.160)	-1.18e-15 (0.115)
POS	0.400*** (0.0837)	0.200*** (0.0601)	1.45e-15 (0.0454)

NEG	-1.250*** (0.280)	-1.000*** (0.155)	-0.800*** (0.161)
Control Variables			
Year 2015	2.05e-15 (0.221)	0.200 (0.194)	1.41e-15 (0.118)
Year 2016	3.85e-15 (0.318)	0.300 (0.256)	2.03e-15 (0.270)
1.Spain	-0.300 (0.385)	1.30e-16 (0.236)	0.400 (0.225)
2.ltaly	0.100 (0.768)	0.300 (0.329)	0.300 (0.252)
3.UK	-2.38e-15 (0.289)	0.200 (0.231)	0.400* (0.195)
4.Germany	0.400 (0.237)	-0.200 (0.259)	-0.400* (0.175)
5.Belgium	0.900*** (0.246)	0.300 (0.203)	1.28e-15 (0.344)
6.Australia	0.1000 (0.429)	0.300 (0.204)	0.400* (0.175)
7.USA	0.900** (0.339)	0.500* (0.197)	0.400** (0.143)
8.France	1.86e-15 (0.483)	-0.300 (0.290)	-0.400* (0.197)
9.Switzerland	-0.400 (0.388)	-0.600* (0.258)	-0.400 (0.339)
Constant	7.900*** (0.224)	8.900*** (0.147)	9.600*** (0.137)
N	649	649	649
Pseudo R ²	0.0917	0.0931	0.0807

Standard errors in parentheses: * p<0.05, ** p<0.01, *** p<0.001

At the second stage, results shown in table 4 indicate that POS is not the same for certified and not-certified scenarios with a 5% of significance, and that not having the certification makes it 45.36% less likely to have positive comments – notice that CI does not include 50% – in other words, having the certification increases the likeliness of getting positive comments with a probability of 54.64%. When applying the same logic to NEG, results vary, since they do not change significantly with or without the certification; thus, the probability of having negative comments when certified is of 50% – notice the 50% not only that is included in the CI, but it is the expected value of the probability of getting NEG without the certification.

Table 4 – Tests for the median of positive and negative comments

CERT	Harrell's C	95% Conf. Interval (CI)		Mann-Witney- Wilcoxon
POS	.4536 (.02113)	[0.4121,	0.4951]	0.0287*
NEG	.5067 (.01411)	[0.4789,	0.5344]	0.6384

a) Harrell's C is the probability of getting POS/NEG without the certification; Jackknife standard error in parenthesis.

In summary, results indicate that even if the certification does not influence directly on customers' satisfaction, it does improve the probability of getting positive comments. Consequently, since customers that give more positive comments are significantly more satisfied, the benefit of the certification is manifested through their positive comments. It is also relevant to indicate that, even if having negative comments has a

b) Mann–Whitney–Wilcoxon indicates the p value for the H_0 that the number of POS/NEG comments is the same with or without certifications; * p<0.05.

worse effect than having positive comments (its coefficients are greater in absolute value), the certification does not change directly or indirectly this behavior.

Qualitative results

Review comments are analyzed based on the certification sections. According to the certification, the hotel has to provide information on environmental quality and other sustainability specifications about the hotel and the destination, but in the current case it only transmits this information through the official website about the commitment of the hotel in a very residual way.

The conservation and improvement of cultural heritage is another key element of the certification, as an essential to create the destination identity. Biosphere shall promote the visitors knowledge on the local cuisine, cultural resources and local products. Only 62 reviews have mentioned the food as a positive element of the hotel, especially the breakfast. For example:

```
"the breakfast buffet was superb"

"the breakfast provided is ideal for a good start of the day"

"excellent breakfast"

"breakfast was tasty!"

"breakfast was included and was fresh and varied"

"breakfast is good value"
```

But there are 44 negative reviews of the food, with comments related to the breakfast such as the lack of traditional products. Both comments, positive and negative, about the food and the cuisine decrease, positive from 42 before the certification to 28 after it, and negative reviews, from 20 to 16. For example:

```
"menu very limited in evening"

"breakfast was poor"

"breakfast was too pricey"

"the roof top terrace bar is expensive"

"there is no Jamon!".
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Another aspect is that the hotel has to contribute to the economic and social development of the destination and the local community, but also the attitude of the hotel related to its employees. The reviews do not show any information –positive or negative- related to the business contributions to the socio-economic development of the destination and/or the responsible behavior towards the employees and the work conditions.

The hotel impact on the environmental conservation is another element of the certification. The reviews (50) show negative opinions about the hotel, which does not ensure appropriate levels of noise emissions and not an adequate insulation rooms, the low level of maintenance of the facilities, the lack of cleanliness, and the darkness of the rooms. The results indicate that the certification does not influence on the customers' satisfaction about the impact of the hotel on the environmental conservation. Conversely, customers are more receptive to criticize these aspects: before the certification 20 negative comments were made, versus 30 after the certification. For example:

"the noise in these rooms were very disturbing as the cleaners had cupboards near our room which they went to every morning and slammed the doors. Behind the lifts was an open atrium and below was the

bar area on the ground floor so for hours late in the evening, and early mornings you could hear clanging dishes and cutlery"

"room cleanliness below expectations"

"noisy air conditioning"

"we chose an interior room because we were told it would be quieter, but continuous blows were heard and could not rest well"

"noise from neighbor rooms"

"as the hotel has a central atrium it is very noisy as you can hear everything that is going on e.g., people, music, lifts, trolleys, clashing of plates and cutlery. Our room was just by the lifts so noise was worse"

"my room was cold. First night I told them and anything not change. And second night I told again. They said ok well solve but they didn't solve it. And they offer me a blanket"

"the windows were poorly isolated"

"could be a bit more clean".

Related to the environmental conservation, the hotel has to create procedures to guarantee cleanliness and maintenance, in bedrooms and common areas alike, as a measure to ensure a correctly service provided. Therefore, the last item of the Biosphere certification is focused on all that concerns to safety, comfort and service which will contribute to the clients' perception of quality and satisfaction. The measures taken by the hotel to ensure client safety are only mention in one review and it is related to the destination, instead of the hotel: "feel safe in the neighborhood". The certification said that the establishment shall inform clients how to behave responsibly with regard to energy saving, water saving, noise and other disturbing factors, and also waste management, but no reviews make explicit reference.

Finally, the main element is the quality client service, where the employees play an important role related to their behavior and its appearance. The certification improves the number of the positives comments related to the service quality (from 88 to 90 comments), and decrease the number of negative comments (from 4 to 3). The staff evaluation is positive in 178 of the reviews. For example:

"very attentive , friendly and always willing to help staff"

"the staff were attentive and were eager to help with questions and directions"

"the staff couldn't do enough for you"

"the staff of Hotel is always there for whatever request"

"staff was very accommodating helping with directions and restaurant suggestions".

They are using adjectives to refer to employees as: "excellent", "friendly", "helpful", "professional", "nice", "attentive", "welcoming", "efficient", "amazing", "knowledgeable", "pleasant", "polite" "great people". It should be mentioned that some of the comments are related to employees in particular:

"Friendliness of booking staff, especially Janelle and Berta"

"Reception Staff (Marc)"

"Top, top service. Particular mentions for Sergio on front desk, Rino on the bar as well as Guiliana. Made us very very welcome".

On the other hand, there are only 11 negative reviews about the employees. Such as:

"The staff could be a little less 'cold' I feel. While this certainly does not apply to everyone, there are a select number of staff members at the reception and the bar who were not rude but not quite nice either, speaking in an almost sarcastic manner when addressing guests"

"not very friendly"

"front desk staffs not really willing to help guests sort out problem"

"the service was poor"

"the staff was noisy"

"not very attentive".

CONCLUSIONS

The main objective of this paper is to analyze if the customers' satisfaction improves after the achievement of the Biosphere certification. Considering 649 ratings regarding one certified hotel, the following, although not concluding, conclusions could be posed.

It seems that the certification has not a significant impact on the hotel, in other words, the satisfaction levels are similar before and after the certification. Thus, the results show that the impact of Biosphere certification is the same of other general certification, as ISO 9001, in the hospitality sector according to the results found in Heras-Saizarbitoria et al. (2015). The difference is that after the certification, the positive comments increase. Furthermore, the customers' nationality is also related with this, as depending on the country of origin, the positive comments increase. Therefore, it is confirmed that nationality can influence the level of satisfaction as Kozak (2001) observed; as well, the perception and the attitudes toward the CSR and its practices, as the results shown in González-Rodríguez et al. (2013) and Fassin et al. (2015).

This could be explained because the period analyzed is one year before the certification and almost one year after. As the hotel was implementing the requirements of the certification, no differences are encountered. Analyzing and comparing the impact considering a wider period of time before obtaining the certificate could bring more differences, but no data were available. Another explanation is that the hotel has these practices internalized and only get the certificate to demonstrate its way of working.

Another important aspect is the word-of-mouth based on the comments posed. Clients' opinions are of high-value for future clients. The literature show how the eWOM has implications for managing the tourism industry, e.g., brand building, product creation, quality and price assurance. Among other marketing tools, eWOM should make tourism practitioners and marketers notice that tourists use online services increasingly and that eWOM is taking a prominent place among other marketing tools.

Thus, implications for hotels are based on improving its services to get positive comments and attract clients and this could be done by internalizing management systems that would help them in increasing the customers' satisfaction. Doing this would impact also on the certification bodies and other institutions promulgating management systems in order to improve their implementation as well as promoting new sectoral management systems, as they are seen positively by the sector as Llach et al. (2011) and Marimon et al. (2011) observed. Finally, the impact on customers will be positive and their satisfaction improved.

The main contribution of this paper is to present one of the first studies on the Biosphere certification concluding that although its impact on customers' satisfaction is low, it helps increasing the positive eWOM.

The main limitation of this paper is the analysis of one single hotel as well as the fact that the Biosphere certification is new and not widely implemented.

Future research will be based on trying to increase the sample and analyze the customers' satisfaction after a certain period of time since the certification. Also, to analyze if the certification has impact on temporality or by the fact of having other management systems implemented.

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Analysis of the possible impacts of ISO 9001:2015 version changes in the quality management system of construction companies

Santos, J.1) and Evangelista, A.1)

¹⁾ Federal University of Rio de Janeiro, Civil Engineering Department, Brazil

ABSTRACT

In General, over the last 15 years the quality management systems of construction companies in Brazil have suffered few changes, even considering the continuous improvement foreseen in ISO 9001. In the 2008 version of ISO 9001, few changes have occurred on the requirements regarding the 2000 version and so there was no need to seek new practices, generating an accommodation on the part of companies that in the last 15 years have kept their practices in relation to quality management. The 2015 version of ISO 9001 published in the month of September brings on your belly, significant modifications that will impulse the construction companies to review their processes and establish new practices to meet new requirements. The impact is not yet being presumed and not respected by most construction companies as they had been granted an adjustment period of up to 3 years by certification bodies (IAF, 2015). However, it is essential that the construction companies to establish a plan of action so that the new requirements should be interpreted and understand perfectly, in order to make possible a simple migration from one model to the other, minimizing possible impacts of these new requests. This work deals with an analysis of the new requirements of ISO 9001:2015 and the possible impacts on the quality management systems of Brazilian construction companies of small and medium-sized businesses. In addition, establish a comparative synthesis of practices commonly adopted by the construction companies and the difficulties experienced to adapt them to the new requirements of the compliance model.

Keywords: ISO 9001:2015, changes in requirements, quality system of construction, impacts of changes.

THE ISO 9001 VERSION 2015

ISO-International Organization for Standardization on 22 September 2015 published the new version of ISO 9001, Quality management systems-Requirements. The changes inserted were quite significant if considered that since the 2000 version of the standard requirements have remained virtually unchanged. A general reading of the text of the new ISO 9001 denotes the trend of corporate strategic management by enterprises that develop their quality management systems. Given to the concerns of users clamour for greater specificity in the requirements for all the productive segments, the current version of ISO 9001 considered as new terminology "products and services" and not only as a comprehensive term. This change in terminology made it possible to emphasize the differences between products and services in the application of the requirements. In synthetic form, one can highlight the main changes that have occurred in the standard:

a) Risk mentality

There is great emphasis on the risk mentality, which happened to be the big challenge and also a powerful tool for companies seeking quality management systems a way to achieve improvements in their productive processes and the quality of their products.

Companies need to plan and implement actions to address the risks and opportunities of its processes and products.

b) Understanding the organization and its context

The organization needs to identify internal and external issues that pertain to your scope, and that may affect the materialization of its mission, its strategic direction and achieve the desired results.

c) Interested parties

There is an expansion in the scope of the quality management system, focused only on the client before. The Organization shall understand the needs and expectations of interested parties and arrange actions and practices that meet these needs and expectations. To do so, you must identify the relevant stakeholders to its quality management system and its requirements that pertain to the quality management system.

d) Processes for the quality management system

The process approach was already contemplated in the previous version in which companies should determine the sequence and interaction of its processes, the resources required, criteria and methods of monitoring and measurement, continuous improvement of these processes, however, in the current version continuing risk mindset is required to be covered the risks and opportunities.

e) Information retained and maintained information

There was sensitive modification in the vocabulary used in the previous version and the current one. The information retained about the evidentiary documentation allowing and demonstrating that a company has developed an activity. Is the picture of what actually occurred? Is the objectives evidenced?

Information already maintained it is the documentation required for the company to support the operation of its processes.

Over the various items of the new version is indicated what should be serviced by the company, if the information held or retained information or both.

f) Actions to address risks and opportunities

As already noted in the item "a" addressing risks and opportunities emerged as the most significant change of all this new version when compared to the previous one. Despite the previous standard already address potential non-conformity and preventive actions, the new version significantly on the issue of risk dives and

opportunity, despite not requiring to be kept or retained documented information, the company needs to demonstrate how could identifie in each case the risks and opportunities and how could plan to approach its risks and opportunities.

In item 9.3 on the critical analysis of the quality management system by the direction, the new standard returns the emphasis in addressing risks and opportunities, when compulsory item predicted in the analysis of the effectiveness of actions taken to address risks and opportunities.

g) Planning to achieve quality objectives

Although in the previous version the quality objectives are already required in the current version, the new aspect is that organizations must determine what they will do to achieve their goals of quality. This includes the indication of what will be done, what resources will be required, who will be responsible, when will be completed and the results will be evaluated.

h) Communication

Although the communication was an important element in the previous version, in this version the company must determine the internal and external communications which are also pertinent to its quality management system. In this way, although not require documented information held or maintained, the company needs to establish how determines what to communicate, when communicating with whom to communicate, how to communicate and who.

THE STATE-OF-THE-ART OF QUALITY MANAGEMENT IN CONSTRUCTION COMPANIES

The implementation of quality management systems in construction companies has been widely increased from the year 2000 with the institution by Federal program focused on achieving better quality in construction. The program was inserted into the PBQP-Brazilian program of quality and productivity and termed as PBQP-H-Brazilian program of quality and Productivity in Habitat. The construction company to guarantee the PBQP-H should deploy comprehensive quality management system to the requirements of the SIAC-Conformity Assessment System of Construction Works and Services which provided four evolutionary levels of certification. In the last level, the set of requirements was consistent with the requirements of NBR ISO 9001 and particular requirements specific to the construction industry. The certification program has gathered strength from 2005 with its recognition and accreditation by the INMETRO-National Institute of Metrology and Quality and Technology. On that occasion the banks and other funding institutions in Brazil started to require the certification in the PBQP-H by the construction companies in return for funding. Currently, according to the Ministry of cities (Ministry of cities, 2016) are more than 3000 construction companies certified at SiAC/PBQP-H.

Many construction companies under the certification process in the PBQP-H requested also the NBR ISO 9001certification. Nowadays, 1856 construction companies are certified in NBR ISO 9001 (INMETRO, 2016).

The latest version of SiAC/PBQP-H was issued in 2012 based on the 2008 version of the NBR ISO 9001. In the same way that ISO 9001:2008, the SiAC/PBQP-H also incorporated a few modifications regarding the 2000 Edition.

The process of development and implementation of quality systems in construction companies occurred by external consulting support. To achieve the great demand and to reduce costs with consulting were available on the market for consulting companies and professional associations consulting cooperative programs for the implementation of the quality management system by observing the requirements of the SiAC/PBQP-H. The cooperative program was conducted to set at the same time of 10 to 20 construction companies. This methodology with the requisite of obtaining certification in SiAC/quick-PBQP-H in order to meet the requirement and obtain funding for the construction meant that the guidelines, policies, procedures and practices to the documented quality management system were adopted as a standard by several construction

companies. The procedures and guidelines were standardized, but the effective practices of management and operation in construction companies do not. Thus, a large and permanent challenge-keeping practices and generate evidence to be demonstrated in the maintenance of certification audits of practices that actually were not practiced. In this way, the developers of these construction companies have become habituated to acting as provided for in the patterns only on the occasion of the audits in order to keep the certification of their companies. Unfortunately, developing a culture and consequently a paradigm: quality management systems don't work and are kept only for obtain the certificate is marketing goals or how to gain access to bank financing with lower rates.

In this hostile environment, the majority of construction companies maintains its quality management systems unchanged year after year, in which the quality policy, quality objectives and goals, the design process, the critical items and items of control of each process remain the same without the continuous improvement or even the changes arising from the changes in the internal and external business environment. The maintenance without significant changes to the requirements of ISO 9001 from 2000 until the last amendment in September 2015 contributed to the fewer commitment of the construction companies.

To raise qualitative data and allow the assessment of the state of the art of the quality management system in construction companies of small-medium businesses, in the months of July, August and September 2015 was carried out a survey with 28 construction companies of small and medium businesses with operations in several states in Brazil. The research had as main objective to identify the perception of construction companies and regarding the obtained results through the implementation of quality management systems (QMS). In each construction company has been heard at least one of the managers responsible for the implementation of the works. In table 1 are presented the characteristics of the construction companies surveyed. Predominantly the studied companies works in the segment of buildings throughout the Brazilian territory, and their quality management systems meet the ISO 9001 requirements simultaneously and the SiAC/PBQP-H. It is important to notice that, in general, the construction companies have attained QMS for 8 years which would have allowed the achievement of continuous improvement in at least two full cycles of three years.

Table 1- Characteristics of builders surveyed

Characteristics	Results		
	19 Buildings		
Segment of the construction	5 Art Works		
companies	1 Sanitation		
	2 Paving		
	1 Foundations		
Diago of porformance	20 all territory of Brazil		
Place of performance	7 the State of Rio de Janeiro		
	1 South and Southeast regions		
	18 certification ISO 9001 has		
Normative reference	20 certification SiAC/PBQP-H has		
	10 certification ISO 9001 and SiAC/PBQP-H		
	has		
Time of implementation of the quality management system	8 years (on average)		

Source: the author (2015)

In table 2 are presented the data obtained in the research for the evaluation quality management system results in 28 construction companies of small and medium-sized businesses. Regarding the observed results, the situations of quality management systems in these construction companies are obsolete and do not reflect the management and operational reality of the construction company. Also, only minimum and basic aspects were adopted to meet the requirements of the normative references, little or nothing to contribute to the improvement of their processes and are considered as a factor which difficult the company productivity.

Table 2- Research for the evaluation of the results of the OMS in construction companies

Rated item	Search result
Adequacy of the standards of the	Unsatisfactory (21 builders)
quality management system with	Satisfactory (4 builders)
the practices of construction	Good (2 builders)
company (*)	Regular (1 construction company)
Contribution of the quality	Unsatisfactory (17 builders)
management system to improve the	Satisfactory (5 builders)
quality of the construction company	Good (5 builders)
(*)	Excellent (1 construction company)
Purpose of the quality management	Funding (17 builders)
system in construction company	Marketing (7 builders)
(**)	Quality improvement (4 builders)
	Unsatisfactory (14 builders)
Involvement of employees of the	Regular (6 builders)
construction company with the	Satisfactory (6 builders)
quality management system (*)	Good (2 builders)
Combulation of the greatity	Unsatisfactory (20 builders)
Contribution of the quality	Satisfactory (3 builders)
management system for the	Good (4 builders)
productivity of the company (*)	Excellent (1 construction company)
Degrees of collation:	
(*) Excellent (90 to 100%) good (80 to	89%) - Satisfactory (60 to 79%) -Regular (50 to
59%) – Unsatisfactory (less than 50%)	

(**) M (marketing)-F (financing)-MQ (quality improvement)

Source: the author (2015)

In summary, it is possible to highlight some peculiarities drawn from the quality management systems of construction companies surveyed:

a) Quality policy

Rarely personalized and inspiring, non-adherent to the scope of the quality management system and not analyzed critically by the construction company as to their suitability.

b) Goals, targets and indicators of quality

General indicators are monitored normally bound, for example, with the customer satisfaction and the amount of non-compliances identified in internal and external audits. Despite the application of verification of the quality of the services provided on the site and almost always be recorded anomalies detected, these data are

not tabulated and monitored and consequently are not used to introduce improvements in operational processes developed in-house or by third party companies.

c) Standardization of operational processes and control items

Under requirement of the SiAC/PBQP-H the construction companies need to develop documented procedures for the critical operational processes referred to as managed services. The procedures include the step-by-step activities to achieve stages of construction work, such as masonry, structure, against ground, etc. Normally, covering also the control items to be checked later or during the development of services and the acceptance criteria as for compliance.

To minimize subsequent difficulty demonstrating evidence of compliance with these procedures are designed in a simplified form, being referred to only essential items. The checks cover usually superficial visual inspection after the completion of the constructive step and rarely more accurate inspections with specific tests and trials.

These documented procedures are rarely reviewed by virtue of not being monitored their results both from the point of view of quality and productivity, and ultimately non-represent what is effectively carried out. Reviews of procedures when they occur are often to reduce controls and practices aiming at the reduction of the generation of objective evidence and consequently facilitating the process for external audit.

d) Empowerment of teams

In general the construction companies use the training as a way to empower themselves and outsourced teams, however, the trainings are carried out by trainees on the basis of executive procedures that are documented to meet the requirement of the SiAC/PBQP-H. The operating procedures are not consistent with operational practices materialized in construction sites. There is little or no absorption by the trained team. On the other hand, the evaluation of the effectiveness of the this training does not contemplate the success of the trained people behavior in their day by day activities, as the continuous improvement of operational processes

e) Training and qualification of contractors for the development of end activities

There is subcontracting some or all operational activities developed in the construction sites. The process used for selection, registration and hiring companies for the development of these activities is usually the lowest price. Pursuant to ISO 9001 service, many construction companies establish criteria for the evaluation of service providers for each service provided. However, that all service providers are assessed as satisfactory. Some construction companies still set as an indicator of quality in the process of obtaining supplies of certain percentage of service providers with satisfactory assessment. In general, there is no variation and the percentage is always 100%.

EXPECTED IMPACTS CAUSED BY THE ADAPTATION TO NEW VERSION OF ISO 9001

As reported at the beginning of this article, many were the changes made to the 2015 version of ISO 9001 However, the most significant aspect from the point of view of the studied universe of construction companies, will certainly be the need to demonstrate evidenced objective in audit processes without an available procedure or registry, using the language of the previous standard version,. The process approach was much more evident in this version, so the sights of old documented procedure will necessarily regard all the process. Ceases to exist the old paradigm "ISO 9001 requires a lot of paperwork, a lot of paper", which promoted the discredit on the quality system and at the same time became a tool for companies to show that their quality management systems exist and meet the requirements of ISO 9001.

Another major concern regards the construction companies that have developed quality systems based on ISO 9001 and SiAC/PBQP-H. The latest version of SiAC/PBQP-H is for 2012 and was based on the 2008 version of ISO 9001. There is still forecast for vista upgrade version ISO 9001:2015. Particularly, in the segment of

buildings there is still the challenge of fitness for NBR 15575 "housing-performance Buildings" published in 2013 with five parties that will certainly be considered in the new version of the SiAC/PBQP-H when it is updated. NBR 15575 establishes the requirements and performance criteria that apply to various systems required at the housing buildings.

Although in the previous version already be required to maintain the integrity of the quality management system whenever changes occur in the Organization, the current version is more clearly the need for the company to not separate the effective management of the business of the quality system. ISO 9001 requires that the company needs to identify the internal and external issues that are relevant to their scope and that they can somehow impact the service to its mission, its strategic direction and the expected results.

ISO 9001:2015 proposes that for the development of the quality management system is necessary to understand the Organization and its context. To the construction companies that currently have developed its strategic planning this task will be easier, since the business goals are defined, planned and disseminated. Therefore, the design of the management system must be customer-focused, but also focus on issues such as the definition of other stakeholders and their expectations and the influence of these on the quality management system.

Another significant impact regards the planning and actions implementation address to the risks and opportunities of its processes and products. Although not required maintenance and retention of information documented, the construction companies will need to demonstrate how to perform this analysis and that effectively there are risks and opportunities in each process and still demonstrates how that the analysis were conducted and the effectiveness of actions taken to address risks and opportunities. Therefore, minimize patterns and practices used by the construction company or documented, to reduce the need of evidence demonstration at audit events will no longer be possible. To demonstrate how to plan and implement the approach of risks and opportunities will be evident the lack of actions to control risks related items and actions for opportunities not considered in the quality management system.

Special attention should be given to information maintained and/or required by ISO 9001 detained: 2015 that in addition to the terminology changes also altered the requirement in several items, changing the previous requirements in proceedings and records. The change on the terminology of quality documents will require the construction companies an exercise in breaking the paradigm in which the objective evidence that the quality management system is deployed and maintained is made using documented procedures and records. This change will affect also the actions of Auditors of quality management system. The evaluation fails to be made into a meeting room filled with documents and happens to be where the activity is being performed and controlled. Demonstrate that it does and how it does continue to be a requirement, therefore, effective practice guidelines established by the quality management system, as well as the training of the employees who will effectively demonstrate the evidence that the quality management system is deployed.

In relation to quality objectives despite the previous version of ISO 9001 already require that these were laid down in the relevant processes, levels and functions needed for the quality management system will require great effort on the part of the builders to suit. As mentioned previously, in the face of purposeful simplification of the objectives of the quality by the construction companies to facilitate the demonstration in audit events and on account of the strengthening of the new ISO 9001 in process approach with risk analysis and opportunities the impact will be great. Control items of operational processes will need to be monitored in order to be able to practice to improve. Another aspect concerns the planning to achieve the goals of quality, even in the absence of information withheld, the construction company must determine: what will be done, what resources will be required, who will be responsible, when it will be completed and the results will be evaluated.

CONCLUSIONS

The adequacy of ISO 9001 devices: 2015 will create a discomfort and small and medium-sized construction companies in Brazil have to review their procedures and practices and adjust the quality goals so that these stay compatible with the management of the business. The quality management system can no longer be a part of the unbound system other systems of the company. This philosophy, in addition to reflect the thinking of the construction company should reflect their actions. The quality management system should be thoroughly internalized so that the full empowerment of employees so that they in addition to understand and practice, can report how activities are developed and monitored.

Quality management systems should be less Cartesian and mainly focused on the mentality of improvement from the broad approach of process. The concepts of risk and opportunities should be present in the evaluation of all the processes of the quality management system and the analysis of the effectiveness of the actions deployed must be evidenced.

The major contribution of the new standard will just force the construction companies to leave their comfort zones, promoting a broad review in their quality management systems with effective focus on process approach to the assessment of risks and opportunities. The construction companies should worry less about the generation of procedures that describe thoroughly their practices and more with the broad approach of process.

The absence of Cartesian procedures require employees of construction companies are effectively trained to understand, practice and be able to report how the processes are carried out and monitored.

For companies that have their quality management systems certified in ISO 9001 and also in the SiAC/PBQP-H the challenge will be even greater because they will have to keep the structure of documentation required by SiAC/PBQP-H that as reported is based on the 2008 version of ISO 9001 and will need also to review their practices to meet ISO 9001 changes simultaneously: 2015.

Despite the current unfavorable economic conjuncture in Brazil, resulting in an unstable and insecure business environment with great recession and thus discouraging investment, the challenge to meet the 2015 version ISO will be positive. In times of difficulties is required the mobilization of teams of collaborators around common goals that are challenging, but especially inspiring. Certainly the adaptation processes of construction companies with the requirements of ISO 9001:2015 will promote much more than a great challenge, will be the tool of mobilization for new achievements in the business environment.

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What drives value?

A comparative study of value drivers and how they are affected by management systems

Raßfeld, C.1, Fiegler, M.2, Witczak, M.1 and Jochem, R.1

¹⁾ Technische Universität Berlin, Chair of Quality Science, Pascalstr. 8-9, 10587 Berlin, Germany

² German Society for Quality (DGQ), August-Schanz-Str. 21A, 60433 Frankfurt, Germany

ABSTRACT

Purpose - The value of a company is determined by those factors that have the largest impact on business results: the key value drivers. Understanding the key value drivers is crucial for better decision making at all levels in an organization. However, there is still a controversial debate on the value contribution of management systems. A critical issue is to evaluate the potential outcome of management systems, particularly those benefits which only have an indirect monetary effect.

Methodology - The Chair of Quality Science at Technische Universität Berlin (TUB) in cooperation with the Germany Society for Quality (DGQ) conducted a cross-sectoral study which examined the relationship between company-specific value drivers and their management systems. The study starts with an exploration of relevant management systems in the corporate landscape, followed by an analysis of relevant value drivers and their impact on corporate performance. The third part investigates the influence of management systems on value drivers and concludes with a brief evaluation of cost drivers necessary for the implementation and maintenance of a management system.

Findings - With a total of 152 respondents, the study provides a comparative overview of relevant value drivers along different dimensions. Furthermore, it was determined how well individual value drivers are addressed by a company's management system and how strong the effects on business success are. Finally, relevant cost drivers of management systems were identified.

Research limitations/implications- The study is limited to 152 respondents from German industries. It would be of high interest to rerun the study with an extension to a larger sample to explore differences and similarities.

Keywords: Management Systems, Value Drivers, Value-based Management, Empirical Study

Paper type: Research paper

INTRODUCTION

In today's challenging times, the process of globalization leads to multidimensional changes in all business areas and affects organizations and companies. A company's main goal of profit maximization can only be achieved successfully if the company has a good strategy that takes the current environmental conditions into account. Additionally, any success-oriented must align activities and processes to increase the corporate value (Koev, 2009).

The corporate value is determined by those factors that have the largest impact on business results: the key value drivers. Understanding the key value drivers is crucial for better decision-making at all organizational levels. The idea behind this approach emerged with the concept of value-based management which has its origins in the work "Creating Shareholder Value" by Alfred Rappaport in 1986 and has remained one of the most widespread management paradigms an intensive discussion in research and practice (Steinhaus and Kraft, 2013; Karrer, 2007). Value-based management deals with the creation, the management and the measurement or estimation of value adding in the company and can therefore be categorized as a future-oriented concept with a strong linkage to strategic planning. This comprises a long-term increase of the corporate value for the benefit of shareholders (shareholder value) or interest groups (stakeholder value), which is to be achieved through a consistent leadership and management of the company on the basis of key performance indicators (Ederer, 2008).

In this context, a company also needs a management system that adaptively and proactively influences the behavior of an organization in a way that it remains viable and capable of development (Schwerdtle, 2013). A management system is a mandatory framework of processes and policies for corporate governance (Löbel et al., 2005). It can be described as the sum of all tools, instruments and processes that will enable the management to lead the company to success. Furthermore, it is the generic term for all systems designed to ensure the quality of performance within the company (Ringswirth, 2013).

However, there is still a controversial debate on the value contribution of management systems. A critical issue is to evaluate the potential outcome of management systems, particularly those benefits which only have an indirect monetary effect. The indirect effects of a management system can be the following (Deuringer, 2013):

- The increase in efficiency (e.g. productivity) leads to liquidity and success
- Improving the performance (e.g. competitiveness) leads to an increase of potential benefits
- The increase in the ability to satisfy the needs of multiple stakeholders leads to a higher capacity for development.

Moreover, recent trends in international standards also give greater emphasis on this topic. The revision of the DIN EN ISO 9001 recommends a stronger focus on value-oriented and economical processes with regard to quality management systems.

For this purpose, the Chair of Quality Science at Technische Universität Berlin (TUB) in cooperation with the Germany Society for Quality (DGQ) conducted a cross-sectoral study which examined the relationship between company-specific value drivers and their management systems. The study starts with an exploration of the current distribution of management systems in the corporate landscape, followed by an analysis of relevant value drivers and their measurement. The third part investigates the impact of management systems on value drivers and corporate performance and concludes with a brief evaluation of cost drivers for the implementation and maintenance of a management system.

RESEARCH METODOLOGHY

The survey was conducted online as this kind of survey allows only small costs and provides short response times as well as anonymity of the participants. As the survey has been published in cooperation with the German Society for Quality (DGQ), most of the participants came out of the circle of its partners.

The population consists of German companies from various industries and sizes. To avoid misunderstandings, terms as value drivers have been defined within the survey. Furthermore, closed and semi-open questions were used with clear and predefined answers. Both, questions with simple yes / no answers and nominal scales as well as ordinal single- and multi-item scales were used. Most of the rating questions had to be answered on a five-point Likert scale (e.g. 1=very low; 5=very high strong). Overall, the survey included 25 questions and took place in September and October 2015 with a total of 152 respondents.

PARTICIPANTS OF THE STUDY

The first part of the study gathered key data of the participating companies such as enterprise size, turnover, and economic sector. Figure 1 shows the distribution of the number of employees working for the surveyed enterprises. From companies with up to 25 employees (3%) to more than 10,000 employees (16%), it can be seen that companies of any size participated in the study.

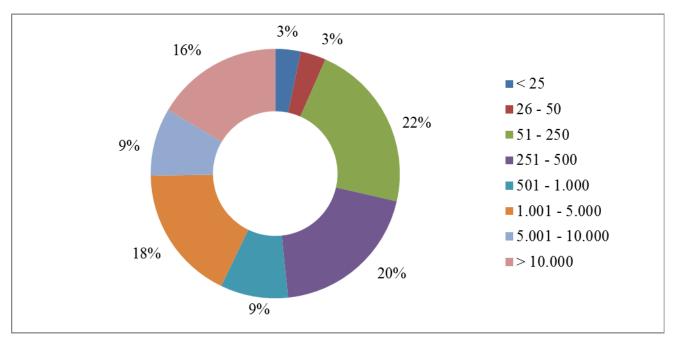


Figure 1 - Headcount

Furthermore, the companies were asked about their turnover in the last financial year. This aimed to classify the companies into size classes. The distribution of turnovers of the surveyed companies results from figure 2.

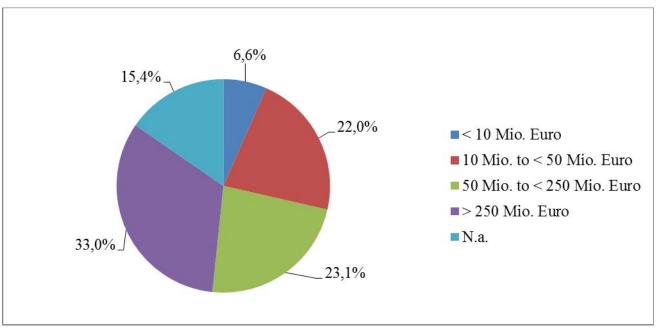


Figure 2 – Last annual turnover.

Figure 3 shows the main economic activity of the chosen branches of business that compose the sample size of the study. The participants had to be limited to the specification of one sector. The most strongly represented companies come from the mechanical and plant engineering (16%), electrical engineering, the automotive industry (both 14%), and from health care (11%). Generally, it can be stated that a large number of companies from different sectors could be obtained for the study.

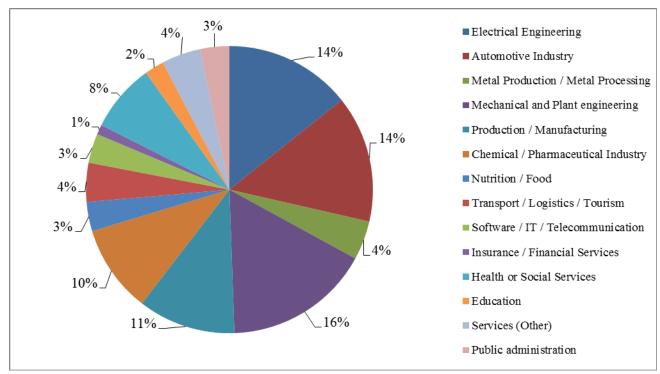


Figure 3 – Branches of Business.

Based on the reported turnovers and numbers of employees, a categorization of companies according to the definition of SME (European Communities, 2003) in micro, small and medium-sized enterprises could be

made. The status of an enterprise is defined according to their staff headcount and turnover or annual balance-sheet total (see table 1). The application of this definition leads to the following distribution for the study: 56 % of the participating companies are classified as SME and 44 % are large scale enterprises.

Table 1 – Enterprise categories

	Micro-sized enterprise	Small-sized enterprise	Medium-sized enterprise
Number of employees	<10	<50	<250
and			
Annual turnover	≤ EUR 2 million	≤ EUR 10 million	≤ EUR 50 million
or			
Annual balance sheet	≤ EUR 2 million	≤ EUR 10 million	≤ EUR 43 million

RESULTS OF THE STUDY

The second part of the questionnaire included the topic of management systems. For this, the companies were asked to provide information about their implemented management systems and their goals and achievements pursued by the use of management systems. The third set of questions referred to the survey of company's value drivers and their measurement by KPI's. Within the fourth part, the study focused on cost drivers and the efficiency of management systems. In the following, selected results of the study are represented.

Management Systems and Objectives

Due to the numerous objectives a company can aim management systems are not confined to just one area. Nowadays it is common to combine various management systems. Different management systems require the greatest possible bundling and integration of individual systems in order to meet growing needs, to minimize workload and to benefit from synergies (Ringswirth, 2013).

The first question covered the issue of relevant management systems either formally implemented or not implemented in the company (Figure 4). Looking at the results, it is obvious that the quality management system is assessed as the most important management system within a company as 120 out of 152 participants stated that. Thereafter, the health and safety management and risk management system are mentioned as relevant with 105 respectively 98 responses followed by the environmental management systems with 93 answers. The content management has been assessed only by a few to be relevant (23 responses) and by most as not relevant to their management system (56 responses). The participants also added management systems as relevant which were not prescribed in the survey. These individual answers include the following: food safety, complaint management system, project management system, business process management system.

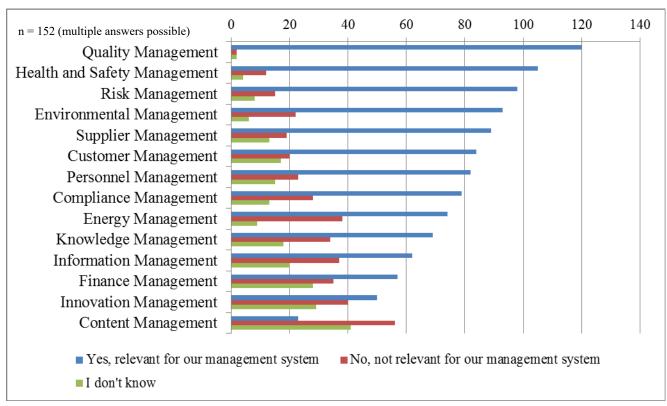


Figure 4 – Relevant Management Systems

It is also of great interest to know the objectives of implementing a management system pursued by these companies. Four main targets were stated by "strongly agree" and "agree" with regard to management systems: the certification proof, the increase of customer satisfaction, the improvement of process efficiency, and the implementation of a company-wide continuous improvement process. Figure 5 also shows that only half intend to implement a management system in their company by results in cost savings or revenue increase. That is remarkable because as already stated; management systems should help companies to reach their economic objectives. Furthermore, it is also self-explanatory that companies want to gain a certification proof but it has to be questioned if this should be the prior goal for a company. Critics often point out, that a certification indicates the fulfillment of requirements temporarily. It does not really indicate that a company has overall competence and regards a management system as an integrated and long-term part of the company.

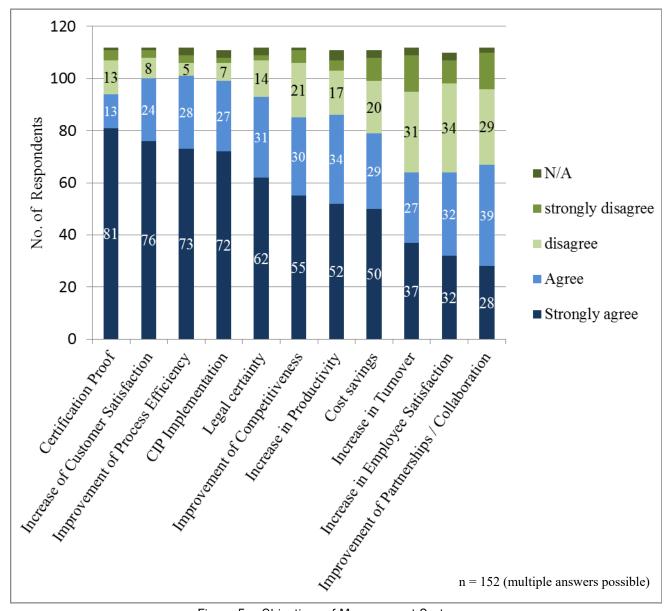


Figure 5 – Objectives of Management Systems

Identification of Value Drivers

Basically, a value driver is a modifiable factor which is highly relevant for the economic results of a company. A positive development of the value driver causes ceteris paribus an improvement of the economic success of the company. A fundamental distinction of value drivers can be made between financial and operational value driver. Financial value drivers cover any kind of monetary figures which are related to business activities and decisions. Operational value drivers are at all different levels of an organization and influence the financial driver and therewith the company's success (Weber and Schäffer, 2014).

Against this background in literature, the value drivers of the surveyed companies were in focus of the next part. Based on the Balanced Scorecard by Kaplan and Norton (1992) the value drivers were divided into four perspectives respectively employee, customer, process, and market dimension. It was of high interest to identify the most relevant value drivers in the corporate context. Therefore, the respondents had the opportunity to specify three value drivers for each perspective from a predefined list. Financial value drivers were not investigated. Nevertheless, it was also possible to add other drivers as well. Table 2 shows the scope of the surveyed value drivers.

Table 2 – Scope of the Requested Value Drivers

Table 2 – Scope of the Requested Value Drivers		
Customer Perspective	Process Perspective	
■ Customer Satisfaction	Process stability	
■ Product Quality	 Standardization 	
■ Service Quality	 Process Documentation 	
■ Delivery Reliability	Innovations	
■ Complaint Management	Data Quality	
■ Customer Loyalty	Capacity Utilization	
■ Customer Retention	 Software Support 	
Product Availability	Conformity to Standards	
■ Customer Acquisition		
Market Perspective	Employee Perspective	
Competitiveness	Employee Motivation	
Price Development	Employee Training	
Brand Strength	■ Staff Management	
Brand StrengthImage	Staff ManagementCorporate Culture	
	-	
■ Image	Corporate Culture	
ImageMarket Share	Corporate CultureCorporate Communications	
ImageMarket ShareSupplier Integration	Corporate CultureCorporate CommunicationsIntellectual Capital	
 Image Market Share Supplier Integration Public Relations 	 Corporate Culture Corporate Communications Intellectual Capital Employee Productivity 	
 Image Market Share Supplier Integration Public Relations Product Communication 	 Corporate Culture Corporate Communications Intellectual Capital Employee Productivity Employer Attractiveness 	

In the following figure, the most relevant value drivers are presented. Concerning the process dimension, it can be stated that *process stability* (73 %), *standardization* (58 %) and *process documentation* (35 %) contribute most to the company's value. Considering the customer dimension, it becomes visible that *customer satisfaction* (79 %), *product quality* (59 %) and *service quality* (39 %) play a vital role for success. The relevant value drivers with regard to the market perspective are competitiveness (54 %), price development (43 %) and brand strength (33 %). In contrast to other value drivers they find a lower level of importance. One possible explanation could be that market drivers are often influenced by external factors like political, technological or socio-cultural conditions. Consequently, companies have only limited influence on these drivers.

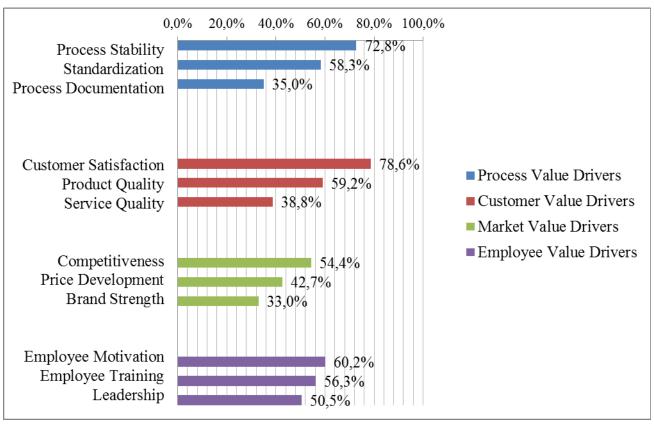


Figure 6 – The Top 3 Value Drivers for Corporate Performance

In addition, the companies were further asked about their frequency to which they perform value driver analyses. A value driver analysis is an important foundation and aims to support management with regard to strategic planning and operational performance. Overall, the results in figure 7 show that about one quarter of the surveyed companies conduct value driver analyses (26 %) continuously. Moreover, 35 % of the respondents perform value driver analyses but at irregular intervals. Almost 30 % of the companies have never dealt with the topic of value driver analysis. Ultimately, only 9 % do not have the knowledge of relevant terms and concepts and do not conduct any value driver analysis accordingly.

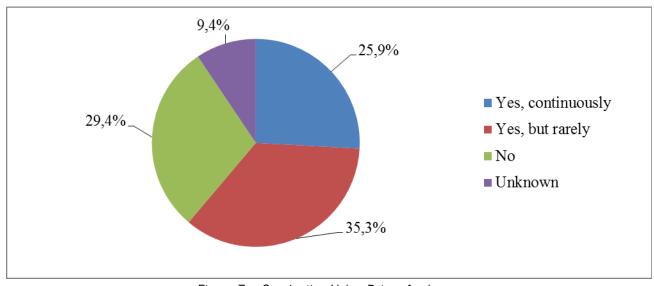


Figure 7 – Conducting Value Driver Analyses

In the course of the survey, the respondents now had the opportunity to make statements about key performance indicators based on their prior value driver specifications. Having knowledge about the relevant value drivers is only one side of the coin. The other side is that key figures must be determined to quantify the value drivers. That enables companies to track and control financial as well as non-financial measures such as product quality, customer satisfaction or employee satisfaction in a preventive and sustainable way. By definition, key figures or KPI's are quantitative data to inform about business matters and are suitable for corporate decision-making (Reichmann, 2011).

Regarding the customer dimension, the systematic determination of KPI's ('Yes' answers) for customer satisfaction (73 %) product (82 %) and service quality (50 %), is most widespread in practice (Figure 8). This high proportion is striking compared to the employee dimension in which less than one third of the companies regularly determine and track KPI's for value drivers like employee motivation (32 %), employee training (13 %) and leadership (21 %). In contrast, process stability as a process value driver is quantified by KPI's by more than 60 % of the companies. Performance indicators for other process value drivers like Standardization and Process Documentation are used only in a few companies (26 % and 29 %). Value drivers related to the market dimension are also captured by KPI's. Here, more than half of the respondents continuously track price development by KPI's. One third of the companies regularly use KPI's to evaluate the competitiveness (31 %) and approximately one quarter to quantify the brand strength (24 %).

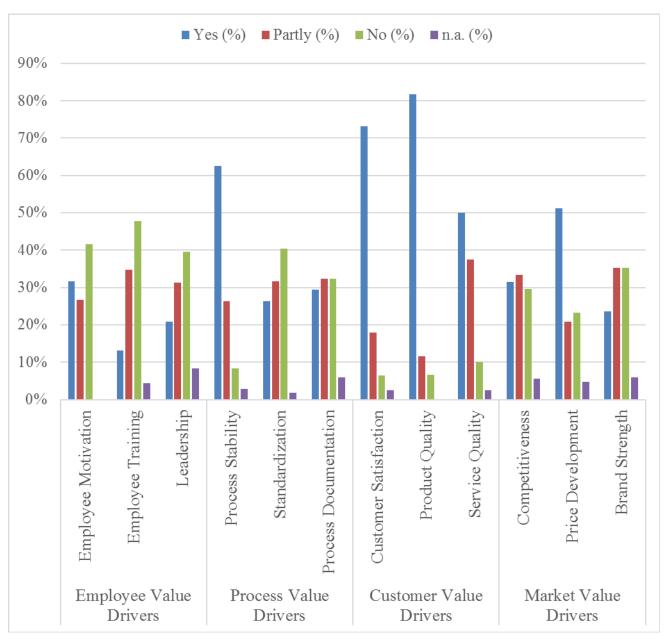


Figure 8 – Determination of Key Performance Indicators

In this context, the organizations were generally asked to specify for what reason they determine key performance indicators within their business. More than half of the respondents (59.2%) determine and record key performance indicators in order to control and improve their processes which are in accordance to the results shown in Figure 9. Approximately 40% of the companies use KPI's for controlling and accounting reasons or as a requirement of the top management.

Ultimately, only 4.6 % of the surveyed companies determine KPI's for other reasons. Among other reasons the following subjects were mentioned: for the strategic direction of the company, for benchmarking (internal and external), to support the strategy process, to measure energy efficiency and to improve the company's performance as a whole.

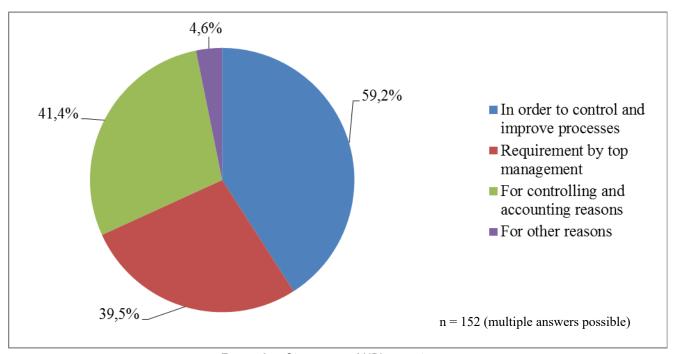


Figure 9 – Objectives of KPI recording

Impact of Management Systems

Despite the identification and measurement of value drivers, the companies were also asked to assess the impact of management systems on value drivers. In Figure 10, selected results of the most influencable value drivers are presented. Regarding the market value drivers, it can be clearly seen that, for example, brand strength can be highly affected by a management system (more than 80% out of 61 companies). In contrast, some companies see only weak potential influence with respect to product communication and image (>20 %).

Slight differences also emerge when comparing the employee value drivers. According to the respondents, a management system has high potential influence on employee qualification (70% out of 53 companies) whereas approximately 40% of the respondents state that corporate culture and intellectual capital is less influenceable by a management system (weak and medium influence). Nevertheless, more than half of the respondents indicated that their management system has a strong influence on these drivers (strong and very strong influence)

Overall, it can be noted that customer and process value drivers can be most influenced by a management system. While a management system has a high impact on value drivers like product quality from the customer dimension (>80% out of 57 companies), the conformity to standards can also be highly influenced by a management system within the process dimension (>70% out of 12 companies).

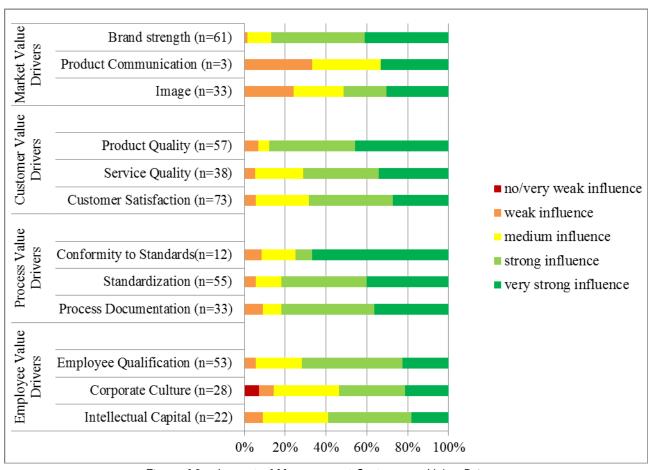


Figure 10 – Impact of Management Systems on Value Drivers

Identification of Cost Drivers

The implementation and development of management systems incur costs. Despite these costs management systems also lead to substantial costs savings and other competitive advantages. Basically, there are two different cost approaches to analyse costs related to management systems. The most commonly used classification for management system costs is a process-oriented categorization in which costs are distinguished in costs for implementation and development or maintenance of management systems (Geiger and Kotte, 2008). Costs of implementation occur, e.g. by means of consulting support, employee efforts and through certification authorities. Thus, those costs constitute an investment in ensuring long-term competitiveness of a company (Binner, 2002), (Bruhn, 2011). On the contrary, costs for the development of management systems e.g. arise from staff training, administrative expenses and audits (Geiger and Kotte, 2008).

A further possibility for structuring costs is the PAF model in which costs are divided into operations-oriented fields: prevention, appraisal and failure costs (Dale and Plunkett, 1999). Prevention costs arise from efforts regarding analyses and eliminations of error causes. Appraisal costs are caused by scheduled inspections which are not performed on the basis of a concrete error. Failure costs result from poor quality such as costs of fixing defects or managing costumer complaints. The latter type of costs can be differentiated between internal and external failure costs. This subdivision indicates whether the incurred costs are caused by a failure detected internally or externally (Geiger and Kotte, 2008). This cost categorization has its origins from Armand V. Feigenbaum who introduced the mentioned types of costs (Feigenbaum, 1956).

Against the background of the different costs approaches and models in literature, companies were asked to specify how they assess the costs of their management systems. Figure 11 presents the main cost drivers of management systems. It can be stated that staff costs, failure costs, differentiated in internal and external

costs, certification costs, costs for coordination efforts and appraisal costs give rise to the largest expenditure (at least 'high costs') for management systems by more than one third of the companies, followed by the costs of service and maintenance and costs of training. Clear differences emerge when comparing the remaining types of costs. Almost half of the respondents state that expenses for communication issues, administration, prevention and consulting play not an important role in monetary terms. These cost positions are evaluated as low or very low (up to 60 %).

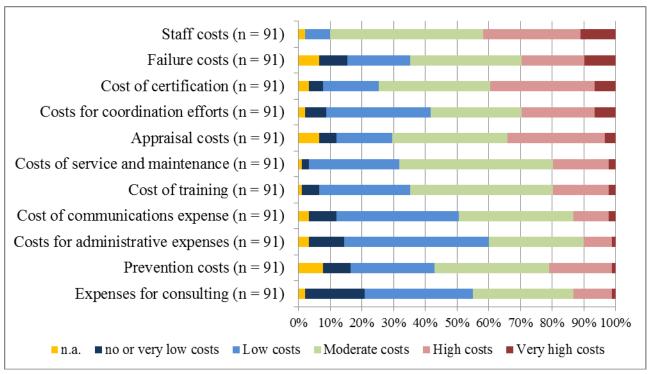


Figure 11 – Cost Drivers of Management Systems

Finally, the participants were asked for a subjective assessment in regard to the cost-benefit-ratio of their management systems. Opinions stated are summarized in figure 12. It is remarkable that approximately two third of all respondents (68 %) consider the profitability of their management system as positive. However, more than 15 % regard it as balanced or cannot make a statement and about one in six companies (17 %) even see the profitability as negative.

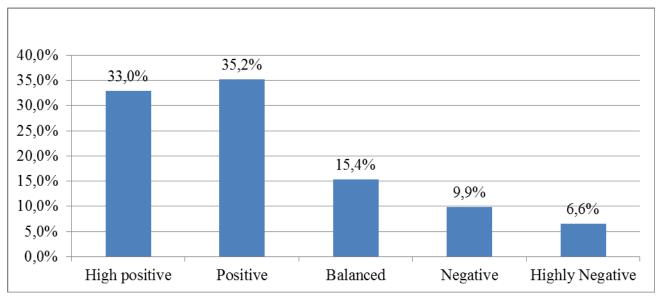


Figure 12 - Cost-Benefit-Ratio of Management Systems

SUMMARY AND CONCLUSION

With a total of 152 respondents, the study provides insights into German companies and their relevant value drivers along the customer, market, process and employee dimension. In this context, it was also determined how well individual value drivers are addressed by a company's management system. However, it can be seen that the quantification of value drivers by key performance indicators is still a particular problem for some companies.

Moreover, it was shown that the management system most widely used is the quality management system according to ISO 9001 that aims to achieve high product and process quality as well as the satisfaction of customers. Besides the quality management system, health and safety, risk and environmental issues are most organized with the help of management systems.

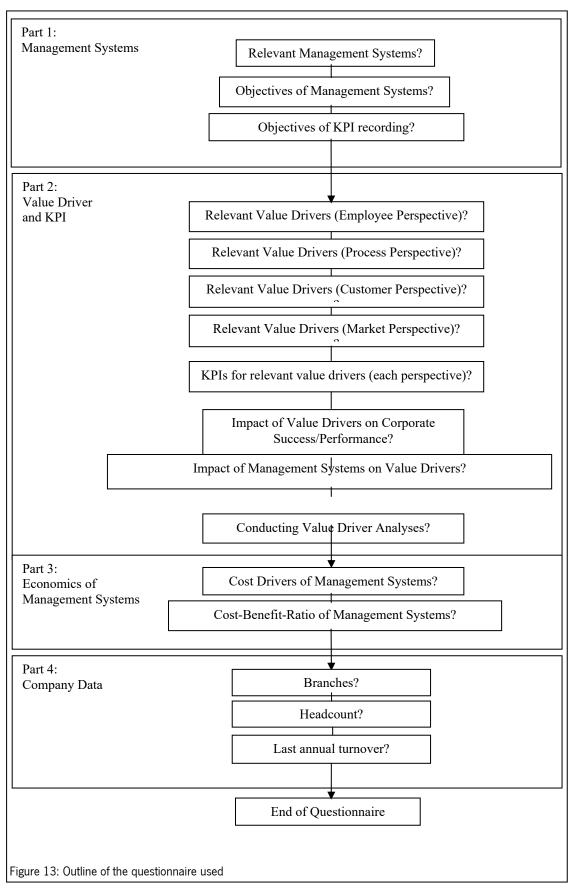
Regardless of the type, the main targets of a management system can be identified. These include in particular the certification proof, the increase of customer satisfaction, the improvement of process efficiency, and the implementation of a company-wide continuous improvement process.

The study also provides a descriptive overview of relevant cost drivers of management systems. Overall, staff costs, failure costs, certification costs, costs for coordination efforts and appraisal costs dominate as cost drivers within the study. Nevertheless, two third of the companies assess the profitability of their management system as positive.

It must be considered that the study is limited to 152 respondents from German industries. It would be of high interest to rerun the study with an extension to a larger international sample to explore differences and similarities. Furthermore, a deeper statistical analysis is necessary in the next step to validate the results and to obtain more research insights.

In conclusion, it becomes visible that a management system has been recognized by companies as a key strategic role in the development of an organization. However, critics often point out that a management system does not make a value-added contribution to the company's success and the use of funds must therefore be kept at a minimum. The success of a management system is therefore attempted to be measured by monetary and non-monetary performance indicators. Consequently, it is necessary to develop holistic approaches and methods to facilitate the determination of costs and benefits in order to quantify the economic value added of a management system.

APPENDIX



AKNOWLEDGEMENTS

We thank the German Society for Quality (DGQ) for their help in developing and distributing the questionnaire. In addition, we thank Mark Witczak for collecting the data and for many helpful discussions.

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The supply chain quality management (SCQM) in middle-income economy countries

Lopez Astudillo, A.¹⁾ Cancelado Carretero, H.M.²⁾

Fajardo Toro, C. H.³⁾ Balbastre Benavent, F.⁴⁾ and Redondo Cano, A.⁵⁾

- ¹⁾ alopez@icesi.edu.co. Universidad Icesi, Colombia
- ²⁾ hcancela@icesi.edu.co. Universidad Icesi, Colombia
- ³⁾ chfajardo@universidadean.edu.co. Universidad EAN, Colombia
- ⁴⁾ francisco.balbastre@uv.es. Universidad de Valencia, España
 - ⁵⁾ ana.redondo@uv.es. Universidad de Valencia, España

ABSTRACT

Purpose: The purpose of this research is to present a descriptive assessment of the level of competitiveness achieved by 30 companies in the graphics industry in Colombia and the factors related to SCQM involved in building competitive advantage. To achieve this goal an instrument has been developed, and based on the results obtained, identify better results through the SCQM.

Design/methodology/approach: This research has been developed with qualitative methodology in 3 phases. The first phase was the design of an instrument which allows to evaluate 6 factors considered key to assessing the competitiveness, and where these factors are important to integrate the SCQM on the organizations structures; the second phase was depth interviews with the CEOs of the 30 companies in this study. The third phase was the information analysis, the understanding and interpretation of the data and information, generate conclusions and recommendations.

Findings: The final analysis presents a group of companies of the same industrial sectors with a competitive level to improve and so could align and engage the SCQM. A number of weaknesses and opportunities for improvement are identified, allowing these companies to strengthen the value chain through integration with customers, suppliers and the environment.

Originality/Value: This study presents a profile in the competitiveness achieved by a group of companies in the same sector through factor analysis. A tool has been constructed based on concepts developed by different researchers associate with SCQM, which could generate a competitive advantage when implemented in the organization. The present work is the first approach that is performed at the printing industry in Colombia graphics affiliated with ANDIGRAF

Keywords: Supply Chain Quality Management, Logistic, Operations Management, Supply Chain.

Paper type: Case study

INTRODUCTION

Understanding the Supply Chain Quality Management (SCQM) can be given from definitions presented by researchers who have contributed to construct with different approaches: explaining and propose how it should integrate with suppliers, integrating the areas of quality and logistics, systems developers cross information between customers and suppliers. This understanding from a broad process or formal coordination complex involves two management areas: the quality and supply chain in business, which are professional areas requiring ability to integrate with others developing a dynamic process of organizational learning (Balbastre et al., 2003).

Fernandes et al. (2014), presents the integration between the Supply chain and quality it as a natural evolution of management practices. This integration allows to reach knowledge in specific areas such as purchasing, manufacturing, distribution and all distribution logistics processes. At the development of the construct, the SCQM evidence an integrative approach since its inception until the recent contributions from various authors, are extended towards the development of a systems approach, complex and co-developed between organizations and stakeholders.

The SCQM in companies at middle-income economy contexts, implies breaking a series of barriers that are implicitly inside the business competitiveness model, as well as generate leadership that includes the ability to develop sustainable advantages through strategies to improve quality management processes and supply chain management, this in order to obtain the best results and generate value through agility in the flow. The study of SCQM in Colombia is emerging. Its development and structure is necessary in order to build applied knowledge, using as a reference the well-founded theory. This work corresponds to a qualitative and exploratory study as foundation to study the application of the SCQM in companies in Colombia.

In this paper shows the results on the qualitative evaluation of SCQM on companies in Colombia of graphics industry. As sample has been taken 30 companies in the sector associated to ANDIGRAF. These companies generates raw materials and media for this industry. The study assesses the ability to integrate the areas of quality and supply chain management. These results allows to do an initial description about SCQM in the companies in Colombia; describes the areas of interest in quality management and supply chain management as the initials steps to generate integration: creation of long-term relationships with suppliers, best practices for the customer demand management , integration with the areas of logistics and the integrated risk management.

The findings show an opportunity to integrate the areas of quality and supply chain from organizations that have a flexible structure and a committed human resources. The work is original as the first evaluation done in this sector of the printing industry in Colombia.

DEVELOPMENT SUPPLY CHAIN QUALITY MANAGEMENT (SCQM).

The Supply Chain Quality Management (SCQM) is presented as a construct through influential authors: Levy et al. (1995, 1998), Cooper M.C. et al (1997) whom identified components of the relationship between quality and Supply chain. Tan K. et al. (1999) identified three factors to develop the SCQM, and Bessant (1992) raises a relationship SCQM paradigms based on price and supplier relationships.

Kuei et al. (2001) and Robinson et al. (2004) defined: the Supply Chain Quality Management (SCQM) is the formal coordination and integration of business processes involving all partners of an organization to prosecute the offer, which measure, analyze and improve continuously the products, services and processes in order to create value and achieve satisfaction intermediaries and final consumers in a market sector.

A SCQM applied to the relationships that generates integrated processes internally and externally allows the development of competitive skills; this concept was introduced by Flynn and Flynn (2005); some of these capabilities that can be identified are: creating positive strategic agencies through collaborative models, build capacity to regenerate resources more efficiently and effectively, have more and better dynamic capabilities, to create distinguishing factors, create costs with stable behavior and structured strategic integration with suppliers and stakeholders.

Foster J.R. (2008) defined SCQM: *it is a system, finding it necessary to develop systems thinking to understand through the holism required in the organization and leadership needed to implement the SCQM.* In this, the author shows four capacities required for the development of a SCQM:

i) Compete to be perceived by other leading private firms members on the supply chain by integration focused on the consumer, the quality information system and technologies used, the development of the relationships with suppliers, outsourcing processes and integration with allies and strengthening leadership in the development of quality in the supply chain.

ii) Present a plan for SCQM through culture in quality management, leading technology, guiding the participation of the Supply chain suppliers, doing the designing and configuring the supply chain through the development of a planning strategic.

iii) Implement initiatives for the development of a SCQM through practices that allow quality agreements between suppliers and buyers, shows that the data and information related to quality in the supply chain are managed, designing actions for implementation a SCQM, deploying policies to strengthen a SCQM and the organizing of an area to guide the SCQM.

iv) Provide skills that enable it to achieve a competitive position through a SCQM.

Kuei, et al (2008), integrates new elements that are necessary to develop SCQM: supply and development of integrated suppliers, which generates a sense of community, tracking and tracing orders shipped to customers. These elements also have to allow the reversive logistics for product waste management, and availability of intenert platforms to obtain information. Deliana et al. (2014) demonstrated the integration of quality in the Supply chain produces a positive return on business competitiveness and improved supply chain management, through the implementation of integrated quality systems and ISO certifications; this adoption of ISO is voluntary.

RESEARCH METODOLOGHY

The proposed research was developed in the sector of graphics arts industry in Colombia. The Companies in this industry in Colombia have been grouped in different associations and one of them is ANDIGRAF (Colombian Association of Graphic Communication Industry), that is 40 years old (1975 to 2015) and have 170 associated companies, corresponding to 80% of national production on this industry. where the participation geographically is: 33 companies in the Antioquia region and north, 28 companies in the western region and 99 companies in the capital center region. The industry Impacts with 31,000 direct jobs and 75,000 indirect at country level, corresponding to 27% of total Colombian exports and generates \$ 52 million US of income to the local economy; Andigraf (2015).

The study is conducted between August 2014 to August 2015 to 30 companies affiliated ANDIGRAF. The president of the association invited 171 member companies to participate in the proposed of which 30 study responded positively (17.5%). Participating companies, that competing in the printing sector with different products, differ in the installed production capacity and technology presented; These companies require processes of raw material supply, processing and delivering finished product, with support shopping areas, production planning, product development and technical sales. The study was held in each city Cali, Medellin and Bogota, through conducting a workshop of four hours where he presented the study objective, the theoretical framework of a SCQM and the benefits they would get at the end of the investigation.

A Total 10 companies for each region were taken as a sample to develop de study. to obtain the information, It was applied direct techniques through in-depth interviews as well as indirect observation techniques, acting as a discreet observer and with a highly structured observation with the general managers of companies, using a tool that allows a similar observation, with identical questions and the same formulation and sequential order.

The authors consider create a approach that lets determine the participation and development of SCQM at each company. They agree that the scope of a competitive position by a company can be achieved through the implementation of the SCQM (Foster, 2008). To verify this approach, it has developed a tool with six factors that would allows to evaluate the competitiveness profile of the company on which it is identified that the SCQM improved the results generated. The six selected factors are to evaluated first the level of competitiveness of selected companies through:

1-Evaluation of the position of rivalry that shows the customer-supplier relationship, based on Michael Porter's diamond. The relationship of the company with customers and suppliers determines how strongly is the degree of rivalry of the organization

2-Evaluation of the value chain through the identification of integration between business units (supply management, transformation management and distribution management) and the functional areas of the company.

3-Evaluation of knowing the decisions based on generic strategy, as well as the knowing of enterprise strategies based on cost or based on differentiation that determine the supply chain and quality required.

4-Evaluation of the adjusted strategy, knowing the development actions related to the supply and use of resources opportunities.

5-Evaluation of the dynamic strategy, knowing the actions for the development of dynamic capabilities related Supply chain and quality.

6-Evaluation of strategic intent and the ability to develop competitive innovation permanently and risk management.

The proposed tool integrates elements referenced by different authors who have analyzed the SCQM and the necessary to generate a competitive position: competitive skills and abilities (Flynn and Flynn, 2005), holism and leadership required (Foster, 2008) and integration and necessary dynamics in the organization (Kuei et al, 2008).

The tool is applied through a depth interview that has an average duration of 2 hours, the researcher presented a contextualization of each factors generating competitiveness and ask the questions to the managers selected. The response is requested by assigning a proposal valuation and the possibility of extending the reasons therefore; the interviewee to responds in a conceptual scale with five options,

- 1: strongly disagree, when the proposal filed generates radical rejection;
- 2: somewhat disagree, when the information presented generates a rejection and at the same time presents acceptance, doubt against any of its components;

- 3: has not been considered, where information generated as a surprise for not having considered in the management of the company, due to ignorance on part of the topic or in whole, as well as by disinterest on the proposed theme;
- 4: somewhat agree, where information generated has a partial acceptance and possibly at the same time not agree on a component presented, as well as have partially implemented the proposed activities, and
 - 5: totally agree, where information generated total acceptance, without hesitation.

The depth interview was held at the headquarters of each company, and at the end of the interview a tour was conducted in the facility and the production process. Later, with the results obtained, each general manager was handed a valuation of the company and the context against other companies evaluated at country level; this allows to compare the level reached on the factors of competitiveness of the company and understand how could implements SCQM to improve. The limits presented in the methodology are defined on the depth of the answers, the difficulty in the process of analyzing the results and quality of the data obtained, Robson C. (1993).

RESULTS

The results obtained from the depth interviews, correspond to the aggregation of the interpretation of the answers given by GMs, considering the scale and context of each offered question, later to determine an average that provides a comprehensive understanding of the status of assessed factor in the company and allows create a profile on competitiveness in the company. (See Chart 1.)

Factors evaluated	Average	Number of questions
Analysis of rivalry in the relation of forces customer / supplier, competition and environment	3.4	22
Analysis of the value chain and strategic business units supply, transformation and distribution	3.8	51
Analysis of the generic strategy and the production chain and quality required	3.76	20
Analysis of the adjusted strategy based on resources and opportunities	3.24	15
Analysis of the capabilities of organizations to compete and supply chain	4.07	24
Analysis of intent (purpose) Strategic and risk management	3.48	12

Chart 1: Six evaluated factors that enable competitiveness in the 30 companies ANDIGRAF.

The 30 companies evaluated feel they have the skills and competencies needed to compete throughout the value chain while considering their customers, their suppliers and the organization holistically. Likewise, they consider has the appropriate value chain to compete with a valuable human resource, and indicates that they have considered all factors that must be considered to integrate a value chain.

Also they consider they have generic strategies to compete in wider markets and reduced generic or specialized products, at the same time, although they considered each strategy, they have missed opportunities. They have low consideration to innovation as a determining factor to compete and low operational risk consideration. They do not see themselves in the market as good rivals and feel they must improve relations with the government and environmental assessment; finally they show that they have not evaluated the resources and opportunities in its entirety to better compete. The following results were generated from the aggregation of the answers provided by respondents, to analyze and gather information from a selective coding, (Boeije, 2010). See Chart 2.

Factors	Variable evaluated	Result	Numb. of Q.
1. Analysis of rivalry			
1.1	Interpretation of the power customers about the company.	3.64	3
1.2	Interpretation of the power of suppliers on the company.	2.78	3
1.3	Interpretation of the power of competence over the company.	3.84	3
	Interpretation of the power of substitute products on the company.		4
1.4		3.33	
1.5	Interpretation of the Government power over the company.	2.32	2
	Interpretation of the power of socio-political events on the company.		2
1.6	Interpretation of the power of technology on business.	4.03 4.17	2
1.8	Interpretation of the power of the internationalization of the company.	3.1	3
Average	Result	3.4	22
2. Analysis of the value chain			
2.1	Finance processes and costs.	4.04	3
2.2	Information systems processes.	3.6	5
2.3	Processes commercial systems.	4.04	5
2.4	Processes for customer differentiation.	3.58	4
2.5	Development processes of logistics and supply.	3.93	8

2.6	Processes developed Productivity.	3.51	12
2.7	Processes developed Quality Management.	3.55	7
2.8	Processes developed Human Resources.	4.19	7
Average	Result	3.8	51
3. Analysis of the generic strategy			
3.1	Strategy based on price war.	2.77	5
3.2	Strategy based on high volume markets.	3.92	3
3.3	strategy based on differentiated markets.	3.84	4
3.4	1x1 strategy based markets.	4.24	3
3.5	Strategy Mix.	4.05	5
Average	Result	3.76	20
4. Analysis of the adjusted strategy based on resources and opportunities			
4.1	Resources and opportunities based on research and development.	2.45	4
4.1	Resources and opportunities based on knowledge, education	2.43	'
4.2	and training.	4.13	5
1,2	Resources and opportunities based on technology	1.10	
4.2	management.	3.15	6
Average	Result	3.24	15
5. Analysis of the capabilities of the organization to compete and supply chain			
5.1	Managerial skills and organizational structure.	4.58	6
5.2	Financial structure.	4.47	4
5.3	Business structure.	3.62	2
5.4	Quality management structure.	4.52	3
5.5	Management of corporate social responsibility.	3.67	2
5.6	Environmental management structure.	3.93	2
5.7	Supply chain management structure.	3.76	5
Average	Result	4.07	24
6. Analysis of strategic intent			
6.1	Risk management.	2.6	2
- · -			2

6.3	Management of research, development and technology.	3.67	2
6.4	Future scenarios.	3.28	4
6.5	Perception of government.	2.47	1
6.6	Perception ANDIGRAF.	4.77	1
Average	Result	3.48	12

Chart 2: Result of the six factors and variables evaluated in the 30 companies investigated.

1.-Analysis of rivarly and the impact of factors involved in a SCQM.

Relative to power of customers on the company consider that customers exert a power that is not closed and autocratic on the company. On power of suppliers aimed at meeting the conditions presented on each order placed. Consider that competition exerts a power over the market that should not be ignored but also considered in themselves. Recognize the existence of substitute products on the market that continually erode the proposals submitted to customers, they believe the government has a real and effective power in macroeconomic variables.

Consider the social events of the environment associated with economic and political decisions have a direct influence on the company. That technological development and availability of it has a determining power due to the transformation that a company can suffer because of acquiring a frontier technology. Power internationalization, it understood as the possibility of the arrival of foreign competition.

Contrast of SCQM with analysis of rivality in the relation of forces customer/ supplier, competition an environment give these results:

The power of customers: the SCQM presents the possibility of developing customer approaches ranging from the generation of trust based initiatives CRM (Customer relationship Management), implementation of QFD (Quality Function Deployment), the development of collaborative business plans CPFR (Collaboration Planning Forecasting and Replacement) and the development of joint business strategies (Hoshin Kanri). The power of suppliers: the SCQM presents the possibility of development of certified deliveries, as well as evaluation plans suppliers for continuous improvement, implement plans of confidence in the estimated purchases CFAR (Collaboration Forecasting and Replacement).

About the power of competition, the SCQM can develop in a sector between competitor's common understanding of quality and services generated by Supply collaborative chain between competitors. The power of substitute products, the SCQM can generate the evaluation to integrate substitute products in the value chain by expanding the original portfolio of businesses and generate synergies for the development of new options. The power of government, the SCQM allows prepares companies through the opportunities provided by Supply chain to develop the presence in foreign markets taking advantage of the signing of new free trade agreements with Colombia with different countries and consolidation of DFI (international physical distribution) effective. Socio-political events, the SCQM allows to consider the company undergoing supply chain generated by companies of goods and services, creating a systemic social infrastructure where new

commercial channels, new products required by customers are transformed into new business opportunities, transforming the activity of a company moving from reactive to proactive through social innovation and social responsibility programs.

With regard to Power of technology, the SCQM considered critical technologies for the design of the supply chain of the company and compliance with standards and quality philosophy. Internationalization, the SCQM encourages cluster development through the association of companies as well as construction of joint value chains.

2-Analysis of the value chain and the impact of factors involved in a SCQM.

The interviewees indicate that they have processes for allocating costs of operations in the company, this cost structure accurately covers the different activities that compose it. Show that information systems are fragmented, mainly oriented towards control of sales and trade; while areas of operations operate with independent and professional systems.

Regarding to Processes related to different customers, agree about the in-depth knowing of customers to offer solutions through products or services; they have relations with traditional customers based on production planning orders received by customers (MTO - Make to order). Identify quality as a guiding operations activities, some companies have been certified ISO 9000 while other areas have qualified and responsible for a quality management system staff; consider the appropriate human resources and a strategic variable for business success. Technical knowledge is evident in operations for developing products and services that meet customer needs.

Contrast of SCQM with the results of the value chain:

The SCQM allows these companies align customer-supplier relations, orienting new approaches to both ways (upstream and downstream) based on trust and business development and long-term supply under the philosophy of building positive dependencies. You need to evaluate every element involved in the value chain, actions that favor the construction of SCQM in the SBU and functional areas.

3-Analysis of the generic strategic and the impact of factors involved in a SCQM.

The interviwees qualify with low rating the generic strategy but they although considered sometimes it is necessary. They expressed the difficulty in generating differentiation in markets through the pursuit of niche markets where the technology gap strongly impacts. Considered to have the organizational flexibility and its operational base to respond to dual strategies. Contrast of SCQM with the results of generic strategies:

The SCQM can generate value chains with higher operating cycles and synchronicity between the customer-supplier chain. The SCQM for structuring value chain founded in supply chains targeted for each type of niche considering the competition in an expanded level going competition between companies to competition between chains.

4- Analysis of the adjusted strategy based on resources and opportunities and the impact of factors involved in a SCQM.

About the adjusted strategy considering the resources available in the company and opportunities based on research and development: In companies evaluated, managers confirmed the need to continually develop a strategy in R & D to expand resources and opportunities to compete. Adjusted strategy considering the resources available in the company and opportunities based on knowledge: throws a strength evaluation in companies related to training and knowledge available to employees of operational areas and they consider it necessary to involve in the management strategy of the technology associated with market trends. Contrast of SCQM with the results of the dynamic strategy knowing the capacity in the organization and the supply chain.

Companies evaluated by implementing SCQM allows capacity building in the organization to compete demonstrated: empowerment in responsible roles and tasks for the development of plans and programs to continue efficiently the quality and supply chain, but in both and parallel to develop a philosophy of quality accompanied by programs and evaluation of recorded data. Transversality on which it develops SCQM allows executives responsible for the financial statements in the figures evidencing the benefits of joint and collaborative work.

5-Analysis of the capabilities of the organization to complete and supply chain and the impact of factors involved in a SCQM.

They consider that the organization has an open door policy for consultation and decision-making problems. Organizations are flat and basic, finding in the area of operations infrastructure with greater complexity, also the commercial area. The capacity in the financial structure of the company for making decisions; they consider that the financial situation of the company have an effective and efficient management, to have a good financial picture in the banking sector and have developed strong relationships with them.

Presents business areas that develops customer relationships to estimate, receive or follow up on orders placed. Quality is defined in the capacity to compete and a continuous requirement from customers. In some of the companies studied, this is met through specifications designed for each product and registration on ISO certified quality; even consider supply chain a direct relationship with suppliers through the purchasing function, it is necessary to integrate the customer-supplier relationship. Assessed to be fulfilling the environmental legal requirements demanded by environmental authorities but say at the same time the need to implement an environmental management system ISO 14000; they express the importance for the development of a CSR agree that in managing an organized company.

Contrast of SCQM with the results of the adjusted strategy knowing the actions for the development of resources and leveraging opportunities

The SCQM allows considering each node of transformation process of goods or services, as well as their suppliers, and the necessary technology centers to support the structure of a supply chain. Human resources must develop a body of knowledge that will provide the ability to develop a systemic approach and consider both customers and supplier's development partner's resources collaboratively.

6-Analysis of strategic intent and the impact of factors involved in a SCQM.

Companies are considered distant versus risk management in the supply chain, they have not considered mitigate or avoid risks that continually occur between the different links in the production chain or customers or suppliers that could affect business continuity. Organizational agility to respond to the interior and environment of the organization; is clear that companies have developed the ability to react to customer requirements or economic environment immediately. Research and development have no assessments of the state of art.

Most companies have not considered the development and exploration of future scenarios. Perception of the Government against the business sector, they believe the government economic policies and posing for graphic printing industry do not favor the competitiveness of companies involved. Andigraf perception, guild associated companies in the sector, they claim that the union encourages, promotes and allows it to be an enabling environment to share, understand and act in a coordinated manner between business scenarios.

Contrast of SCQM with the results of the strategic intent and the ability to develop competitive innovation permanently.

The implementation of the SCQM in the organizations of the printing industry sector would include management of cross-risk integrating the risks that arise with customers and suppliers, enabling the development of plans for resilience and continuity.

Factors evaluated through in-depth interviews and observations that permitted a profile on the competitiveness achieved by companies and then propose how can the SCQM participate in its improvement.

1-Variables that allow assess the status and development of customers. Prajogo et al (2008), associated the SCOM with the value chain.

Power customers about the company.	3.64
Value chain: development of commercial systems.	4.04
Value chain: ability to develop differentiated customers.	3.58
Generic strategy: 1x1 market development.	4.24
Capabilities of the organization and supply chain: commercial capacity.	3.62
Strategic intent: risk management.	2.6

Chart 3: Results of development of customers

Companies consider presenting skills to develop markets tailored to the needs of customers and have developed commercial systems markets microniches oriented capabilities. It is necessary to consider the risk management applied in this variable customer. It is an opportunity to guide SCQM to the requirements of customers and the market.

2-Variables to evaluate the state and development of suppliers. (Wang et al,1999), associated to the power of suppliers with SCQM.

Power of suppliers on businesses.	2.78
Value chain: supply logistics.	3.93
Capabilities of the organization and the supply chain: supply chain management.	3.76
Strategic intent: risk management.	2.6

Chart 4: Results state and development of suppliers.

Companies consider that suppliers have low power over its decisions reinforced with a supply logistics based on compliance with trade agreements established by a purchasing process. It is an opportunity to guide SCQM and strengthen relationships with suppliers

3-Variables for assessing the research, development and technology. (Prajogo et al, 2008), a documentary that technology and R & D determine the development of the SCQM.

Value chain: power of technology.	4.17
Development of differentiated markets.	3.84
Based research and development resources and opportunities.	2.45
Resources and opportunities oriented technology management.	3.15
Management of research, development and technology.	3.67
Assessment of future scenarios.	3.28

Chart 5: Results research, development and technology

Technology is considered to have a high power to generate differentiation in the markets. In contrast to this statement, the evaluated companies attach importance to technology but do not develop a coherent strategy.

4-Variables for assessing the organization. Lin c. et al (2013), presents critical paths for the development of SCQM, human resource management and knowledge management

Value chain: Human resources.	4.19
Strategy based on knowledge, training and human resources training resources.	4.13
Managerial capabilities, structure and organization.	4.38
Organizational agility.	4.13

Chart 6: Results related to the organization.

Companies evaluate positively the necessary human resources for the organization, with high skills, proven experience and ability to work under pressure. The managers define themselves providing efficient agility for decision making to external and internal situations.

5-Variables to assess the conditions of the organization to the market uncertainty. Reza A.A: et al (2010), guides the development of SCQM through strategic planning and long-term vision.

Rivalry: substitute products and power exerted on the sector.	3.33
Resources and opportunities: research and development.	2.45
Technology Management.	3.15
Strategic intent: research, development and technology.	3.67
Risk management.	2.6

Chart 7: Results market uncertainty

Companies evident in substitute products to traditional products made by companies in the printing industry sector to directly influence markets and business; despite this the resources for research and development, technology, technology as a strategic resource, have values that say a lack of attention to the uncertainty of the markets that have plunged the need to manage risk. Technology oriented and promotes the implementation of the SCQM.

6-Variables to assess the conditions of the organization against the socioeconomic organization against uncertainty. Kuei et al. (2008), considered to develop SCQM the adoption of advanced technologies and network development.

Government power.	2.32
Perception of government.	2.47
Power of socio-political events on the company.	4.03
Power of the internationalization of the markets.	3.1
Corporate environmental management.	3.93
Corporate social responsibility.	3.67
Risk management.	2.6
Future scenarios.	3.28

Chart 8: Results the socioeconomic organization against uncertainty

Companies consider themselves with strengths that allows them to cope with the social and political events, but the context against the interpretation of the power of the government and the perception of it highlighted the need to explore in depth the political and economic environment industry. It is necessary to contextualize the development of socio-political contexts SCQM.

7-Variables to assess the quality in the organization from a broad approach. Foster S. J.R. et al (2008) consider the quality tools, process structure and methods related to ISO 9000 to develop SCQM.

Value chain: Quality Management.	3.55
Value chain productivity.	3.51
Development of differentiated markets.	3.84

organizational capabilities and supply chain: Quality Management.	4.52
organizational capabilities and supply chain: environmental management.	3.76
Value chain: information systems.	3.6

Chart 9: Results quality in the organization

Companies define quality a central capacity to develop differentiated markets, but in contrast to assess the quality related value chain and productivity is necessary to create programs to strengthen quality management within the organization and supply chain. The quality management is considered a strategic condition in business and is an opportunity to implement the SCQM.

8-Variables used to assess the supply chain in the organization. Fraisal et al (2013), determines the construction of the supply chain and quality effects to structure SCQM.

Power customers about the company.	3.64
Power of suppliers on the company.	2.78
Power of the internationalization of the company.	3.1
Value chain: logistics and supply processes.	3.93
Value chain processes on information systems.	3.6
Generic strategy: trade capacity.	3.62
Generic strategy: differentiated markets.	3.84
Risk management.	2.6

Chart 10: Results supply chain in the organization

The supply chain in companies present in general terms, a chance to improve on relations with customers, suppliers, processes that allow the development of the functions related to logistics and capabilities to develop both local and international markets.

CONCLUSIONS

The 30 companies evaluated consider that they have very agile organizations, with managerial capabilities to enable an effective market orientation and human resources committed to high levels of training and education.

Also believe that have a quality management that can meet the requirements of markets and customers, generating differentiated approaches and effective business systems.

In contrast, the participation of the SCQM in building competitive advantage of companies is oriented towards the ability to buy raw materials, can improve this relationship by developing platforms that enable the integration of customers and suppliers;

On the other hand, they considered that only an orientation towards commercial relations based on order fulfillment can integrate researching for the development of new components, allowing the integration of innovation and technology to market development.

They partially assessed the socio-political and economic environment by identifying factors that could affect them, causing a lack of greater integration with corporate environmental management and social responsibility.

All companies have a degree of implemented technology to support the quality and supply chain. It is necessary to develop strategies for researching, innovation, design and development that integrates technology implementation as well as integrating the proposed plans with SCQM.

AKNOWLEDGEMENTS

This research was conducted with the support of the ANDIGRAF association, its president Maria Alexandra Gruesso and general managers, commercial of companies of cities: Bogota, Medellin and Cali. Doctoral program support ICESI University, Faculty of Industrial Engineering, Department of Industrial Engineering. Thank Silvia Guzman, assistant research.

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Improving Quality of Healthcare through the Selection of Right Technology: An Expert System Approach for a Public Sector Hospital

Ayyaz Ahmad, Zahra Badar Munir

Institute of Quality & Technology Management, University of the Punjab Lahore 54590, Pakistan

ABSTRACT

Purpose. The role of technology in health care is significant due to the accuracy of the output desired to provide the quality health care. It is noted that the technology related decisions are made by the people having little awareness regarding the issue of right technology selection and its possible impact on the quality of health care. The condition is not favourable particularly in developing countries public sector hospitals where it is quite common to select the wrong alternative or the underutilization of the selected technology. The purpose of this study is not only to highlight the importance of the technology selection issues in health care system but also to develop practical solutions to address the challenges.

Approach. The research systematically highlighted the importance of technology selection in providing quality health care and an Expert System for the selection of Auto haematology analyser was developed and applied, to select the best system in a public sector hospital. The developed system uses the Analytic Hierarchy Process (AHP) based Expert Choice® Shell which takes the preferences of the user to arrive at an optimal solution.

Findings. A framework for the selection of medical equipment was developed which surfaced many parameters. The identified parameters were not the part of decision making and decision without considering these parameters could end up with a wrong or underutilized technology alternative. The developed expert system prioritized all the alternatives based on the user requirements which could provide a great help for decision makers particularly when number of alternatives increase.

Originality/Value: The research highlights the critical importance of the health care technology selection process and through a case study points out the limitation of the current procedures. An expert system was developed and applied in a public sector hospital which can be modified for other technology selection processes. The research will provide more refined methods of technology selection process to ensure true utilization of the investments and high quality of the health care to its customers.

Note: The analysis used in the paper is a sample from a large data analysis for illustration purpose.

Paper Type: Research Paper

Keywords: Expert System, Healthcare, Quality, Technology Selection.

INTRODUCTION

Progression in medical technology, global competitive economy and reduce life time of technologies are compelling hospitals for the adoption of new equipment. Hospitals are the main buyers and user of medical technologies. Their technology implementation decisions not only affect the financial resources but also have a great impact in determination of the degree of quality the system is capable to produce. Technology Assessment is fairly a new area and it ancestries can be traced back in 1960 in USA, when technology started to amend the way of life. Even the improved technology assessment methods has evolved during last decades but there are appalling requirements to discover more effective means (Tran & Daim, 2008). An important decision problem for managers is to develop an assessment system to guide process selection decisions, by integrating the up-to-date technology and techniques available, at very early stage of the decision process. The decision criteria may be based on speed, capacity, functional requirements, desired output, quality etc. These attributes should be harmonized with the distinctive equipment features to reach at best solutions. Numerous conflicting scenarios exist, where the partial capability of the decision maker make situation more complicated. Increase in variety of alternatives make the decision making task more difficult (Rudder et al., 2008).

Technology Selection is a specialized area where selection cannot be based on technical parameters only. The selected alternative must be in line with the business objectives so that it can contribute in uplifting of the system. Such situation warrants understanding of both the business and technical dimensions, whereas in majority of cases such relation is hard to recognize by the decision makers (Tate & Nordlund, 1996). Understanding the technology and its impact on business operation and competitive position are an essential and critical part of any technology related initiatives. Technology diffusion is composed of many different decisions, which are the outcome of equating undefined returns of the new technology with the unclear adoption cost and understanding of these factors is indispensable (Hall & Beethika, 2003). According to Chan et al. (2000) the selection and validation processes demand exploration of the large number of economic and analytical features and the change in the external markets or customer desires usually elicits the replacement of the older technologies or introduction of the new technology to address these changes, such factors can also be treated as "Push" for technological change.

ISSUES OF IMPLEMENTATION OF TECHNOLOGY AT HOSPITALS

The selection of the right technology which meets both the customer requirements and financial goals is becoming a unnerving task due to several conflicting criterion and increase in number of available alternatives. Coye & Kell (2006) argued that many factors are contributing in this complex decision making process which includes increase in new medical technologies, reducing access to financial resources and the limited capacity of the decision makers. Billete et al. (2014) suggested that the new technology must be need based on right selection criteria. Unwanted technology parameters just cause high capital cost and do not work properly according to hospital needs. One of the factors which must be considered during the process of technology selection is the high cost associated with the health care technology. Any wrong selection in the selected solution may lead towards a complete desuetude or the underutilization of the technology which ultimately results in substantial financial losses and reduced healthcare quality. In public sector hospitals predominantly in developing countries, at first the situation goes undetected and if something surfaced than due to several reasons which include social setups, governance issues in government departments, the matter normally is restricted to files only without taking any practical measures. David (2008) argued that "The feature of cost escalation that should catch our eyes most is the role that medical technology plays. Health care economist estimates that 40-50% of annual cost increase can be traced to new technologies". Such a huge investment which ultimately is linked with the quality of the service to the patients deserve detailed investigations

particularly the close partnership of technology experts with the health professionals to arrive at optimal solutions. The demand for cautious assessment of drugs, supplies and equipment is growing in clinical practices (White & Smith, 1993). "A lack of detailed, neutral information about candidate technologies leaves hospital administrators poorly prepared to fend off physician champions of undesirable technologies or to advance beneficial technologies. Hospitals' decisions about technology investments have historically relied largely on information supplied by vendors" (Coye & Kell, 2006).

EXPERT SYSTEM DEVELOPMENT AND APPLICATION IN A PUBLIC SECTOR HOSPITAL

Selection of technology is a daunting task. There are several issues with the selection of right technology. The first and the foremost is the development of selection criterion: i.e. which factors must be considered during the selection of technology. Second significant concern is the availability of large number of alternatives due to rapid advancement in the technology. When large number of selection parameters cartel with the properties of the available alternatives, it ends up in a complex situation, where several trade-off scenarios exist. Under such circumstances making decision particularly for a person with a limited knowledge about the technology, selecting the right alternative is almost impossible and the ultimate result is the mismatch between what is actually required and what is purchased. It not only affects the quality of the health care but results in financial losses, as large amount of money is also tied up with the technology due to the high cost associated with medical technology. Such situations demands interventions of the experts, who work closely with health professionals to arrive at improved solutions.

A technology selection model is developed by using practical application of Expert Choice® `software which is based on Analytic Hierarchy Process (AHP). "The strength of the AHP approach lies in its competency to build a complex, multi-attribute, multi-person and multi-parity problem; it can also handle both qualitative and quantitative data. Pairwise comparison can be made using a scale which indicates the intensity with which one element dominates with respect to a higher level element" (Tiwari & Banerjee, 2001). The main steps involved in the AHP process are,

- Stating problem & objective,
- Collect all the parameters effecting the objective,
- Structuring problem in the form of hierarchy stating objectives, sub objectives and alternatives.
- Pairwise Comparison of every element with one above in to get the numerical value.
- Synthesis of the result.
- Sensitivity Analysis

The developed expert system was applied in a public sector hospital for the selection of Optimum Auto Haematology Analyser. Data was collected from the technical staff of the hospital and selection criterion was discussed in detail for any further refinement. The first step includes defining the problem and creating a hierarchical model of decision problem. In decision making, a problem is decomposed into its constituent parts, simpler components. This structure consists of different levels the highest level is goal, then it have criteria, sub-criteria and alternative at the bottom of model. The expert system was built upon the data collected from literature and hospitals equipment parameters, some of them are such as Manufacturer, Price, Functions Performed, Accuracy etc. Figure 1 shows sample tree view of the selection criteria developed in Expert Choice®. (The original tree diagram involves many more parameters but due to the sake of simplicity only few of them are shown here)

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Model Name: CopyTechnology Selection Model for Hospital

Treeview

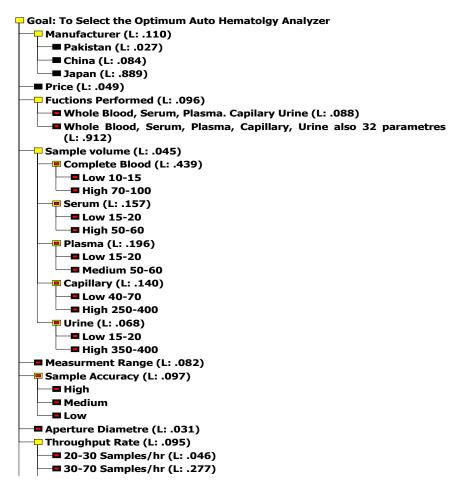


Figure 1- The Tree view with hierarchical structures

Total five alternatives were identified. Figure 2 shows the abilities of the alternatives to satisfy selection parameters. The data from the manufacturers were obtained against the defined parameters in Figure 1 and were placed in the knowledgebase to measure the ability to meet the defined parameter by the equipment under consideration against each parameter.

	DIRECT	DIRECT	DIRECT		
Alternative	High 350-400	Measurment Range (L: .082)	High		
EasyLyte	.980	.200	.460		
BC-2800	.950	.440	.500		
BC-3000 Plus	.030	.440	.590		
SYSmex	.040	.830	.950		
XE-2100 SYSmex	.070	1.000	.930		

	DIRECT	DIRECT	DIRECT
Alternative	Medium	Low	Aperture Diametre (L: .031)
EasyLyte	.420	.840	
BC-2800	.440	.810	
BC-3000 Plus	.460	.370	
SYSmex	.060	.180	
XE-2100 SYSmex	.100	.170	

	DIRECT	DIRECT	DIRECT		
Alternative	20-30 Samples/hr (L: .046)	30-70 Samples/hr (L: .277)	70-150 Samples/hr (L: .677)		
EasyLyte	.940	.030	.030		
BC-2800	.920	.810	.070		
BC-3000 Plus	.020	.800	.040		
SYSmex	.050	.110	.670		
XE-2100 SYSmex	.050	.110	1.000		

Figure 2 - Weightage of alternatives according to the selection parameters

ASSESSING THE WEIGHTS OF THE CRITERIA

The parameters identified carry different weights in the process of final decision. The importance of one parameter for one hospital may entirely be different from another hospital. The developed application can be equally applied under all circumstances. Determination of the priority value for the user against

the predefined selection criteria was the next step where Figure. 3 shows the questionnaire used to determine the priorities of the user according to the selection parameters.

Compare the relative importance with respect to: Goal: To Select the Optimum Auto Hematolgy Analyzer

Grde one number per row below using the scale: 1 = Equal 3 = Moderate 5 = Strong 7 = Very strong 9 = Extreme

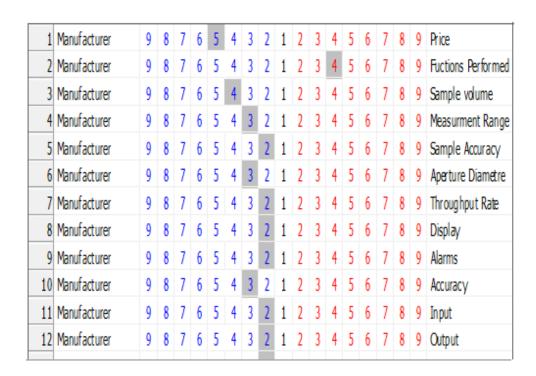


Figure 3- Alternatives relative importance with respect to selection parameters

RESULTS OF SYNTHESIS

The synthesis result for five equipment is shown in Figure 4. The list is developed based on rating of each alternative, which is grounded upon ranking of selection criteria. The list of five equipment was made by ranking the values from high to low by using the Expert Choice® to ease the analysis process. The list clearly indicates the XE-2100 SYSmex is the optimal system which meets the requirement of the user whereas the other alternatives are ranked according to the priorities, just in case the availability of the first priority is not

possible

Synthesis with respect to:

Goal: To Select the Optimum Auto Hematolgy Analyzer

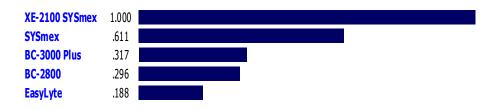


Figure 4: Result of Synthesis according to the priorities

SENSITIVITY ANALYSIS

Sensitivity analysis was the final step of decision process and is shown by what-if analysis provided in Figure 5. The user slightly changes the priorities in order to observe the impacts on results, which is completed by dragging the priority values; at the left the priority values on the alternative were also changed. If the user change the priority values and the new values does not change the decision it is said to be robust. For example change the values like manufacturer 11.0% to 7.8 as shown in Figure 6 and such as function performed 9.6 to 6.8 and so on change the others values of parameters as shown in Figure 5. This shows that slight modification of values does not impact on the result and decision is stable as shown in Figure 6, where the XE-2100 SYsmex is still the top selection even though the user slightly changes his preferences. This validates the result findings and the selection of selected equipment is appropriate and stable.

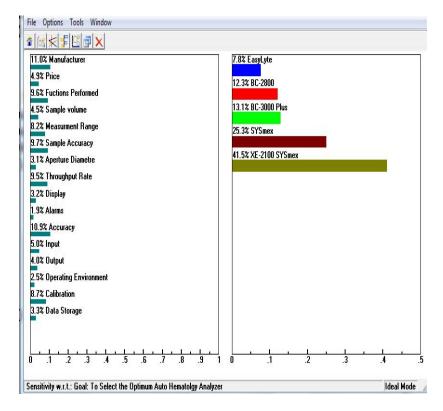


Figure 5: Sensitivity/ What-If Analysis

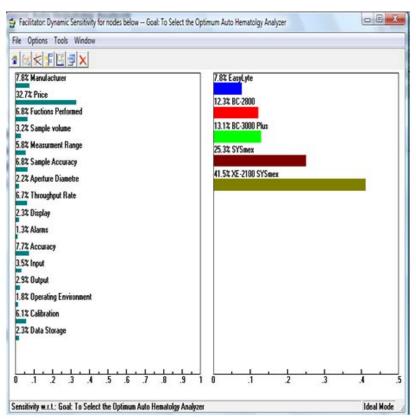


Figure 6: Sensitivity/ What-If Analysis (After Change in Prefrences)

CONCLUSION

The selections of the right technology have critical impact on the quality of output produced. A right selection not only results in more customer satisfaction but at the same time results in saving of large amount of sum which otherwise can be wasted by investing in wrong alternatives. Advancement in technology and increase in number of alternatives has made the selection process tricky where the combination of several parameters need to be identified and then decision is required to be made out of several confliction criterion. This is a complicated task and by considering the hospital structures and expertise is not easy to find particularly in developing countries.

An expert system is developed not only to provide assistance in the selection of technology but also to show the complexity involved in the process of technology selection. This may help administrations to divert their attentions and to develop more formal and realistic approaches in making such decision. The research first developed a framework of identified parameters and then offered solution based on the user's priorities given to the expert system. The developed expert system can be utilized in any case, depending on the unique individual requirements. This study also suggests exceptional attention and further research need to be carried out to exactly know the cost tied up with the wrong selections. It will also help to highlight the gravity of the issue.

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The EFQM model and the integration of management systems as different methodologies to achieve stakeholders' satisfaction

Navas, J.L.1) and Bernardo, M.1)

Department of Business, Universitat de Barcelona, Av. Diagonal, 690, 08034 Barcelona (Spain)

ABSTRACT

Purpose - The aim of this paper is to analyze, through a literature review, if the EFQM model and the integration of management systems are similar practices to achieve stakeholders' satisfaction.

Design/methodology/approach - The methodology applied is a literature review in which each practice is analyzed separately and then jointly to describe a dependence relationship. This is the starting point for which a two-strategy methodology is proposed to understand when a company decides to implement one or the other.

Findings - The results show that these two practices have the same objective, satisfying all the stakeholders, but are different methodologies that companies can use to achieve this aim. Organizations will choose one of them depending on their management strategy but also on their commitment and resources availability. Based on this research, a methodology defining two strategies that an organization can implement is proposed for future research.

Originality/value - Although studies analyzing the relationship between these two practices have been published before, this is, to the best of the authors' knowledge, the first paper comparing them at the same level and proposing them as different methodologies to achieve the same objective.

Keywords: stakeholders' satisfaction, EFQM model, integration of management systems, methodology.

Paper type: Conceptual paper

INTRODUCTION

The current highly competitive environment in which companies operate has led organizations to adopt different management systems standard (MSSs). This means the presence of multiple management systems (MSs) that often operate in isolation and cover different functions (de Oliveira, 2013). While most of the international standards are for product or process, it is very remarkable the success achieved in recent years by the standards of MSs referring to different aspects of business, such as: quality and environmental MSs with a highly successful dissemination of ISO 9001 and ISO 14001 (ISO, 2015); prevention of labor hazards and health and safety at work (e.g., OHSAS 18001, ISO 45001); innovation (e.g., UNE 166002) and social responsibility (e.g., SA8000, AA1000). The majority of these standards follow a similar structure, implementation process and verification by a third party (Heras and Casadesús, 2006).

In this context, the great majority of organizations with multiple MSs implemented have decided to manage them as a single and more efficient MS (Douglas and Glen, 2000; Salomone, 2008; Bernardo et al., 2009), the integrated management system (IMS). Several authors have identified the main motivations for the integration process, for example it has proven to be beneficial for internal cohesion, improve efficiency, corporate culture, image, strategy and the stakeholders' involvement (Karapetrovic, 2003; Bernardo et al., 2015). While every single MS is persuading a benefit for a specific stakeholder of the organization, the integration of multiple function-specific MSs aims to increase and widening this benefit to all the stakeholders.

But integrating different MSs is not the only managerial practice to satisfy all stakeholders. Parallel to the proliferation of different MSs, the European Foundation for Quality Management (EFQM) developed over the past decades the EFQM excellence model as a means of self-assessment and determining the processes of continuous improvement in both private and public organizations (EFQM, 2013). This excellence model provides a holistic tool to assess the effectiveness of the strategy defined for all stakeholders in an organization. In short, it is a cause-effect model that allows understanding the results of any decisions made in the company and allows self-assessment continuously, meaning a focus not only in one specific area of the organization but also for a general satisfaction of all the stakeholders involved (EFQM, 2013).

Both practices, the integration of MSs and the EFQM model have been related in terms of dependency, i.e., one proposes that in order to integrate, the EFQM model could be used as a methodology (Tarí and Molina-Azorín, 2010), while the other proposes the contrary, i.e., that excellence can be achieve through integration (Asif et al., 2009). To the best of the authors' knowledge, no proposals have been done comparing both practices at the same level.

Thus, taking the abovementioned into account, the aim of this paper is to analyze, through a literature review, if the EFQM model and the integration of MSs are similar practices to achieve stakeholders' satisfaction.

The paper follows with a brief review of the integration of MSs and the EFQM model and their relationship. The proposal of methodology is presented next and the conclusions section close the paper.

MANAGEMENT SYSTEMS INTEGRATION

The integration of MSs can be defined as "the process of unifying different function-specific management systems in a unique and more effective integrated management system" (Beckmerhagen et al., 2003). The Integrated Management System (IMS) can be defined as a "set of interconnect processes that share a pool of human resources, information, materials, infrastructures and financial resources with the aim of achieving a set of objectives related to a great variety of stakeholders' satisfaction" (Karapetrovic and Willborn, 1998a; Karapetrovic, 2003).

Thus, the final aim of managing the implemented MSs as a unique MSs is twofold: to increase efficiency and to satisfy all the organizations' stakeholders. In order to do so, the integration process can be described in 5

main aspects (Bernardo et al., 2012a; Domingues et al., 2015): strategy, methodology, level, audits, benefits and difficulties. They are explained below.

The 'integration strategy' refers to the implementation order of the multiple MSs and also the amount of MSs. When considering the two most common MSs, i.e., ISO 9001 and ISO 14001, the most followed strategies are to establish (Karapetrovic and Willborn, 1998a): first the QMS and second the EMS; first the EMS and second the QMS; and QMS and EMS simultaneously. If other MSs are implemented in the moment of starting the integration process, they are also considered depending on the model (process map, PDCA, etc.) or following the chronological publication order (Karapetrovic, 2002; Karapetrovic and Jonker, 2003). Labodová (2004) proposed two sequences: (1) implementing the MSs sequentially (step-by-step) and then integrating them or (2) implementing the IMS directly. The empirical studies published regarding this aspect show that the great majority of organizations implement first the QMS and then the EMS, although in some cases, mainly because of the sector requirements, the sequence of implementing first EMS and then QMS is also followed (see e.g., Douglas and Glen, 2000; Karapetrovic et al., 2006; Zeng et al., 2007; Griffith and Bhutto, 2008; Salomone, 2008; Karapetrovic and Casadesus, 2009; Abad et al., 2014).

The 'integration methodology' is the model or tools used in the integration process. This aspect is the least standardized although several proposals have been published from different sources. The national standardization bodies have published different guidelines (AENOR, 2005; BSI, 2012), and ISO has published a manual (ISO, 2008). The academia has also proposed several methodologies (Karapetrovic and Willborn, 1998a; Jonker and Karapetrovic, 2004; Karapetrovic, 2005; de Oliveira, 2013; Pal Pandi et al., 2016). For example, Karapetrovic et al. (2006) found that the most used for integration was the process approach, because the majority of the organizations in the sample had implemented first the ISO 9001. Asif et al. (2009) present a methodology to achieve excellence in which the integration of MSs is a key step and on the other side, Tarí and Molina-Azorín (2010) argued that the EFQM model could be a methodology to achieve the integration of MSs. Rebelo et al. (2014) also propose a model with the aim of improving the organizations' competitiveness and value added.

The 'integration level' is the degree at which the different MSs can be common. This aspect has been widely analyzed in the literature and several levels have been proposed (Karapetrovic, 2002; Bernardo et al., 2009; Santos et al., 2011; Sampaio et al., 2012; Abad et al., 2014), but they are mainly based on Karapetrovic (2003)'s three-level proposal: no integration, partial integration and full integration. In addition, Bernardo et al. (2012a) argue that those organizations that implement QMS and EMS simultaneously achieve higher levels of integration.

The 'integration of audits' refers to the integration level of both the internal and the external audits, that may result in benefits, such as the optimized use of resources (Karapetrovic and Willborn, 1998b; Douglas and Glen, 2000; Zeng et al., 2007; Kraus and Grosskopf, 2008; Salomone, 2008), and reduction of time due to multidisciplinary auditors who have the capacity of auditing different MSs (Douglas and Glen, 2000; Kraus and Grosskopf, 2008; Simon et al., 2011). Karapetrovic and Willborn (2000) introduced a generic audit guideline based on the process approach and Karapetrovic and Willborn (1998b) presented the audits also as a starting point for the integration process. Empirical studies found, in general terms, that the internal audits are more integrated than the external (e.g., Beckmerhagen et al., 2003; Bernardo et al., 2010; Simon et al., 2014; Hoy and Foley, 2015).

Regarding the 'integration benefits and difficulties', the most highlighted benefits are costs savings, operational benefits, better external image and improved customer satisfaction (Salomone, 2008; Zeng et al., 2011; Bernardo et al., 2015), while the main difficulties are the lack of resources and employees' motivation (Salomone, 2008; Bernardo et al., 2012b; Gianni and Gotzamani, 2015).

But other aspects about the IMS have been also analyzed. For example, Rocha et al. (2007) propose a model based on three different options, named 'ascension', 'augmentation' and 'assimilation', depending on the MSs or managerial practices that organizations could implement, but with the final aim of integrating all of

them in an IMS. In the same vein, González et al. (2014) propose a model to calculate the costs of IMS implementation as a tool to support the decision-making process. Almeida et al. (2014) found that the critical success factors when integrating are top management involvement, availability of human and financial resources and training. Ferrón Vílchez and Darnall (2014) argued that having two MSs improves the organizations' performance (see also de Oliveira, 2013). Other studies relate the integration of MSs with customer satisfaction (Simon and Pentji Yaya, 2012) or innovation performance (Bernardo, 2014; Hernandez-Vivanco et al., 2016).

EFQM EXCELLENCE MODEL

By the time the European Foundation for Quality Management (EFQM) was founded, it was also created the EFQM Excellence Model, a non-prescriptive framework that recognizes that there are many approaches to achieve sustainable excellence (Ghobadian and Woo, 1996).

The EFQM model is the main reference for European companies aiming to achieve sustainable performance by meeting all stakeholders' expectations. The founding members developed a multi-dimensional quality management representation, known as the EFQM model, and introduced the principles of self-assessment and the European Quality Award Program (Nabitz et al., 2000). The essence of the EFQM model is that performance must meet the expectations, needs and demands of the stakeholders and customers (Nabitz et al., 2000).

The EFQM model appeared to become the reference model for deploying the total quality management (TQM) in Europe providing a holistic tool for assessing how effective companies are in developing and delivering a strategy focused on stakeholders. Although the EFQM model is not intended to represent a TQM system, it has been seen as a standard by Bemowski (1996) and Uzumeri (1997). The EFQM is a model in which an integrated system could be built (see Griffin 1998; Jonker and Klaver 1998) and is considered to constitute a valid representation of TQM (Ghobadian and Woo, 1996; Eskildsen, 1998; Van der Wiele et al., 2000; Westlund, 2001). Recently, Bou-Llusar et al. (2009)'s findings supported the EFQM model as an operational framework for TQM.

Following its recommendation, the EFQM model can be used in different ways (EFQM, 2013): (1) as a tool for self-assessment; (2) as a way to benchmark with other organizations; (3) as a guideline to identify areas for improvement; (4) as the basis for a common vocabulary and a way of thinking; as well as (5) a structure for the organization's MS. Similarly, the EFQM model is explored in terms of different tools for systematic performance management (Wongrassamee et al., 2003), self-assessment (Tari, 2006), teamwork development (Castka et al., 2003), and benchmarking (Moeller et al., 2000; Castka et al., 2004). The EFQM model allows the understanding of a cause-effect relationship between what is the organization doing and its results. This model consists of three main parts: (1) EFQM fundamental concepts, (2) the EFQM criteria and sub-criteria and (3) the RADAR logic (Bolboli and Reiche, 2015).

The "fundamental concepts of excellence" is the theoretical framework that constitutes the basis of the EFQM and defines 'Excellence' (Vallejo et al., 2006). As it is defined in the model (EFQM, 2013), this framework has eight generic concepts that provide the theoretical guidelines that should guide the organization: sustaining outstanding results, customer value added focus, leadership with vision and inspiration, management with agility, people talent development and involvement, developing organizational capabilities, harnessing creativity and innovation and creating a sustainable future. The model logic considers that excellence involves balancing the stakeholders' needs (Nabitz and Klazinga, 1999). The EFQM has shown in 90s and 2000s its validity in relation to the aim for which it was conceived, recognizing excellence, which is the highest level of organizational quality (Conti, 2007).

This model has nine "criteria" including leadership, people, strategy, partnerships and resources, processes, people results, customer results, society results, and business results. These dimensions are grouped into two

main criteria (see figure 1), the "enablers" (leadership, people, strategy, partnerships and resources, and processes), and the "results" (people results, customer results, society results, and key performance results). This assembly system depicts that "an organization with well-developed enablers will have excellent results" (Nabitz et al., 2000). Therefore, excellent results are achieved through effective application of enablers. Enabler criteria are concerned with how the organization undertakes key activities; on the other hand, results criteria are concerned with what results are being achieved (Heras-Saizarbitoria et al., 2011). The model represents the criteria to be met to assess progress towards excellence and gives companies a holistic overview of their organization.

The EFQM model enablers and results are effectively linked to each other (Calvo de Mora et al., 2005; Sadeh and Arumugam, 2010). The model emphasizes the causal relationship between them (Bou-Llusar et al., 2009), results feedback (Vernero et al., 2007) and leadership are the most effective criteria having the largest influence on other excellence concepts (Sadeh and Arumugam, 2010). The arrows emphasize the dynamic nature of the model, showing learning, creativity and innovation helping to improve the enablers that in turn lead to improved results. This structure assumes the existence of interrelations among enablers and results and the fact that having success in an isolated area is not enough to achieve excellence (Naylor, 1999).

The EFQM recommends organizations to conduct a self-assessment as a strategy to improve their overall efficiency (Hakes, 2007). The EFQM model is offered as a tool that managers can find useful for the self-evaluation of their organizations (Van der Wiele et al., 2000; Ahmed et al., 2003). It can also help producing a more customer-oriented culture (Hides et al., 2004) and it is a practical tool that can be used as a guideline to identify areas for improvement (Moeller, 2001; Dodangeh et al., 2011).

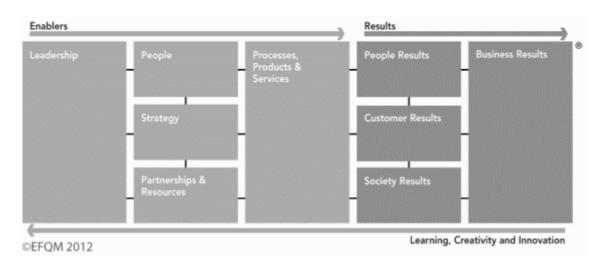


Figure 1 – EFQM Model Source: EFQM (2013)

At the heart of the EFQM excellence model lies a logic known as "RADAR". It is a measuring system which stands for Results, Approach, Deployment, Assessment, and Review (EFQM, 2013). The elements of approach, deployment, assessment and review are used when assessing the "enabler" criteria, while the results element is used when assessing the "results" criteria. The evaluation process is based on awarding points on a scale from 0 to 100, corresponding with an evaluation in percentages (Herget and Hierl, 2007). According to EFQM (2013), RADAR logic plays a key role for successful implementation of the EFQM model and is a dynamic assessment framework and powerful management tool that provides a structured approach to evaluate the performance of an organization. The basic idea behind the RADAR logic is that the model criteria provide an instrument or rating system for comparing an organization with other organizations (Tutuncu and Kucukusta, 2007).

Concerning performance measurement and innovation, the EFQM model is one of the most complete models that can be used to measure the performance of the innovation process, because it can be done through all of its criteria (Ivanova and Avasilcăia, 2013). The effective implementation of model leads to performance improvement in both short- and long-term periods (Boulter et al., 2013; Moll and Kohler, 2013). Regarding the business results, the experts indicate that the implementation of the EFQM model contributes to a reduction in inconsistencies and quality costs. It is also considered a contribution to cost savings and to an increase in the security of operations which, taken together, contribute to a decrease in errors and defects produced (Heras et al., 2006).

RELATIONSHIP BETWEEN THE MSs INTEGRATION AND THE EFQM MODEL

The relationship between these two practices analyzed in the literature has been based on their dependence, i.e., the EFQM model is presented as the methodology to integrate MSs (Tarí and Molina-Azorín, 2010) and on the other side; integration is a step to achieve excellence (Asif et al., 2009).

Regarding the first direction of the relationship, as commented, Tarí and Molina-Azorín (2010) proposed an approach for the integration of quality and environmental MSs (QEM system) based on the EFQM model acting as a framework. In this relationship, the 5 enablers of the model were identified as integrated management dimensions and the 4 model results used as outcome measures of the integration of management systems. In other words, the EFQM model meets the requirements of QMS and EMS and facilitates their integration. That is, the EFQM model categories support the development of actions that fulfil the QM and EM dimensions suggested in the literature and also cover the requirements of QMS and EMS (e.g. management commitment, resource management, measurement, and analysis and improvement).

In the same line, Wilkinson and Dale (1999) noted that the EFQM model can be a valuable tool for the establishment of an IMS. As a holistic model, based on the pursuit of excellence, clearly defines the relationship between business decisions and results with processes of continuous self-assessment, makes integration possible to overcome any barrier presented by integration processes.

The other direction of the relationship, i.e., the integration of MSs is a step to achieve excellence, is discussed in Asif et al. (2009). These authors propose the Process Embedded Design of Integrated Management Systems (PEDIMS) model in which the organization achieves excellence in four main steps: (1) core processes, in which the key processes are designed; (2) operational excellence, in which the management should be efficient and maximizing the value for stakeholders; (3) integration in the strategy and operations, in which the integration of MSs should be integrated also in the processes, and (4) business excellence.

From another point of view, Rocha et al. (2007) proposed a model for the maintenance or sustainability of the IMS. The model has three main axes: (1) 'ascension', in which the satisfaction for a particular stakeholder is enhanced (e.g., an organization that has the ISO 9001 already implemented, implements the EFQM model); (2) 'augmentation', in which the organization wants to go more in-depth in a part of the MS (e.g., an organization that has the ISO 9001 already implemented, implements one of the MSs of the ISO 10000 series for customer satisfaction); and (3) 'assimilation', in which the IMS is continuously improved.

METHODOLOGY PROPOSAL

The literature review conducted allows concluding that the main aim of both practices is to increase or improve stakeholders' satisfaction. Depending on the strategy adopted by the organization, this satisfaction could be achieved by integrating the existing MSs or by the implementation of the EFQM model.

In this sense, integration of MSs should be considered as an addition of different standards being previously implemented in an organization where each one is focused on for a specific stakeholder area. So, it could be understood as a sequential way of reaching stakeholders' satisfaction and it is incremental every time the

company integrates another type of MS. On the other side, the EFQM model is a simultaneous way of reaching all stakeholders' satisfaction at the same time because it is a holistic model with the purpose of connecting and assessing all areas in a company. This explanation is shown in figure 2.

The proposal is similar to Labodová (2004)'s proposal, in which two strategies were presented: step-by-step or integrated. The current proposal could be classified in these two same possibilities:

- "Step-by-step" refers to the integration of MSs in which the function-specific MSs are introduced sequentially and thus, the global satisfaction is gradually achieved by adding the specific stakeholders' satisfaction. The result of the integration process, i.e., the IMS, satisfies all the stakeholders.

In figure 2 it is shown by adding to the initial IMS (created by two MSs as it is the most common, see e.g., Douglas and Glen, 2000; Zeng et al., 2007; Bernardo et al., 2009), new MSs that satisfy different stakeholders. The IMS could grow as much as the MSs implemented and integrated.

This methodology could also be related to Rocha et al. (2007)'s proposal. In the model the 'ascension' and 'augmentation' axes propose that additional managerial practices are implemented with the aim of integrating all them into an IMS, the 'assimilation' axis.

The time needed to implement this methodology depends on the number of organization's stakeholders. Regarding the difficulty of implementing and integrating new MSs, it will be reduced over time first because of the experienced gained but also because ISO is applying the High Level Structure (HLS) to all its new and renewed MSs. The HLS means that all MSs have the same structure enhancing their integration. On the other hand, this process could finally achieve a more tailored and dedicated result regarding the organization needs.

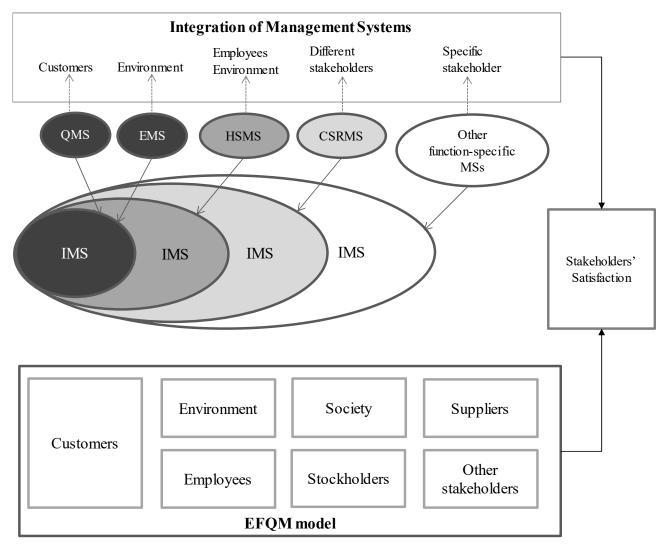


Figure 2 – Methodology proposal

- "Integrated" refers to the EFQM model implementation as it considers all the organization's stakeholders as part of the model and has a holistic vision of it. Additional practices can also be implemented, but the model covers the main stakeholders and its aim is to satisfy all them.
 - This methodology proposed a "one shot" implementation of all stakeholders' satisfaction. In this case, the organization would consider all the stakeholders' needs at the same time and provide a global management solution for all areas. This approach depicts a holistic view of the organization but it could also mean a higher degree of implementation complexity due to the existing areas interrelations.

It could be considered the same case when the organization decides to implement an IMS directly if it covers the same stakeholders as the EFQM model.

Which methodology is the most appropriate depends on the organization. It seems clear that those organizations that have implemented multiple MSs will chose to follow the step-by-step methodology because it allows following with the same strategy of MSs implementation and integration. Other organizations with a more holistic strategy and no previous MSs implemented would decide to implement the EFQM model. The number of resources, current business plan and top management commitment are important variables that could mediate and would directly affect this decision.

However, choosing one methodology does not mean refusing the other, i.e., one organization could decide to integrate MSs and then implement the EFQM model because of a cultural and strategic change or because the market demands having this practice implemented. Moreover, one organization could implement the EFQM model and then integrate an additional new MS that could complete other stakeholder's satisfaction not initially considered. In any case, the dependence relationship that previous proposals were posing is not considered in the current proposal as it considers both practices at the same level and complementary.

CONCLUSIONS

MSs literature has traditionally presented the IMS and the EFQM model as two practices very dependent one from the other, in which EFQM could act as a framework to carry the integration of multiple MSs implemented or the IMS as a path to reach excellence in an organization. Thus, the usual relationship established by scholars between both practices has been focused on how one methodology relays on the other proving always a high degree of interdependency between them.

The literature review presented in this study allows concluding that both methodologies have the same ultimate goal of increasing and improving the stakeholders' satisfaction. Furthermore, the way on how each one achieves this aim is different and proves that IMS and the EFQM model are independent but complementary methodologies. A new classification methodology is proposed with two ways of reaching stakeholders' satisfaction based on the main aspects of both practices. One is sequential ("step-by-step") and represents the IMS methodology, for which every single MS implemented and integrated in the organization aims to increase the global satisfaction by covering a specific stakeholder need. The other is simultaneous ("integrated") and represents the EFQM model with its holistic view aiming to improve all stakeholders' satisfaction at the same time. Organizations will choose one of them depending on their current managerial situation and their strategy, the latter relaying on commitment and resources available.

Previous studies analyzing these two practices have based the relationship on its dependency, but this is the first proposal, to the best of the authors' knowledge, in which both are compared at the same level. Implications for managers are the provision of two different methodologies to achieve stakeholders' satisfaction widening their options to improve. For the academia, this different point of view of methodologies could open new research lines.

As a conceptual paper, future studies including qualitative and quantitative research will be needed to reinforce the main conclusions of this paper.

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The evolution of intensity certification in ISO 9001 and ISO 14001: a comparative analysis by countries

Prestanicola, C.1, Galetto, M.2 and Marimon, F3

- ¹⁾ Master Student, Department of Management and Production Engineering, Politecnico di Torino, Turin, Italy
- ²⁾ Associate Professor, Department of Management and Production Engineering, Politecnico di Torino, Turin, Italy
- ³⁾ Professor, Department of Economy and Business Organization, Universidad Internacional de Catalunya,
 Barcelona, Spain

ABSTRACT

Purpose -This paper has two main objectives: the first one is to provide a literature review of the most widespread management standard certificates, ISO 9001 and ISO 14001 and the second one is to pursue and intensify the previous researches about certification intensity level in both ISO standards.

Design/methodology/approach - We will trace the evolution of ISO 9001 and ISO 14001 in terms of diffusion, improvements, and analogies from their inceptions until nowadays. For each standard, we will look at its internalization and its decertification.

For this purpose, 16 countries have been selected along the period from 1999, the first year covered by ISO Survey in relation to both ISO 9001 and ISO 14001, until 2014.

An analysis on the evolution pattern of certification intensity levels for each country will be provided by plotting the intensity certification rates of both standards. A particular attention will be paid to China, Italy, Japan and Spain.

Findings – Through both quantitative and qualitative analysis, the patterns for the selected countries have been traced. Every country shows a specific trend because of its idiosyncratic history and of its increasing participation in the international economic context. Nevertheless, some categorizations are provided, focusing more on similarities than on dissimilarities countries' patterns can show. For this purpose, the classification into expansive, mature, retrocessive behavior is used.

Originality/value - Particular attention is paid to the studies conducted by Marimon, Casadesùs, and Heras resulting in two articles published in 2008 and 2010. Based on these, our analysis will focus on the concept of certification intensity level aiming at discovering how much a country is certified against its wealth and how its certification level evolves over time.

Keywords: ISO 9001, ISO 14001, evolution, intensity level.

Paper type Research paper

INTRODUCTION

The current study aims at pursuing and intensifying the previous researches conducted by F. Marimon et al. about certification intensity level in both ISO 9001 and ISO 14001 standards.

In particular, it has its origins in the two following articles: ISO 14001 diffusion after the success of ISO 9001 model and Certification intensity level of the leading nations in ISO 9000 and ISO 14000 standards (Marimon et al., 2008) (Marimon et al., 2010).

In the former, what is most relevant for our research is the identification and the classification of the three differentiated behaviors that Marimon et al. have detected by observing the country "movements" on the graph built.

The distinguished behaviors are named *expansionist* since an upwards relation is dominant, *mature* since a negative relation is present and finally *retrocessive* as a downward relation is relevant.

Thus a country shows an expansionist behavior when it presents a of growth phase for both standards rates, a mature one when it has an increasing ISO 14000 intensity rates but a decreasing ISO 9000 rates and a retrocessive one when it lives a decertification stage in both standards.

The latter provides the guideline of our research, concerning both the selection of the leading countries and the definition of the certification intensity index. Therefore, the leading countries comprises only the following four countries: China, Italy, Japan and Spain. They have been selected for two reasons. The first is that at that time they had the highest rankings in both of the amount of ISO 9000 and ISO 14000 series certifications, the second that they presented the highest growth rates in certifications.

ISO 9001 overview

ISO 9001 is the standard that gives the guidelines for a Quality Management System. It belongs to the ISO 9000 family, which provides other 16 standards to help an organization on aspects as performance improvements, auditing, training and so on in terms of quality. Nevertheless, ISO 9001 is the only standard in the ISO 9000 series that can be used for certification.

Currently the latest available version is ISO 9001:2015, released on Wednesday 23rd September

2015. This moment was considered by important specialists in the field as "beginning of a new era in the development of quality management systems".

ISO 9001 has been updated to take into account the different challenges that businesses now face. For example, increased globalization has changed the way we do business and organizations often operate more complex supply chains, and there are increased expectations from customers. ISO 9001 needs to reflect these changes in order to remain relevant. Moreover, it is more compatible with other management systems, such as ISO 14001, ISO 22301, ISO 27001 and ISO 20000, making the integration even easier.

ISO 9001:2015 represents the first major revision since 9000. The scope of the standard has not changed. However, the structure and core terms were modified to allow the above-mentioned integration more easily with other international management systems standards. It also brings many

challenges for implementation, transition, and maintenance of the QMS, as enhancement of the process approach and PDCA cycle, decentralization of the system and spread of responsibilities for the QMS throughout the organization, greater involvement of the top management in the QMS, introduction of risk-based thinking in the QMS and higher emphasis on performance monitoring.

ISO 14001 overview

In the field of environment, ISO has developed standards that help organizations to take a proactive approach to managing environmental issues: the ISO 14000 family. These series can be implemented in any type of organization in either public or private sectors.

Beyond ISO 14001, other 20 international standards belong to this family. Nevertheless, organizations can only register to ISO 14001, as well as to ISO 9001 in ISO 9000 series.

ISO 14001 is the principal management system standard, which specifies the requirements for the formulation and maintenance of an Environmental Management System EMS. This helps to control environmental aspects, reduce impacts and ensure legal compliance.

To keep in mind, ISO 14001 does not state requirements for environmental performance, but maps out a framework that a company or organization can follow to set up an effective EMS, as well as ISO 9001 does for a QMS.

In-line with ISO's commitment to review their standards regularly to ensure they remain recognized as best practice, ISO 14001 presents two revisions of the one published in 1996: the first in 2005 and the latest in 2015.

This revised ISO 14001 was published on 9th September 2015, 10 years later the previous ISO 14001:2005. This is an important step forward for a critical environmental standard. In fact, all environmental challenges, i.e. water, air, soil, waste, biodiversity, ecosystem services, climate challenges, etc., are incorporated in one standard.

The new version responds to the latest trends, such as an increasing recognition by companies of their impact on the environment. It implies a bigger need to better understand and manage this impact. The changes also ensure that the standard is compatible with other management system standards to facilitate the integration processes. Moreover, ISO 14001:2015 focuses mainly on sustainable development by incorporating a new way of thinking. In fact, the purpose is not only to prevent pollution and wastefulness, but also to protect the environment from harm and degradation.

Whit this in mind, it is not surprising that key improvements in this version are associated to increased prominence of environmental management within the organization's strategic planning processes, greater input from leadership and a stronger commitment to proactive initiatives that boost environmental performance. Additionally, ISO 14001:2015 requires a focus on life-cycle, considering each stage of a product or service, from development to end-of-life and a more effective communication strategy.

LITERATURE REVIEW

The introduction of ISO 9001 and ISO 14001 took place in different moments, that is in 1987 for the former and in 1996 for the latter, and for different reasons, that is of quality management for the former and of environmental management for the latter.

Nevertheless, both certifications present very similar structure and philosophy. In fact, during the elaboration of the ISO 14000 standard, the ISO's technical committee TC207 have understood that the new standard had to be consistent with the previous successful ISO 9001 in order to promote

its acceptance and its diffusion. Moreover, this would foster a smooth integration between quality and environment management systems with the resulting benefits in efficiency and in costs (Poksinska et al., 2003). Therefore, these two certifications are connected since their origin.

Several studies have been conducted to explore the relationship between ISO 9001 and ISO 14001 in terms of analogies, benefits, diffusion, drivers and degree of environmentalism. Corbett & Kirsch (2001) have been the firsts to carry out relevant findings by their qualitative and quantitative

analysis of organizations in six countries. A key finding of this paper is that patterns of international certification to ISO 14000 are strongly correlated with those to ISO 9000, even though there are other significant explanatory factors like export-propensity and environmentalism.

By further exploring the drivers of ISO 14000 certifications and providing a different model from the Corbett and Kirsch one, Vastag, (2004) had achieved similar results.

Marimon et al., (2006) have analyzed the worldwide diffusion process of ISO 9000 and ISO 1400 standards determining that the pattern of diffusion is similar for both certifications and that the diffusion phenomenon is parallel trough different sectors of economic activity.

With this in view, it appears clear that in most cases the sequence of implementation trails the publication of standards, namely ISO 9001, the most common tool for the Quality Management Systems QMS, is usually followed by an ISO 14001 to comply with the Environmental Management System EMS. The studies

conducted by Karapetrovic & Casadesùs, (2009) confirm this sequence of implementation in the development of an Integrated Management System IMS. Marimon et al. (2006) have analyzed the worldwide diffusion process of ISO 9000 and ISO 1400 standards determining that the pattern of diffusion is similar for both certifications and that the diffusion phenomenon is parallel trough different sectors of economic activity.

It is no coincidence that more and more companies adopt and implement the integration of quality and environmental standards in order to wholly satisfy customer's needs of innovative and environmentally friendly products (Simon & Yaya, 2012). Heras-Saizarbitoria & Boiral, (2013) give a valuable summary on ISO 9001 and ISO 14001 by focusing on different from various perspectives.

RESEARCH METODOLOGHY

The concept of certification intensity level is aiming at discovering how much a country is certified against its wealth and how its certification level evolves over time.

To build a similar index, therefore it needs to possess two kinds of data: the number of certifications and an economic performance indicator, both by each country for each year. For the formers the database used is *ISO Survey of Management System Standard Certifications, 2014* and for the

latters World Bank, International Comparison Program database.

Once all data achieved, the next step is to compute the certification intensity indexes and then to build the evolution pattern of the certification intensity levels for each country.

Before proceeding ahead, a broad view of the data source is provided in the following sections.

ISO

International Standard Organization is an independent, non-governmental international organization with a membership of 162 national standards bodies. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.

The aim of International Standards is to make things work. They give world-class specifications for products, services and systems, to ensure quality, safety and efficiency. They are instrumental in facilitating international trade.

ISO has published more than 20500 International Standards and related documents, covering almost every industry, from technology, to food safety, to agriculture and healthcare. ISO International Standards affect everyone, everywhere.

World Bank

The World Bank is a vital source of financial and technical assistance to developing countries around the world. It is not a bank in the ordinary sense but a unique partnership to reduce poverty and support development through policy advice, research and analysis, and technical assistance.

To ensure that countries can access the best global expertise and help generate cutting-edge knowledge, the Bank is constantly seeking to improve the way it shares its knowledge and engages with clients and the public at large. For example, World Bank provides the Open Data website in order to offer free access to comprehensive, downloadable indicators aboutdevelopment in countries around the globe.

Computing certification intensity indexes

By focusing on ISO 9001 and ISO 14001, in 2014 1138155 and 324148 are respectively the bundle of certifications released for each one. Currently the 16 countries as follows represent the most ISO certified countries and together they cover more than 79% of ISO 9001 certifications distributed globally and more than 81% of ISO 14001 ones: China, Italy, Germany, Japan, India, United Kingdom, Spain, United States of

America, France, Australia, Romania, Brazil, Colombia, Czech Republic, Republic of Korea and Malaysia. That is why they represent a good sample to analyze.

Once all data for each selected country is achieved, the next step is to compute the certification intensity indexes. To avoid any confusion and to be concise, we will label the certification intensity index of ISO 9001 as p9 and that one of ISO 14001 as p14. We need to compute both for each country for each year of the already defined period.

Then,

$$p9_{t} = \frac{N9001_{t}}{G_{t}}$$

$$p14_t = \frac{N14001_t}{G_r}$$

where $N9001_{t}$ is the number of ISO 9001 in the t year, $N14001_{t}$ is the number of ISO 9001 in the t year and G_{t} is the GNI based on PPP in the same t year.

This analysis covers the period between 1999 and 2014, for a total amount of 15 years.

For each one of the two standards, we will compute 240 indexes (15years*16countries),

for a total amount of 480. The intensity indexes are in the scientific notation. In particular, the data for p9 are expressed in E-09, those of p14 in E-12. Before going on, we have to make some annotations about the findings: for both p9 and p14, Romania's indexes are up to 2012 included and some countries (i.e. China, Japan, Spain, United States of America, Brazil and Czech Republic) miss their indexes for 2014. These deficiencies are due to the lack of data about GNI based on PPP in 2014. From now on, we will ignore the exponential part and use only the digits such as it will be easier understand and read the graphs and the data themselves.

The certification intensity indexes p9 and p14 are useful to effectively analyze the relationship between ISO 9001 and ISO 14001 certifications.

For this purpose, we will plot the certification intensity rates for both standards on the same graph for our 16 countries. The graph thus obtained shows the evolution pattern of the certification intensity levels for each country. In fact by this, it is possible to observe the path each individual country follows in the years from 1999 to 2014 with regard to the number of certifications. In Figure 1, the patterns of China, Japan, Italy and Spain are provided as example.

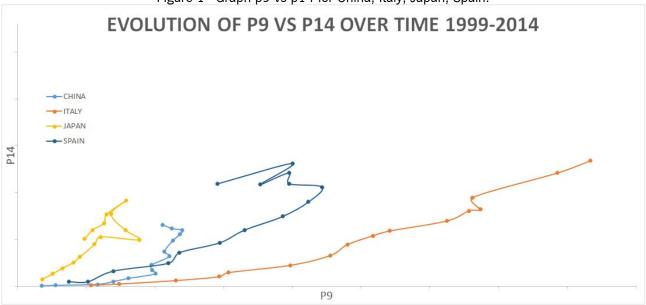


Figure 1 - Graph p9 vs p14 for China, Italy, Japan, Spain.

An interesting phenomenon: the decertification

The phenomenon of decertification is going to increase for both ISO 9001 and ISO 14001 certifications. Essentially, there are two ways of thinking about motivations of abandoning the standards.

Firstly, it would seem that a market exhaustion has been achieved. In fact, if at the beginning certificating against a standard could bring competitive advantage and a better corporate image, nowadays companies do not have interest to invest any more money just to demonstrate a proper implementation. Therefore, they prefer continuing to use the standard without be certified. It means each tool and procedures obtained by ISO 9001 are internalized and become simply common practices in an organization.

Secondly, part of decertification could be explained by taking into account that there are companies get the certifications but do not force themselves to implement properly the standards. Similar attitude brings no benefits to companies. Therefore, when they have to renew their certifications, they are not interesting to do it (Marimon et al., 2009) (Sansalvador & Brotons, 2015) (Heras-Saizarbitoria et al., 2016) (Bernardo & Simon, 2014).

ISO Survey of Management System Standard Certifications, 2014 reveals the data about withdraws of ISO 9001 and ISO 14001 standard. In Tables1 and 2, we can look at ones relative to the 16 countries selected. These data cover a period of only 6 years, from 2006 until 2011. Any information about the last 5 years have not yet been released. Empty cells mean no data are recorded by ISO for that country in that year.

In absolute terms, China presents the highest number of withdraw for both standards, followed therefore by Spain and Malaysia. It appears evident by looking at the Graph 1 and 2.

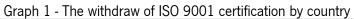
A similar decline context can lead us to think the launch of the new standards, ISO 9001:2015 and ISO 14001:20153, is a way to push a recovery in certifications.

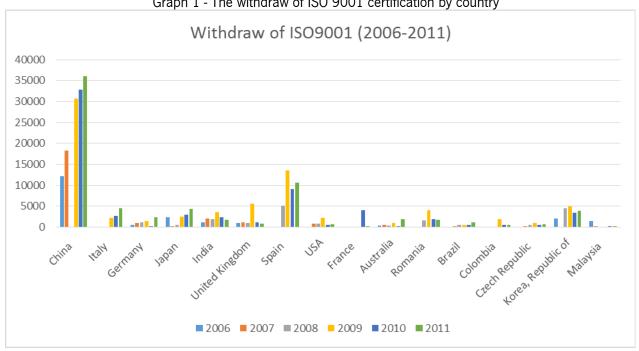
Table 1- ISO 9001 Withdraw

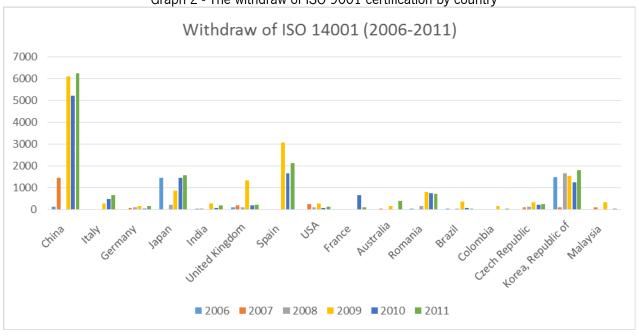
Country	2006	2007	2008	2009	2010	2011
China	12176	18260		30669	32848	36116
Italy				2174	2636	4461
Germany	567	1061	1226	1458	275	2435
Japan	2320	188	476	2580	2976	4323
India	1193	2034	1939	3558	2321	1808
United Kingdom	1030	1233	994	5559	1087	899
Spain			5170	13504	9118	10576
USA		863	877	2165	488	668
France	85	97	80	40	4140	269
Australia	443	573	454	981	209	1857
Romania		138	1674	4112	1942	1841
Brazil		228	607	496	485	1199
Colombia	148	151	145	1887	476	586
Czech Republic		263	618	1045	620	750
Korea, Republic of	2114		4519	4949	3504	3986
Malaysia	1402	274	137	142	203	303

Table 2 - ISO 14001 Withdraw

Country	2006	2007	2008	2009	2010	2011
China	134	1452		6084	5217	6255
Italy				279	509	678
Germany	13	94	114	185	43	182
Japan	1466		245	874	1452	1578
India	45	54	38	278	91	194
United Kingdom	107	207	124	1347	211	236
Spain				3076	1654	2141
USA		248	124	289	76	140
France	6	4	9	5	663	113
Australia	34	42	36	175	34	411
Romania	61	7	173	825	748	728
Brazil	54	25	46	371	97	47
Colombia	16	9	2	170	14	42
Czech Republic		101	153	353	220	255
Korea, Republic of	1491	101	1679	1547	1253	1820
Malaysia	10	113	18	345	22	42







Graph 2 - The withdraw of ISO 9001 certification by country

RESULTS

The results obtained by comparative analyses among countries are supplied here.

More specifically, we arrange two analysis. The first one focuses on the comparison among China, Italy, Japan and Spain by exploiting the investigations concerning the evolution pattern of each countries in order to verify if the trends and forecasts in the previous researches are correct and, if not, to investigate the possible causes of such discrepancies.

The second analysis offers a complete and general comparison among all other 12 countries.

Focus on China, Japan, Italy and Spain

These four countries have been chosen essentially because they were the most certified with the highest growth rates in certifications of both ISO 9001 and ISO 14001. Nowadays, the scenario is a bit different. In fact, the four countries are still in the Top 10 for number of certifications in ISO 9001 and ISO 14001 but only China and Italy are in the Top 10 for growth rates in both certifications.

Tables 3, 4, 5 and 6 show the ISO rankings provided by ISO Survey of Management System Standard Certifications, 2014.

It has to be noted that the patterns provided by Marimon et al. are referred to a period of six years, from 2002 to 2007. Instead, our patterns cover a longer period, from 1999 to 2013, in which the previous shortest is obviously included. We can see the summary graphs for both case studies in Graph 3 and 4.

According to the classification proposed by the same Marimon et al. (2008) the four countries belonged to the category of expansionist behavior. Nevertheless, at first sight, in the current researches Japan and Spain present different paths than expectations. Focusing on the final trend of their paths, in fact, we can see they do not follow an expansive behavior, as we would have expected. Instead, these two countries present a retrocessive pattern. This would confirm their absence in the Top 10 countries for ISO 9001 and ISO 14001 growth.

China, Italy, Japan and Spain occupy the highest rankings with respect to both ISO 9001 and ISO 14001 standards during the period analyzed by Marimon et al. in the *article Certification intensity level of the leading nations in ISO 9000 and ISO 14001 standards*. In particular, Italy shows the highest effort to spread ISO 9001 standard, above China and Spain, as seen in Graph 3. In fact, here we can find Italy on the right side of the graph, meaning the best intensity index in ISO 9001.

Regarding to the effort to spread ISO 14001 standard, Spain is the first by positioning above Japan and Italy. In the above-mentioned Graph 3, effectively we see the highest intensity value in ISO 14001 is provided by Spain.

Moreover, all four countries exhibit a growing trend in both intensity indexes, as their pattern towards the upper right corner demonstrate. For such reason, these countries belong to the category of expansionistic behavior, according to the classification proposed by Marimon et al., (2008).

It is also evident that Spain and Italy show similar and parallel patterns, despite the fact the former is focusing on dissemination of ISO 14001 standard, whereas the latter on that of ISO 9001.

During the period analyzed by Marimon et al., the other two countries are still in earlier stages of the diffusion of both standards. Then, they present a bigger concentration on ISO 14001 certification than on ISO 9001 one. Overall, China and Japan exhibit a more moderate evolution compared to Italy and Spain.

Table 3 - Top 10 countries for ISO 9001 certificates

Top 10 countries for ISO 9001 certificates - 2014		
1	China	342800
2	Italy	168960
3	Germany	55363
4	Japan	45785
5	India	41016
6	United Kingdom	40200
7	Spain	36005
8	USA	33008
9	France	29122

Table 4 - Top 10 countries for ISO 9001 growth

Top 10 countries for ISO 9001 growth - 2014		
1	Italy	9215
2	Australia	6608
3	China	5767
4	Belarus	2833
5	Mexico	2538
6	Turkey	1794
7	Canada	1277
8	Colombia	1146
9	Portugal	965
10	Slovakia	713

Table 5 - Top 10 countries for ISO 14001 certificates

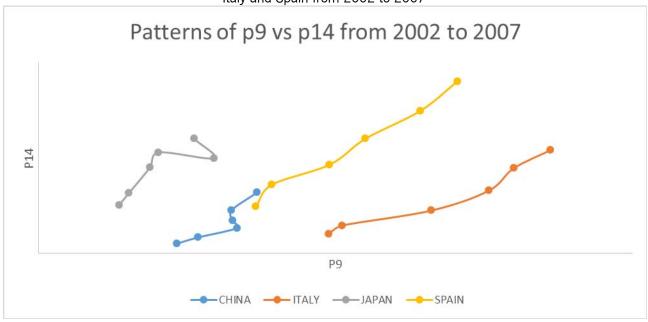
Top 10 countries for ISO 14001 certificates - 2014		
1	China	117758
2	Italy	27178
3	Japan	23753
4	United Kingdom	16685
5	Spain	13869

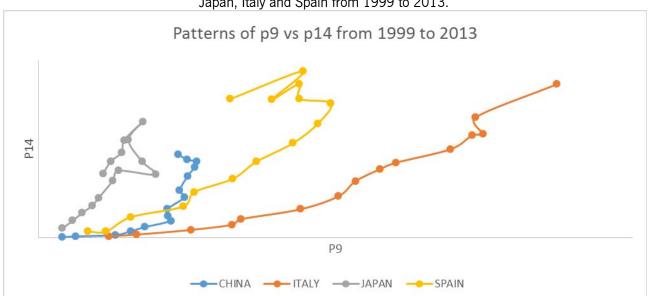
6	Romania	9302
7	France	8306
8	Germany	7708
9	USA	6586
10	India	6446

Table 6 - Top 10 countries for ISO 14001 growth

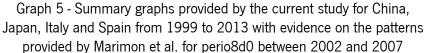
Top 10 countries for ISO 14001 growth - 2014		
1	China	13023
2	Italy	2560
3	Australia	2358
4	Czech Republic	1039
5	Colombia	667
6	India	574
7	Romania	558
8	USA	515
9	Turkey	499
10	Bulgaria	388

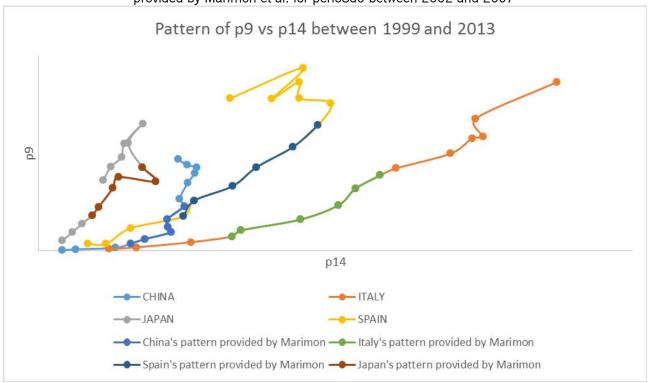
Graph 3 - Summary graphs provided by Marimon et al. for China, Japan, Italy and Spain from 2002 to 2007





Graph 4 - Summary graphs provided by the current study for China, Japan, Italy and Spain from 1999 to 2013.





To evaluate the current scenario, we need to look at how things have changed over the last years. Graph 5 shows the evolution patterns of each country in relation to ISO 9001 certification intensity level against ISO 14001 certification one. Moreover, the same Graph 5 highlights the patterns provided by Marimon et al. for the period between 2002 and 2007.

What emerges is that any country no longer shows a clear expansionistic behavior, except Italy. In fact, this last is the only country whose pattern remains regular and smooth over time. Its intensity levels in both ISO 9001 and ISO 14001 standard do not experience any stop. For this reason, Italy retains its position as the best country in ISO 9001 growth, whereas it is the second in ISO 14001 growth, behind China. Furthermore,

it is the best country in terms of number of both certifications, always below China. Thus, the development of Italian pattern seems entirely suitable for the expansion expectations.

The similarity of trend shown by Italy and Spain disappears beyond 2008. Unlike Italy, Spain reaches a critical stage for its certification commitment. The movements towards the upper-left area prove a decrease in ISO 9001 certification intensity and a swing in ISO 14001 one. Because of such changes, Spain has lost its supremacy in quality and environmental certifications and currently it has no place among the leading countries ranking. Therefore, the predicted expansive behavior for Spain has been disregarded.

Nevertheless, an analogy between Spain and China emerges if their recent developments are considered. As well as Spanish, Chinese pattern moves towards the upper-left area. It implies ISO 9001 certification intensity is decreasing but ISO 14001 is not. In fact, unlike Spain, Japan continues its expansion in ISO 14001 without any uncertainty. Actually, China presents the best growth in this environmental certification, where it ranks as the third position in the growth of quality certifications. Despite the current diminishing development, China retains its supremacy in absolute terms, meaning China still owns the highest amount of certifucation, both quality and environmental. So far, we can say its behavior is no longer expansive rather it is mature.

Finally, Japan shows the most unexpected pattern. By looking at Graph 5, we can identify a sharp reversal in Japanese trend after 2009. That is the case of a retrocessive behavior. Both ISO 1400 and ISO 9001 certification decrease. In particular, the drop of the environmental standard is much faster, as the speedy movements towards the bottom-left area demonstrate. With this in mind, it is no surprising Japan does not appear in the leading countries for growth in these two kind of certifications.

To sum up, we can state that Italy does not provide any changes in its certification expansion over time, China and Spain have moved from an expansive to a mature pattern. Instead, Japan have moved to an extraordinary retrocessive pattern directly.

Comparison among the other countries

The following section focuses on the remaining countries, which are Germany, India, United Kingdom, United States of America, France, Australia, Romania, Brazil, Colombia, Czech Republic, Republic of Korea and Malaysia. Despite each country presents its idiosyncratic evolution, we will try to identify similar trends and classify them. To this end, we distinguish the next four categories. Thus, a comparison among the countries within the same group is provided.

The typical expansive pattern

Germany, Colombia, Romania and France exhibit increasing developments. In fact, all these countries move towards the upper-right area.

To understand if they have also the same growth rate we need to plot all patterns together. By doing this, what emerges is that Romania is the most expansionist country and, because of this, its pattern hide the others completely. Among the remaining three countries, Colombia has the fastest growth in both ISO 9001 and ISO 14001 certification intensity, as shown in Graph 6. France and Germany respectively follow with more moderate certification levels.

An exclusive mature pattern

In Graph 7, two countries show unusual patterns. Since the beginning, their ISO 9001 certification intensity decrease, whereas their ISO 14001 certification level increase. That is the reason of the label exclusive mature. United Kingdom and Australia belong to this category.

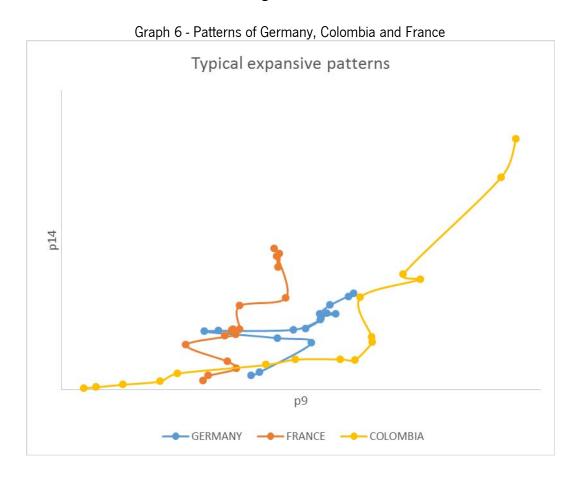
By a comparison between them, we can verify the pattern of United Kingdom is smoother than that of Australia. In fact, this last country exhibits some sharp falls in ISO 14001 certifications intensity. Instead, United Kingdom has an almost continuous expansion in this same certification.

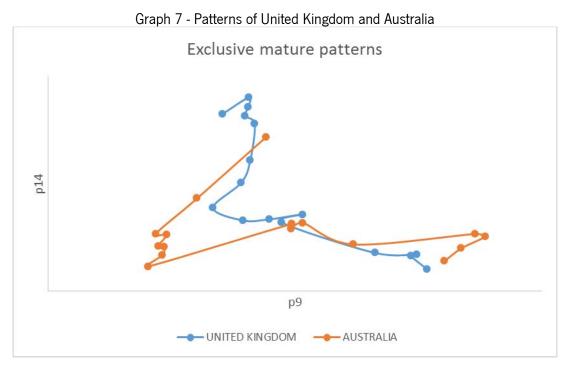
A swinging pattern

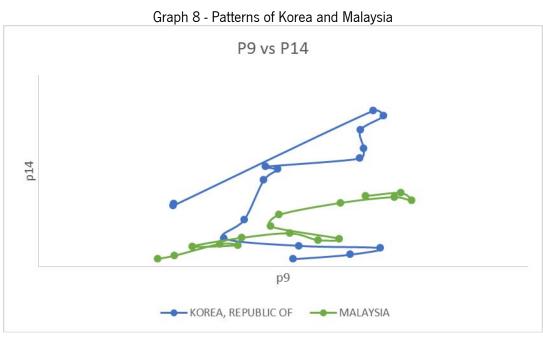
India, Malaysia, United States of America, Brazil, Czech Republic, and Republic of Korea exhibit irregular pattern. They move up and down, right and left with no particular trend. Nevertheless, it is possible investigate their size in term of growth. To end this, all six countries are plotted in a graph. It appears clear Republic of Korea and Malaysia have similar growth rate. Moreover, both show a retrocessive phase in the last few years. In Graph 8, we can see their final reversal. Lastly, Republic of Korea has a much sharper drop in both certification intensity levels than Malaysia.

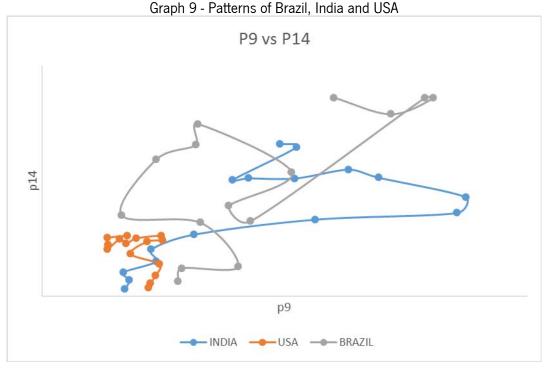
By grouping together Brazil, India and United States of America, we can verify that USA is the country with the worst growth in ISO 14001 and ISO 9001 certification intensities among them. Instead, Brazil is the best one. As Graph 9 shown, Brazilian pattern is contorted with high certification intensity period followed by low ones. It is noteworthy also the huge certification commitment in ISO 9001 certification provided by India, as the increasing curve demonstrates. However, during the last period it is progressively eroded.

Finally, we need to make some observations on the pattern of Czech Republic shown in Graph 10. It is generally expansive but presents too many bends. However, this country has the highest certification intensity in both ISO 9001 and ISO 14001 standards among all six countries.









Graph 10 - Patterns of Czech Republic.

P9 vs P14

p9

CZECH REPUBLIC

CONCLUSIONS

This research represents an investigation on how certification intensity by countries has evolved over time. Two kinds of certifications are considered, namely ISO 9001 and ISO 14001 standards. The former reflects the degree of commitment a country takes in terms of quality management, the second one in terms of environmental management.

Through both quantitative and qualitative analysis, the patterns for the selected countries have been traced. Every country shows a specific trend because of its idiosyncratic history and of its increasing participation in the international economic context. It is obvious that no country presents a real regular pattern. In fact, small fluctuations are present towards up or

down, right or left. Therefore, it implies continuously drops and increases in ISO 9001 and ISO 14001 certification intensities.

Nevertheless, some categorizations are provided, focusing more on similarities than on dissimilarities countries' patterns can show. For this purpose, the classification into expansive, mature, retrocessive behavior is used.

Italy, Colombia, France, Germany and Romania continue to be expansionist countries. Australia and United Kingdom show an exclusive mature patterns. The remaining countries, namely Brazil, China, Czech Republic, India, Japan, Spain, Malaysia, Republic of Korea, United States of America show a swinging trend. It means countries experience each of mentioned behavior, including the retrocessive one.

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Methods used for final inspection in order to obtain the conformity of housing units in the delivery to the client

Noronha, M. P. P., Santos, J. and Evangelista, A. C. J.

Federal University of Rio de Janeiro, Civil Engineering Department, Brazil

ABSTRACT

The increasing competition between construction companies in Brazil, during the last years, made the sector faces a substantial change. With the increasing of the quality level demanded by the consumers, the companies were pushed and stimulated to seek best levels of performance. The units are routinely delivered to the clients with no conformity and, it is normally the cause of the clients' dissatisfaction and complaints, forcing the companies to repair a high percentage of the units. The number of the complaint was increasing until 2014, but it begun to decrease in 2015, probably following the civil construction decline and the Brazilian economy crisis. (Foundation Procon SP, 2015). Repairs made to remedy the complaints generate additional costs not budgeted for construction companies and brings the customer to have disorders that may vary from the non-use of all or part of the housing unit. The way used by construction companies to mitigate this problem is to perform a general inspection on the unit and in the common areas of the project before the final inspection with the presence of the client. This work collects and analyzes the general inspection methods, practised by builders, and performs four case studies, along with construction workers, to identify the practices used. Based on studies conducted, and the results obtained after the delivery of housing units and identified good practice is made a proposal of improvement for the General inspection of tool housing units before the delivery to the client.

Keywords: final inspection, training, quality, customer.

Paper type: Research paper

THE CONSTRUCTION QUALITY OF RESIDENTIAL BUILDINGS IN BRAZIL

Due to Brazilian characteristics, when compared to other industries, the construction industry is the one that has the potential to generate jobs and income and increase in value of the final product for short and medium term. This is since it has a great capacity to absorb a lot of labor with little or no qualifications. In times of crisis as currently experienced in Brazil is recognized as an important sector for the economy, mainly with regard to unemployment and income indices.

The construction industry, despite the recession that has occurred since 2015, accounted for 10.1% of Brazil's GDP. In the first quarter of 2015, employed 13.5% of the country's workforce and generated R\$ 253.6 billion (FIESP, 2015). It is evident the importance of this sector regarding the Brazilian economy and also its social role in the generation of large volumes of employment. Another major factor is that Brazil has a high housing deficit. In the last survey conducted in 2013, this housing deficit amounted to 5.846 million units (VIANA et al, 2015).

Nevertheless, even being crucial in the Brazilian economic growth, it does not receive large investments to a necessary and sufficient improvement of its production flow. According to Dantas (2011), it can be said that despite significant technological advances in the design of new materials and construction systems, the construction industry still has artisanal character, since it uses very few techniques that have made progress in other sectors industrial and enabled significant productivity increases.

Typically, the labor of the construction industry is characterized by being poorly qualified staff. According to Souza (2012) the predominant form of labor is formed by male migrants from distant regions of the country, with low education and low-skilled. According to Kirchner et all (2011), the construction workforce consists of 60.3% with educational background from illiterate to complete elementary, of which 39.7% have only incomplete primary education (eighth incomplete series). This feature makes it difficult to obtain better compliance rates in constructions performed.

Trying to seek standardization, certain contractors perform training on the procedures to be applied. However, due to differences between practice and standard procedures, plus the high turnover of the workforce, the results remain inexpressible.

Another strong issue related to labor in this sector is the outsourcing component. Part or all of the core activities are outsourced to other companies. Their employees often were disconnected from builders and encouraged to open small construction companies. This methodology has been adopted by large construction companies with the aim of avoiding heavy labor costs and therefore reduces production costs. These new business constructions have no professional qualification, logistics concepts and even less quality.

Aiming to increase production, small construction companies are hired by contract system linking the release of payment for the full implementation of a work step. However, focused on producing fast to get the fastest possible payment such workers downplay the quality of the service performed, causing direct and indirect irreparable losses to the construction company responsible for the venture.

The consequences of this type of management can be seen in the current situation of the Brazilian civil construction, which is known for having a high amount of activities that do not add value, low productivity and high waste of labor and raw materials. These problems are not limited to the production chain, and also excel in the managerial sector, featuring an industry delay shown fragmented and opaque rules (Arantes, 2010).

Regarding operating procedures, although they are standardized as work instructions, in practice, the activities are not performed as described. They are also developed inspections to verify the compliance of the steps undertaken in construction. Verification records are established with the items to be inspected and these records are used by trainees of civil engineering or architecture, and building technicians. According to Souza (2012) processes are measured and documented since it is necessary to find the failures and seek solutions to be streamlined and promote continuous improvement. However, because they require multiple documents and pass by several professionals, generate bureaucracy to reach the ultimate goal.

In addition to these factors, the lack of proper planning for the implementation of the projects is peculiar to most construction companies. When planning is designed, another failure is not monitoring the work progress and replanning according to the results achieved. The high incidence of outsourced at the construction site and the lack of management of deadlines and tasks makes the construction depend on the contractors who are usually focused on their specific goals, not the goals of the enterprise.

As a result of a compound of unskilled labor environment, high turnover and that planning is non-existent or deficient, the production of housing units, with rare exceptions, will be quality lower than expected by the end customer. The result is the construction of defective housing units with visible defects and hidden defects. Nonconformities of housing units end up being discovered during the final inspection performed with customers on delivery of housing unit, or even after delivery by the customer during use. The detected defects and anomalies need to be fixed. This overloads the service sector, since it assumes the responsibility of the units after the acceptance of the property by the customer. In this context, it is clear the importance of the final inspection done by the construction company before the customer inspection.

THE FINAL INSPECTION OF THE HOUSING UNIT BEFORE THE CUSTOMER INSPECTION

Conceptualization

As Santos et al. (2003), at a time when all services are completed, construction as the guidance and management of the programming work is carried out the final inspection, that is, before internal inspection by the customer.

Paulo (2014) claims for the guarantee of customer satisfaction, should be carried out a final inspection and the non-conformities identified should be addressed before the formal handover to the client. The inspection must be carried out by housing unit and not by sampling. The inspection should also include the common areas and must be done through checklists.

The inspection process

The final inspection process consists of verifying the final conditions in which they find the housing units. It aims to simulate the end-customer presence on the property's delivery inspection, thus seeking to find possible non-conformities arising from faults in the construction process and correct them before delivery to the customer.

To perform the inspections, spreadsheets are used which contains all the services that will be checked by the verifier.

As Paulo (2014) internal inspection must be performed by a professional who has not participated in the construction of the same. This Providence aims to ensure impartiality and to ensure greater note any flaws.

Usually, most of the construction companies use their trainees to make such verification. However, some use a professional located in service since this professional receives complaints and requires corrective actions. Thus, with the experience of complaints and non-conformities, it can better understand the non-conformities that construction workers onsite. Spreadsheets are prepared by the responsible for the execution of the work with the participation of the responsible for quality control.

Spreadsheets consist of checklists that are adapted to the peculiarities of each project. Such lists shall include all services provided in the construction of this unit such as hydraulic and electrical installations, carpentry, painting, porcelain and metal, ceramics, and other constructive steps that were part of the construction.

The internal inspection should be laid down in the quality of the work plan and contain the relation of every room and also the services running in them, with the question as or and a space to put some kind of note. (PAULO, 2014)

The difficulties in the inspections materialization

In general there is little commitment of the engineer responsible for the execution of the work with the compliance checks of the activities developed, either along the implementation of several constructive steps, be it in final inspection before the inspection with the client. Of course if the quality inspections performed at each stage were effective constructive there would be no non-conformities during the final inspection. Exception the anomalies caused by the development of constructive steps superimposed on an activity already released. As already mentioned in previous item inspections usually are performed by interns that beyond this task builds up other production control-related, document control, and calculation of quantities of materials, among others. As there is no charge, and follow-up on the part of the engineer responsible for the execution of work the trainees perform the inspections so superficial, under pressure, of an accelerated rate and incomplete. On the other hand the requirement of logging of compliance inspections is to meet the certification of quality, is to demonstrate that his service was performed, contributes to objective evidence that they breed not obsolete the reality of work. Many times inspection sheets are filled in the Office and the inspections are not carried out effectively. (SANTOS, 2005)

The strong involvement of these trainees with other operational activities linked to the production of the work and also the exactions of the engineer responsible for the execution of the work to achieve the deadlines and his non-involvement with inspections promote psychological aspects that favour the production at the expense of the inspection activities. In this environment, the perception of interns is compromised and the constructive failures no longer identified and incorporated into housing unit only being detected in final inspection performed by the client.

CASE STUDY - MARKET VISION OF THE FINAL COMPLIANCE INSPECTIONS

Four construction companies were selected to be used at the case study. Regarding the request of their responsible their names cannot be revealed and it was omitted in this work. A general characterization of each company was used at the analysis of collected data establishes. In this way will be termed as the construction companies A, B, C and D.

To obtain the data required for the study was developed a questionnaire with 35 questions related to the possible non-conformities to be found in the works. The questionnaire was used as a guide in the conduct of interviews with officials and other representatives of construction companies participating in the case study. During the interviews, the questionnaire was used only as a guide, since it was given to the respondent complete freedom to carry out the highlights and explanations deemed most relevant. The questionnaires the following issues:

- a) Describe your company's and the enterprise studied;
- b) Describe your position;
- c) Performed delivery of units to customers?
- d) Participated or supported the technical assistance team.
- e) Which the service that offers a higher incidence of non-conformity during the inspection with the client?
- f) Which would be these non-conformities?
- g) As the company is doing to address them?
- h) Could be provided the service procedure?
- i) There are standard service check sheets?
- i) As the dictations of standard service check?
- k) In his opinion such chips mentioned are efficient and effective?

- 1) The other employees, for example, master, person in charge, has access to such records?
- m) They know, in fact, fill them and understand them?
- n) Should be made the same for the operational framework, in order to improve its use?
- o) How is the statement of non-conformity, attested on verification of standard service, the part of operating work?
- p) The team that will perform the part of the framework of the repair work? She is fixed or performs other activities of the work?
- q) Is there a plan for correction of non-conformities?
- r) How is the last inspection before the owner? There is no verification certificate end of standard service?
- s) Which model and how is the inspection of delivery of units?
- t) Report the demobilization of personnel at that stage (percentage)?
- u) This new cash is enough for delivery?
- v) Exists to make the delivery of the housing units?
- w) As the schedule with the client? There is communication between engineering and the industry that will schedule?
- x) There is some kind of difficulty in scheduling?
- y) The delivery team is composed of what employees?
- z) How is made the Division of projects to be delivered by this team?
- aa) AA) going on some pending, demonstrated by the owner, what is done?
- bb) There is an operational support team to address it immediately.
- cc) What is your training?
- dd) If the score is not terminated at the time of delivery, what the company does?
- ee) As the rescheduling (before or after housing units that were not surveyed).
- ff) The acceptance of the client, what is done?
- gg) How long the technical assistance team takes on the responsibility of the units?
- hh) There is a procedure of delivery of these units for the team that will take over after the technical assistance?
- ii) Which the team strategy of work used to complete the unsold housing units and that therefore, will remain under the responsibility of the construction company?

CONSTRUCTION COMPANY "A"

Description of Construction Company

The company studied is a construtora e incorporadora, of medium, with 18 years of experience in the markets of the States of Rio de Janeiro and Minas Gerais. The "construction company" performs construction work for residential and commercial buildings, urbanization of large areas and management of construction in different segments, such as hospitality, residential and commercial. The "construction company" has its quality

management system ISO 9001:2008 certified and the level of SiAC/PBQP-H (a program exclusively for civil construction).

Characterization of housing development

The project studied is a residential building located in the neighborhood of Barra da Tijuca, in Rio de Janeiro.

In the work the construction company has 150 employees and technical staff composed of: 1 contract manager, production engineer 1, 2, 3 masters in charge of work and 4 interns.

Interview conducted

The interview was conducted with the production engineer of the work. The same is for 2 years in the construction company, even as it has formed. Was an intern this construction company in other works? According to the report obtained by the service of painting presented the highest rates of non-compliance in final inspection with the owner. Reported that after each complete constructive step compliance inspection is carried out and completed the Verification Certificate of service by the operational staff of the work, such as master of works, responsible for service and interns.

If any kind of non-compliance, a signaling the problem with their immediate treatment proposed by the action team. To this end, it is made an informal checklist and delivered the team that will perform the repair. Then rescan is made terminating the service.

With the housing unit freed by the operational framework, will be filled by the interns final inspection form. This consists of a team of pre-inspection set-up work in which are checked items of construction, before requesting the client to receive the property. Recorded any anomaly, the same will be described and treated. Then, the account the repair crew. Later, date re-inspection required. In possession of the authorization, the administrative sector engineering schedule the delivery of the unit with the client.

This process is carried out the final inspection with the client. You can see the non-targeting of checks, the discretion of the customer.

Reported that there is no specific training for delivery staff comprised of interns.

There is an emergency team called SOS trim meet in case of existence of pending issues, composed of 1 Mason, 1 fireman, 1pintor and 1limpador. In the event you can't solve instantly, is made present in the demo file, in continuous Act, a rescheduling of delivery. Otherwise, if the client accept the conditions of the property, this sign the term of receiving unit (s)-TRU.

According to the engineer, the scheduling is done in order from bottom to top. It is noteworthy that only revistoria will be made, so that all units have been inspected. It is also to inform the scheduling difficulties with the client. This happens because the majority prefer to schedule on weekends. Overloading as well, such days that are limited in time, due to the determination of the Union building.

CONSTRUCTION COMPANY "B"

Description of Construction Company

The company studied is a construtora e incorporadora, of large, multinational, with over 30 years of experience. The "construction company B" performs construction work for residential and commercial buildings in the Southeast, Midwest and South. The "construction company B" has its quality management system ISO 9001:2008 certified and the level of SiAC/PBQP-H (a program exclusively for civil construction).

Characterization of housing development

The project studied is a residential building located in the neighborhood of Vila da Penha, in the city of Rio de Janeiro. The project consists of: accommodation, economic pattern, 312 units, 18000 m².

250 employees and technical staff composed of: 1 contract manager, production engineers, 3 4 Administrative and 243 in the field.

Interview conducted

The interview was conducted with the contracts engineer of this project. This has 3 years in Construction Company, same time graduating as a civil engineer. It was intern at Construction Company before completing his degree.

According to interview with the engineer, it was mentioned that the painting shows the highest rates of non-compliance in final inspection with the owner. However, the engineer has had difficulty, on a smaller scale with the placement services of sanitary vitreous Chinaware and metal. There are standardized procedures for the implementation of constructive activities in the work, called PES-Service execution Procedure.

In order to minimize errors, the company has the following method:

With the occurrence of errors, improve the executing team (can be the contractor or its employees that perform the painting) through a better selection for future works, and immediate rectification of the team who are painting units, through layoffs and hiring and training.

Improve the application of the concept of completing a step, that is, start a service or pavement, the total end of previous activity or walk. With this, the sequence is improved and the control of services. Thus, there is no overlap and concentration of services and staff in the environment. Completed the service, trainees, teachers and guardians will check the service through specific service check sheet. To do this, go to the site to fill it. Clarified that the same is carried out respecting the peculiarities of the work. Such testers are trained in accordance with the quality policy of the company, by the Manager of the work. Much of the time that training becomes bureaucratic, so just filling out papers and file generation for future auditing.

If any kind of non-conformity, is made a sign of the problem with its immediate action, proposed by testers. These show the location of the non-conformity to the restorative team, informally. Reported that this team belongs to the frame of the work, running so other services in addition to the repairs, too. Then, the testers team returns to the scenario marked, rechecks and causes validation, ending the service.

Upon completion of the services, is designed a unit to serve as a model. The same will be presented to the Board and to the customer, being subject to approval. If approved, all the units will follow this pattern.

Then the engineering, through its administrative, will schedule a visit from the owner. With this, will be held the End of survey completion. This procedure is executed by the respective interns responsible of the blocks.

However, the existence of disputes, is requested the team consisting of 1 (a), 1 (a), 1 firefighter (a) 1 and (a) cleaner and 1 (one) electrician. In the event you can't solve instantly, is made the demonstration of the inspection plug in, in continuous Act, a rescheduling of delivery.

CONSTRUCTION COMPANY "C"

Description of construction company

The construction company analyzed is among the ten largest civil construction companies of Brazil. It operates in all regions of Brazil in medium and high standard works. Been on the market for more than 50 years. Has another construction company for works of low standard. The "construction company C" has its quality management system ISO 9001:2008 certified and the level of SiAC/PBQP-H (a program exclusively for civil construction).

Characterization of housing development

Venture, located in the Neighborhood of Barra da Tijuca, of very high standard. Consists of 4 blocks with 60 units per block and block 1 with 90 units, totaling 330 residential units. Has a private club with several leisure

areas. A curiosity about the work is that it has the largest private cellar of Latin America, for common use of all residents.

Interview conducted

The interview that company was made with the Assistant engineer who has appeared in various processes of supply of units. This is a civil engineering student who is already in construction company for 5 years, however, never participated or supported the technical assistance team.

The respondent pointed out the following services that present the greatest non-conformities: donning, hydraulic systems, aluminum frames.

For each operating company service maintains a default procedure called PE-enforcement procedure. Completed the service, trainees will check the service through specific services verification tokens for each activity. For that, you're going to fill her place. These can be accompanied by teachers and guardians if need. It was mentioned that the filling of these chips becomes only bureaucratic.

If any kind of non-conformity, is made a sign of the problem with its immediate action, proposed by testers. This can be done in the field or in scheduled meetings with these teams. Clarified that such part of the frame of the work team, running so other services in addition to the repairs, too. Then the body of checkers returns to the scenario marked, rechecks and causes validation, ending the service.

In order to reduce these non-conformities, the company adopts the following the demand of third parties to be completed the end of each stage before it starts a new constructive step.

Upon completion of all services, interns fill out the survey form in advance. Found some pending, will be resolved as the others above have been implemented.

Then the unit delivery schedule by the customer relationship sector. So, such sector communicates the team work, weekly agenda containing which units will be delivered. Sometimes there are many units in the same week, a fact that affects the quality of the final finishing services.

The part of the delivery to the owner is made with an outsourced company architect and construction team. This consists of: engineers, interns, bricklayers, plumbers and cleaners and paint team. But there's no training for what this team perform this service. In this case, you fill in the survey by the respective Residential Term interns responsible of the blocks. The existence of loose ends, is requested the team consisting of 1 (a), 1 (a), 1 firefighter (a) 1 and (a) and 1 (one) cleaner electrician make the repairs. In the event you can't solve instantly, is made present in the demo file, in continuous Act, a rescheduling of delivery.

CONSTRUCTION COMPANY "D"

Description of Construction Company

The parsed construction company is one of the largest in the business of civil construction in Brazil. It operates in all regions of Brazil in medium and high standard works, have been on the market for more than 50 years. Incorporated a company for low standard. The "construction company C" has its quality management system ISO 9001:2008 certified and the level of SiAC/PBQP-H (a program exclusively for civil construction).

Characterization of the enterprise

The project is located in the Neighborhood of Barra da Tijuca. Consists of 6 blocks with total of 440 housing units.

Interview conducted

In this interview construction company was made with civil engineering intern who attended the delivery team of housing units to customers. It should be pointed out that unlike the other interviews, was not provided, verification procedures, term of receipt of property.

The respondent indicted that the painting was the service that most presented non-conformities.

Operational services in the company must be performed in accordance with standard operating procedures called PES-Service execution Procedure.

Completed the service, trainees, check the service through specific service check sheets. To do this, go to the site to fill it. These can be accompanied by teachers and guardians if need.

If any kind of non-conformity, is made a sign of the problem with its immediate action, proposed by testers. The chips are delivered to repairing team. This can be done in the field or in scheduled meetings with this team. Clarified that the team is a part of the framework of restorative work, running so other services in addition to the repairs, too. Then, the testers return to the scenario marked, check again and causes validation, ending the service.

Upon completion of all services, the unit is inspected by the team of the work and also by an architect outside of work and only after it is released to the customer survey. The respondent pointed out that as there are many different types of clients and a large volume of housing units, end up causing some points, mainly details executives, pass unnoticed.

Then the delivery schedule for the customer relationship sector. So, such sector communicates the team work, weekly agenda containing which units will be delivered.

The delivery of the unit to the customer is made for third-party professional or work team. But there's no training for qualification of staff. Is done filling out survey, by their Term interns responsible of the blocks.

The existence of loose ends, is requested the team consisting of 1 (a), 1 (a), 1 firefighter (a) 1 and (a) cleaner and 1 (one) electrician. In the event you can't solve instantly, is made present in the demo file, in continuous Act, a rescheduling of delivery.

PROPOSAL FOR IMPROVEMENT IN FINAL INSPECTION METHODS

As a result of the tabulation and analysis of responses to the issues raised in the interviews and in the suggestions for improvements proposed by respondents were selected proposals of good practice to optimize the final inspections of housing units before the final inspection by the customer to the delivery of the unit. Best practices proposals are presented without highlight of order of importance and should be analyzed by the construction companies in order to identify those which effectively can be deployed or adapted the held of each company:

Good practice 1: default procedure for delivery of work

Elaboration of a legal standard to be followed by all the works for the delivery of housing developments. The document should contain a description of the practices to be used in the construction company since the final inspection of the internal housing units, the registration and treatment of non-conformities, scheduling and performing final inspection with the presence of the client and the actual delivery of the housing unit. The regulatory standard should contain the description of good practices described here.

Good practice 2: training of team work

General training, effective work team regarding the quality. Includes mainly the framework for engineers, architects, technicians and interns. With this you can run all the constructive steps the work correctly according to the quality management system. Importance also to the increased awareness of the team, mostly

engineers and masters who have greater engagement with the compliance inspections and monitoring of its results.

Good practice 3: structuring the inspection team

Creation of a subsector subject to quality management team to run the final inspection of units. This subsector must have a Manager (engineer or architect), and interns. If necessary, depending on the size of the construction company, you can count on other engineers and architects report to this Manager, and the criterion and need of the company. The idea is to have a specialized team in final inspection, non-exclusive, quality management, but that can be thrown at the time of final inspection and delivery of housing developments and that can act independently with autonomy.

Good practice 4: flexible checklist

Checklist for carrying out the final inspection of the units must be very flexible allowing the professional responsible for not only the inspection record of all relevant and sufficient information, but also check items not foreseen that are relevant to the characteristics of the housing unit that had not been foreseen.

Good practice 5: programming the final inspection

The inspection team manager (see good practice 3) will be responsible for dividing teams by the works. For this, production engineers of the works will have the obligation to request, in advance, the presence of the team for the final inspection.

Good practice 6: plant and equipment for the final inspection

All works should be able to receive the inspection team as scheduled (good practice 5) providing physical space in the Office, working structure, inspection equipment calibrated, necessary for the correct execution.

Good practice 7: treatment of non-conformities

The checklists and identified non-conformities, these should be discussed with the engineer responsible for the execution of the work and its master and crew. The responsible for the treatment of non-conformity under the coordination of the engineer responsible must establish corrective actions and deadlines for the completion of treatment. The inspection team should also set the date of date re-inspection required housing unit.

Good practice 8: delivery of the housing units

Released by the housing unit must be inspection conducted compliance inspection schedule with the presence of the client. This inspection must participate in at least one of the members of the inspection team which carried out the final inspection of the work. This practice will facilitate the interaction and greater confidence on the part of the customer.

Good practice 9: delivery of the housing units

At least, should be made once weekly meetings between the inspection team and the team final of the work. For the purpose of exchanging information, planning of inspections, as is being inspected the property, assessment of the progress of the treatment of non-conformities and recptividade of customers in units already delivered.

Good practice 10: indicators information

In addition, the final inspection team must present the works team of quality management of the construction company of nonconformities identified, mean-time-to-repair, customer receptivity at the time of the final inspection, the non-compliances identified by the client and the justifications thereof be flaws. The quality management team should promote the dissemination of for involvement of teams and science of management.

Good practice 11: delivery report of customer work

Complete deliveries of all the housing units marketed the team manager enterprise inspection shall prepare a report containing all the data from the internal final inspection to final inspection with the client and delivery of the keys to the client. This document should suffer critical analysis done by the quality management team in conjunction with the team of managers and the Board. As a result of this meeting a plan of improvements must be formatted with the aspects deemed relevant.

CONCLUSIONS

There has been inadequate and inefficient use of quality management in construction. Several factors such as: competitiveness, production, non-specialized labor, sloppy planning and product management, services, superficial compliance inspections, and wrong can be the justification. With that, it appears, in General, subject to any exceptions due to the construction industry performs and manages works so unproductive and without quality. In this context, doesn't pay attention and respect deserved by its customers.

The obstacles to final inspection of housing units facing, extrapolate the boundaries of the own quality management system of the construction companies. As can be deduced by the interviews. The inspections are done wrongly, superficially, without commitment and are not monitored by the management team.

Emphasis is placed on production without tools such as planning and control is effectively practiced. In the name of increased production the good practices of the conformity inspection of constructive steps are abandoned and work managers lose a support tool for the management of quality of the enterprise. The absence of quality indicators, measurable goals and management of same prevents is deployed a favourable environment for the continuous improvement of constructive practices already committed errors in repeating previous ventures.

The proper use of compliance inspections carried out at the end of the work before the inspection together with the customer to the delivery of the housing units allows optimizing the delivery of units to end customers, generating products with quality and durability. Thus, decreasing the unnecessary overhead in the service sector and the costs involved with flaws.

Future studies may be done on the issue of how to improve the final budget impacts units of a company due to: maintain an effective high for unnecessary time on grounds of non-acceptance of units, costs with the rework made by technical assistance in possession of low effective. Besides the taint associated with the company's brand with units delivered with bad quality standards.

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Planning the Quality Management Organization – Development of a Roadmapping oriented QFD Approach

Behmer, Falk¹, Jochem, Roland ²

¹Fraunhofer IPK, Division Quality Management, Berlin, Germany, falk.behmer@ipk.fraunhofer.de

²Technische Universität (TU) Berlin, Department for Quality Science, Berlin, Germany, roland.jochem@tu-berlin.de

ABSTRACT

Purpose – This paper summarizes recent empiric research findings on Quality Management Organization (QMO) planning activities in manufacturing enterprises. Based on these findings, it presents a planning method concept that helps practitioners to plan their QMO in a more pro-active manner. This includes a description of working steps, tools and stakeholders to be involved in the planning process.

Methodology – Foundational data was gathered from the author's own empiric research conducted between the November 2014 and April 2016 within manufacturing enterprises in Germany, Switzerland and Austria. Based on findings regarding current QMO structures, tools, stakeholder involvement and requirements towards a praxis-oriented planning approach, a methodology is developed to plan the QMO long-term and in line with corporate strategy. This methodology is based on Roadmapping as a strategic planning tool and Quality Function Deployment as a design tool.

Findings – A comprehensive, pro-active planning approach supports effective design of the QMO. At the same time, a gap exists between the need for pro-active planning and current corporate practice. A Quality Function Deployment approach combined with Technology Roadmapping and Utility Analysis appears promising as a planning method that serves practitioners to plan the QMO with sufficient scope and time frame.

Value – The methodology presented in this paper lays the foundation for development of a practitioner-oriented planning method to plan the QMO pro-actively and in accordance with the overall corporate strategy in terms of products, technologies, markets and associated legal requirements. At the same time, this paper reviews the state-of-the-art of QMO planning and presents recent findings of empirical research.

Keywords – Corporate Planning, Quality Management Organization, Roadmapping, QFD

Paper type: Research / Conceptual paper

INTRODUTION

Manufacturing enterprises have always had to adapt to changing environments. Mega trends of the 21st century include globally linked value chains, fierce market and resource competition, shortened product life cycles, digitization and a demographic development towards an elderly society (National Intelligence Council 2012). Quality is a key factor in order to maintain competitiveness in today's market conditions (Westkämper 2006, Bruhn 2011). This is especially true for high wage countries such as Germany, Austria and Switzerland where defending competitive advantages becomes more and more difficult. Therefore it is important to create new advantages through active anticipation of future developments such as changing customer requirements, norms and regulations, technological advances as well as socio-political changes. Timely actions have become a critical success factor (Krystek 2006).

Creating ideal organizational framework conditions for Quality Management (QM) in order to realize the planned quality of products and services has therefore become an important managerial task. DIN EN ISO 9004:2009 already emphasizes the requirement of adequate organizational planning and structuring, especially in the field of QM. Planning the Quality Management Organization (QMO) has developed into an essential task.

Increased market complexity has led to increased organizational complexity, weakening the ability of organizations to adapt to changing conditions (Bliss 2000, Keuper 2014). Increased market and organizational complexity simultaneously increase the time necessary for adapting while decreasing the time that is actually available, driven by shorter life cycles and faster flows of information (Bleicher 2004). Hence, many enterprises can no longer cope with the maxim of "structure follows strategy" (Chandler 2003). If adapted to Quality Management, this means that a quality strategy can no longer be supported by a QMO (). In such cases the organization itself can become a limiting factor – "strategy follows structure" (Scholz 2000).

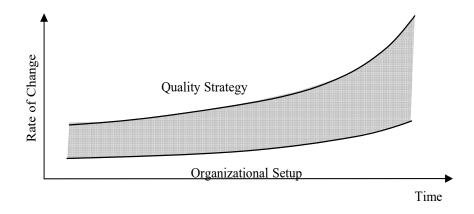


Figure 1: The problem of the "Organizational Gap" applied to Quality Management (based on Vahs 2015)

Quality issues of large manufacturers usually catch large media attention. High quality costs created by image loss through non-conformities are not limited to one particular industry but draw special attention when consumers are directly affected. For example, 2014 marked a record of car recalls in the US, which affected most international car manufacturers (Center of Automotive Research 2014). Other examples are faulty cell phones (Farr 2014) or health damaging food products (Hunt 2015).

Praxis shows that organizational changes are often initiated only under high pressure of substantial quality problems. In these situations, quality managers often lack the time to strategically approach organizational redesign and development measures as they are fully engaged in "Fire Fighting" actions (Figure 2). This can easily result in a vicious circle that is hard to break without major external support.

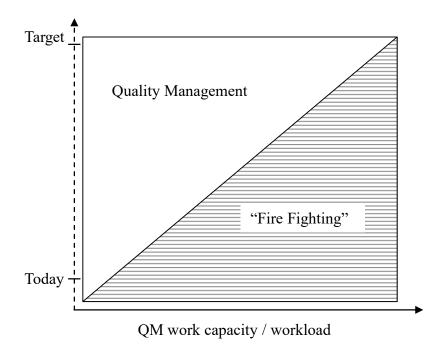


Figure 2: Visualization of the misbalance in workload often found in QM

But it's not only re-occurring quality crises that push quality managers from a rather reactive towards a more pro-active planning approach. DIN EN ISO 9001:2015 defines the responsibilities of top management for the Quality Management System (QMS). First of all, it holds responsibility for its effectiveness. Secondly, it has to ensure that the quality strategy and goals that apply to the QMS are sufficiently secured, and align with the overall strategy of the organization. As a result, the strategic scope must be extended by a quality dimension, making the planning of the QMO an essential part of corporate planning. As a result, quality management today frequently also incorporates organizational design and development (Sommerhoff 2012).

Goals

Our research aims to develop a planning methodology that allows for pro-active QMO planning, while accounting for all other important factors. It is intended to support quality managers with the complex task of designing and developing the organization in order to reduce to a minimum the gap between strategy and organizational capabilities.

Out of this overall goal the following aims for the planning method can be derived:

- Consider other planning dimensions that affect what a QMO must be able to deliver
- Create transparency to improve communication between QM and the organization
- Systematically identify important design and development areas to plan the QMO according to needs
- Define measures that are prioritized based on cost, time and other enterprise-specific factors

With these aims the methodology actively supports the implementation of a pro-active quality management that is rooted in the revision of DIN EN ISO 9001, which currently requires companies to implement a basic form of risk management. A systematic planning methodology can help to identify risks and to plan organizational counter measures accordingly. Furthermore, it will support decision makers in aligning QMO-related planning to the corporate strategy.

QMO PLANNING

Quality management has to fulfil a wide range of tasks. Customer requirements come first, but in addition, there are legal, normative, and economic feasibility requirements. Top Management is directly responsible for the QM effectiveness and must therefore actively support it across hierarchies throughout the organization (Kamiske 2011). The QMO serves as a backbone to fulfill this task.

OMO Definition

A large set of tasks makes QM a typical cross-functional discipline. It is occupied with the analysis, control and evaluation of material and immaterial production and service processes. Hence, QM includes the entire range of quality-related tasks and objectives (Linß 2011).

Its practical tasks are described in DIN EN ISO 9000:2015 which defines QM as "coordinated activities to direct and control an organization with regards to quality". In summary these tasks are:

- Definition of quality policies and quality objectives
- Definition of processes to achieve these objectives
- Quality planning
- Quality assurance
- Quality control
- Quality improvement

Therefore the Quality Management Organization can be defined as one or more persons that have their own functions with responsibilities, authorities and relationships to achieve the quality objectives of a superordinate organization (compare DIN 2015, 3.2.1 "Organization").

Ever since the TQM movement started it has become obvious that a QMO cannot only be described by looking at the organizational structure, underlying processes and information systems. Furthermore, the human factor has gained a substantial role. Educational and social aspects as well as work culture must also be taken into account. Hard factors such as strategy, process, project and performance management serve as a foundational support element (Lindsey and Petrick 1997).

To plan an organization, its context must be taken into account. DIN EN ISO 9000:2015 refers to the organizational context of an organization as the "combination of internal and external issues that can have impact on an organization's approach to developing and achieving its objectives". Hence, QMO planning must take a substantial range of issues into account. Existing planning methodologies often describe only a very generic approach (e.g. Schreyögg 2008) or aim at specific organizational challenges (e.g. Schaefer 1997). A holistic approach that specifically supports quality managers in this highly important task of planning the QMO is missing thus far. This was supported by the interview findings. In order to develop a suitable planning approach, our research aimed at identifying requirements towards the content (what must be planned?) and the process (how to plan it?).

Empirical findings: Requirements towards a QMO planning methodology

The summarized findings are based on an online survey conducted in in November and December of 2014. Key topics were current QMO structures, associated planning and reorganizing practices.

Participants from Germany, Austria and Switzerland were selected based on the following criteria:

- 1. Must be a manufacturing business in line with the German Census Bureau manufacturing sector classification
- 2. More than EUR 10. Mio in annual sales

The survey was limited to the manufacturing sector because of the fundamentally different QMO requirements in this sector compared to the service industry (Seghezzi et al., 2013). The minimum sales requirement was set to focus explicitly on companies with quality-related structures; this was assumed to be more likely in larger companies.

After an initial evaluation of the results, interviews were performed to gain a deeper understanding of QMO characteristics, current planning activities and requirements towards a QMO-specific organizational planning approach.

Regarding QMO planning the following insights were drawn from the survey (Behmer et al 2015a, Behmer et al 2015b):

- There is no universal optimal structure for the QMO in manufacturing enterprises. Structures were found to be independent from the industry sector, and the same structures showed different effectiveness in companies of the same sector and same size. Hence, QMO planning must take the individual situation of enterprises into account.
- The most important triggers for changing the QMO were quality problems, changing customer demands, new products and the implementation of new technologies.
- A comprehensive and long-term planning approach and QMO effectiveness are positively correlated.
- Pro-active planning tools like Technology Roadmapping are hardly used.
- Overall, there is a gap between the rated importance of pro-active QMO planning and actual business practice, meaning that quality manager consider comprehensive, long-term planning very important but haven't incorporated this attitudes into their current planning practice.
- A main reason why projects to change/reorganize the QMO failed in the past was missing clarity regarding organizational goals and relationships.

Semi-structured interviews (Bortz and Döring 2009) were performed between December 2015 and April 2016 in person during on-site visits and via telephone with seven available survey participants.

Participant Nr. Number of sites Industry Revenue **Employees** Unknown <100 1 1 Electronics 2 Textiles ~280 m. ~1330 30 3 Automobile Unknown <100 1 4 Fine mechanics / Optics 4.5 bn. ~25000 70 5 ~130 1 Automobile Unknown ~3500 6 400 m. 9 Electronics 80 m. ~400 7 Electronics 3

Table 1: Profiles of interview participants

The content reflected the key topics of the survey with a particular focus on QMO planning activities. Initially, it was elaborated which aspects of the QMO should be considered during the planning process. A selection of QMO descriptors and possible characteristics that were named during the interviews are presented below in Table 2.

Table 2: Selection of QMO descriptors to be considered during planning

QMO descriptor	Example characteristic
	Functional
Primary	Divisional
organization	Matrix
	Mixed
	Centralized QM
Configuration	Decentralized QM
	Flat hierarchy levels
	Product management
	Project management
Secondary	Key-Account-Management
organization elements	Strategic business units
	Quality circles
	Quality Taskforce
	QMS
Quality Management systems	IMS
,	Knowledge Management
	Interface definition
Processes	Process KPI
110005505	Workflow support
	Minimization of interfaces

	Customers
	Supplier
Stakeholder integration into the QMO	Sales and distribution
	Production
	Research and development
	Qualification to apply quality tools
Employees	Systematic qualification management
	Quality supporting corporate culture
	CAQ solutions
Quality enhancing technology	Process assistants
	Digitization of quality assurance
	Process descriptions
Documentation	Organization charts
Documentation	Competence matrices
	Q-Job descriptions

Interview participants were also asked for their application-oriented requirements towards a planning tool. Findings from the initial survey were the need for more transparency; especially the visibility of relationships between different objectives and organizational initiatives. The requirement to involve different stakeholder groups into the QMO planning process was also expressed, through participant demands for an interdisciplinary planning approach. The most frequently stated requirements are summarized below:

- A QMO-specific planning method should incorporate and visualize relationships between the QMO and other field of planning. This feature would improve the overall alignment of planning activities with other departments and could significantly improve communication.
- It should allow for covering a planning horizon of 3-5 years.
- It should be easy to use with the possibility of individualization and minimize the planning effort; ideally as a tool based on standard software.
- Interdisciplinary work should be incorporated in a workshop environment.
- The intended outcome should be clear, even at the beginning of the planning process.

DEVELOPING A NEW PLANNING METHODOLOGY

Organizational Planning

Planning is a theoretical attempt to elaborate the future, based on defined objectives. It is a systematic deliberation and definition of objectives, measures and resources to achieve these objectives. On a generic level, planning usually contains the following elements (Hammer 2011):

Definition of objectives

- Definition of measures, associated methods and required resources in order to describe alternative actions
- Decision regarding which alternative should be selected
- Documentation of selected measures in order to realize the selected alternative

In the context of organizational planning, these elements are usually distributed in sequential phases (Figure 3).

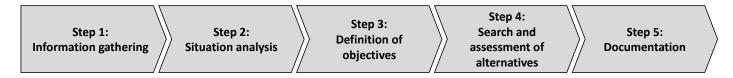


Figure 3: Phase model for organizational planning (Vahs 2015)

- Step 1 is gathering important information regarding the organizational context. This especially includes the corporate strategy like markets, products, technologies, resources and so on. Information is systematically documented and serves as a framework for the actual planning process.
- Step 2 aims at the analysis of the current internal situation. Focus lies within the description of deficiencies and existing strengths, which allows for localization of improvement areas.
- In Step 3 objectives are derived qualitatively or quantitatively. These objectives are prioritized and summarized in a consistent target system.
- Step 4 sources potential ideas of how to achieve these objectives. Alternative measures are being developed and collected in a catalogue. In order to evaluate these measures, a rating system is defined that allows alternatives to be ranked based on the impact on the target system. As a result, the best-suited measures are selected and consolidated in an organizational concept.
- Step 5 includes documenting the selected measures. Tasks and responsibilities are projected, required resources listed and milestones defined. This documentation serves as the basis for realizing the plan.

This plan usually entails measures for organizational design (technical-oriented change approach) and organizational development (behavior-oriented change approach). Design measures aim at processes, associated structures and technologies and are often referred to as *business reengineering*. On the other hand, *organizational development* measures focus on the soft parts and especially include aspects of business culture and working climate (Vahs 2015). Even though the underlying change management theories of both approaches are fundamentally different, comprehensive organizational planning is only possible when both aspects are taken into account (Lindsay and Petrick 1997).

The documented plan must be regularly reviewed to ensure that is still in line with the overall company objectives. Ideal times are usually before the annual budget process, or whenever significant changes in the corporate strategy are undertaken.

QMO Planning Methodology

The process model presented above must be supported with appropriate tools in order to be practically applied. The methodology presented below was developed specifically for quality managers to enable them to plan the QMO according to the requirements revealed during preceding research. It incorporates the techniques of Technology Roadmapping, Quality Function Deployment (QFD) and Utility Analysis. QFD and utility analysis are well known tools to most quality managers; Roadmapping is an intuitive concept that can be learnt quickly if it should be unknown.

Of course, there are other tools available to support the organizational planning process but in summary, most of them lack individually in certain important aspects of QMO planning. Weaknesses are especially a detail level (focus on only specific elements) that doesn't match the strategic planning approach, the limitation to a

certain planning phases or the missing capability to incorporate multiple planning dimensions. An exemplary overview of planning techniques is given by (Hüber and Jahnes 1998) or by (Krink 1983).

Our methodology is summarized in Figure 4.

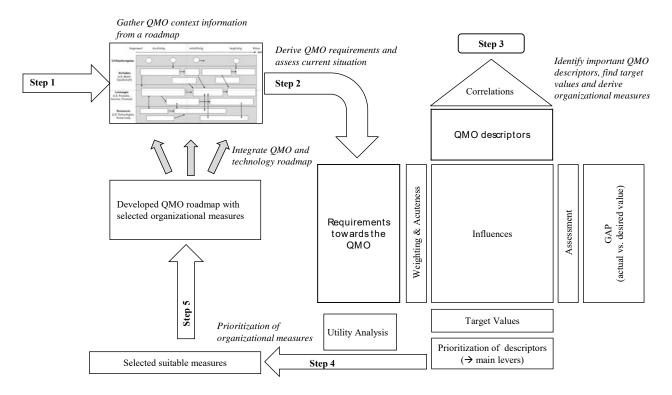


Figure 4: Summarized planning methodology

The overall objective is to align QMO planning with the most relevant other planning fields by deriving requirements towards the QMO from existing plans that can – or already have been – documented in a roadmap. Through utilizing QFD these requirements are translated into suitable QMO characteristics. Based on this translation, measures can be planned and documented in an additional roadmap layer, analogue to market, product or technology planning.

Step 1: Roadmapping-based information gathering

Technology Roadmapping is a widely used technique (Barker and Smith 1995) to support strategic and long-range planning. It often serves as a graphical tool to explore the linkages between evolving and developing markets, products and technologies. The included term *technology* is usually associated with science and engineering but can also relate to areas that support an effective science and engineering application. This includes the organizational structure and processes of a company (Phaal et al. 2004). A generic example is presented in Figure 5.

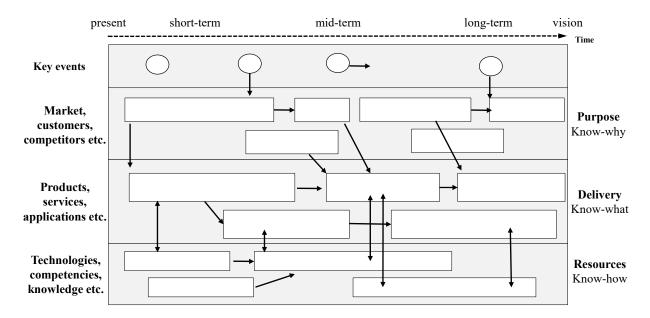


Figure 5: Generic example of an enterprise roadmap (Phaal et al. 2004 and EIRMA 1997)

Technology Roadmapping has been adopted by organizations to pursue different strategic aims and therefore represents an umbrella term. The overall benefit of this concept is a time-based structure to develop, represent and communicate strategic plans while accounting for the synergies between different planning layers. It can address very different organizational aims and its graphical forms and terms therefore vary (Phaal et al. 2004). For the purpose of planning the QMO along markets, products, technologies and other relevant dimensions, the term "QMO Roadmapping" appears suitable.

Because Quality Management aims directly at the quality of provided products and services but must also take many other perspectives into account, Roadmapping appears an ideal tool to gather information regarding the context of the QMO. Just like required technologies can be derived from planned products in a market pull approach, it would be highly beneficial to derive required QMO characteristics in order to plan them along in an additional roadmap layer. Of course, this approach could also be applied to plan for QMO features that allow for innovative product or service quality characteristics that are subsequently brought to the market, as in a market push approach.

The Roadmapping-based information gathering should especially aim at the following:

- Identifying the overall quality objectives of the enterprise
- Analyzing existing roadmaps (e.g. for products, markets, technologies, etc.) and the impact on the requirements towards the QMO that can be drawn from them
- Analyzing changes in the environmental conditions (e.g. laws, standards, etc.) and their impact on the requirements towards the QMO
- Vice-versa, also identifying opportunities where QMO changes can enable new product and service characteristics that have potential to create competitive advantage

Roadmapping is an interdisciplinary approach (Fichter and Beucker 2012) and therefore allows for integrating important stakeholder groups into the information gathering process. Existing roadmaps can be used and incorporated; alternatively new roadmaps can be created.

Step 2: Situation Analysis using the QFD "House of Quality"

Quality Function Deployment was originally developed to integrate quality into every step of the product development process. The central instrument of this approach is the so-called "House of Quality". In a five-phase process, it helps translate customer requirements into product specifications, component

specifications, processes and finally process parameters (Schmitt und Pfeifer 2010). The shortened and simplified descriptions below refer to phase 1 (Linß 2011):

- 1. Customer and market requirements are collected, structured and weighted.
- 2. Based on this, current products are evaluated and compared to competitor products.
- 3. Product characteristics are developed that have an impact on customer requirements. Target values are derived and the necessary direction of change is defined for each characteristic.
- 4. In the core of the house, relationships between listed product characteristics and customer requirements are evaluated, usually with a scoring system of 9 (strong), 6 (medium), 3 (weak) and 0 (non-existent). Finally, these values are multiplied by the importance of each requirement and summed up in order to calculate the overall importance of each product characteristic.
- 5. In the roof, correlations between product characteristics are elaborated.
- 6. Elements to be realized are selected.

Additional measures are usually integrated, like the possibility of realizing target values of each factor or additional information that helps to understand the current situation or target values.

The approach described is a standard tool of quality management and its application in QFD already outlines the possibility to plan different aspects of an organization. Combined with Technology Roadmapping, the House of Quality can serve as a "linking grid" to connect strategic key perspectives (markets, products, technologies) with each other (Phaal et al. 2003).

It can also be adopted to integrate the QMO into strategic corporate planning activities. In this case, customer requirements are replaced by requirements towards the Quality Management Organization identified from the Technology Roadmap, and product characteristics by QMO characteristics (Figure 6).

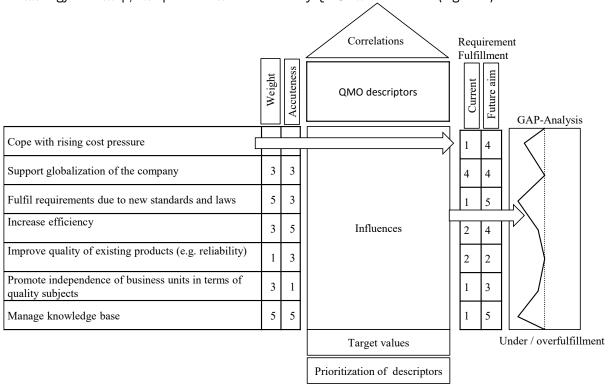


Figure 6: Schematic view on step 2

The technology roadmap serves as the basis to define future QMO requirements. As the roadmap usually incorporates the customer perspective through products and a quality strategy, requirements towards the QMO can be derived in an internal workshop. Exemplary requirements are listed in Table 3. In order to complete step 2 (situation analysis) of the organizational planning process, the identified requirements are

weighted according to their importance and acuteness. The acuteness is an important factor because the requirements towards the QMO are tied to events from the roadmap whose chronology must be considered.

Table 3: Exemplary requirements towards the QMO derived from the Roadmap

Intentions	Market	Cope with rising cost pressure
		Support globalization of the company
	Legal form	Fulfil requirements due to new standards and laws
		Satisfy growing quality expectations
		Obtain ecological sustainability
	D	Error prevention in R&D, production and logistics
Performance	Processes	Increase efficiency
	Products	Development of innovative products
		Improve quality of existing products (e.g. reliability)
	Service	Increase customer satisfaction
Resources	Technology	Ensure quality during the development of innovative technologies
		Rise the degree of digitalization and secure data
	Abilities	Promote self-government/independence of business units relating to quality subjects
		Manage knowledge base

Finally, the current degree to which these requirements are fulfilled by the current QMO is assessed. Additionally, the desired future level of requirement fulfillment is elaborated. A comparison of the current assessment and the desired future level of requirement fulfillment (Gap Analysis in line-diagram) can help to identify the most critical areas for improvement and give an overview regarding the current state of fitness for the future.

Step 3: Definition of objectives using the QFD "House of Quality"

The objective of this step is to identify the future direction of how the QMO should be designed and developed to match the requirements derived from the technology roadmap. In order to do so, quality related organizational characteristics – descriptors – have to be identified that have the strongest positive relationship with the previously rated future requirements. This activity also entails setting out target values for each descriptor. Ideally, these target values are quantified. As this might pose a challenge in a QMO planning context, qualitative targets may be described where necessary. QM representatives, as experts within the QMO, should also identify correlations between QMO descriptors in order to identify synergies and conflicts.

The requirement weight is multiplied by the level of influence as a QMO descriptor, and the values are summed up in the bottom of the house and allow for the identification of most important organizational improvement areas. Additionally, each descriptor has an "acuteness value" that is the overall sum from the products of the requirement acuteness and influence of the descriptor. These results are the input for the subsequent search and assessment of alternatives.

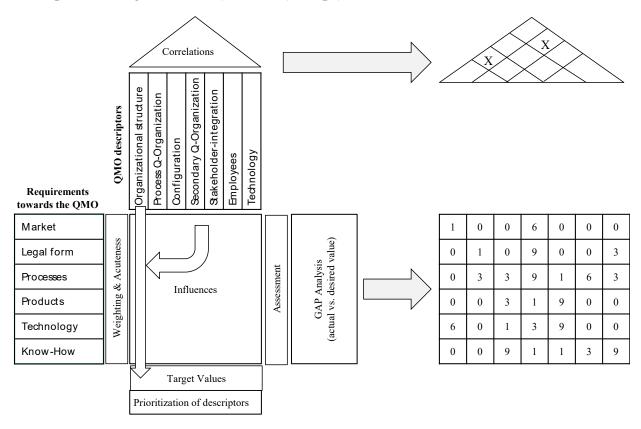


Figure 7: Schematic view on step 3

Step 4: Search and assessment of alternatives using a Utility Analysis

The objective of step 4 is the selection of those QMO descriptors, whose defined target values should be implemented with organizational measures. At this stage, comprehensive information regarding the QMO descriptors that support the identified requirements most strongly and their chronological priority is available. Additionally, the Gap Analysis provides an overview about the greatest weaknesses of the current QMO setup towards future requirements. Of course there are other factors that must be taken into account for this decision; feasibility (resource availability and company politics), visibility of impact and return on investment – if possible to calculate – are examples that were registered during interviews.

While a classical QFD usually incorporates the feasibility aspect, it seems clearer to separate the utility analysis from the "House of Quality" instrument in an extra table. The highest ranked QMO descriptors are listed in lines; the defined utility dimensions are added in columns. These utility factors can also be weighted to express an under- or overweight. After rating the selected descriptors, the overall score can be calculated from the product sum. For the final selection of those QMO characteristics whose target values are supposed to be realized, the time-considering acuteness value of each descriptor should be additionally consulted. This allows for the development of a QMO development plan with short-, mid- and long-term initiatives.

As the descriptors only describe QMO features, suitable measures must be derived in a subsequent, more detailed planning phase. Praxis shows that this is an enterprise-specific task that requires the involvement of different stakeholder groups, which have to be brought together with consideration of the individual business situation.

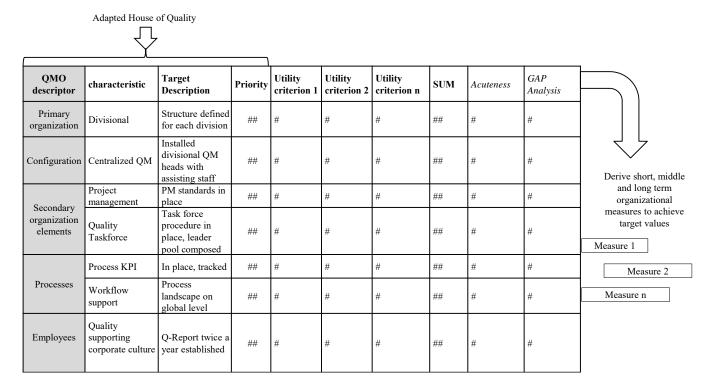


Figure 8: Schematic view on step 4

Step 5: Documentation using the initial Roadmap (from step 1)

Step 5 aims to document of a plan to adapt the QMO according to future requirements. The measures developed in step 5 are visualized in a time bar with the same length of the roadmap used in step 1. This time bar is added as an additional layer to the initial roadmap.

One required feature of a new planning methodology is the visualization of interrelationships between the planned measures of different dimensions. These relationships can be expressed with arrows that indicate connections and dependencies. Comments may additionally be added to provide important key information.

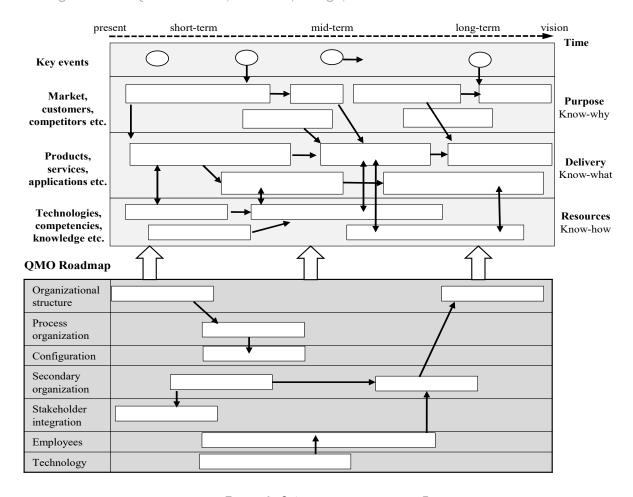


Figure 9: Schematic view on step 5

CONCLUSIONS

Planning for an effective QMO is a key task for quality managers today. As quality relates to many inside and outside factors, a comprehensive perspective on future requirements towards the QMO is necessary. A survey showed that a comprehensive, pro-active planning approach is positively correlated to the QMO's effectiveness. A gap between current corporate practice and the perceived importance of pro-active QMO planning indicates a lack of sufficient organizational planning methods. This assumption was supported by subsequent interviews conducted with survey participants from the manufacturing sector in Germany. They revealed an extensive need to also incorporate soft factors into the organizational planning process such as a quality-focused company culture, employee training and integration of different stakeholder groups into the QMO. However, hard factors like the overall organizational structure, processes or supporting information technologies remain important planning variables.

The presented planning methodology allows quality managers to systematically identify future requirements towards the QMO using Technology Roadmapping. It helps to create a comprehensive view on targeted markets, products and technologies but also allows incorporating of further quality related aspects, such as the legal and normative environment. These factors were identified among the strongest triggers for reorganization in a QMO context. QFD as a standard tool of QM supports a systematic translation of these requirements into QMO characteristics and to derive organizational measures accordingly. Integrating these measures into a roadmap allows for visualizing relationships between the market, product, technology as well as other important planning dimensions and the QMO. A key requirement towards a new planning methodology can therefore be fulfilled in a superior way.

The planning methodology fulfills all requirements frequently stated by the interviewed QM practitioners and can help to integrate the QMO into the corporate planning process which is required according to DIN EN ISO 9001:2015. As a next step, a suitable rating system for the adapted House of Quality and the utility analysis will be developed. To validate the methodology, a software demonstrator will be created to apply the planning method in a pilot case. In the future, the planning method could be realized as a software tool and should serve corporate quality managers as well as external consultants to facilitate effective QMOs in manufacturing enterprises.

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Evaluating quality-inspection effectiveness and affordability in short-run productions

Franceschini, F., Galetto, M., Genta, G. and Maisano, D.A.

Department of Management and Production Engineering, Politecnico di Torino, Turin, Italy

ABSTRACT

Purpose – Illustrating a practical method for supporting the design of quality inspections in short-run and single-unit manufacturing processes.

Design/methodology/approach – Processes are decomposed into a number of steps, which are potentially critical to defect generation. Several parameters concerning effectiveness and cost of the inspections are identified and aggregated into a probabilistic model for representing the process propensity to produce defects. Two indicators related to the effectiveness and cost of inspections are defined and tested through a case study concerning a short-run manufacturing process in the automotive industry.

Findings — The combined use of the proposed indicators allows to support the selection of the more appropriate inspection procedures, in a simple and practical way.

Research limitations/implications – The above indicators and probabilistic model rely on the following simplifying assumptions: (i) possible occurrence of a single defect typology in each step, and (ii) absence of correlation between the parameters related to different steps. Future research will focus on developing more general probabilistic models and identifying practical methods to estimate the relevant parameters.

Practical implications – The proposed model and indicators may be applied to a variety of industrial contexts, related to short-run and single-unit productions.

Originality/value – The proposed model and indicators allow to identify the more effective and affordable inspection procedures for short-run and single-unit productions. Their quantitative connotation represents an important novelty with respect to the classical qualitative approaches. Also, the proposed model and indicators take account of possible inspection errors.

Keywords: Quality inspection, Short-run, Inspection effectiveness, Inspection cost.

Paper type: Research paper

1. INTRODUCTION

The manufacturing of complex products is typically organized into several steps: acquisition of raw materials, processing, assembly, functional testing, etc. Quality inspections are usually performed to check whether specifications and functional requirements are satisfied, and to identify defects and/or anomalies. Inspection may be governed by strict or non-strict rules (e.g., periodical controls, fixed-percentage control, etc.) and organized through well-defined or heuristic procedures.

More specifically, if an inspection is performed, it may be conducted in four different ways: (i) simple inspection, that is to inspect a single item once; (ii) fractional inspection, that is to inspect a fixed fraction of items in a batch, where zero and one (full batch) are the two extreme cases; (iii) repeated inspection, that is to inspect the same item(s) more than once; and (iv) dynamic inspection, that is to inspect items in a batch sequentially and a decision of whether to reject or accept the batch is made dynamically instead of at a fixed fraction (Mandroli et al., 2006).

The inspection strategies are significantly affected by the production volume. In the case of mass production, Statistical Process Control (SPC) techniques can be straightforwardly applied (Montgomery, 2013). On the other hand, in the case of productions of single units, small-sized lots (i.e., the so-called *short-runs*) or in the start-up of a process, most of the SPC techniques are inappropriate (Del Castillo et al., 1996; Marques et al., 2015).

The present paper analyses the quality-inspection procedures for short-run and single-unit manufacturing processes, focussing on the individual *operations* or *manufacturing steps* that they consist of. The paper provides some guidelines for supporting the design and assessment of suitable inspection procedures, through the definition of a probabilistic model for defect prediction. In other words, the paper tries to answer the following research question: *considering a short-run or single-unit manufacturing process with several possible inspection procedures, how the more effective and affordable ones can be determined?*

Two types of errors are associated with an inspection: (i) the wrong rejection of a conforming unit, which is known as type-I error; and (ii) the erroneous acceptance of a nonconforming unit, which is known as type-II error (Mandroli et al., 2006). However, some authors simply assumed a perfect inspection and some other authors only considered one of the two types of error (Lee and Rosenblatt, 1987; Veatch, 2000). In the present paper, both types of errors are taken into account (Raz and Kaspi, 1991; Shiau, 2002).

The construction of the probabilistic model is based on the following phases:

- I. estimating the probability of occurrence of defects and that of (not) detecting them, in each manufacturing step;
- II. combining the above probabilities into a model, which depicts the overall effectiveness and affordability of the inspection procedure.

This model has both an analytical and predictive connotation. Currently, similar approaches are mostly implemented in the software engineering field (Rawat and Dubey, 2012). Furthermore, inspection-oriented quality-assurance strategies are mainly aimed at identifying optimal formulations (Jewkes, 1995). In the present paper, the problem of comparing several possible inspection procedures is dealt with.

The remainder of the paper is organized into four sections. Sect. 2 illustrates the probabilistic model and its characteristic parameters. Sect. 3 describes two practical indicators, which depict the overall effectiveness and affordability of an inspection procedure; the description is supported by several examples. Sect. 4 presents a structured case study, concerning the application of the proposed model and indicators in the short-run production of components for luxury cars. Sect. 5 summarizes the original contributions of this research, focusing on its implications, limitations and possible future developments.

2. MODEL DEFINITION

2.1. Assumptions

Let us decompose the production process into *manufacturing steps* or just *steps*, i.e., individual operations providing an added value to the final product. The proposed model is based on the following hypotheses:

- 1. For each step, there can be one-and-only-one defect typology.
- 2. Defects originated in the different steps are uncorrelated.
- 3. The occurrence of defects and that of inspection errors are uncorrelated.

The first hypothesis is not so stringent, as the totality of the defects in a single step can be interpreted as a unique "macro-defect". On the other hand, the second and third hypotheses may sometimes not be satisfied.

2.2. Parameter definition

Each *i*th step of the production process is modelled with a Bernoulli distribution (Montgomery, 2013). Then, each step can be described through three parameters:

- p; probability of occurrence of the defect in the Ath step (i.e. the parameter of the Bernoulli distribution);
- α; probability of (erroneously) detecting the defect when it is not present in the inspection in the it is step (false defect or false positive);
- β ; probability of not detecting the defect when it is present in the inspection in the *i*th step (*false negative*).

The index is included between 1 and m, i.e. the total number of steps.

The first parameter concerns the quality (or, reversing the perspective, defectiveness) of the process, while the other two parameters concern the quality of the inspection.

The above parameters are usually difficult to estimate. Since p_i is related to the characteristics of the process and its propensity to generate defects, an *a priori* estimate of this parameter can be obtained through adequate defect-generation models; alternative approaches may be based on empirical methods (e.g., use of prior experience) and/or simulations. On the other hand, the estimation of α_i and β_i is related to the type-I and type-II errors, which strictly depend on the inspector activity and inspection procedure (Tang and Schneider, 1987; Duffuaa and Khan, 2005).

2.3. Conceptual representation of the process

The graph in Figure 1 represents a generic production process with m steps in series. The graph in Figure 2 represents another production process, consisting of two steps in parallel, followed by a third one (in series). More complex processes can be represented using graphs with mixed structures (in series and in parallel). Consistently with what described in Sects. 2.1 and 2.2, each (\not -th) step can be associated with three parameters (p, α , β).

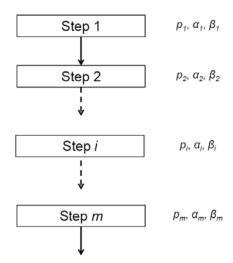


Figure 1 – Representation of a production process with m steps in series.

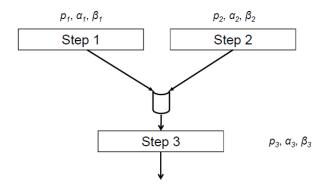


Figure 2 – Representation of a production process with two steps in parallel, followed by a third one (in series). Logical *AND* operator is exploited.

2.4. Model formulation

The following probabilities can be calculated for each (*i*th) step:

$$P(\text{detecting the defect in the step } i) = p_i \cdot (1 - \beta_i) + (1 - p_i) \cdot \alpha_i$$
(1)

and

$$P(\text{not detecting the defect in the step } i) = p_i \cdot \beta_i + (1 - p_i) \cdot (1 - \alpha_i)$$
 (2)

where *i* is included between 1 and *m*, i.e. the total number of steps.

In the case the defect is detected, it will be *authentic'* with a probability $p_i(1-)$ or *false* with a probability $(1-p)\cdot$ (see Eq. (1)). On the other hand, in the case no defect is detected, this will be the result of an inspection error (false negative) with a probability p_i , or will be due to the real absence of any defect with a probability $(1-p)\cdot(1-)$. The above probabilities represent the "elementary bricks" for the construction of some indicators depicting the performance of the inspection procedures, which are presented in Sect. 3.

Considering a generic process with *m* steps, irrespectively from being in series, parallel or mixed structure, the above probabilities can be combined together:

¹ i.e., a defect, which is actually present.

$$P(\text{detecting the defects in all the } m \text{ steps}) = \prod_{i=1}^{m} \left[p_i \cdot (1 - \beta)_i + (1 - p_i) \cdot \alpha_i \right]$$
(3)

and

$$P(\text{not detecting the defects in all the } m \text{ steps}) = \prod_{i=1}^{m} \left[p_i \cdot \beta_i + (1 - p_i) \cdot (1 - \alpha_i) \right]$$
 (4)

It is possible, more generally, to calculate the probability of detecting the defects in k out of m steps, where k is included between 1 and m, by using binomial-like models.

The probabilities in Eqs. (3) and (4) are related to the complexity of the process, in terms of number of steps (m), quality of the process (p), and quality of the inspection $(\alpha, \text{ and } \beta)$ in each step.

3. PROPOSED INDICATORS

Different kinds of inspection activities may be adopted for checking the conformity of the output of a specific manufacturing step, e.g., visual check, dimensional verification, etc. (Dowling et al., 1997; See, 2012). In order to compare the effectiveness and affordability of the alternative inspection activities, the two indicators discussed in the following subsections can be used (Ng and Van Hui, 1997; Wang et al., 2010).

3.1. Inspection effectiveness

Let us consider m Bernoulli random variables (X), defined as follows:

- $X_i = 0$: when (i) an authentic defect is detected or (ii) no defect is present in the *i*th inspection.
- $X_i = 1$: when an authentic defect is not detected in the *i*th inspection.

According to the model formulated in Sect. 2.4, the following relationships hold:

$$P(X_{i} = 0) = p_{i} \cdot (1 - \beta_{i}) + (1 - p_{i}) = 1 - p_{i} \cdot \beta_{i}$$

$$P(X_{i} = 1) = p_{i} \cdot \beta_{i}$$
(5)

where i is included between 1 and m. Therefore, the mean number of authentic defects unnoticed in the ith inspection is:

$$E(X_i) = p_i \cdot \beta_i \tag{6}$$

which is obviously a quantity included between 0 and 1.

Thus, the mean total number of authentic defects, which are not detected in the overall inspection procedure is:

$$D = \sum_{i=1}^{m} E(X_i) = \sum_{i=1}^{m} p_i \cdot \beta_i$$
 (7)

The variable D provides an indication of the overall effectiveness of inspections.

3.2. Inspection cost

The total cost for inspection and defect removal related to each (*i*th) step may be expressed, as a first approximation, as follows:

$$C_{tot,i} = c_i + NRC_i \cdot p_i \cdot (1 - \beta_i) + URC_i \cdot (1 - p_i) \cdot \alpha_i + NDC_i \cdot p_i \cdot \beta_i$$
(8)

where:

• c_i is the cost of the *i*th inspection;

- NRC is the necessary-repair cost, i.e., the necessary cost for removing the defect;
- *URC*, is the unnecessary-repair cost, i.e., the cost incurred when identifying false defects; e.g., despite there is no cost required for defect removal, the overall process can be slowed down, with a consequent extra cost.
- NDC is the cost of undetected defect, i.e., the cost related to the missing detection of defects.

Apart from the estimates of the probabilities p_n α_r and β_r , the calculation of the total cost therefore requires the estimate of additional cost parameters. In general, c_r and NRC_r are known costs, URC_r is generally known or easy to estimate, while cost NDC_r is difficult to estimate since it may depend on difficult-to-quantify factors, such as image loss, after-sales repair cost, etc.

The total cost for inspection and defect removal related to the overall production process can be expressed as:

$$C_{tot} = \sum_{i=1}^{m} C_{tot,i} \tag{9}$$

When comparing two or more inspection procedures, the costs related to the $NRC_i \cdot p_i \cdot (1-\beta_i)$ contributions must be excluded, since they have an opposite behaviour against the variation of , in comparison to the other contributions depending from , and , i.e. $URC_i \cdot (1-p_i) \cdot \alpha_i$ and $NDC_i \cdot p_i \cdot \beta_i$. In fact, when , and , decrease/increase, $URC_i \cdot (1-p_i) \cdot \alpha_i$ and $NDC_i \cdot p_i \cdot \beta_i$ decrease/increase while $NRC_i \cdot p_i \cdot (1-\beta_i)$ increases/decreases producing a compensation effect which biases the comparison between the procedures. Hence, from equation (8), the cost related only to the inspection procedure is:

$$C_{tot,i}^* = c_i + URC_i \cdot (1 - p_i) \cdot \alpha_i + NDC_i \cdot p_i \cdot \beta_i$$
(10)

Accordingly, the corresponding total cost related only to the inspection procedure for the overall production process is:

$$C_{tot}^{*} = \sum_{i=1}^{m} C_{tot,i}^{*} \tag{11}$$

The indicator C_{tot} provides a preliminary indication of the cost related exclusively to the inspection procedure in use. In this sense, it can be used as a proxy for inspection affordability.

3.3. Examples and remarks

Let us now focus the attention on a didactic example. A production process consists of m=5 steps with three different inspection procedures:

- Procedure A in which two steps only (i.e., step 1 and 5) are subject to inspection;
- Procedure B in which the totality of the steps are subject to inspection.
- Procedure C in which the totality of the steps are not inspected.

The effectiveness of the three alternative inspection procedures can be evaluated using the indicator defined in Eq. (7). The mean total number of (authentic) defects, which are not detected in the three procedures are respectively:

$$D_{A} = p_{1} \cdot \beta_{1} + p_{2} + p_{3} + p_{4} + p_{5} \cdot \beta_{5}$$

$$D_{B} = p_{1} \cdot \beta_{1} + p_{2} \cdot \beta_{2} + p_{3} \cdot \beta_{3} + p_{4} \cdot \beta_{4} + p_{5} \cdot \beta_{5}$$

$$D_{C} = p_{1} + p_{2} + p_{3} + p_{4} + p_{5}$$
(12)

in which, for a generic $\dot{\epsilon}$ th step with no inspection, the corresponding β , was replaced with 1. Assuming that the β , related to a generic $\dot{\epsilon}$ th step with inspection has the same value irrespective of the inspection procedure, it follows that:

$$D_C \ge D_A \ge D_B \tag{13}$$

Not surprisingly, the procedure C is the worst one in terms of effectiveness. From the viewpoint of inspection cost, by applying Eq. (11), it is obtained:

$$C_{tot,A}^{*} = c_{1} + URC_{1} \cdot (1 - p_{1}) \cdot \alpha_{1} + NDC_{1} \cdot p_{1} \cdot \beta_{1} + NDC_{2} \cdot p_{2} + NDC_{3} \cdot p_{3} + NDC_{4} \cdot p_{4} + c_{5} + URC_{5} \cdot (1 - p_{5}) \cdot \alpha_{5} + NDC_{5} \cdot p_{5} \cdot \beta_{5}$$

$$C_{tot,B}^{*} = \sum_{i=1}^{5} \left[c_{i} + URC_{i} \cdot (1 - p_{i}) \cdot \alpha_{i} + NDC_{i} \cdot p_{i} \cdot \beta_{i} \right]$$

$$C_{tot,C}^{*} = \sum_{i=1}^{5} NDC_{i} \cdot p_{i}$$
(14)

So, if the ith step is not subject to inspection, then $c_i = 0$, $c_i = 0$ and $c_i = 1$. Assuming that, for the step with inspection, the parameters (probabilities and costs) are known, the cost c_i can be calculated and the alternatives inspection procedures compared with each other.

For example, if the c_i values tend to be higher than the URC_i values and the p_i values are relatively low, then the procedure C_i in which all the steps are not subject to inspection, will be likely to be more convenient than the others. Conversely, if the c_i values tend to be low and the p_i values tend to be high, then the procedure B_i in which all the steps are subject to inspection, will be likely to be more convenient than the others.

4. PRACTICAL CASE STUDY

4.1. Process description and modelling

Let us now consider an automotive manufacturing process aimed at producing the front fender of a luxury car. Due to the relatively small number of parts produced over time, it can be considered a short-run production. The manufacturing process is organized into four main operations: three welding operations in three different working locations (ops. 10, 20 and 30) and a final activity of calibrating and assembly (op. 40). Figure 3 shows, as an example, one the welding operations (op. 30), while Figure 4 shows the calibrating and assembly operation (op. 40).



Figure 3 – Welding operation no. 30. Red circles show the corresponding weld areas.



Figure 4 – Calibrating and assembly operation (op. 40).

The two last operations involve the use of a calibrated artefact for dimensional verification of the frame geometry and then the assembly of brackets and bushings. Each of the three welding operations should be preceded by a corresponding activity of set-up of welding parameters (ops. 10', 20' and 30'). Therefore, the process can be divided into seven total steps (three for set-up, three for welding and one of calibrating and assembly), as represented in Figure 5.

Set-up operations are in series with the relevant welding operations. The three pairs of set-up and welding operations are in parallel with each other and followed by the (unique) operation of calibrating and assembly (op. 40).

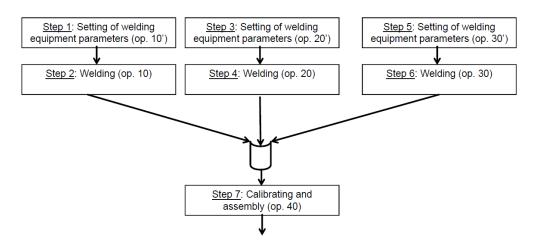


Figure 5 – Flow chart representing the production process exemplified.

For the same process of interest, two alternative inspection procedures are compared. In the first procedure, self-inspections are performed after welding operations (ops. 10, 20 and 30) and a final inspection is performed by an appointed staff after the calibrating and assembly operation (op. 40). Figure 6 represents the production process integrated with the first inspection procedure.

In the second inspection procedure, the individual self-inspections are performed after each of the seven steps (see Figure 7).

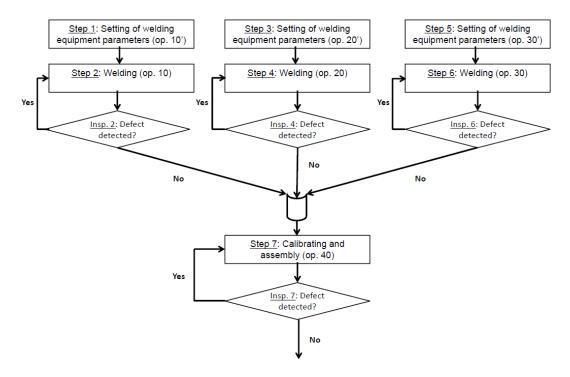


Figure 6 – Flow chart representing the production process, integrated with the first inspection procedure. A self-inspection is performed after the steps 2, 4 and 6, while an inspection by an appointed staff is executed after the step 7.

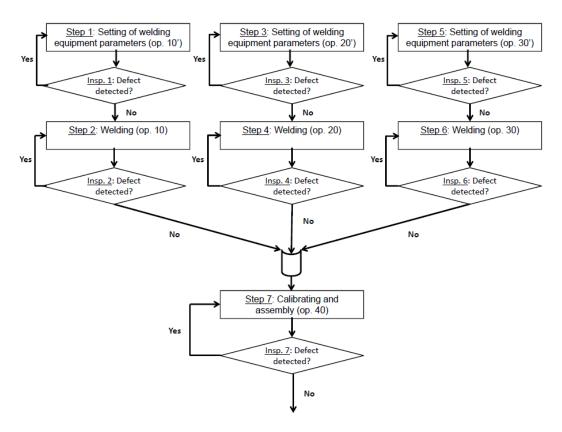


Figure 7 – Flow chart representing the production process, integrated with the second inspection procedure. A self-inspection is performed after each of the seven steps.

4.2. Comparison of inspection procedures

The indicators described in Sects. 3.1 and 3.2 were applied to compare the two inspection procedures introduced in Sect. 4.1. Tables 1 and 2 report estimates based on prior experience of the indicators for each process step, considering the first and the second inspection procedure respectively. Estimates of cost parameters are just indicative because their actual values are confidential.

Table 1 – Estimates of probabilities and cost parameters related to the first inspection procedure. The
parameters that did not need to be estimated are italicized.

Step no.	Operation type	p ; [%]	a_i [%]	β , [%]	c , [€]	<i>URC</i> , [€]	<i>NDC</i> ,[€]
1, 3, 5	Set-up parameters	0.1	0.0	100.0	0	10	100
2, 4, 6	Welding	5.0	1.5	1.0	10	150	400
7	Calibrating and assembly	1.0	4.0	2.0	50	200	500

Table 2 – Estimates of probabilities and cost parameters related to the second inspection procedure.

Step no.	Operation type	p ; [%]	a_i [%]	β , [%]	c , [€]	<i>URC,</i> [€]	<i>NDC</i> ,[€]
1, 3, 5	Set-up parameters	0.1	1.0	0.5	5	10	100
2, 4, 6	Welding	5.0	1.5	1.0	10	150	400
7	Calibrating and assembly	1.0	2.0	1.5	20	200	500

For both the inspection procedures, it is supposed that the p_i values related to steps 1, 3, 5 and steps 2, 4, 6 are coincident, while those related to step 7 are independent:

$$p_{setting} = p_1 = p_3 = p_5$$

$$p_{welding} = p_2 = p_4 = p_6$$

$$p_{calibrating} = p_7$$
(15)

Similar considerations apply to the other parameters, i.e. α , β , c, URC, and NDC.

Let us now focus the attention on the calculation of the indicators D and C_{tot} defined in Sects. 3.1 and 3.2. Eq. (7), related to the effectiveness of inspections, becomes:

$$D = 3 \cdot p_{setting} \cdot \beta_{setting} + 3 \cdot p_{welding} \cdot \beta_{welding} + p_{calibrating} \cdot \beta_{calibrating}$$
 (16)

while Eq. (11), related to inspection costs, becomes:

$$C_{tot}^{*} = 3 \cdot c_{setting} + 3 \cdot URC_{setting} \cdot (1 - p_{setting}) \cdot \alpha_{setting} + 3 \cdot NDC_{setting} \cdot p_{setting} \cdot \beta_{setting} + \\ + 3 \cdot c_{welding} + 3 \cdot URC_{welding} \cdot (1 - p_{welding}) \cdot \alpha_{welding} + 3 \cdot NDC_{welding} \cdot p_{welding} \cdot \beta_{welding} + \\ + c_{calibrating} + URC_{calibrating} \cdot (1 - p_{calibrating}) \cdot \alpha_{calibrating} + NDC_{calibrating} \cdot p_{calibrating} \cdot \beta_{calibrating}$$

$$(17)$$

Table 3 reports the numerical values of D and C_{ω} calculated for both the inspection procedures, using the parameters in Table 1 and Table 2 respectively.

Table 3 – Indicators values calculated for the two inspection procedures.

Indicator	First procedure	Second procedure
D	0.0047	0.0017
<i>C</i> * _{tot} [€]	95.33	76.35

This result shows that the second inspection procedure is significantly better, as it has lower mean total number of undetected defects (D) and mean total inspection cost (C_{ω}).

For the purpose of example, Figure 8 shows the 3D surface plot of D, for the second inspection procedure, as a function of $p_{welding}$ and $p_{calibrating}$, while $p_{setting}$, $p_{setting}$, $p_{setting}$, and $p_{calibrating}$ are kept constant to the values shown in Table 2. In this situation, the effect of $p_{welding}$ is predominant.

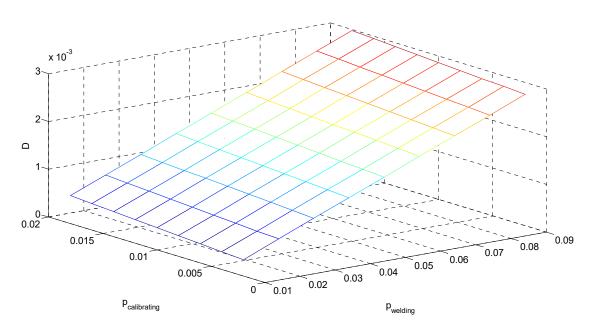


Figure 8 – 3D surface plot of D for the second inspection procedure, against $p_{welding}$ and $p_{calibrating}$.

5. CONCLUSIONS

In manufacturing processes, the inspection strategy is strictly related to the production volume. SPC techniques are popular for mass productions, although difficult to manage for short-run and single-unit productions. This paper examined the latter ones, defining an overall probabilistic model for defect prediction.

Also, two indicators for estimating the expected inspection effectiveness and cost were defined. According to a cost-benefit logic, the combined use of these indicators makes it possible to compare two or more inspection procedures in order to select the more effective and affordable for a process of interest.

The model and the indicators proposed in this paper may be exploited for a wide range of industrial process. An application example concerning a short-run production in the automotive industry exemplified the comparison of two different inspection procedures.

The major limitation of the probabilistic model and the proposed indicators is that they require the estimation of various not-so-easily-quantifiable parameters (i.e., p_n α_n β_n c_n URC_n NDC_n). A thorough understanding of the process of interest and the opinion of experts may contribute to overcome this limitation (at least partially).

Another limitation concern the simplifying assumptions introduced, i.e., (i) a single type of defect for each manufacturing step and (ii) the absence of correlation between the parameters related to the different steps. Future research will concern the development of defect-generation models for estimating the parameters ρ_n α_n β_r . Also, it is planned to develop a statistical model for estimating the dispersion of the output parameters D and C_{vx} with respect to that of the input parameters ρ_n α_n β_n c_n URC_r and NDC_r .

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Self-Assessment Using a Business Excellence Model: an empirical study on Brazilian SMEs

Machado, M.C.1, Mendes, E.F.1, Telles, R.1, Sampaio, P.2 and Santos, C. E.1

- 1) Paulista University
- ²⁾ University of Minho

ABSTRACT

Purpose – The purpose of this paper is to identify the business excellence status of a set of Brazilian SMEs and to propose a specific self-assessment framework, which could be used by small and medium enterprises.

Design/methodology/approach – The paper presents a model for self-assessment based on eight criteria for business excellence, namely leadership; strategy and planning; customers; society; information and knowledge; people; processes; and results. The self-assessment system e-Meg, provided by the National Quality Foundation (FNQ), was applied for collecting data from 76 Brazilian SMEs. The data was used for a factorial analysis to reduce the number of criteria for self-assessment in SMEs.

Findings – This work identified that the SMEs are far from what could be considered the business excellence. In all criteria the surveyed organizations analyzed showed underperformance. But it was realized that, despite being far from the best practices, companies are willing to begin a process of improvement towards business excellence. For this reason, a specific model for self-assessment is proposed.

Practical implications – The model developed for business excellence self-assessment can be used by small and medium enterprises to evaluate their performance and excellence periodically.

Originality/value – The model developed for business excellence can contribute significantly to existing literature on business excellence. Further research can help in refining the criteria to this self-assessment framework to make the model a holistic one.

Keywords - Business Excellence, Self-assessment, Small- to Medium-Sized Enterprise, SME.

Paper type: Research paper

INTRODUCTION

Similar to other countries, Brazilian small and medium enterprises (SMEs) contribute significantly to the economy, through their products and services. However, SMEs face various challenges, namely financial constraints, unavailability of professional talent, lack of modern technologies, etc. (J. P. Antony and Bhattacharyya, 2010). Despite these difficulties, SMEs need to progress into their journey to business excellence. Business excellence, organizational performance and quality management, applied to SMEs has been discussed academically by many researchers (Abdul Talib et al., 2009; J. Antony and Bhattacharyya, 2010; J. P. Antony and Bhattacharyya, 2010; McAdam and Kelly, 2002; Mendes and Lourenço, 2014; Simpson et al., 2012; Sinisammal, 2012; Teixeira et al., 2015). There are studies on excellence in business that assume that the best practices used by large companies could be scaled down and applied to SMEs. Other studies argue that SMEs in a benchmarking process can develop their understanding of excellence in business and share their practice among other SMEs (McAdam and Kelly, 2002). In both situations, SMEs need to assess their current performance (Hudson et al., 2001; Teixeira et al., 2015). A self-assessment of the business can show whether SMEs are close to or away from the managerial excellence. The process, practice, and management of the self-assessment can be used to influence the organization strategy (Ritchie and Dale, 2000), and to develop decision models and analyzes tools for supporting the organizational performance assessment process (Chin et al., 2003). However, some researchers say that SMEs have different organizational characteristics comparing to large companies, and, for this reason, SMEs also need a different self-assessment instrument (J. Antony and Bhattacharyya, 2010; Ates et al., 2013; Garengo et al., 2005). Then we developed the following research question: What would be, in fact, an appropriate selfassessment framework for SMEs?

This work is based on a survey that was carried out in 76 Brazilian SMEs to identify their status of business excellence and to propose a self-assessment framework specific for SMEs. To do so, we used the self-assessment system e-Meg (FNQ, 2015a), provided by the Brazilian National Quality Foundation (FNQ). The application of self-assessment, in every organization, was oriented by a researcher, whose role was to dispel any doubt regarding the understanding of the evaluation criteria. The assessment framework is supported in eight criteria for excellence, namely leadership; strategy and planning; customers; society; information and knowledge; people; processes; results. Each criterion is subdivided into items, generating 23 evaluation items. All results were compiled in a spreadsheet and statistically analyzed.

LITERATURE REVIEW

Business Excellence Model

In 1951, The Union of Japanese Scientists and Engineers (JUSE) introduced the "Deming Prize", that was the first globally known business excellence model (Talwar, 2011). The main purpose of the award was to recognize the excellence in the application of the concepts proposed by Deming. Nowadays, many organizations have attempted to improve their performance through business excellence models such as the Malcolm Baldrige Model, the European Excellence Model (Williams et al., 2006), or, Brazilian National Quality Foundation (FNQ). Hardjono (2001), argues that the look on the concept of business excellence must be extended to include other dimensions because the ability of the company to grow and to improve continuously is also determined by its social competencies, ethical responsibility, and environmental contributions. Thus, Business Excellence Models (BEMs) embody both the adoption of a collection of what have been widely acknowledged to be best practices and the measurement of stakeholder-related performance results (Escrig and de Menezes, 2015). A model of excellence is, therefore, a management structure that allows organizations of all types and sizes assess their progress on the road to excellence in business, allowing them

to identify strengths and weaknesses regarding best practices as well as its mission and vision. Often, the model is used to integrate management methods and tools (Hohan et al., 2015).

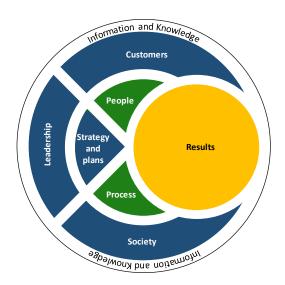


Figure 1 – Brazilian Business Excellence Model (MEG).

The Brazilian Excellence Model of Business – MEG, Figure 1, reflects the experience, the knowledge and the research of different organizations and Brazil and abroad experts. However, before being consolidated as MEG, FNQ adopted other international methodologies. From 1992 to 1996, it was used the American model of Baldridge Total Quality Management Foundation.

From 1995, some changes were made to the model, but always following the structure of the Malcolm Baldridge National Quality Award, until 2000, when the first version of MEG was launched, the first genuinely Brazilian model management (MEG, 2016). The MEG's eight criteria for excellence are leadership; strategy and plans; customers; society; information and knowledge; peoples; Process; Results (Figure 1).

Self-assessment

In a broader context, self-assessment can be understood as a methodology for continuous improvement that an organization can develop both in a total quality management (TQM) context or as an independent strategy (Tarí, 2008). Self-assessment implies the use of a model on which to base the evaluation and diagnostics (Ritchie and Dale, 2000). Several authors have referenced the European Excellence Model of the European Foundation for Quality Management (EFQM) as an important model for self-assessment (Asif and Gouthier, 2014; Bou-Llusar et al., 2009; Escrig and de Menezes, 2015; Hardjono, 2001; Hohan et al., 2015).

The Brazilian National Quality Foundation defines self-assessment as an organizational management diagnostic process, focusing on results, based on the Business Excellence Model (MEG), allowing instigate and conduct reflections for organizations to self-assess accurately (FNQ, 2015b).

Ritchie & Dale (2000) explain that are many definitions of self-assessment, but the EFQM has one that combines all:

"Self-assessment is a comprehensive, systematic and regular review of an organization's activities and results against a model of business excellence. The self-assessment process

allows the organization to discern clearly its strengths and areas in which improvements can be made and culminates in planned improvement actions which are monitored for progress." (Ritchie & Dale, 2000, p.241)

Organizational excellence on SMEs

The environmental context, in which SMEs are embedded, offer some peculiarities to use models of business excellence. (McAdam and Kelly, 2002). Such peculiarities can be advantages or disadvantages. Some of the advantages of SMEs are an entrepreneurial spirit, lack of bureaucracy, increased flexibility and ability to respond to unexpected developments in the field, and close collaboration with suppliers and customers (Rakićević et al., 2015). Some of the major disadvantages of SMEs are the lack of resources, lack of training, lack of long-term planning, shortage of staff and lack of resources for major consulting (Dora et al., 2015). The advantages and disadvantages associated with the company's sector and size can assist in the construction of an excellence model that is suitable SMEs (Abdul Talib et al., 2009).

Sometimes, SMEs can receive support services for their organizational excellence development and, for this reason, may have superior performance (Doh and Kim, 2014). Some of these support services may be training and education, exportation, mentoring and consulting, knowledge, networking, etc. (Rakićević et al., 2015). However, in many cases, SMEs do not have such support, and the only way to get a better organizational performance is through a business excellence model.

RESEARCH METODOLOGHY

General Methodology Aspects

This study can be classified as descriptive one, constituting a "kind of conclusive research that has as primary objective the description of something – usually characteristics or functions" (Malhotra, 2006, p. 102). Data obtained through descriptive research can provide valuable information on units of study related to relevant characteristics and also on associations between these characteristics (Parassuraman et al., 2004). In addition to the descriptive approach, the literature identifies, in general, two types of research: exploratory and causal (Malhotra, 2006). These alternatives were not used because (i) exploratory research tends not to provide relevant results for phenomena widely studied, on which there are developed theorizing, and (ii) explanatory investigation does not have showed adequated to the purpose of the research.

This research can be further interpreted as quantitative. Quantitative investigations can be understood as a "research method that seeks to quantify data and typically applies some form of statistical analysis" (Malhotra, 2006, p. 154). Comprising "the collection of significant data, more representative samples of respondents and numerical calculations to the results (Parassuraman et al., 2004, p. 194). McDaniel and Gates (2003, p. 120) define this type of research as "studies using mathematical analysis".

This empirical research is a survey. Survey research consist of a factual instrument of data records or opinions that can be applied to a group of homogeneous nature, having at least one common attribute, such as belonging to a specific industry, for example (Flynn et al., 1990). Survey research is frequently used "to the questions like who, what, where, and how", with the quality of being "easy to explain, as well as to understand" (Saunders et al., 2007, p. 138).

The choice of research universe (i.e. small and medium-sized companies in the State of São Paulo) is justified by two aspects. (1) The study contribution focuses on the conceptual and functional development of Excellence Model approach for SME. (2) The SME relevance associated with its importance to the Brazilian economic and social context.

Data collection

The research population can be understood as the universe of SME enterprises in Brazil. Data for this study were collected from SMEs in the state of São Paulo, Brazil. We selected 76 companies that would fit with small and medium enterprises, and we have 100% of return. In the Table 1 can be observed the frequency distribution of the companies selected for the study. The highest percentage of small companies is related to the randomness of the sample.

Table 1 – Frequency distribution by size

			25 c.=c	
Size	Frequency	%	Valid %	Cum. %
Small	50	65,8	65,8	65,8
Medium	26	34,2	34,2	100,0
Total	76	100,0	100,0	

Thus, the sampling should be recognized as intentional, according to criteria determined by the researcher (Cooper and Schindler, 2003), with the participation of voluntary respondents (Saunders et al., 2007). Depending on the data collection option, the sample is not probabilistic (Cooper and Schindler, 2003). Although the external validity is compromised by this decision, jeopardizing the possibility of generalizing the results (Sampieri et al., 2003), this approach can provide access to "rich information to explore the issue of research" (Saunders et al., 2007).

Table 2 shows the areas of activity of the companies and reveals that the companies analyzed were concentrated in two sectors, service (22) and retail (42), totaled 84.2% of the sample.

Table 2 – Frequency distribution by sector

Sector	Frequency	%	Valid %	Cum. %
Service	22	28,9	28,9	28,9
Retail	42	55,3	55,3	84,2
Industry	8	10,5	10,5	94,7
Education	2	2,6	2,6	97,4
Cooperative	2	2,6	2,6	100,0
Total	76	100,0	100,0	

For data collection was used the e-Meg (excellence in management software) provided by FNQ. This software brings together issues that are applied to the assessment of the organization, to define what is the degree of organization of management with respect to each of the eight criteria.

Data analysis and research limitations

Data analysis was conducted by univariate and multivariate approach. Under univariate perspective, we used descriptive statistics involving position and dispersion measurements in the critical analysis of the variables considered in the evaluation of Business Excellence dimensions (Table 3), related to the objectives of the study. It was later developed a cross-table by exploiting potential correlations between the variables of the research, two by two (Table 4), seeking to identify collinear relationships between them. The results suggest the convenience of construction of a factor analysis (Table 7), oriented to the description of synthesizers factors of the phenomenon, facilitating its understanding by reducing variables and allowing the adoption of

simpler instruments for evaluation. The main research limitations, particularly linked to the method adopted are: (a) the descriptive nature of the study does not allow the discussion or inference of a possible cause-and-effect relationship between variables, limiting the supply information about intensity, dispersion, and correlations. (B) Not probabilistic and intentional nature of the sample, obtained by survey, limited indications and results to the sample considered, providing potentially relevant information to the population. And, (c) conclusions conditioned to techniques employed for examination and assessment of data, with actual observation of qualifications, evaluation parameters (reliability and validity, for example) and establish significance levels.

RESULTS

Statistical Analysis of Business Model Attributes

The purpose of this section is to present the results of evaluations of SME on the eight attributes for the Excellence Business Model (i.e. Leadership, Strategy and Plans, Customers, Society, Information and Knowledge, People, Process, and Results. Table 3 displays the attributes related to quality related to the averages, standard deviations, and coefficients of variation for three constructs adopted for analysis: small sizes firm, medium-sized firms and the sample (composition of both).

	Table 3 - De	escriptiv	e statis	tics (of the Busi	ness Mo	del attri	bu <u>tes</u>			
ATTRIBUTES	SMA	LL SIZES			MEDIUM SIZES				SAMPLE		
	AVERAGE	STD DEV.	CV (%)		AVERAGE	STD DEV.	CV (%)	AVE	RAGE	STD DEV.	CV (%)
Leadership	7,9	12,9	164		9,3	7,5	80	8	3,4	11,4	136
Strategy and plans	0,4	2,0	500		2,9	5,5	189	1	,3	3,8	301
Customers	7,7	14,3	185		7,3	8,3	113	7	7 ,6	12,5	165
Society	8,6	19,4	226		2,9	3,2	108	6	5,7	16,1	242
Inform. and knowledge	4,1	7,4	181		7,3	11,1	152	5	5,2	9,0	173
Peoples	6,6	12,8	195		4,5	3,8	83	5	5,9	10,7	182
Process	10,4	16,5	159		9,4	10,8	115	1	0,0	14,8	148
Results	10,0	14,0	140		21,0	21,7	103	1	3,8	17,8	129

The coefficients of variation (CV), defined as the ratio of standard deviations and averages, is a parameter that provides an overview of the concentration of data around the mean, in particular on the kurtosis of this distribution. Thus, the CV is an indicator that modulates the relevant average, (i.e. The higher the CV, the lower the average importance and higher the dispersion of the values obtained. (Pimentel Gomes, 1990) suggest the following classification for CV: low (less than 10%), medium (between 10 and 20%); high, (between 20 and 30%); and very high (more than 30%).

The appreciation of the CV values clearly indicates significant dispersion of data, what would compromise the use of non-parametric tests in the evaluation of parameters. In this sample, the smaller CV value found is 83%, which prevents the consideration of averages as appropriate parameters to measure the position of data distribution for any of the considered variables (attributes) Garcia (1989) e Spiegel (1996). However, 80% of those aggregated values (attribute and category) are not high enough to compromise the average results (Garcia, 1989; Spiegel, 1996). On the other hand, dispersion levels around the mean, offer an important

indication of the actual functionality of the model in understanding, diagnosis and prescription of strategies, and actions aimed at improving the Business Model Assessment.

The studied attributes deserve a more focused analysis in the context of the object of the study by referring to relevant considerations about potential differences between fundamental groups of the population studied. This perspective suggests that the important dispersions reveal discrepancies observed on understanding the dimensions surveyed by the different participants in the sample business.

Correlation analysis between the Excellence Model Attributes

Although the descriptive statistics, focused on the parameters of the distribution of quality variables, have been relatively weak in terms of adequacy and functionality for the sample used (consisting of partial sample SME), it should be recognized that the excellence model has been successfully used in large companies. That is, the model dimensions provide, to some extent, bases to the excellence management approach.

To explore the structure of this construct, we developed a cross-analysis of the attributes of excellence model, seeking to identify the presence of correlations that offer the opportunity to develop a more appropriate model to SME, but based on Business Excellence Model.

Table 4 presents the Pearson correlation coefficients resulting from the research variables crossing, two by two, seeking to identify collinear relationships between these.

The important presence of statistically significant correlations between variables, indicating the effective possibility of reducing variables, and, consequently, the simplification the model, allowing the construction of a more functional alternative for SME. Through a multivariate approach, such as factor analysis, it would be feasible to establish bases for the design of a construct-oriented for SME.

The factorial technique, according to Hair et al. (1998), it is potentially indicated when there is a substantial number of simple correlations greater than 0.30, which was observed in the results shown in Table 4. which leads to the use of factor analysis.

Table 4 – Correlation matrix among quality attributes

	1	2	3	4	5	6	7	8
1. Leadership	1,000	,223	,882**	,468**	,392**	,699**	,660*	,514**
2. Strategy and plans	,223	1,000	,193	-,055	,312**	,055	,137	,508**
3. Customers	,882	,193	1,000	,501**	,437**	,682**	,768**	,378**
4. Society	,468**	-,055	,501**	1,000	,106	,694**	,691**	,184
5. Information and knowledge	,392**	,312**	,437**	,106	1,000	,206	,379**	,232*
6. Peoples	,699**	,055	,682**	,694**	,206	1,000	,658**	,403**
7. Process	,660**	,137	,768**	,691**	,379**	,658**	1,000	,368**
8. Results	,514**	,508**	,378**	,184	,232*	,403**	,368**	1,000

^{**}Statistically significant at p < 0.01.

Reliability and Validity of Constructs

Proper use of multivariate techniques needs to meet your premises or at least the recognition of the requirements that have not been wholly or partially met. Reliability and validity are essential parameters in the development of factor analysis as significance criteria and accuracy of measuring instruments. In this study, the evaluation becomes more necessary as there is a high dispersion of data and the existence of significant correlations between variables.

^{*} Statistically significant at p < 0.05.

The reliability of a scale is associated with precision with which a concept is being measured. Providing the possibility of repeating the instrument in different situations. The most widely used procedure in the measurement of reliability is the calculation of Cronbach's alpha (Cooper and Schindler, 2003; Van Der Velde et al., 2004).

Table 5 - Reliability of the constructs

Construct	Alfa Cronbach	Alfa Cronbach Stand.	N
SMALL SIZES	0,868	0,855	50
MEDIUM SIZES	0,788	0,878	26
SAMPLE (SME)	0,845	0,851	76

Hair et al. (1998) indicate Cronbach's alpha equal to or greater than 0.7 for general studies and 0.6 for exploratory studies. Thus, the Cronbach's alphas were calculated for each of the constructs that make up the data collection instrument, with the results shown in Table 5. It is evident, therefore, that all constructs exceeded the limit, and that therefore they are considered reliable.

Van Der Velde et al. (2004) understand that reliability is a condition for the assessment of validity. Validity refers to the instrument's ability to measure what it purports to measure. In other words, an instrument can be highly reliable, but may not be valid for not assess the intended concept. Held up the test Kayser-Meyer-Olkin (KMO) and Bartlett's sphericity in assessing the validity of the constructs used. In Table 6, the calculations performed are presented to the constructs, developed and proposed in this research.

Table 6 - Validity of the constructs

Construct	Kayser-Meyer-Olkin (KMO)	Bartlett test	Bartlett Sig.
SMALL SIZES	0,715	273,466	0,000
MEDIUM SIZES	0,686	157,801	0,000
SAMPLE (SME)	0,749	377,430	0,000

The values for the three constructs indicate their reliability. Regarding the validity, it is acceptable KMO higher than 0.5, while for Bartlett's test of sphericity, the benchmark for the valuation parameter is the lower level of significance 0.05 (Hair et al., 1998). For both indicators can be admitted that the validity requirements have been met.

Factor analysis for excellence model attributes

Considering the results of statistical analysis of the data indicating the model dimensions as relatively limited basis functional indications for SME, and the presence of statistically significant correlations between these dimensions, the factor analysis is presented as a multivariate technique particularly appropriate for two their distinctive attributes:

- (1) dimensions of analysis reduction for understanding a phenomenon from factors (integrating model variables);
- (2) optimized maintenance explanatory power of the phenomenon, driven by the variance explained portion.

The approach to quality management, from the data obtained for the eight model variables (understood as analysis dimensions) using the exploratory factor analysis, we generated two different factors according to the results obtained (Table 7).

The resulting model of factor analysis holds 70.41% of the total variance of variables, which can be considered satisfactory (Hair et al., 1998).

Table 7 - Factor analysis for excellence model attributes

FACTOR	MODEL	СОМРО	ONENTS	COMMUNALITY
FACTOR	VARIABLES	1	2	- COMMUNALITY
	People	0,868	0,129	0,770
	Process	0,850	0,237	0,779
OPERATIONS (45.0% of the total variance)	Society	0,842	-0,128	0,725
	Customers	0,817	0,376	0,809
	Leadership	0,773	0,443	0,794
	Estrategy and plans	-0,110	0,860	0,752
STRATEGY (25,4% of the total variance)	Results	0,278	0,724	0,601
the total variance,	Information and knowledge	0,243	0,587	0,404
Eigenvalue		4,17	1,463	5,633
Variance		0,4497	0,2544	0,7041

Rotated matrix factorization for convergence with six iterations;

varimax rotation method with Kaiser normalization;

Coefficient Kaiser-Meyer-Olkin = 0.749; Sig = 0.000;

70.41% of the total variance explained by two factors.

The first factor, called Operation factor, is the most important in the composition of the factorial design, corresponding to 45.0% of the variance and comprising five of the eight variables (People, Processes, Company, Customers and Leadership). Which can be more directly associated with the operational dimension of management excellence. The second factor identified as Strategy factor, accounts for 25.4% of total variance, consisting of three model variables (Strategies and Plans, Results and Information and knowledge) associated with the strategic dimension of management excellence. For information, which has an instrumental nature and also contributes to the assessment of the degree of robustness of the factor structure, it must be recognized:

- (1) the sample size suggests that the values of the factor loadings compatible or greater than 0.6 are significant, with loads exceeding 0.70 are considered indicative of well-defined structure factor models;
- (2) communality values, expressing the portion of the total variance explained by the factors of the variable, to indicate an upper 70% explanation for most of the model variables; and
- (3) the value of the eigenvalues shows the proportion of the variance each factor is capable of retaining, i.e., Operation factor retains the variance of about four variables while Strategy factor retains the variance of approximately 1.5 variables.

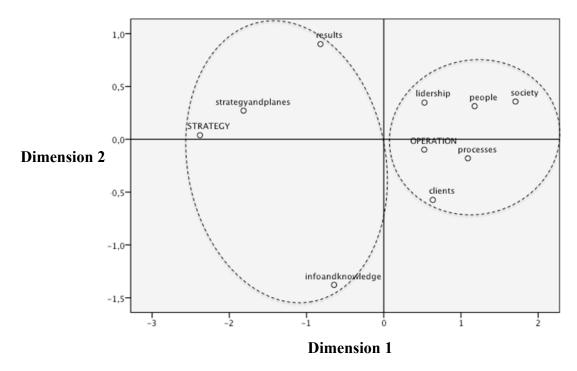


Figure 2 – Map of factors by multidimensional scaling.

CONCLUSIONS

Many studies on Business Excellence Models were held in the SME context. Some of these studies found that the best practices used by large companies could be used with some adjustments in SME. However, this research has identified that SME are far from the minimum levels of excellence and, perhaps, a simple reduction in the parameters established by the model of excellence, used by large companies, were not enough to adapt for use in SME.

Other studies indicate that SMEs can develop their understanding of excellence from the sharing of information and practices, a benchmarking process. However, from the data collected in this research, it was observed that the SME have poor performance in all criteria which would prevent a benchmarking process between them.

The results of this study revealed the possibility of developing a specific excellence model for SME. This model would consist of only two dimensions "Operation" and "Strategy". The dimension "Operation" encompass related aspects, leadership, people, society, processes and customers, and the dimension "Strategy" the aspects, strategy issues and plans, information and knowledge and results. With these new set of dimensions, the SME would be evaluated respecting their characteristics and limitations.

The limitations of this study are associated with the size and representativeness of the sample; it was held in a particular region of Brazil avoiding thus the generalization to other international contexts. Replication of this study in other countries appears as an opportunity for future studies, as well as the comparison of results with those presented in this research.

The proposal presented here can be a valuable tool for the development of SME towards business excellence.

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The dyad partnership-credibility and the qualification of suppliers

Simone Ribeiro Sarges (ssarges@hotmail.com) Department of Production and Systems - University of Minho CAPES – Brazil

Marcelo Oliveira (maoliveira.0312@gmail.com) Department of Production and Systems - University of Minho

Fernando Romero (fromero@dps.uminho.pt) Department of Production and Systems -University of Minho

Sérgio Sousa (sds@dps.uminho.pt) Department of Production and Systems -University of Minho

SUMMARY

The need to improve relations between company and supplier suggests that the dyad partnership and credibility must be enhanced in order to maximize gains for both parties that would otherwise not take place. This study demonstrates that companies and suppliers feel the need to review the results achieved by both parties and to influence the way they treat their relationships in the supply of goods and services.

This study highlights the need to explore two aspects: firstly, the focus of the importance of supplier partnership for improvement of the company and, secondly, the need to create links based in credibility for the improvement of relations between company and supplier, in order to establish a win-win process in their purchasing and supplying activities. This research applied a questionnaire to 154 elements of various industrial segments. The results confirm the widespread perception on the part of elements of the companies of the need for deepening the partnership between company and supplier, but it verified, however, less openness with regard to the sharing of knowledge, which can be an obstacle to the realization of this deepening. The analysis is done under the perspective of the qualification of suppliers.

Keywords: supplier, partnership, reliability, qualification

Paper type: Case study

INTRODUCTION

The market for the supply of goods and services has been the focus of studies that show the need for integration and partnership between company and supplier (Danese, 2013) because, currently, manufacturers become increasingly dependent on their suppliers to gain competitive advantage (Huo et al., 2013). As the knowledge required to produce or successfully develop a new product is often found in more than one company, a change becomes necessary in the way as suppliers and buyers interact with each other, from a shared network with more open information (Petrick & Echols, 2004).

The strengthening of the relationship between company and supplier has been accomplished through the possibilities offered by technological tools, especially information and communication technologies (ICT). The main technological tools used have been the internet, intranets, business-to-business (B2B) and business-to-consumer (B2C) platforms and e-marketplaces. Thus, ICT and, more generally, the World Wide Web, have forced most organizations to rethink the way they do business and how they can restructure it. As a result, ICTs have become a critical asset in product differentiation and daily operations, as well as in strategic management (Nucciarelli, Alberto; Gastaldi, 2008).

However, the technological tools cannot be considered as the only way of solving all the problems in integration with customers. The nature of client integration is also a social process, so it is necessary to consider other factors in addition to technology for improving customer integration (He, Keung Lai, Sun and Chen, 2014).

This research showed that there was an interest of the participants in having greater interaction between companies and their suppliers in the supplier qualification process, as a means to obtain cost reductions in production processes. This article aims to explore the social aspects of this process, in particular those related to the deepening of the nature of partnership, and to the credibility factor between company and supplier, having in mind the supplier qualification.

We present results based on surveys of multinational companies located in the Industrial Pole of Manaus, where employees from different areas of activity related to the supply process, in particular in the areas of engineering, quality, materials, production and purchasing, responded to the survey questions.

The next section of the article frames the theme, referring to approaches linked to the value of the partnership between the company and suppliers and to conceptual developments observed in several studies that address the issue of trust. The following sections refer to the methodology adopted and the presentation and analysis of the results. The concluding sections include a final analysis and the limitations and conclusions.

THEME BACKGROUND: AGGREGATED VALUES IN CREDIBLE PARTNERSHIPS BETWEEN COMPANIES AND SUPPLIERS

In the field of supply chain management is taking place change management driven by the effectiveness of new management practices in leading industries (McCutcheon & Stuart, 2000).

Studies show that partnerships with suppliers have several important aspects among which we can highlight the sharing of knowledge (Cai, Goh, de Souza, & Li, 2012), the relationship management (Day, Magnan, & Moeller, 2010), and the performance of the supplier (Dubois & Pedersen, 2002), among others. The relationship management is considered the most fragile component (Johnston, McCutcheon, Stuart, & Kerwood, 2004).

These aspects can be developed as an integral part of a strategic path of the company from which responsibilities between the parties are defined. The competitive advantage of these partnerships can derive from close relations of supply throughout the lifetime of a relationship and at various levels between company and supplier (Day et al., 2010).

The relationship between company and supplier collaborates to develop a win-win process, and one can highlight three components: a) information flows, b) provision of product flows and c) relationship management.

- a) Information flows in terms of supply have a direct impact on the plans of production scheduling, inventory control and delivery of individual members of the supply chain. Greater exchange of information, coupled with a best level of quality of information, makes the partnership more effective and improves the relationship between company and supplier (Heikkila, 2002).
- b) The supply of goods' flows is a component focused on the strategic collaboration with partners in the supply chain and the management of intra and inter-organizational processes, and aims to achieve effective and efficient flow of products to deliver maximum value for customer at low cost and high speed (Flynn, Huo, & Zhao, 2010).
- c) Relationship management with suppliers (SRM) is a business process to manage all contacts between an organization and its suppliers. Suppliers, here, refers to any organization that sells something to the company that operates the SRM application. SRM is the activity of the implementation process, including the creation, development, and stabilization of relationships, and includes the dissolution of relationships with non-qualified suppliers, in order to generate and increase the value within these relationships (Tseng, 2014).

Qualification can be defined as a method to demonstrate that an entity or process is able to meet or exceed specific technical requirements. The qualification aims to ensure an acceptable level of variability for all requirements of the product affected by the design and manufacturing, such as geometric dimensions, material properties and product features (Azarian & Pecht, 2008).

Qualification is a process by which the company tries to reduce market uncertainty and may be seen as a process in which the relationship between the companies is marked by strong ties of complementarity and interdependence, where the issue of trust becomes a central factor for the quality of the relationship. In this process, the company seeks to identify potential suppliers and determine their qualifications as a possible supplier of the company (Carr & Pearson, 1999).

For a process of supplier qualification are considered as factors necessary for the consolidation of supply partnership the delivery, time and cost, leaving aside, or in background, other factors such as: quality of service, containment of non-compliance, the overall performance of company and supplier, partnership and trust necessary for the proper development of their relationship (Chicksand, 2015). The uncertainty in the market may be another important dimension of the insecurity of that relationship because, in an environment shaped by rapid changes in the market, no company can predict accurately future changes (Lee, Yeung, Edwin & Cheng, 2009).

Companies that tend to believe and trust in their suppliers in order to maintain a committed partnership with the outcome of these have an explicit interest in the results and development of the supplier, and create a loyalty and priority in the services provided by suppliers (Blonska, Storey, Rozemeijer, Wetzels, & de Ruyter, 2013). This happens because due to the security/confidence that the company shows in its transactional relationship with the supplier, and whose essential requirement is the absence of opportunistic behavior by both the company and supplier.

Trust has been defined as a psychological state comprising the intention to accept vulnerability based on positive expectations of the intentions or behavior of another. It can be seen as the level of credibility and commitment by the supplier to promote the interests of the buyer, as perceived by the buyer (Schoenherr, Narayanan, & Narasimhan, 2015).

The trust between company and supplier may be linked to factors such as, for example, satisfaction, fair results and the propensity to continue to work, and that should be considered in relational processes by companies (Alejandro Souza, Boles, Ribeiro & Monteiro, 2011), since they tend to reinforce results obtained whithin such a line of work with their suppliers (Ates, Wynstra, & van Raaij, 2015).

The credibility and loyalty from the supplier to the customer goes beyond the formal barriers (based on pure market transactions) existing in relations between companies, and imply that the provider trusts the client and tends to put the respective company at the top of its priorities in the client portfolio, considering it the most important in the supply board (Adobor & McMullen, 2014).

In this context, there is a significant reduction of limits or barriers that prevent the customer to invest in key suppliers, through supplier strengthening or development programs, and in view of the investment in time and resources required from the customers. These programs can be implemented with a limited number of strategic suppliers (Nagati & Rebolledo, 2013).

Companies can also open their physical structure to suppliers, provide training, etc., as a way of being able to develop their activities in accordance with more efficient methods, according to business need. Studies showed that this collaboration creates a link of supplier's responsibility with the company, which strengthens the relationship, the partnership and the supplier's commitment to achieve the goals together with the company (Li, Humphreys, Yeung & Cheng, 2012).

RESEARCH METHOD

Given the overall objectives and the literature review, a questionnaire was made to estimate practices regarding the qualification of suppliers. We sought to evaluate the relationship of trust between company and supplier, including the involvement and the benefits of the relationship between the parties and confidence aspects of qualifying agreements.

The questionnaire consisted of closed questions with multiple choice answers and was applied to 154 employees in engineering, quality, materials, production and purchasing of six multinational companies from the following industries: metallurgy, production of electronic components and electronic products for consumption.

The six multinational companies have their headquarters in North America (two American companies), in Asia (one Taiwan company and two companies in China) and South America (one Brazilian company). Interviewed companies are subsidiaries that are installed in the Industrial Pole of Manaus - PIM, in Brazil, acting essentially as production outposts. They are focused on the areas of production of electronic components, mechanical engineering and end consumer products such as televisions, set-box, displays, boxes. All six researched companies play a role both as supplier and customer, since they provide intermediate products and are purchasing production inputs.

The nature of the industrial activity that emerged with the Industrial Pole of Manaus is the result of a tax incentive policy that was implemented to offset the unfavorable geographical location of

the city of Manaus relative to main suppliers and consumers centers where technology-related economic activities play a major role (Araujo Filho, 2005).

The sampling technique used in this study was of convenience and the questionnaire was directly administered (the interviewer was present in the completion of the questionnaire). Respondents are part of a group of professionals who have the following functions: inspectors of production processes, analysts, leaders, buyers and coordinators of the departments in which they are inserted. These individuals act on operating processes and therefore on return of the information about the result of the quality of the product provided by the supplier. Thus, they have some influence on the qualification of suppliers.

In the survey we asked participants to quantitatively identify their perception about the partnership between the company and the supplier, the benefits of sharing knowledge on the exclusive provider, the management of supplier quality, supplier qualification, reduction costs, in addition to information in order to meet the mutual needs in support of both parties and the involvement of the supplier partnership to improve development processes and products.

In this article, some of the topics covered in the questionnaire will be analyzed. We will address only the issues related to the partnership and the supplier's credibility. These two issues were addressed in the questionnaire through four questions each, for a total of eight questions. These questions attempt to cover gaps in the supplier qualification process and they provide information on how companies interact on some dificult to measure aspects, but that may appear in the future as indicators in the processes for supplier qualification.

In terms of composition of the sample, the quality and production areas were the major participants, followed by engineering, materials / logistics and others, and purchasing was the area with the smallest representation (Figure 1).

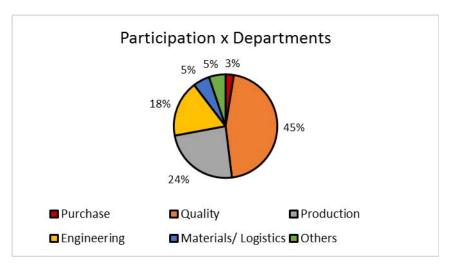


Figure 1: Participation of departments in the data collection process.

The question of the number of participants by area of the company is relevant because it indicates, in itself, the greatest interest that these areas have in the topics on research, particularly on the issues of partnership and trust between company and supplier.

In the process of conducting the survey, it was observed interest by the part of the engineering and production areas for these themes regarding possible advantages of supplier qualification

processes, if and when they effectively become partners of the company, not just distant parts of a purchase agreement sale. It was emphasized that a greater supplier involvement in improvement processes, on cost reduction and on the exchange of knowledge, will benefit the two parties, company and supplier.

PRESENTATION AND ANALYSIS OF RESULTS

The partnership between company and supplier

This section will address issues related to the partnership between the company and suppliers. In the following tables, data are presented separately to cover the aspects mentioned so that each participant could evaluate and rank it opinion on those statements.

The four survey questions that addressed the topic of the partnership are:

- A1: the relationship between company and supplier is considered important due to the benefits of combining the strengths of knowledge in production processes for both parties;
- B1: the importance of the company to make partnerships with the supplier with the benefit of mutually share information about production process improvements;
- C1: the need for qualification procedures for suppliers to describe the most appropriate way to cover your needs as a business and needs to support the supplier and, finally;
- D1: the validity of the company to increase the involvement of the partnership with the vendor focused on improving development processes and product.

Table 1 shows the obtained results, with response averages and the percentage of respondents by area of operation and by question, in which the columns correspond to the four questions. The total number of respondents of the companies that took part in the survey was 154 participants. Not all questions were responded by all participants, and so the percentages vary slightly according to the question. One Likert scale with five points was used: 1. strongly disagree, 2. disagree, 3. agree, 4. fairly agree and 5. totally agree.

Table 1: Average concordance of responses per question regarding the partnership between company and supplier, by department.

Departments	, ,	A1	B1	C1	D1	Total
Purchase	Average	4,00	4,00	4,25	3,25	3,88
	% respondents	2,59%	2,61%	2,61%	2,59%	2,60%
Engineering	Average	3,67	4,08	4,27	4,19	4,05
	% respondents	17,53%	16,99%	16,99%	17,53%	17,20%
Materials/ Logistics	Average	4,13	4,38	3,75	4,13	4,09
	% respondents	5,19%	5,22%	5,22%	5,19%	5,20%
Quality	Average	3,86	4,06	3,96	4,11	4,00
	% respondents	45,45%	45,75%	45,75%	45,45%	45,6%
Production	Average	3,73	3,92	3,62	3,81	3,77
	% respondents	24,0%	24,2%	24,2%	24,0%	24,1%
Other	Average	3,88	3,88	3,63	4,00	3,84
	% respondents	5,19%	5,22%	5,22%	5,19%	5,21%
Total	Average	3,81	4,03	3,91	4,03	3,94

% respondents 100,0% 100,0% 100,0% 100,0% 100,0%

Table 1 shows the average of the responses related to the areas where the companies operate by department. In general, it was observed a positive assessment of the questions, suggesting that the partnership between the company and suppliers can be considered as strategic, or at least very important. It should be noted that these aspects are not currently considered by these companies in the qualification processes.

It can also be seen that the participation of quality (45.6%) and production (24.1%) departments is much more significant than other departments, showing a greater interest in the topic, which probably is due, as explained by some participants, to the fact that the results of the supplier qualification processes most directly affects the outcome of the production process, in particular on product quality.

On the other hand, the results in Table 1 showed that the total average in the areas of purchasing and production have the lowest results on the importance of partnership between the company and supplier (respectively 3.88 and 3.77), which seems a little contradictory to the previous explanation. The production area (with 3.77) presents the lowest average and this may be due to the fact that production area addresses noncompliance automatically sending the problem to other departments so they can act in the correction of the respective non-conformities related to the acquisition of inputs from their suppliers. These departments will be those who most felt the impact of non-quality. This seems to be confirmed by the results of the areas of material, quality and engineering which have a total average greater than 4, showing that these departments will feel most the impact of non-quality. They are also the areas which will make transactions arising from non-conformity of production processes with the respective vendors for improvements and corrections of products purchased by the company. Thus, these areas are those who value more a deepening and improvement of the partnership.

However, in general, regardless of the number of participants by areas, and depending on the average shown in Table 1, partnership between the company and supplier is perceived as important.

Another way to evaluate the relevance of the partnership between the company and supplier is observing the origin of the company. Table 2 shows the average responses according to the national origin of the company. The Likert scale used was the same as in the previous table. In these results, in general, there are no significant differences between the values of companies depending on their origin.

Table 2: Average answers for question regarding the partnership between company and supplier, by origin of the company

by origin of the company.						
Origin		A1	B1	C1	D1	Total
American	Average	3,79	3,95	3,81	3,84	3,85
	% respondents	37,01%	36,60%	37,25%	37,01%	36,97%
Λ:	Average	3,77	4,09	4,02	4,13	4,00
Asian	% respondents	36,36%	36,60%	35,94%	36,36%	36,37%
Brazilian	Average	3,90	4,07	3,90	4,15	4,01
	% respondents	26,62%	26,79%	26,79%	26,62%	26,70%

Total	Average	3,81	4,03	3,91	4,03	3,94
Total	% respondents	100,0%	100,0%	100,0%	100,0%	100,0%

American companies have the lowest total average and interestingly, the Brazilian has the highest total average. However, the differences are very small. An almost uniform tendency is observed in the companies considering as important to include and strengthen aspects of the partnership with suppliers to improve their production processes.

Credibility as a result of improvement strategy between company and supplier

The issues related to this topic are intended to understand aspects related to the trust between the agreements on partnership, considering the practice of win-win process between enterprise and supplier and involving credibility in the relationship developed between the parties.

The four survey questions that addressed the issue of credibility are:

A2: It is fair to say that there is a competitive advantage for the company in having relationships with suppliers so as to consolidate the credibility of the supplier.

B2: the supplier has credibility in relation to the company and shares knowledge processes as needed in favor of both parties.

C2: the need for the company to encourage improvement actions in partnership provision to promote a long-term cooperation with the supplier.

D2: the importance of the company to direct efforts in problem solving policy in order to find beneficial solutions for the company and its suppliers.

Table 3 presents the results of the questions, showing the percentage of respondent by area of operation and the average by question, in which the columns correspond to the four questions. One Likert scale with five points was used: 1. strongly disagree, 2. disagree, 3. agree, 4. fairly agree and 5 totally agree.

Table 3: Average answers for question regarding the credibility of company and supplier, by department.

Departments		A2	B2	C2	D2	Total
Purchase	Average	3,50	3,00	3,75	3,50	3,44
	% respondents	2,61%	2,64%	2,63%	2,61%	2,62%
Engineering	Average	3,70	3,19	3,74	4,19	3,70
	% respondents	17,64%	17,88%	17,76%	17,64%	17,73%
Materials/ Logistics	Average	3,88	3,50	3,50	3,63	3,63
	% respondents	5,26%	5,29%	5,26%	5,22%	5,26%
Quality	Average	3,65	3,49	3,70	3,74	3,64
	% respondents	45,09%	45,00%	45,39%	45,09%	45,14%
Production	Average	3,65	3,39	3,86	3,78	3,67
	% respondents	24,18%	23,84%	24,34%	24,18%	24,14%
Other	Average	3,25	3,00	3,86	3,25	3,34
	% respondents	5,22%	5,29%	4,60%	5,22%	5,08%

Total	Average	3,65	3,37	3,74	3,79	3,64
	% respondents	100,0%	100,0%	100,0%	100,0%	100,0%

The credibility in partnership relations can be considered as a delicate process because other factors such as the market situation, the company's stability and strategic background can define the relationship between company and supplier as is regards trust.

As shown in Table 3, the purchasing area has the lowest value in terms of participation (2.62%) and the lowest total average (3.44). This result is interesting because the purchasing area is the initial contact with suppliers or new suppliers, and in general, it is the department that has a higher frequency of contact and knowledge of the suppliers. The indication of a relatively modest ranking in terms of credibility suggests that this is a factor that contains some weaknesses and that can or should be improved.

In general, the purchasing area can be considered as the primary channel of interaction with suppliers, and through which the company, along with other departments, may assess and manage partnership characteristics and credibility with suppliers, improving its capability to chose better supliers.

Note that the total averages shown in table 3, are allways less than 4 and lower than the total averages in table 2, which refers to the need for strengthening the relationship. It seems therefore that although there is agreement on the need to deepen the nature of the partnership, the question of credibility arises as a most sensitive aspect.

Similar to the analysis above, we present below the results regarding the credibility in the relationship between suppliers and companies, considering the origin of the company and using the Likert scale of five points mentioned above. It shows a tendency of the participants to believe in strengthening the trust between the parties.

Table 4: Average answers for question regarding the partnership between company and supplier,

Origin	-	A2	B2	C2	D2	Total
	Average	3,45	3,23	3,77	3,79	3,56
American	% respondents	36,60%	37,08%	36,84%	36,60%	36,84%
Asian	Average	3,73	3,41	3,60	3,80	3,64
	% respondents	36,60%	36,15%	36,18%	36,60%	36,38%
Brazilian	Average	3,80	3,51	3,90	3,78	3,75
Diazillati	% respondents	26,79%	27,15%	26,97%	26,79%	26,93%
Total	Average	3,65	3,37	3,74	3,79	3,64
	% respondents	100,0%	100,0%	100,0%	100,0%	100,0%

The overall averages are very similar, with no significant differences among the companies considering their origin, and there seems to be agreement on the fact that trust or credibility is an important factor in the supplier qualification process, even though the results are slightly higher than the lower level of agreement, reflecting the sensitivity of the factor, as mentioned above.

INTEGRATED ANALYSIS OF PARTNERSHIP AND CREDIBILITY

The results of this study indicate that participants tend to perceive a need for greater interaction between company and supplier. Clearly, there is a perception that this improvement in the partnership may result in benefits for both parties.

Alongside these results, it was observed that companies tend, in their supplier qualification process, to capture suppliers in a traditional way, not considering the aspects considered here related to the partnership and credibility, or doing it warily. That is, as suggested in other studies (Spekman & Carraway, 2006), the partnership is merely formal which makes the credibility in this relational process noticeably fragile.

Traditional approaches to supplier qualification processes possibly probably result in timid improvements and cost reductions (Li, Humphreys, Yeung, & Edwin Cheng, 2007), By contrast, the aim of a stronger partnership is to strengthen the reciprocal relational responsibilities between the parties and therefore the achievement of positive results. The relationship between company and supplier is important for the benefits of combining the strengths of knowledge in their production processes.

One possible aspect that can be considered relevant to the relationship between company and supplier is linked to the fact that the companies are located in a specific industrial concentration which brings together about 475 small, medium and large companies (SUFRAMA, 2016) which were attracted by a policy of tax incentives. The geographic proximity may be a factor that enhances interest in closer relations. On the other hand, the somewhat volatile nature of the location stimulus, driven more by tax reasons than by a perceived need for geographical proximity to other partners, can be an obstacle to closer relations.

The participants considered that it was needed a focused work for the company in order to review the supplier's involvement in decisions on business processes and improvements in transactional processes and which will result in improving production processes. This reformulation of the relationship between company and supplier is considered necessary because the participants perceive in their routine activities opportunities for improvements that can be developed in partnership with companies.

This reinforces the conclusions of several studies (Wong, Tjosvold, & Yu, 2005) that partnership and trust between companies and suppliers is heading towards an evolution in the relational management in order to achieve better results by avoiding opportunistic behavior.

The question that has lower average results is the question B2, which has to do with sharing company information with the supplier, which seems to be a worrying indicator of the development of the relationship between company and supplier. The answers seem to indicate that the participants consider not important that the company involves the supplier more intensively on improvements and strategy decisions. It is considered that this relational characteristic weakens the possibility of greater commitment by the supplier resulting that it limits himself to decisions from its customers' purchasing management, promoting a relational discomfort and an increased congnitive distance between the parties (Lumineau & Henderson, 2012).

CONCLUSION

In the scenario assessed in the survey, there was a tendency among companies and suppliers to agree that partnership and trust tend to be influencing factors in reducing costs in order to increase their profits. However, the collaborating companies of this research indicated that the qualification processes currently employed are still formal in nature and similar to qualification systems adopted by companies in a more general context.

From the results, there is an opening in attitudes relative to partnership and credibility, which are regarded as components that can be more explicitly introduced in the supplier qualification process. However, the participants did not see mutual assistance for growth and development and resulting improvements in partnership and trust, as the major ruling factor for supplier qualification.

The survey also highlights the fact that companies, as they keep this qualification vision with its suppliers, limiting the possibility of improvements in production processes, do not potentiate the process of economic growth for both parties. This is due to the perception of the participants that being the supplier involved in the client process may give rise to opportunistic behavior by the part of the supplier (Bhattacharya, Singh & Nand, 2014).

Following this study, and as a way to complement it and substantiate it, it would be important to conduct a comparative study of supplier qualification practices and make a contrast with the trends revealed here. The implication of the results of this research reinforces the need for reconsideration of the supplier qualification process for companies and the evaluation of possible improvements that partnership and trust can bring to the relationship between them.

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Monitoring audit quality performance: a contribution based on the analysis of audit reports

Ricardo Rocha (ricardofdrochafeup@gmail.com)

Department of Electrical and Computer Engineering, School of Engineering,

University of Porto, Portugal

Joana Guimarães Sá (joana.sa@apcer.pt) APCER, Av. Dr. António Macedo, 4450-617 Leça da Palmeira, Portugal

Henriqueta Nóvoa (hnovoa@fe.up.pt)

Department of Industrial Engineering and Management, School of Engineering, University of Porto, Portugal

ABSTRACT

Purpose: The process of conducting management system audits, the core activity of a certification provider, is a demanding process requiring specialized auditors according to the different industrial sectors or services under analysis. As such, these processes need to be continuously assessed in order to stay accurate and efficient. For APCER, a leading Portuguese certification provider operating worldwide, this continual assessment is particularly critical in order to ensure its leadership position and strengthen its evaluation methods.

Design/methodology/approach: Using descriptive analyses, this work analyses the certification process according to ISO 9001:2008 standard of APCER over the past five years. Based in a sample of 6436 audit reports, an analysis was performed to identify if there are clauses of the standard where there is an evidence of under or over allocation of resources in the auditing process, through an analysis of the number of findings and non-conformities by clause.

Findings: The results of the analysis suggest that audits generally guarantee a fairly accurate verification of all clauses according to audit objectives and do not indicate evidence of over or under resource allocation. However, the study shows that there are significant differences in the value ranges of the number of findings in each clause, when looked up according to organization size, audit duration, business area and audit type.

Practical implications: APCER has performed a similar assessment five years ago, based on a smaller sample of audit reports, an analysis that originated a set of guidelines for the auditors. The results obtained with the actual analysis, based in a much larger database, reinforce the fact that the auditing guidelines previously issued where followed. This database provides feedback from the audit process and can be the base of the definition of new performance indicators to management, indicators that will be extremely helpful for the effectiveness and improvement of the auditing process.

Originality/value: Information based on real data of audit reports belonging to a certification provider covering a large time span (five years) is scarce in the literature, being the reason why this type of analysis is relevant for an effective improvement of the certification process.

Keywords: certification process, ISO standards, ISO 9001:2008; audit process; audit

performance

Paper type: Case Study

INTRODUTION

Certification of a management system is a means of providing assurance that the organization has implemented a Quality Management System (QMS) effectively, conforms to standard requirements, is able to fulfil the organization's quality policy and objectives to achieve the intended outcomes. Amongst all standards, ISO 9001 is by far the most popular and adopted standard worldwide, with an impressive number of more than 1,1 million organizations certified by the end of 2014 (International Organization For Certification 2014).

This success led to the proliferation of certification bodies around the globe and a fierce competition between them, putting a spotlight on the credibility of the certification bodies and on the value added of the certification process.

Thus, as in any other process, the certification process of these certification's providers needs to be constantly assessed and improved. These improvements should be heavily based on data, where audit reports play a vital role, being a valuable source of information.

APCER is the leading certification body in Portugal, undergoing periodically internal assessments of its certification processes. In fact, in order to ensure its market's share and high level of credibility, the company highly rates the importance of monitoring auditor's work in a cost effective way, helping companies to implement and maintain effective quality management systems (QMS).

This paper addresses the last assessment of the company's certification process, based on a detailed analysis of all audit reports related to ISO 9001:2008 performed between 2011 and 2015, information that is available in the company's information system. The main objectives of this paper are two-fold: (1) identify the clauses of the standard that show evidence of over or under resource allocation in the certification audit process of the QMS, (2) understand the incidence of findings and non-conformities in the different clauses of the standard according to company size, audit duration, business area and type of audit. This analysis enables the identification of possible improvements in the audit process, either at the planning, execution or reporting stage. Furthermore, it will contribute to the definition of relevant performance indicators of the audit process.

The paper is organized as follows: after a brief literature review in section 2, the research methodology is presented in section 3. Section 4 analyses the results obtained when looking at the data from different perspectives and, finally, section 5. discusses comprehensively the results and opens up future avenues of research.

LITERATURE REVIEW

ISO 9001 certification is a multi-tier governance system involving multiple players, that can be gathered in four major groups: the certified organizations, certification bodies and their auditors, accreditation bodies and standard setters (Castka et al. 2015).

The literature concerning this research area mostly addresses the added value that these certification processes might represent for organizations adopting these standards, subject that can be broadly divided according to (1) the subjacent motivations of the organization applying for the certification of its quality management system (Sampaio, Saraiva, and Rodrigues 2010)(Heras-Saizarbitoria and Boiral 2013)(Castka et al. 2015)(Boiral 2012); (2) the benefits that an organization might accomplish as a consequence of a successful implementation (Fonseca 2015) (Tarí, Molina-azorín, and Heras 2013)(Hoy and Foley 2015)(Raßfeld et al. 2015)(Heras-Saizarbitoria and Boiral 2013)(Sampaio, Saraiva, and Monteiro 2012)(Poksinska, Dahlgaard, and Eklund 2006) and, finally, (3) problems/cautions that must be addressed while implementing these standards (Singh 2008)(Boiral 2012).

Common to all these threads of investigation is the perspective taken, mostly with a company's viewpoint, whilst little research has been done focusing on the other key players of the extended value-chain of the certification process, namely third-party certification bodies (Lal, 2004). (Castka et al. 2015). In fact, and according to the same authors, the role of certification bodies remains somewhat overlooked in the literature despite their evident impact on certification (Lal, 2004), compared to other factors such as the implementation process itself (Castka et al. 2015). As a result, and as Boiral clearly stated (Boiral 2012), the certification audit process itself has not been subject to theorization.

Certification bodies provide a wide range of certification services for management systems; e.g. ISO 9001 for quality, ISO 14001 for environment; SA 8000 for social responsibility issues in supply chains (Castka et al. 2015). This fact, together with the wide dissemination of management standards worldwide, has led to a proliferation of third party certification bodies, making the selection of the right certification body for a specific firm a tough challenge (Lal, 2004) (Castka et al. 2015). Therefore, the choice of a credible and reputable certification provider, a provider that delivers insightful audits and really impacts quality management practices, relies mostly in the organizations' perception of the consistency of the auditing process of the certification provider over time, and in the quality of its auditors, depending on its personal characteristics, knowledge skills, industry and audit experience (Power and Terziovski 2007).

As such, the consistency of the certification process is clearly a major area of research that needs to be more thoroughly explored. In fact, this type of research is not straightforward, as it depends heavily on certification bodies' willingness to collaborate and share internal data of the auditing process publicly, while safeguarding confidentiality.

Nevertheless, strengthening the certification process and enhancing the credibility of certification bodies is clearly mandatory, particularly when we are experiencing times when ISO's popular quality management standard is consistently showing lower market shares, a fact that might be partially explained by the high number of certified companies in most developed countries as well as to the worldwide economic uncertainty (Castka et al. 2015).

RESEARCH METODOLOGHY

Since 2009 APCER has a specific application to ease up the task of writing audit reports, uploading automatically client's information from the database and enabling easy storage. Until then, the reports were written in a word format, which made it difficult to gather and analyze data. By using this new application, the relevant information regarding the audited organization and respective audit planning is automatically loaded (information concerning the organization, such as the number of employees, sector, sites, certification scope, audit duration, audit type,

sampling details and assigned audit team), enabling the auditor to focus on the core aspects of the audit report, i.e. evaluating and interpreting correctly the findings and drafting conclusions.

It was decided to focus the analysis in a period of five years, from 2011 to 2015, a period considered sufficient in order to draw valid conclusions. Only certification processes according to ISO 9001:2008 were considered. In order to tackle the considerable size of the files and provide easy to use management tools, all data were exported to Microsoft Excel and later worked on with Microsoft SQL Server PowerPivot technology.

RESULTS

ISO 9001:2008 is a standard that defines the requirements for a management system, "where an organization needs to demonstrate its ability to consistently provide products that meet customer and applicable statutory and regulatory requirements and aims to enhance customer satisfaction through and effective application of the system (...)" (ISO 9001:2008, 1. Scope). The standard proposes a process approach to quality management integrated with the PDCA cycle for continual improvement, as two of the core foundations for a management system.

Figure 1 illustrates the relation of the standard with the process approach and PDCA cycle ("ISO 9001: Quality Management Systems - Requirements" 2008).

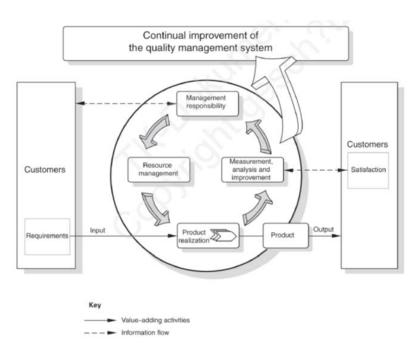


Figure 1 - Representation of the structure of ISO 9001:2018 in a process based approach integrated with the PDCA cycle (In ISO 9001:2008)

ISO 9001:2008 is applicable to all kinds of organizations and can be used for certification purposes. The certification process relies fundamentally on the audit process to gather the information needed to make a reliable certification decision.

According to ISO 19011:2011, an "Audit is a systematic, independent and documented process for obtaining audit evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled". Objective evidence is the term used to refer to verifiable information that is collected throughout the audit, relevant for the evaluation of the management system. This

information is collected by the audit team through observation, interviews, statements of fact, analysis of records and documents. These evidences are compared with the audit criteria, i.e. the requirements of the standard and other related requirements that the organization has to fulfill, enabling to determine findings of conformity or nonconformity according to audit criteria.

For certification purposes, findings of nonconformity are classified according to its severity and are allocated to the most relevant audit criteria that they do not fulfill, indicating the related clause of the standard (APCER):

- "Non Conformity (NC) non-fulfilment of a requirement;
- Major Non Conformity (NCM) Nonconformity that represents a failure to fulfil one or more requirements of the management system standard or a situation that raises significant doubt about the ability of the organization's management system to achieve its intended outputs."

Two other types of findings are defined (APCER):

- "Area of Concern (AS) Audit findings that can become a NC or NCM, if the audited organization does not define and implement any actions; or any finding that the audited organization has timely identified as nonconformity, or potential nonconformity, and is implementing a proper and timely corrective action accepted by the certification body (CB) but that, by its relevance, the effective closure needs to be followed by the CB;
- Opportunity for Improvement (OM) Audit finding that identify potential areas of improvement, but do not include recommendations or specific solutions. These audit findings do not put at risk the ability of the management system to fulfil the specified requirements."

It should be noted that not all audit reports are in the database, being the proportion of reports registered in the system vs. the number of performed audits between 42% to 57%, depending on the year. This is mainly due to the fact that it is mandatory a paper print of the report signed by the audit team and the auditee representative. Therefore, the upload of the report in xml format into the database is not critical in the process, and therefore the procedure is not controlled.

An analysis of the distribution of findings (NC+NCM+AS+OM) in all the database reports for the five-year period under analysis gives an immediate insight of the clauses of the standard that might be over or under audited, enabling a better perspective of the possible pitfalls of the certification process. This analysis was then refined taken into consideration different factors, e.g. the business area, the size of the organization, the audit type and certification maturity.

Standard Clause

The first analysis performed was the distribution of audit findings by standard clauses (Figure 2). Being the standard a systematic approach of interrelated elements, each standard clause addresses a specific management system element and contains a set of requirements that might be interconnected with other requirements of other clauses.

It is important to notice that not all standard clauses contain the same number of requirements, nor have the same importance or criticality for the management system in different organization's contexts. Therefore, the distribution of the allocation of findings per clause does not allow to draw immediate conclusions of under or over allocations, but gives an overview of the aggregated audit results, showing which areas are typically targeted for more or less findings.

In the Pareto chart in Figure 2, you can see that clauses 8.2 - Monitoring and Measurement, 7.5 - Production and Service Provision, 6.2 - Human Resources, 4.2 - Documentation Requirements and 7.4 - Purchasing, are the ones with more findings, representing 54% of the total findings. In the other extreme, summing 4% of the total, are the clauses 5.2 - Customer Focus, 8.1 - General,

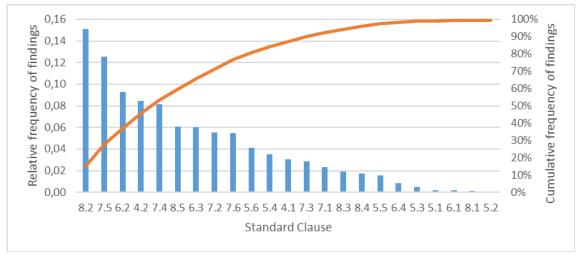


Figure 2- Pareto diagram of findings according to the standard clause

6.1 - Provision of Resources, 5.1 - Management Commitment, 5.3 - Quality Policy, 6.4 - Work Environment, 5.5 - Responsibility, Authority and Communication and 8.4 - Analysis of Data. A clear Pareto effect is seen on the graph, with a small number of standard clauses including most of the findings.

This analysis is now done only for non-conformities, aggregating the Non Conformities and Major Non Conformities (NC+NCM) (Figure 3).

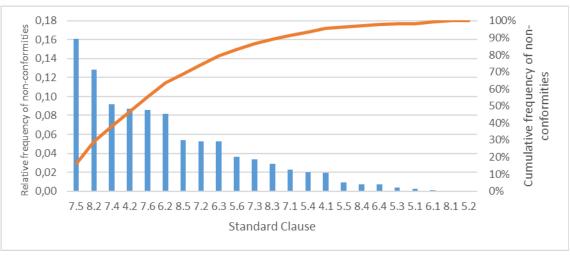


Figure 3 - Pareto diagram of non-conformities according to the standard clause

The Pareto for nonconformities shows, as for the overall findings, that four of the same standard clauses are more frequent: 7.5, 8.2, 7.4 and 4.2. Together with 7.6 - Control of Monitoring and Measurement Equipment, they account for 55% of the total. However, the order is different, noting that now clause 7.5 is the more frequent clause, changing position with clause 8.2, and that Section 6.2 switches place with clause 7.6.

On the opposite side, 5% of non-conformities are allocated to the same five sections referred previously for total findings. Looking at plausible causes for the clauses and therein requirements showing lower frequencies of findings and nonconformities, it could be argued that: 5.2 Customer Focus - requires top management to ensure customer focus through the determination and fulfilment of its requirements, by applying sections 7.2.1 and 8.2.1. Deviations are more likely to be directly identified in these clauses that have a more objective and operational nature. On the other hand, together with 5.1 Management Commitment, identification of objective evidence against top management is difficult to substantiate and to report. The report concerning top management commitment and customer focus tends to be stated in the audit conclusions and recommendation for certification. It is recognized that allocation of direct deviations to people, either top management or other roles, tends to be a point of conflict with the organization and does not build on overall improvement.

Section 8.1 General, sets generic requirements for an organization to apply all requirements of clause 8, so all deviations are also more likely to be identified in other sub clauses of 8. A deviation to this clause would substantiate a major failure in applying monitoring and measurement as a whole, an unlikely situation in an organization seeking certification or being certified. The same rational applies to 6.1 General, an overarching requirement for all section 6 on Provision of resources.

Finally, 5.3 - Quality Policy sets very objective, documented and easy to evidence requirements, so a low frequency of findings is also plausible and expected.

The requirements with more findings and nonconformities are 7.5 and 8.2, as 7.5 addresses the core of what the organization's operational activities are, Production and service provision. It is a very lengthy clause for planning and control of production and service provision. Clause 8.2 addresses monitoring and measuring, ranging from customer satisfaction, internal audits, monitoring and measurement of process and product. To sum up, these clauses aggregate the requirements that set the relevant information on quality management system performance. By its relevance and by the number of requirements contained in theses clauses, it is easy to accept a higher number of findings when compared to other clauses. Therefore, a comparison of frequency per clause has to be carefully balanced with the number of requirements. One of the conclusions of this study was that audit reports should allocate findings to more detailed clauses, i.e. sub clauses, recommendation followed for ISO 9001:2015 audit report.

In 2008, APCER conducted a similar study of Nonconformities in a sample of initial certification and recertification audits, where it concluded that the primarily focus of the audits was also clause 7.5 Production and Service Provision. But, by that time, the study also showed a strong incidence of non-conformities related to documental issues and an almost complete absence of findings related to analysis of data (8.4). The study was presented to auditors with recommendations to lower bureaucratic findings, reinforce field verification and data analysis. Information from the present study shows that auditors reacted positively to these recommendations, by reducing NC in 4.2 – Documentation and showing more findings in 8.4 (although still, not very frequent).

Business sector

The sector in which the organization operates influences the findings detected during the audit process.

According to ISO/IEC TS 17021-3:2013, business sectors are defined as "the economic activities covering a broad range of technical areas...". These businesses sectors were previously defined by APCER according to auditor's competence in the field and technical area. In this analysis an automatic correspondence with the organization's NACE codes was done in order to ensure larger and more representative samples per sector, while also protecting confidentiality. Data was classified into 10 business sectors, according to:

- 01 Primary;
- 02 Extractive;
- 03 First Transformation;
- 04 Industrial;
- 05 Utilities;
- 06 Environment;
- 07 Services;
- 08 Trade;
- 09 Health and Social Services:
- 10 Education.

In order to evaluate the impact of this factor, several analyses were made, e.g. distribution of reports and average findings per business sector or the distribution of findings per clause and business sector, analyses that have revealed a large variability in specific clauses (Figure 4). It is important to notice that, when comparing data from different business sectors, the number of reports differs substantially, a variation that is consistent with the distribution of certified organization per business sector of APCER (which, in turn, closely follows the profile distribution for Portugal from the ISO web survey).

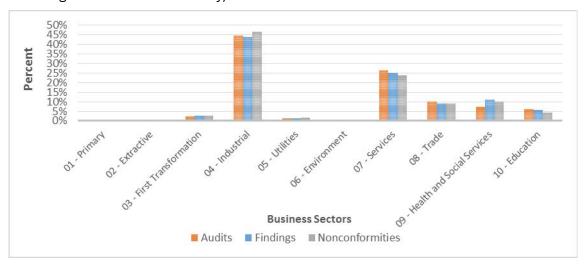


Figure 4 - Distribution of findings, nonconformities and reports per business sector

Due to confidentiality clauses, only the aggregated information of business sectors (i.e. not being detailed per business sector) concerning the variability by clause of nonconformities will be displayed (Figure 5). Boxplots are a very straightforward tool to show this variability, showing immediately what are the clauses where the variation per business sector is higher or lower. For example, Figure 5 shows that clause 8.2 - Monitoring and Measurement is by far the one with a higher variability between business sectors. In general, if we compare the clauses with lower frequency in Figure 4 with the distribution in Figure 2 (non-conformities according to standard clause), they obviously are approximately the same. By further looking at the values of disparity within each clause, we can identify the sectors that represent outliers: for example, in clause 7.5 – Production and Service Provision, the outlier represents the values in sector 9 - Health and Social Services. The explanation for this value might be due to the fact that this sector is a new comer when compared with other business sectors, very complex and highly regulated.

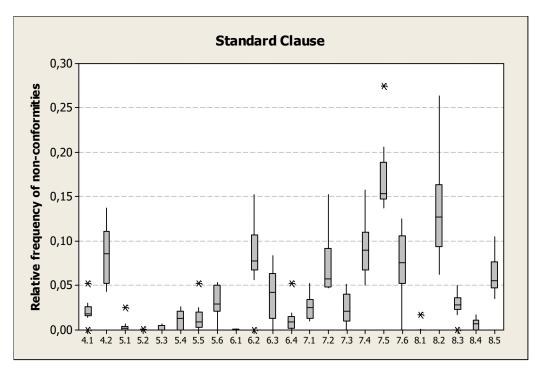


Figure 5 - Boxplot of relative frequency of non-conformities

Analysis per business sector shows that, typically, the sector is a major source of variation in frequency of allocation of findings and nonconformities per clause. This information deserves a more detailed analysis in order to outline possible patterns or profile of nonconformities and findings allocation per sector, information that might be really useful for the sector itself.

Size of the organization

Having the knowledge of the certification process and of its audit planning requirements, we then analyze to what extent the size of the organization influences the allocation of non-conformities. The size of the organization is the more relevant factor to determine audit duration and is measured by the number of people in the organization (employee and outsourced). While bearing in mind that the total findings and nonconformities in the audit have a direct relation to audit duration, the objective is to analyze these values according to organization size. Data was

gathered in three classes using the classification defined in Portuguese Decree -Law n° 372/2007 of 6th of November.

- Small organizations less than 50 employees;
- Medium organizations between 50 and 250 employees;
- Large organizations over 250 employees.

As the absolute frequency of audit reports per business size differs between the three groups, the relative frequency of findings per number of reports depending on the size of the class was analyzed instead (Figure 6).

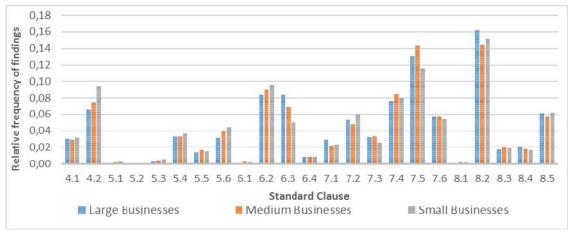


Figure 6 - Frequency of findings per business dimension

We can observe that there are marked differences in certain standard clauses for different organization sizes. It is curious to notice that small organizations, usually with shorter audits, have a higher concentration of findings in clauses 4.2 - Documentation Requirements, 5.6 - Management Review and 6.2 - Human Resources when compared with bigger organizations. In large organizations there is a higher relative frequency values in clauses 6.3 - Infrastructure and 8.2 - Monitoring and Measurement. Looking at 7.5 - Production and Service Provision, we found that the largest number of relative frequency happens in medium-sized organizations.

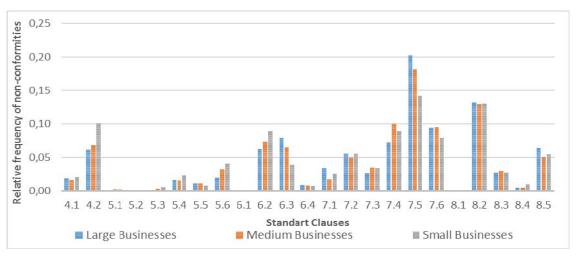


Figure 7 - Frequency of non-conformities per business dimension

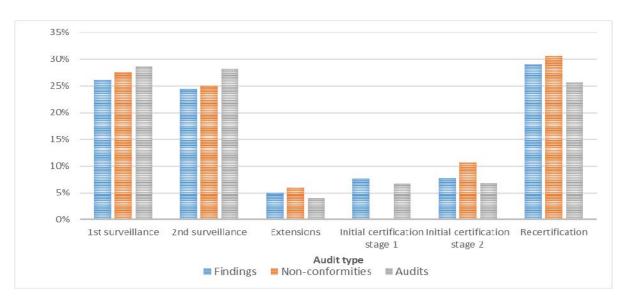
Considering now only non-conformities (Figure 7), the values are consistent with the values observed of total findings (Figure 6), with a similar distribution. In fact, in clauses where small organizations had a higher relative frequency of findings the same occurs for nonconformities (4.2, 5.6 and 6.2). The same goes for NC identified in 6.3 - Infrastructure where large organizations have the highest relative frequency. Regarding 8.2 - Monitoring and Measurement the relative frequencies of NC are very similar between the different groups. A higher relative frequency 7.5 - Production and Service Provision is observed in large organizations when compared with small size organizations.

Audit type

A management system certificate has a validity of three years and the number of audits carried out within this period is called the certification cycle. The goal of this analysis is to assess whether differences exist between the different types of audit, namely: a certification audit at the 1^{st} and 2^{nd} stage, 1^{st} and 2^{nd} annual surveillance audits, and, finally, recertification and extensions audits.

Initial certification audits are done in two stages and have the objective of analyzing the conformity of the organization QMS to all standard requirements, comprehending a large sample of activities, products, services and, where applicable, sites of the organization. Stage 1 audits have no identification of nonconformities, and only areas of concern and eventual opportunities for improvement are taken into account. Annual surveillance audits have about 1/3 of the audit duration of the initial certification, a lower sampling level, and it is not necessary to audit all sections of the standard, as the objective now is simply to assess if the organization maintains the QMS active and is able to fulfil its objectives, including continuous improvement. The recertification audit has similar objectives of the initial certification, making a full evaluation of compliance, encompassing all certification requirements and a larger sample. Its audit duration is about 2/3 of initial certification audit. Therefore, audit type varies in term of audit duration and audit objectives. Extension audits are special audits to increase the scope of the certification, either by including more products and services or sites. They analyse the full standard in relation to the new area to be extended.

Results are depicted in order to protect confidentiality issues (Figure 8).



The frequency of findings and non-conformities is higher in recertification than in surveillance, when compared to the relative frequency of audits. In the initial certification stage 2 there is a higher incidence of non-conformities than findings by number of audits. Notice that certification audits stage 1 and 2 have lower frequencies as these audits only occur once per organization. The values of non-conformities and findings in surveillances are lower than in certification and recertification, which might be directly linked to audit duration and larger samples.

Certification maturity

For certified organizations that keep the focus on continuous improvement, it seems reasonable to expect that the number of findings and nonconformities decrease over the years, as certified organization get more mature.

In order to evaluate this trend over the years and draw preliminary conclusions, a sample of 1500 audit reports belonging to organizations with a history of seven or more years of certification was analyzed. Figure 9 shows the average of findings per audit along the certification process:

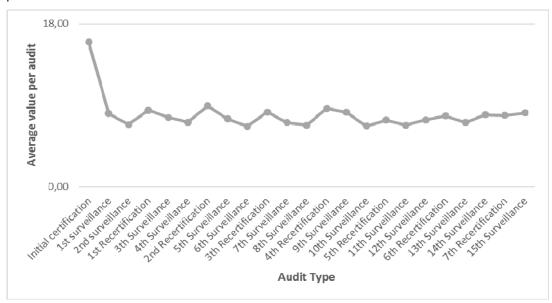


Figure 9 - Average of findings per audit along the certification cycle

With the exception of the initial certification audit, it can be seen from Figure 9 that there is a slight tendency to reduce the average number of findings over the years, as expected.

When analyzing non-conformities (Figure 10) we clearly notice a difference in frequency of non-conformities between the initial certification and recertification compared with surveillances, consistent with the analysis per audit type. In fact, it is expected that as management systems of organizations mature, the complexity and depth of the audit process also matures, reaching higher efficiency levels.

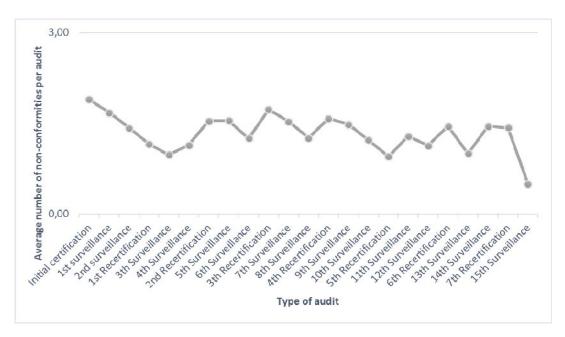


Figure 10 - Average number non-conformities per audit by maturity of the QMS

This result clearly indicates that, in average, a certification process does continue to add value to organizations, by continuously identifying nonconformities and findings that lead to continual improvement.

DISCUSSION

The results of the analysis suggest that audits generally guarantee a fairly accurate verification of all clauses according to audit objectives and do not indicate evidence of over or under resource allocation in the audit process. Having this said, it is also not possible to state that there are no audits where an over or sub allocation of audit resources occurred. Based on this preliminary results it seems reasonable to conclude that the use of an indicator of nonconformities per clause to assess audit quality is not straightforward.

The study shows that the values of frequency of findings and NC per clause vary significantly when considering factors such as business sector, organization size, audit duration and audit type. This analysis is at its early stages and needs to be further exploited with more in-depth statistical analysis and further study.

Nevertheless, these results allow the certification body to adapt methodologies for audit processes taking advantage of the changes to the new ISO 9001:2015, thus enhancing the value of its audits for their customers. This study also provides a comprehensive feedback on audit results reflecting the work of the audit team and aggregated information on the organizations performance that needs to be further exploited to gain more insights on audit performance.

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Total Quality Management and Corporate Social Responsibility. Literature review. The case of Nabeiro Delta Cafés Group

Nogueiro, T.1, Saraiva, M.2 and Jorge, F.3

¹⁾Teresa Nogueiro <u>tpn@uevora.pt</u> Universidade de Évora

² Margarida Saraiva <u>msaraiva@uevora.pt</u> Universidade de Évora

³⁾ Fátima Jorge <u>mfj@uevora.pt</u> Universidade de Évora

ABSTRACT

The relationship between the themes of Total Quality Management (TQM) and Social Responsibility (CSR) through the concepts, approaches and models of excellence is a reality of sustainable and stable companies. Being organizations, people, act correctly and rightly do in society go through a quality management and social responsibility thereof. It is based on these two philosophies (Total Quality Management and Corporate Social Responsibility), which developed this literature review work, essentially based on a relational analysis in two papers, namely: "TQM and CSR Nexus" by Ghobadian et al. (2007) and "The Corporate Social Responsibility Audit Within the Quality Management Framework," de Kok et al. (2001) and applied to an organizational situation in concrete: the Nabeiro Delta Cafés Group - SGPS, SA.

Keywords: Total Quality Management (TQM), Models of Excellence, Corporate Social Responsibility (CSR), Sustainability.

INTRODUCTION

Social responsibility is a relatively recent management concept (Ghobadian *et al.*, 2007). Business ethics and social responsibility are themes that have been given considerable attention in organizations and academic papers (Carroll, 1999). Coworkers, clients, suppliers, competitors and governments are being increasingly demanding regarding management issues, where stakeholders expect management to take an active role in the debate about social problems (unemployment, poverty, infrastructures) and proactively think about the effects of business in society in general (Kok *et al.*, 2001). It is a mandatory subject in organizations (Quintero-Garzón, Carrión-García, Jordá-Rodriguez, & Rodriguez-Córdoba, 2015).

There are evidences that social responsibility is an idea that might have appeared in Europe (Wolf, 2002). The new imperatives for social responsibility are increasing the challenge for the proper acquisition and development of skills and abilities (Matten & Moon, 2004).

Friedman was the first to discuss social responsibility, claiming that you should let business people do what they must, and that means, letting them take care of their business (Kok *et al.*, 2001). For Friedman (1962) social responsibility is about using the resources and carrying out activities to increase profit, as long as it is within the established rules (Atakan & Eker, 2007). This vision was subject to criticism from authors like Shaw and Barry (Kok *et al.*, 2001). For these authors, a business must take in consideration the long term social costs of its activities and profit. The existence of any corporation is founded on the purpose of benefiting the society (Shaw & Barry, 1992). Mintzberg (1983) assumes that managers will take some social responsibility in decision making as they are part of the society as well. According to Frolova and Lapina (2014) the development of the CSR concept shows that it reflects the main issues and concerns of the society and that there is a strong connection between the companies and social relationships. Over time, companies began to realize that CSR shows, in fact, benefits to those who started taking it in consideration in their daily operations (Quintero-Garzón, Carrión-García, Jordá-Rodriguez, & Rodriguez-Córdoba, 2015).

The increasing social and ethical concerns have led organizations to think evolutionarily in quality, especially those who intend to make an approach toward excellence. However, those concerns are not yet incorporated in the current excellence models (Nakano, 1999, Kok *et al.*, 2001).

David Garvin (1998) classifies the evolution of quality in four eras, namely those of the Inspection, the Statistical Quality Control, the Quality Assurance and the Total Quality Management. Garvin (1998) also classifies five different approaches to the concept of quality. Thus, he presents the transcendental (quality is innate excellence, is absolute and universally accepted); based on the product (quality is an accurate and measurable variable, derived from the attributes of the product, where the only way to make it better is to have more costs); based on the user (quality is a subjective variable where the better the product the more satisfied the customer); based on production (quality is an accurate and measurable variable, derived from de degree of conformity of the product); and based on value (applies two distinct concepts: excellence and value, which highlights the quality-price package).

Total Quality Management model is focused on the consumer satisfaction (user), participative management and result oriented. Methodologies and theories of Total Quality Management (TQM) are frequently associated to better financial performances and "progress" in attitudes and motivation among government officers, achieve reinvention and objectives oriented towards results (Milakovich, 2004).

The application for a prize or an audit certificate, encourages workers to improve their processes and services and provides a recognition on the part of external evaluators, providing objective evidence on performing gaps. Prizes can also serve as an effective way to disseminate knowledge about better personnel and technology management practices (Milakovich, 2004).

Prizes have already been largely used by governments as a way of recognizing an exceptional performance, both individually and organizational (Bovaird e Löffler, 2009).

In many countries and regions were created Quality Awards (Kok *et al.*, 2001). These had their origin in the private sector (Bovaird e Löffler, 2009). The best known is the Deming Award, created in Japan in 1951, by Japanese Union Scientists and Engineers. Others followed, such as the Australian Quality Award in 1986, Malcolm Baldrige National Quality Award from the United States of America in 1987 and the European Quality Award in 1992 created by the European Foundation for Quality Management (Kok *et al.*, 2001; Bovaird e Löffler, 2009).

There is a close relationship between some of these competitive awards and some non-competitive associated awards. This is the case, for example, of the competitive European Quality Award that uses the same criteria as the Excellence Model – EFQM, enabling organizations to request accreditation at different levels (Bovaird e Löffler, 2009). Meanwhile, the countries of the European Union have developed a Common Assessment Framework (CAF), based on the Excellence Model. It is a model of self-evaluation and a tool for improving quality (CAF, 2013; Bovaird e Löffler, 2009).

According to Bou-Llusar *et al.* (2009), investigators such as Ghobadian and Woo, Curcovic, Van der Wiele, Yong and Wilkinson have considered quality models as operational structures for Total Quality Management.

The objectives of this paper are: (1) presenting a state of the art regarding the Total Quality Management (TQM) and Social Responsibility themes, (2) make a relational analysis of both of the selected articles, and (3) the analysis of a study case that reflects a specific organizational situation related to the theme.

The articles selected for the development of this paper are "*TQM and CSR Nexus*", by Ghobadian *et al.* from 2007 and "*A Corporate Social Responsibility Audit within a Quality Management Framework*", by Kok *et al.* from 2001.

This paper presents a state of the art about Quality and Corporate Social Responsibility (CSR), focusing on the evolution of the concepts and other relevant aspects. Follows a relational analysis of the thematic versed in the said articles, methodology used and final considerations. Lastly there will be an analysis to the case of the company Delta Cafés.

LITERATURE REVIEW

Quality

The concept of Quality is part of the new paradigm of modern society. The cultural evolution of a people can be demonstrated by the evolution of that concept.

The quality movement dates back to the 20s of last century (Coopers e Lybrand e EFQM, 1994-5, quoted by Ghobadian *et al.*, 2007). So it turns out that Quality is a theme discussed for several years now. The initial idea arose in the United States of America, during the World War II, where the quality control of the produced and sold weapons was crucial to the success of this industry.

Rocha (2006) speaks of five schools: Deming, Juran, Feigenbaum, Crosby and Ishikawa. These five authors make an independent and differentiated approach to the subject of Total Quality Management, ranging from quality control to quality management itself.

In recognition of the great strategic impact of TQM in organizations, as well as the quality of products/services, the expression Business Excellence replaced the expression TQM (Ghobadian *et al.*, 2007).

Deming is considered by many as the "father" of quality, having distinguished himself by collaborating with the Japanese in the post-war industrial reconstruction.

Other authors such as Genichi Taguchi, Shigeo Shingo, Tom Peters and Claus Moller, contributed to the evolution of the concept of quality and are considered, just like the previous authors, "gurus" of quality (Roch, 2006). Table 1 presents a summary of some quality definitions.

Table 1 - Summary of the definitions of Quality (Source: Self elaboration)

Author	Development prospects of the products or services	Definition of Quality
Taguchi (1986)	Consequences	The loss a product causes to society after being shipped instead of the losses caused by intrinsic functions.
Juran (1993)	Consequences	Adaptation to the utilization
Crosby (1979)	Results	Compliance with the requirements
Ishikawa (1985)	Results	Lack of variation in the quality characteristics.
Deming (1986)	Process	The process that leads to results through products/services that can be sold to consumers, who will then be pleased.
Shigeo Shingo	Process	Process of continuous monitoring and potential feedback instrumentation.
Tribus (1993)	Consequences	This is what makes it possible for a consumer to have a passion for the product or service.
Moller (1992)	Process	The quality of the product should not be the focus of the issue but human resources.
Peters (1982)	Results	It is never reached but must be constantly sought, both because and for the client.
Feigenbaum (1983)	Process	It is a way of management and should incorporate the participation of all and be customer-oriented.
Shewart (1939)	Consequences	It is something subjective and objective.
ISO 8402	Results	Totality of the characteristics of an entity.
APQ	Results	It is the totality of characteristics of a product or service that determine its ability to satisfy a given need.
EOQC	Results	Quality is the totality of characteristics of a product or service that enables it to meet certain needs.
ASQC		
ISO 9000	Consequences	Degree of requirements satisfaction, given by a set of intrinsic characteristics
Silva (1955)	Consequences	What characterizes a person or thing that distinguishes it from others

The implementation of a process of change in the organization is, generically, a difficult task, however the commitment to quality is considered a great competitive advantage that could serve as a motto to the change process.

The quality has several dimensions such as technical assistance and technical and functional characteristics of a product or service, the aesthetic appearance, price, safety, service, environment, among others. While recognizing that quality is a subjective component, it is imperative it is objectified and quantified so that it is measurable, otherwise it will not be liable to control (Pires, 2004).

When questioning several people about the meaning of the term quality you can certainly obtain seemingly divergent definitions. And why apparently divergent? Because the definition of quality depends on who defines it and the reasons why it does so. Despite the lack of consensus, it appears that the definitions do not compete with each other and instead complement each other in a single search for excellence (Pike & Barnes, 1996; Nogueiro, 2008).

For Pride *et al.* (2008), TQM is the coordination of efforts aimed at improving customer satisfaction, increasing employee participation, strengthening partnerships with suppliers and promoting an organizational atmosphere of continuous quality improvement.

The relationship between quality, environment, health and safety and social responsibility is increasingly becoming a concern for all. Although the price of a product or service is important, this is becoming a smaller factor of importance in the acquisition thereof (Lopes and Capricho, 2007).

For Ghobadian et al. (2007) the values underlying the Total Quality Management are: (1) convergence of interests of employees, shareholders, customers, suppliers and the whole society; (2) emphasis on honesty and personal, collective and system integrity; (3) achieve the satisfaction of stakeholders is everyone's priority; (4) people are considered as guarantors of the internal key to success; (5) management is responsible for creating an environment in which employees can show the best of their ability; (6) the organization is seen as a chain of linked processes; (7) the organization seeks continuous improvement rather than static optimization; (8) the emphasis is on prevention rather than detection; (9) interaction between employees, customers and suppliers is encouraged; (10) in organizations, fear is put aside, when concerning relationships; (11) the errors are seen as learning opportunities and the system encourages and allows employees to take responsibility for their activities within an agreed framework; (12) the relationship with the supplier is based on continuous interaction, information sharing and collaboration; (13) mutual respect is the basis of all relationships; (14) decisions are based on facts rather than opinions, and consensus rather than the edicts; (15) the functional integration is actively sought and encouraged; (16) opening is encouraged and exercised within and outside the organization.

Corporate Social Responsibility

Social responsibility can be said that it is a relatively new management concept and that it is still in development therefore has not yet reached maturity (Ghobadian *et al.*, 2007).

Social responsibility is the recognition that business activities have an impact on society and that this impact is considered in management decision making (Pride *et al.*, 2008).

The social responsibility theme has been being treated since 1953. It began at the hands of Howard Bowen, with the issue of his work *Responsibility of the Businessman* (Carroll, 1979). In 1958, in contrast to Bowen's ideas, Levitt states that the role of the companies is to generate profits and that the function of ensuring social welfare rests with the State. In the 60s of the last century the expression proposed by Bowen "social responsibility of businessmen" changes to "corporate social responsibility" (Carroll, 1999). The theme of Corporate Social Responsibility is thus present, since companies began emerging (Cajazeira and Barbieri, n/d).

Bucholz & Rosenthal (2001, quoted by Cajazeira and Barbieri, n/d) consider that due to large and deep social transformations that occurred in the 60s and 70s of the twentieth century that affected the business environment, among which highlight the interest in minority rights, the equality of women's rights, environmental protection, security and welfare of workers and consumers' concerns, the issue of corporate social responsibility blossomed. Then, they emphasize that Corporate Social Responsibility is an essentially ethical concept, implying a new way of thinking about human well-being and the existence of a commitment to improving the quality of life; it is thus a moral term that involves a duty to someone or something.

Frederick (1960) argues that social responsibility includes a public attitude towards the human and economic resources, so they are not placed in a restricted way at the disposal of the interests of private persons and companies. It is also during this period, that another school of classical thought, argues that the organization exists to maximize profits and dividends and obey the rules (Friedman, 1962; Hayek, 1967).

Davis (1973) defined Corporate Social Responsibility as the organization's commitment to analyze the effects caused by the decision making process, going beyond legal obligations and resulting in social and economic benefits.

CSR definitions vary. To Frederick (1986), CSR is fundamentally an obligation of the organizations to work for social promotion. For Preston and Post (1975) CSR is the extension of entrepreneurial role that goes beyond its economic goals. Carroll (1979, quoted by Ghobadian *et al.*, 2007) provides a definition where the organizations' social responsibility covers economic, legal expectations, ethical and discretionary aspects that society has of organizations at a given point in time.

The values underlying the concept of social responsibility are (1) the sought to understand and meet the needs of stakeholders, including customers, owners, employees, suppliers and society in general; (2) the integrity of the individual and collective actions; (3) honor; (4) justice; (5) respect; (6) participation; and (7) individual and collective responsibility with others (Ghobadian *et al.*, 2007).

In the late twentieth century, the opinion regarding the CSR being related to the sustainability of the organization had become increasingly popular. In this context, sustainability is not just environmental issues. Companies are regarded as part of the society and should contribute positively to the mutual relationship (Frolova & Lapina, 2014).

The assessment of the CRS is liable to be conducted. Social audits are reports on the social conscience of the company (Poe, 1994 quoted by Kok *et al.*, 2001). For Vinten (1998, quoted by Kok *et al.*, 2001), social audit is a review to ensure that the organization gives due attention to social responsibilities to those who are directly and indirectly affected by their decisions, and simultaneously is achieved a balance in business planning between these aspects and more traditional business objectives.

The reasons to undertake a social audit are, on brief terms: (1) as part of the strategic and operational planning process, to review existing practices with regard to social, internal and external responsibility; (2) to define the strengths and weaknesses in the strategy and practices; (3) relating to the development of an improvement plan; (4) to measure progress in relation to the efforts undertaken for the implementation of social responsibility in the organization; (5) to obtain the participation of people who are able to contribute to the development of social responsibility (Humble, 1975 cited by Kok et al., 2001).

Awareness of the need to avoid abuse of a weaker partner is only one aspect of a general, more ethical awareness that can be achieved through the selection and training of personnel. The ethical awareness of each of the members of the organization is an aspect to consider in the ethical climate of the organization. Ethical awareness of the organization requires morally autonomous members or morally heteronomous and an ethical climate and/or firm codes of conduct. Moral autonomy is the capacity that individuals have to acquire their own moral values and apply them in making decisions with ethical implications, while

heteronomy occurs when moral laws are taken from sources other than their own (Tsahuridu and McKenna, 2000 cited by Kok et al, 2001) - in this case from a code of conduct or ethical climate of the organization.

The ethical vision of the organization is "the legal and moral justification for the existence of any company is that it benefits society" (Ostapski and Isaacs, 1992 quoted by Kok *et al.*, 2001). At this level, much attention is given to the ethical awareness, without a structured approach for the development of an ethical climate through training and communication in the organization.

According to Basu and Palazzo (2008) quoted by Benavides-Velasco *et al.* (2014) there are several reasons for a company to implement CSR: to provide a specific response to requests from stakeholders, to improve business performance, to enhance corporate reputation, to generate customer loyalty or to anticipate legal sanctions.

Relational analysis

The strength of the TQM is based on the combination of success established between the scientific school of management (does not assume that people adapt to the system) and the social school of management related to human behavior (based on the premise that employees are honored), and thus the correction is replaced by cooperation. The employees are allowed to take the initiative and participate in decision-making processes relevant to them and if there is no transgression against organizational values there is no place to sanctions. The organization is seen as a system of cultural interrelationships instead of a set of tasks, processes and procedures (Ghobadian et al., 2007).

The work of the quality gurus suggest a strong link between the movement of the ideals of quality and theory, and ethical concepts based on virtue, equity, rights and free conceptualisation of ethics. Commitment, integrity, participation, trust, honesty, property and reward the efforts of those who are directly or indirectly involved, within and outside the organization are emphasized elements in the work of Crosby, Deming, Duran and Ishikawa (Ghobadian and Speller, 1994 cited by Ghobadian et al., 2007). According to the work of Ishikawa and Taguchi, the values of TQM defend the greatest virtues (Ghobadian et al., 2007).

The results obtained by the implementation of TQM in an organization, are beneficial and an added value for them. Ghobadian et al. (2007) identifies a 1990 study from the United States Accounting Office (GAO) where it is revealed that by the implementation of TQM, companies had superior financial performance, improved relationships of employees, improved operating procedures and increased customer satisfaction. Analyzing the principles of CSR is obvious that many of them are consistent with the principles of quality management, continuous improvement, organizational commitment, social and stakeholders needs (Frolova and Lapina, 2014). It is Knowles (2011) which states that on the heart of both relies the respect for the individual, integrity, decency and justice.

In addition to awards such as the EQA and MBNQA, there are international quality standards such as the ISO 9000 series for quality and ISO 14001 for the environment. Whether the premiums either the rules are since its implementation, motivating factors of stimulating companies to manage in quality. To be able to award the quality premium, there are several criteria to be met by the organizations managing in quality. The model of excellence EQA emphasizes what they are and which are on the basis of the award of the European Quality Award.

According to Koch et al. (2001), it was the first model that showed explicitly that social responsibility is strongly linked to thinking in quality. The model consists in the definition of nine criteria that integrate subcriteria that will enable the recognition of the key issues of evaluation and for which are traced indicators for its materialization (Carapeto and Fonseca, 2006). The combination of these nine criteria shows us that the results-oriented citizens, for employees and for society is achieved through strong leadership by defining a strategy and planning, the management of human resources, the management of partnerships

and of resources, and the management of processes and change. The final result will be the overall performance of the organization (key performance) (Nogueiro, 2008). Other results have to do with the satisfaction of customers and employees and the impact on society (Kok et al., 2001). The combination of all criteria defines what is to manage in quality by the use of terms and concepts easily accepted by managers. This simplicity allowed to encourage the use of this model not only for applications for awards but as a self-assessment tool, as a connecting thread of the implementation of a management based on quality. Another model that is also related to social responsibility is the MBNQA model. The criteria underlying this model is essentially related to ethics transaction, where on a restricted way also customer needs are taken into account. There then arises the relationship with CSR.

The extent of the relationship of these models to social responsibility is based on three fundamental questions (Brand, 1989 cited by Kok et al., 2001). The questions are:

- 1- The model requires a clear organization's mission statement?
- 2- The model requires the organization to be clear in public debate?
- 3- The model requires ethical codes?

Ghobadian et al. (2007) argue that, despite the apparent differences in the definitions of TQM and CSR throughout history and in-depth development of the concept of TQM, there is considerable overlap between the values that underpin the two concepts. The novelty of CSR and the low diffusion levels, mean that there is less experience with the implementation of elements of the processes of social responsibility. Moreover, some of these elements are common elements to the map TQM and therefore they can be implemented as part of TQM processes. This will require some adjustment and require the rethinking of TQM elements.

TQM and CSR are considered potential sources for achieving sustainable competitive advantage (Benavides-Velasco, Quintana-García, & Striking-Lara, 2014). Based on other authors, Benavides et al. (2014) states that TQM is a management philosophy widely recognized that focuses on the process of continuous improvement in organizations to promote additional value to customers and meet their needs, bringing profit and productivity. Companies are also encouraged to behave in a socially responsible manner.

Moir (2001, cited by Ghobadian et al., 2007) argues that both TQM and CSR share similar ethical anchors.

Ghobadian et al. (2007) states that the Total Quality Management and Social Responsibility, have a common philosophical root and the values that both defend, show a significant overlap. The elements of TQM and CSR overlap in fact, significantly, but there are differences.

Figure 1 aims to systematically present the problem of TQM and CSR and the relationship between them, through the MBNQA and EQA excellence models.

METHODOLOGY

For the preparation of this article, the methodology used was content analysis of two scientific articles on the theme of Social Responsibility and Quality. The articles in question are "TQM and CSR Nexus" of Ghobadian et al., published in 2007 in the International Journal of Quality and Reliability Management and "The Corporate Social Responsibility Audit Within the Quality Management Framework" of Kok et al., published in 2001 in the Journal of Business Ethics.

For both issues it is made a literature review with the objective of placing both issues in historical and contextual terms, defining the state of the art.

Based on the articles is made a relational analysis between the philosophies of TQM and social responsibility, quality excellence models and the elements of the TQM process, aspects and elements of the social responsibility process and CSR audit tools.

In order to illustrate the relationship between TQM and CSR, is presented the company's case Nabeiro Group Delta Cafes. In this case it is shown that in a sustainable way both concepts and practices have evolved and have conjugate, allowing the improvement of the economic, social and environmental performance.

Philosophy

Anchored on the ethical considerations of human behavior / school of thought of social system; expands the organization's horizon beyond economic performance.



Means Results Model Results People management concerning **Key Performance** management eadership people Quality Results Planning and Results citizens / Strategy customers European Processes (EQA) **Partnerships** Results in and Resources society Learning and Innovation

Comparison of models, MBNQA and ECA in relation to Social Responsibilty

Mission: Focus on key stakeholders, the principles of quality and economic values; little attention to social responsibility and ethical values; no attention given to codes of conduct.

Public debate: restricted to key stakeholders; only addresses issues related to the quality values; little attention given to ethical values; Business results strongly focused on financial results.

Codes of ethics: is not given explicit attention to codes of conduct and ethics.

Type of ethics: transaction towards the ethical recognition.

Responsibility: minimum legal compliance position, tending to the position of self-interest.

Mission: Focus on key stakeholders, strongly focused on economic goals; Business results strongly guided by financial aspects.

Public debate: Strongly focused on participants who have direct influence on business results; subjects must have a direct link with bottom-line organizations.

Codes of ethics: is not given explicit attention to codes of conduct and ethics.

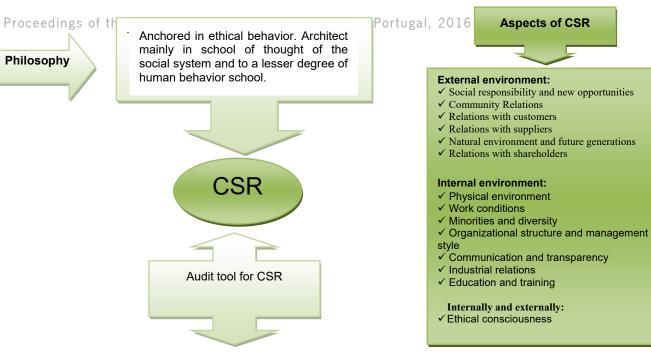
Type of ethics: Ethic recognition toward the transaction ethics.

Responsibility: enlightened position of self-interest, tending to the position of respect for the legal minimum

TQM Process Elements

- ✓ Promotion of the values and principles of TQM;
- ✓ Open and participatory management style;
- ✓ Focus on customer, employees, society and owner's needs;
- ✓ Delegation of authority and responsibility to the lowest level of the organization;
- √ Use of the creative ability of employees through active participation;
- ✓ Opening of wide sharing and communication of information;
- ✓ Development of partnerships with key stakeholders;
- ✓ Empowerment of employees to address problems and making decisions;
- √ Bilateral communication;
- ✓ Development of HR;
- ✓ Improvement and lifelong learning
- ✓ Teamwork
- ✓ Focus on the process and not on the task
- ✓ Elimination of error sources and design of systems that make difficult this occurrence

Results: The benefits of TQM are large and affect all aspects of the organization, including financial performance.



Structuring Standard Revised Ad hoc planning **Planned** planning planning planning extension ✓ Costs ✓ Costs ✓ Law enforcement ✓ Costs ✓ Consider the needs of ✓ Law enforcement ✓ Law enforcement ✓ Government ✓ Consider the the independente ✓ Unstructured ethical pressure society/from the needs of society approach that influence influence on business business results results **External environment:** ✓ Structured approach: ✓ Ethical approach ✓ Social responsibility and new oppotunities with some review and ✓ Community relations integration of CSR structure ✓ Customer relations aspects ✓ Relations with suppliers ✓ Natural environment and future generations ✓ Values and clear rules ✓ Relations with stakeholders ✓ Development of an ethical climate **Internal environment:** ✓ Development of ✓ Physical environment ethical codes ✓ Working conditions CSR aspects ✓ Attention to ✓ Minorities and diversity organizational ✓ Organizational structure and management style ✓ Communication and transparency implementation ✓ Industrial relations ✓ Education and training Internally and externally: ✓ Ethical consciousness

CSR Process Elements

- Integrity: based on the theory of virtue and ethics, requiring the integrity of action on all forms of agency that constitute the company;
- Equity: derives from the theory of rights and justice, and its goal is to assure that equity is perceived in the business activities:
- ✓ Benefits: based on the utilitarian perspective, emphasizing the need to consider the benefits of an action. The goal is to create the greatest "amount of good" for the greatest number of stakeholders affected by the action;
- ✓ Voice: based on the theory of distributive justice requires that the interests of the parties are protected through active and visible participation in decision making at all levels;
- ✓ Transparency: based on freedom and the theory of informed choice. full disclosure and to provide information to the parties to enable them to make decisions that do not compromise their well-being;
- ✓ Without damage: based on the philosophy of rights, demanding that the company does not engage in actions that cause damage, applying to people, the environment and ecosystems;
- ✓ Liberty: Based on the theory of freedom and ethics, emphasizing the individual's right to engage or not transactions with the company;
- ✓ **Caution:** based on virtue and on the theories of the rights of ethics, focusing on the protection and promotion of positive rights of the company.

Results: Yhe impact can be large but potentially indirect.

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Source: Self elaboration

THE CASE OF DELTA CAFES

Citing Comendador Rui Nabeiro, President of Nabeiro Group Delta Cafés - SGPS, SA at the second International Conference about Alentejo and Water, held in Campo Maior, on 8 and 9 June 2007, "For Delta Cafés - SGPS, SA, as for all other companies in the Group Nabeiro, to promote sustainability is more than a duty and an obligation: it is assumed responsibility. It is our way of being and living life. It is part of our culture. The values and principles of business that always guided me, are based on a human face management and a fundamental commitment: our responsibility to future generations, our responsibility to the future. So I assume, always, that competitiveness depends on the ability to generate value in the economic, social and environmental areas, in looking for a dynamic balance between the different needs by establishing partnerships with all stakeholders. This binding dialogue must be based on added value generating relations for all stakeholders " (Document available at http://ciaa.adpmweb.org/docs/DeltaCafesSGPS.pdf, 19/02/2009).

In the company's sustainability report for 2014, Comendador Rui Nabeiro declares a "human face management and a fundamental commitment: Face the future with responsibility and respect for future generations"

Who is Delta Cafés?

Rui Nabeiro created in 1961 its own brand of coffee in the Alentejo village of Campo Maior. Its success was based on the quality of products, service excellence and an attitude of Relationship Marketing, earning the community's trust by making every customer a friend and thus gaining the loyalty of partners. All these factors contributed to the sustained and stable growth of the business. Associated with its commercial activity is the social dimension that allowed him recognition through the award of the Prize European Most Trusted Brands of Reader's Digest, 2002-2007.

Consolidation of business, led in 1998 to redesign the Nabeiro Group - Delta Cafés, which caused the creation of 22 companies.

The Novadelta SA was the first Portuguese company in the sector to be certified in 1994 by the quality standards system NP EN 29002 / ISO 9002. The internationalization process involved the creation of communication universes / service / range, segmented by target markets.

Strategic Guidelines

The company identifies six strategic lines of action:

- Maximizing value from partnerships with different stakeholders with whom they interact in the development of the activity (employees, coffee farmers, shareholders, customers, suppliers, community, state, environment and non-governmental organizations);
- ➤ Decrease the negative effects generated by the activity through responsible environmental and social management;
- Promotion of responsible trade;
- Promotion of innovation;
- Ethical performance, respecting the international principles of human rights;
- Maintenance of a shared governance model, with the integration of the company's business strategy, the concerns of stakeholders with whom they interact and are affected by the development of the company's activity.

The Mission

The mission of Delta Cafés company meet the real needs of different types of market, for the total satisfaction and loyalty of consumers / customers through social responsible business for the purpose of community integrated development.

The Corporate Social Responsibility

Delta Cafés is a company that conveys the image of an organization with a human face (Gago et al., 2005).

In terms of the several dimensions, social responsibility and sustainable development are seen in an integrated perspective. The integrated management system (IMS) company allows you to manage the economic, social and environmental aspects. Organizes its functioning, so that all activities and processes carried out by the team of Delta Cafés, lead to their mission. The IMS promotes the work in interdisciplinary teams. The participatory management based on dialogue, to define needs and objectives of stakeholders, seeking the responsible balance between economic, environmental and social performance.

Social Dimension

The people management is guided by a set of policies based on principles such as respect for human rights, professional development, equal opportunities and non-discrimination; commitment to continuing education, freedom of speech, safety and health, professional and personal fulfillment; initiative and creativity, good work climate settled in the development of human relations, nondiscrimination, professional development through career plans. The 2007 data, more than 85% of the Delta, were part of the undertaking's managerial staff, an effort to create conditions of stability and competitiveness in local communities. Employees benefit from health insurance, transport services and cafeteria free in Delta Cafés Industrial Units and special conditions in addition to household goods and services in banking, automobile, travel, food, security products, as well as all products and services of Nabeiro Group. The company develops and applies an integrated management system which includes hygiene policies, health and safety, applied to all employees. The annual process of planning, monitoring and performance assessment based on a clear definition of specific, realistic and measurable objectives, the definition of responsibilities and each function skills, a continuous monitoring of performance throughout the year and an overall assessment of the performance achieved for one year, based on objective criteria. The training policy intended to enable adaptation of employees to changing working conditions resulting from technological developments and changes in the economic context.

Environmental Dimension

In 2007, Delta has developed the Planet Delta program that aims to minimize the environmental impact of their activities and help raising awareness among citizens and authorities to conserve the planet. They made the calculation of the carbon footprint, identifying the sources of emissions of gases with greenhouse effect, and defined the borders of the accounting. They distributed efficient light bulbs, in order to increase efficient energy consumption. Reported raising awareness messages to climate change. In order to promote biodiversity the company has promoted the sustainable consumption of coffee through fair trade practices, of the organic coffee recovery and preserving ecosystems. It holds certification NP EN ISO 14001 and EMAS that ensure the existence of an environmental management system. Also some practices were adopted to decrease waste production by promoting the use of other materials, minimization of waste and reintegrating them in the value chain. There has also been, reduction of water consumption. The visual impact of the company is minimized by green surroundings and garden areas. The noise is properly addressed.

Community Dimension and Partnerships

In 2005, it was created under the auspices of Delta Cafés, the Social Solidarity Association Heart Delta whose aim was to integrate all volunteer activities and social-oriented projects, developing innovative projects and services in the communities where they are present. However, the Association has created

various assets and services in particular Educational Alice Nabeiro Center, Early Intervention, Support Service for Children and Youth, Corporate Volunteering, environmental projects and citizenship. Volunteering is also present through actions carried out within the health, social welfare and environment. Finally, in 2012, it was created a social fund of the employees.

Future Commitments

The commitments of the company will continue to be with the employees, the community and customers, through the continuity of implemented projects, and others whose implementation is expected to accomplish national and international level.

Figure 2 attached shows in a systematic way the information regarding various dimensions of Delta Cafés such as positive impacts, negative impacts and affected parties along the coffee life cycle, i.e., from its origins to marketing. At the bottom we are facing the systematization of good practices in the value chain.

Figure 2 - The dimensions of Delta Cafés / best practices in the value chain **BOAS PRÁTICAS** PRESENCA NA COMUNIDADE NA CADEIA DE VALOR Apoio a atividades e projetos que promovem o **IMPACTOS POSITIVOS** IMPACTOS POSITIVOS desenvolvimento de comunidades competitivas. Criação de emprego direto e indireto. Contribuição para a competitividade dos países em vias Fixação da noculação e aumento da natalidade no de desenvolvemento. A Inovação promove a criação de valor. concelho de Campo Maior. Criação de emprego IMPACTOS POSITIVOS Aposta na criação de redes de conhecimento. Melhoria das condiciles sociais e económicas das Crescimento económico das comunidades. Crucão de competências nos clientes Horeca Contribui para a competitividade dos palses em vias comunidades. de deservolvimento. Criação de valor na cadeia nacional e local. Melhoria das condições sociais. Promoção de voluntariado empresarial, Criação indireta de emprego Desenvolvimento do tecido empresarial. através da Associação Coração Delta. IMPACTOS NEGATIVOS Crescimento económico. Aumento da competitividade da comunidade local. Aposta na formação de crianças e jovens através Melhoria das condições sociais. Efeitos colaterais nestativos de crescimento econômic **IMPACTOS NEGATIVOS** do Centro Educativo Alice Nabeiro (CEAN), Manual · Incentivos para o não abandoso das terras Preço do cald. de Empreendedorismo "Ter ideias para mudar o Promoção da biodiversidade das espécies cafeeiras. Consumo de recursos (água e energia). Consumo dos recursos. Mundo", Manual para Jovens Empreendedores. Policicão atmosférica e sonora. TRANSPORTE DO CAFÉ PARTE INTERESSADA IMPACTADA IMPACTOS NEGATIVOS Produção de residuos. Desde os países produtores Apoio a crianças e jovens com necessidades Efeitos colaterais do crescimento económico. Consumo de materiais Clientes até ao porto de Lisboa, é educativas especiais. Penda da biodivernidade. Cotaboradores Consumo de recursos (água e energia). realizado por via marítima, PARTE INTERESSADA IMPACTADA Comunidade local O Centro de Formação Comendador Rui Nabeiro, a partir dal até à estação de Fornecedores PARTE INTERESSADA IMPACTADA Elvas é utilizado o comboio, em parceria com inúmeras instituições, faculta Enlaboradores Estado que reduz os custos econóformações que permitem colmatar as lacunas de Comunidade local Fornecedores micos e as emissões de CO₂. competências na comunidade. Difusão da cultura e ciência do café através do Centro de Ciência do Café. ORIGENS DO CAFÉ TRANSFORMAÇÃO DO CAFÉ COMERCIALIZAÇÃO DO CAFÉ O processo de transformação do Os princípios orientadores de IMPACTOS POSITIVOS Gama de produtos alargada, adaptada IMPACTOS POSITIVOS negócio contribuem para a procafé é feito com a preocupação de aos diferentes mercados. Criação de emprego direto e indireto. Promocão do desenvolvimento das comunidades dução de café de forma responotimizar o consumo de recursos. + Fomento do espírito de empreendedor nas sável nas vertentes económica, **IMPACTOS NEGATIVOS** Diferentes canais de comunicação crianças e jovens social e ambiental. A Delta Cafés tem um sistema de para ouvir as partes interessadas. Poluição atmosférica e sonora. Promoção da aquisição de competências na gestão integrada que incorpora a comunidade local. PARTE INTERESSADA IMPACTADA De forma a promover a biodiver-Qualidade, a Segurança Alimentar, Otimização e racionalização de rotas PARTE INTERESSADA IMPACTADA sidade, adquirimos mais de 60 o Ambiente, a Responsabilidade de distribuição. Fornecedores origens distintas. Comunidade Social e a Saúde e Segurança dos Clientes colaboradores. Formação para os profissionais da res- Colaboradores tauração, na Escola Barista Grão Mayor. Em Angola, temos desenvolvido Comunidade várias ações para promover a A Delta Cafés realiza o adequado + Estado capacitação dos produtores. tratamento de resíduos gerados Garantia de rastreabilidade total na cadeia alimentar. pela sua atividade.

Desenho e implementação de um sistema de Customer Relationship Management (CRM).

Source: Delta Sustainability Report, 2014

FINAL CONSIDERATIONS

The relationship between quality, environment, health and safety and social responsibility is increasingly a concern for all. There is also a long time interest in the nature of the relationship between TQM and CSR (Ghobadian *et al.*, 2007).

Despite the existence of consensus on various definitions of quality, it appears that they do not compete, but complement each other in one sense of striving for excellence (Pike e Barnes, 1996; Nogueiro, 2008).

The definition of Total Quality Management (TQM) as the concept of quality varies with the author and the domain in which it is the object of study. TQM can be considered as a philosophy of business management that recognizes that the needs of customers and the organization's goals are inseparable. There are key elements that enable the organization to strive to become a TQM organization.

Social responsibility (CSR) can be considered as a management concept, relatively recent. Due to this concept, it is expected to have an active participation of all stakeholders in the debate on social problems (unemployment, poverty, etc.) and that, cumulatively, if proactively think about the effects of business in society in general. Currently, social responsibility is increasing the challenge for the acquisition and development of appropriate skills and aptitudes. The evolution of the concept allowed to define initially, social responsibility based on letting people take care of business (Friedman, 1962), to then be approached from a perspective in which the support assumption is that managers would take some social responsibility in decision-making, whereas they themselves are part of the society (Mintzberg, 1983). The existence of any corporation is based in order to benefit society (Shaw and Barry, 1992). CSR definitions vary (Ghobadian et al., 2007) ending in its definition, the importance of economic performance, recognizing that companies serve a wide range of stakeholders, highlighting the importance of the need to balance factors such as economic performance, meeting the expectations of stakeholders and responsibility to society. There are values such as participation, honor, justice, among others, underlying the concept of social responsibility.

It is possible to assess social responsibility. Social audits are tools that allow to endorse on the social conscience of the company; these can be considered a review to ensure that the organization gives due attention to social responsibilities to those who are directly and indirectly affected by its size and simultaneously is achieved a balance in business planning between these aspects and the more traditional business goals.

TQM can be used as an enhancer factor of the development of an ethically sensitive corporate culture. Models such as the MBNQA and EQA / EFQM incorporate a social responsibility element and management practices compatible with the defender of the ideals of CSR (Ghobadian and Woo, 1996 and Martin-Castilla, 2002 cited by Ghobadian et al., 2007). The relation of both models to social responsibility, is ground in three fundamental aspects: the existence of a clear organization's mission statement; the organization is clear in the public debate; and the existence of ethical codes (Kok et al., 2001).

TQM and CSR result of the organization act properly. TQM can be used as an accelerator for the spread of CSR. Integrated coexistence of both in the organization is important.

The case of the company Nabeiro Group Delta Cafes corroborates all relational analysis made between the subjects TQM and CSR. The relationship between these concepts and practices enable companies to improve the economic, social and environmental performance.

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Promoting change and easing quality management into higher education institutions

Duarte, R.1, Lacerda-Nobre, A.2, Ramos-Pires, A.1,4, Duarte, J.3, and Silva-Ribeiro, J.2,3

- ¹⁾ DEM, Escola Superior de Tecnologia de Setúbal, Instituto Politécnico de Setúbal, Campus IPS, Estefanilha, 2914-761 Setúbal, Portugal
- ² DEG, Escola Superior de Ciências Empresariais, Instituto Politécnico de Setúbal, Campus IPS, Estefanilha, 2914-761 Setúbal, Portugal
 - ³¹ UNIQUA, Instituto Politecnico de Setúbal, Campus IPS, Estefanilha, 2914-761 Setúbal, Portugal
- ⁴⁾ Associação Portuguesa para a Qualidade, Pólo Tecnológico de Lisboa, Rua Carlos Alves n°.3, 1600-515 Lisboa, Portugal

ABSTRACT

Purpose - The purpose of this paper is to investigate the benefit of aligning quality management with organisational change and to describe the circumstances for which such alignment is possible.

Design - The paper starts by drawing a parallel between difficulties associated with organisational change and those found when implementing quality management systems in higher education. From this initial analysis characteristics of quality management systems conducive to organisation change are highlighted. A case study is presented that includes several (but not all) of the characteristics that support organisational change and lessons from the implementation of this quality management system are used to draw conclusions.

Findings - The study found that quality management systems that accept variability and diversity are better fit to create the necessary conditions for organisational change to take place. It was also found that within the higher education institutions context, the promotion of academic success is a good candidate for a unifying shared belief at organisational level, and, because change is easier when supported on a shared belief, quality management systems benefit from being centred on the core objective of academic success.

Practical implications - Because knowledge is above all local and regional, reporting local experiences contributes to a better understanding of the challenges facing those wishing to implement effective quality management systems in higher education institutions. Key features highlighted with the presentation of the case study should also assist developers of quality management systems.

Originality - This paper is the first to discuss the successful implementation of quality management systems in higher education institutions in connection to academic success, used as a driver for organisational change and as a unifying shared belief.

Keywords: Higher education; quality management systems; academic success; shared belief; change culture.

Paper type: Research paper

1. INTRODUCTION

The number of Higher Education Institutions (HEIs) with quality management systems increased significantly since the first reported cases in the 1980s (see Kanji et al., 1999). According to a 2010 European University Association survey (Loukkola and Zhang, 2010), of over 200 HEIs from 36 countries the majority already had an internal quality assurance system. This owes much to the 1999 Bologna Declaration and to the subsequent definition, in 2005, of guidelines for the development of institutional quality management systems (the European Standards and Guidelines, ESG, by ENQA, 2005)¹.

Researchers who foresaw in the 1990s the growth of quality management in higher education (among others, Williams, 1993; Owlia and Aspinwall, 1996) were correct in doing so; quality assurance in higher education "won't go away", and the scientific literature shows how Quality Management Systems (QMS) are being used to improve HEIs' administrative services — e.g., front-office, back-office, library, and internationalisation (Owlia and Aspinwall, 1996; Nadiri et al., 2009; Vauterin et al., 2011; Min et al., 2012) — but also to improve course design/ delivery, and as a tool to reframe higher education service models (Yeo and Li, 2014; Noaman et al., 2013).

From the standpoint of academic staff, it is generally recognised that the accountability introduced by quality systems is appropriate and beneficial. Advantages associated with QMS are increased openness, which allows for a better detection of weaknesses, more transparency and fairness and more opportunities to work closer together (Hoecht, 2006). Frequently reported disadvantages of QMS relate to incommensurability (when comparing the effort required by QMS to end results), bureaucracy and shift towards managerialism. Relevant to the discussion of QMS in HEIs is also the fact that often quality management is implemented as a response to external accreditation pressure, suggesting that QMS in HEIs does not stand on its own value but as an external demand for accountability (Newton, 2002). As a consequence, from HEIs' stakeholders perspective (especially, from the academic staff perspective), QMS may not reflect the institution's inner needs, and the stakeholders expectations.

Indeed, concerning the specific case of the teaching and learning process, academic staff is often sceptical of the benefits that might arise from QMS. Already in the 1990s Jauch and Orwig (1997) claimed that important quality management principles were contrary to the essence of higher education teaching and learning, and presented the following arguments to support their claim:

- Quality management asks for the reduction in processes variability, which is contrary to both students being an active part of teaching, and to innovation in the teaching process itself;
- Quality management emphasises customer focus, asking for identifiable customers that are able to define and recognise quality; which is a subject of much debate in higher education, due to the multifaceted characteristics of HEIs' stakeholders;
- Quality management assumes employees willingness to be empowered by quality, which is questionable given that in HEIs academic staff already have complete discretion over course design, and over scientific and pedagogical issues.

Obviously, these arguments can be refuted, and today several successful examples of QMS implemented in HEIs could be presented, nevertheless, it should be recognised that more than 20 years after the first reported implementations, "primordial fears" against QMS in HEIs (like the ones above) are still common. Why? Most likely because too many QMS have been implemented without proper account for the specific characteristics of HEIs, and QMS became associated with problems of trust, control and professional autonomy. Newton (2002); Brennan and Shah (2000); Hoecht (2006) or Hackman and Wageman (1995) report on such

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¹ Though not mandatory, and not used as an integrated whole, according to Loukkola and Zhang (2010) HEIs tend to consider these guidelines when implementing their quality management systems.

problems mentioning reactions to QMS implementation that include academics detached attitude with cases of window dressing and cynical "playing the game" attitudes, which leave organisations untouched, whilst simultaneously generating the same repetitive behaviour dynamics, with or without quality management systems.

The present paper starts from the premise that implementing changes in HEIs is difficult, especially in processes related to teaching and learning. It recognises that a successful implementation of QMS depends, to a great extent, on the ability to link quality to a meaningful inner need, a need that makes the efforts and the difficulties associated with change worthwhile to stakeholders. Additionally, the paper posits that organisational change associated to QMS should be preceded by an easing-in process to promote individual and organisational learning.

In the following sections, the difficulties implementing changes in HEIs are reviewed and a parallel to the difficulties found when implementing QMS in HEIs is established. Arguments supporting the use of academic success as the driver and as the unifying shared belief supporting change in HEIs are then discussed, and a report from experience on actual strategies for easing QMS into HEIs is presented. The paper finishes summing up reasons for the gap between espoused and in-use practices associated with QMS in HEIs, and reiterating ways for easing quality management into HEIs.

2. QUALITY MANAGEMENT AND BEHAVIOUR CHANGES

More than 2000 years ago Heraclitus stated that everything is in a continual state of flux and that nothing is permanent, but change. To survive in an ever changing environment individuals (organisations) develop control mechanisms in the attempt to cope with change. However, relying solely on the ability to adapt to changes isn't the only solution—nor the best one, whenever changes fall outside the range of adaptation—, individuals (organisations) can also withdraw and search for other environments and, more importantly, they may attempt to secure adequate environmental conditions by governing (directly and indirectly) the environment.

Individuals (organisations) are in continuous search for adequate environments to settle and prosper, and, when confronted with the need to change, they react. These reactions can be extreme; for individuals, somatic and emotional symptoms such as exhaustion, irritability, crying, when forced to cope with new conditions, are examples of extreme reactions (Bozak, 2003). Reactions can also be more subtle — albeit equally harmful — as in the case of decreased morale and lack of trust (in management, a business partner, etc.).

Behaviour scientists have long discussed individuals' (organisations') reactions to change and the ability to learn and adapt to change and, hence, to survive and flourish. In the analysis of behaviour, a parallel to principles of control theory is frequently used (Staddon, 2003; Argyris et al., 1985). According to Argyris et al., when an individual (organisation) is in equilibrium and detects an environmental change, actions follow according to the generic pattern: In a situation with governing variables g, to achieve consequence c (and restore equilibrium), do action a. Such formalism allows a cybernetic-like representation of individuals' (organisations') reactions to change, as depicted in Figure 1.

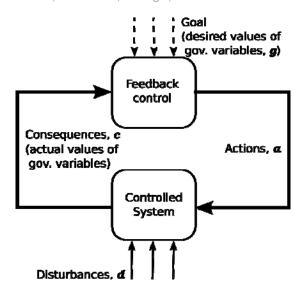


Figure 1 – Cybernetic interpretation of individual/ group adapting to changes (based on Argyris et al., 1985).

In Figure 1 inputs and outputs of an individual (or of an organisation) are represented with arrows entering and leaving the box labelled feedback control. Every individual (organisation) has a set of goals related to the governing variables, for example, the goals related to skills learned by a class. In order to achieve these goals, specific actions have to be taken, which will influence the controlled system and translate into consequences and new values of governing variables. The error—the gap—between actual and desired values of the governing variables determines the need for corrective actions.

But the controlled system is also subject to disturbances *d*, and, if on account of these disturbances values of governing variables change, individuals (organisations) react in order to restore the desired values of governing variables and cancel the effect of disturbances.

In HEIs, the implementation of QMS represents a disturbance, and one that doesn't go away, for quality systems demand continuous improvement. Because of what has been written in the previous paragraph, a reaction to the implementation of QMS is expected. As explained, the objective of this reaction is to restore the desired values of governing variables, set prior to the disturbance by the QMS.

For the specific case of changes to the teaching and learning process, and considering the difficulty in agreeing to what is a HEI client and what is meant by "product quality", frequently, information produced by quality systems is insufficient, ambiguous and performance indexes are inconsistent. Furthermore, to enforce change, management often resorts to top-down approaches, bringing about coercion and threatening issues. Argyris et al. (1985) describe the consequences of a change process conducted in such a way: according to these researchers, individuals (organisations) reaction will lead to dysfunctional group and intergroup dynamics, with win/ loose situations, games of deception, camouflaging of errors and the mismatch (a gap) between espoused practices and actual *in-use* practices.

Argyris et al. also discuss with great detail what should be done to avoid dysfunctional dynamics. For the purpose of this paper, Figure 1 is enough to understand Argyris et al. main arguments. Before implementing changes, individuals' (organisations') goals should be questioned and revised. Change would then spring from within, and not as an external demand. Using Lewin's model of organisational change (Schein, 1999), the initial stage during which existing organisational goals are questioned, and new ones are communicated, is called "unfreezing" stage. Lewin's model considers two additional stages, the change stage, and the refreezing stage, but for the discussion of QMS in HEIs, and given the scientific and pedagogic discretion of academic staff, the unfreezing stage is critical and will be the focus of this paper.

In the next section communicating the need for change is discussed in detail.

3. COMMUNICATING ACADEMIC SUCCESS TO PROMOTE CHANGE

Quality models for HEIs are structured around processes to deal with administrative services, library, staff, research, curriculum development, learning and teaching, etc., and, in order to assess quality in different processes, different performance indexes are used. The operational need for performance indexes does not restrain quality being associated with a core and unifying shared belief that is clearly understood by stakeholders and around which the need for change is centred. In fact, considering the skills and high quality standards of HEIs' human resources, it could be argued that for HEIs QMS should focus on strengthening shared beliefs rather than on imposing quantitative performance indexes. This line of thought will not be pursued, but is mentioned because it introduces one simple and yet very important question: Which shared belief should HEIs focus on? Which shared belief would be meaningful to the largest number of stakeholders?

In HEIs, all individual objectives coalesce into the single larger one of educating and graduating students. This objective can be restated more effectively as the promotion of academic success². As explained in Section 2, when implementing changes it is important to communicate the need for change; academic success is a meaningful driver for all HEIs' stakeholders and its use as a unifying shared belief will be one of the subjects dealt with in the present paper. However, before discussing how to communicate and how to embed academic success in QMS, it is important to explain what makes academic success and how it is measured.

3.1 What makes academic success

Academic success depends on a constellation of factors which change over time, from the moment a student enrols until their graduation. According to Tinto (1975), among these factors are the following: the individual's prior experience (academic and cultural); the academic and social environment they experience in the HEI, including grade performance, interactions with peers and faculty; and, naturally, individual attributes, such as perceived competence, self-determination, project-formulation/ instrumentality of action (Carré, 1998). In a given moment in time, all these factors make up the individual's motivational pattern that lies beneath the decision to enrol and to persist.

To promote academic success — and prevent dropout — contemporary HEIs have programmes (Swail et al., 2003; Swail, 2004) that include financial aid and diverse academic services. For example, the services include digital library, platforms for autonomous/ distance learning, tutoring, and investment in social integration with activities that stimulate students' interaction with peers and faculty.

Many of these services are classified by QMS as supporting processes, however, it is clear that these so called "support" processes are important determinants of academic success (the following sections will help clarify the importance of this argument). Traditionally, for academic success other processes, such as the curriculum development and the teaching and learning process are judged more important. As mentioned in the Introduction, typically, and from QMS implementation standpoint, the latter process is the one most difficult to address.

3.2 Measuring academic success

Academic success is traditionally specified by quantitative indexes such as Grade Point Average (GPA), number of enrolments until graduation, or dropout rate. These indexes or metrics are simple to understand by managers, faculty, students and employers. It is natural that when implementing QMS these indexes are used.

² Focusing on academic success has advantages because it is not easy to find a performance index for "education" and because it allows monitoring performance at any moment, not only at graduation.

However, an analysis relying on such indexes requires careful interpretation and should not be detached from the analysis of students' background. In other words, socio-economic background influences academic performance, even if this influence occurs through complex and non-linear relationships.

With the democratisation of higher education, supported by policies promoting free and compulsory secondary education, life-long learning and internationalisation, variability in students' academic and cultural background, and also in motives to enrol and to persist increased significantly. For HEIs, this means the ability to cope, simultaneously, with populations that have specific and often very different instructional needs and frailties. HEIs (especially public ones) are being asked to deal with inputs — undergraduate students — with highly variable characteristics but are expected to deliver an output — graduate students — with a much smaller variability. This is a difficult task because when little control of input variability is allowed, larger variability in the output is expected.

For an effective implementation of QMS, realising the difficulties HEIs have to reduce output variability could not be overemphasised, and if key QMS procedures are supported by indexes that measure only the output of the learning/ socialisation process and are blind to input characteristics (students background/ motivation to enrol), then QMS will stand on inconsistent/ incomplete information and dysfunctional dynamics such as those described in the introductory section will take place. This applies to all processes but especially for the learning and teaching core process, for which academic success is, typically, measured directly³.

3.3 Embedding academic success in quality management systems

Adequate embedding of academic success depends on two main aspects: first, explicit support from top management, as active leaders and change champions, who have the ability to learn and the authority to create the conditions in which adaptations are possible and natural; and, second, the ability to accept variability, that is, a wide spectrum of diversity regarding key variables. Figure 2 represents the interlinks between different management levels in HEIs and how different skills can be used to promote nested change.

Figure 2 represents (on the right side), for the course unit level, the dynamic interaction between academic staff and course unit. Through performance indexes, such as GPA, course unit reacts to specific actions, for example, it may react to a teaching style or to contents lectured. But a unit belongs to a course and course coordination should be able to learn and to create the necessary conditions in which teachers are capable of introducing changes (to either reduce variability or to accept variability and work with it).

³ An example of how indexes influence the perception of performance was the change that occurred in Portuguese secondary schools ranking in 2015. Prior to 2015, based on students GPA, public schools typically ranked poorly when compared with private ones, however, in 2015 a new index was used that considered not only students' GPA but also students' social background and with this slight change public schools immediately jumped to top positions (TSF, 2015).

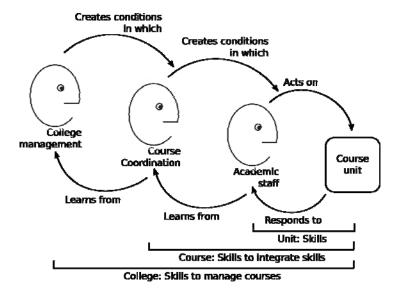


Figure 2 – Nested change: from action at course unit level to shared belief. Figure inspired on Dubberly and Pangaro (2010).

Upstream from the course coordination, college management also learns from course results, and also creates conditions for courses to develop and to flourish. And it is part of college management discretion and decision power to choose between emphasising absolute performance indexes, such as GPA, number of enrolments until graduation, dropout rate, or else combining these indexes with students' background and emphasising relative progresses in students' skills.

Communicating academic performance requires, first of all, an understanding of what makes academic success and a careful decision process regarding how it can be effectively measured. This understanding is only possible with adequate information to support decision making, and the ability to learn from all stakeholders. Therefore, embedding academic success indexes in quality systems requires using QMS to communicate academic success as its ultimate institutional goal, and including students' success in most performance indexes (not only for the teaching and learning process).

4. CHANGE AND QUALITY MANAGEMENT HAND-IN-HAND: A REPORT FROM EXPERIENCE

The present section describes the implementation of a QMS within a HEI setting. The QMS is not an ideal one nor is it the archetype of what has been written in previous sections. However, its analysis contributes to the empirical and practical grounding of an open reflexion about the crucial role of quality management in higher education, both for promoting higher performance and a positive attitude towards a change culture. Moreover, recognising that knowledge is above all local and regional, reporting local experiences certainly contributes to a wider and better understanding of the challenges facing those that wish to implement effective QMS in HEIs.

4.1 Brief description of the quality management system

The implementation of the QMS started in 2008 as a consequence of the HEI decision to apply for an evaluation by the European University Association. A formal quality management structure was set up headed by a pro-rector. From its inception the focus of the QMS has been on the teaching and learning process and on the development of tools to improve this process, moreover, it was assumed from the start that QMS would emphasise the availability of information to assist decision making, rather than the definition of organisational procedures. This strategy was rooted in two developing axis. The first axis considered the development of the existing Information and Technology (IT) support system. The second axis considered the active promotion of applied research on topics of interest to quality management. The main objective of this latter axis was to

promote cross-fertilisation between academics' Research & Development (R&D) interests and QMS organisational practice. Figure 3 presents a schematic description of the interconnection sought between R&D and QMS.

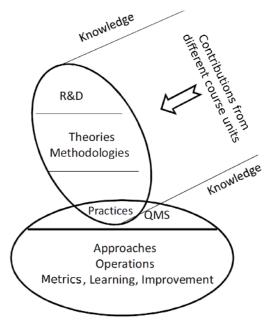


Figure 3 – Linking R&D to QMS operations (Ramos-Pires, 2011).

The implementation timetable considered a first stage that is related to the "unfreezing" mentioned previously. This stage focused on raising HEI stakeholders awareness towards the crucial importance of QMS and aimed at preparing the organisation for change, mainly by providing the necessary "knowledge of the variables with impact on results" (Ramos-Pires, 2011), but also by promoting organisational learning through R&D activities associated and supporting QMS.

After "unfreezing", actual change is being promoted with the development of operational procedures and rules on which the HEI will stand to ensure effective quality management.

4.2 Report from experience

The experience related to the present case study has revealed interesting perspectives that lead to "food for thought" regarding the implementation of quality systems in HEIs.

Section 4.1 stated that the first axis to be developed by QMS was the existing IT support system. This proved a wise decision because it allowed early in the QMS implementation process to uncover important weaknesses, namely, the lack of integration between college IT subsystems and the need to implement changes for easier access to databases. The fact that these problems were identified and specific efforts were made towards correction testify for the adequacy of the adopted strategy. As stated previously improving the teaching and learning process was from the start a priority, and with improved IT services regular reports were introduced to assess performance at course unit level and for each course.

Regarding the QMS second development axis—link between R&D and QMS—, in spite of the initial difficulties in gathering data, important progresses were made to characterise the institution and to raise awareness towards the need for quality management. Initial technical reports focused on (Ramos-Pires, 2011):

- Socio-demographic characterisation of students.
- Monitoring the teaching-learning process (development of harmonised questionnaires).
- Setting generic rules and gathering information necessary to certify courses.

Complementary studies with emphasis on students' dropout.

Longitudinal studies that followed individual students' academic trajectories, as well as the analysis of curriculum development throughout time were also performed (Duarte et al., 2014; Lourenço et al., 2013).

Regarding the planned connection between QMS and doctorate studies performed by academic staff, work was carried out on topics related to marketing, innovation (and quality) and information systems in HEIs. The impact of linking R&D to QMS is difficult to evaluate because it extends far beyond the production of documents. In fact, because R&D was carried by academic staff who are members of HEIs governing bodies, it is fair to assume that this was the most important contribute of the second axis—the development in a natural way (without external enforcing) of an institutional culture for quality.

When it comes to the topic of centring QMS on the topic of academic success, the need for quality management wasn't explicitly linked to academic success, however, all individual course unit reports and course reports emphasised academic success and enforced corrective actions for course units with success rates below a specified minimum. An interesting point is that, contradicting the warning presented in Section 3.2, the implemented system has been unable to use performance indexes that consider students' background. The justification lays in the difficulty in agreeing on the selection and use of the available sociodemographic data. However, because course units with low success are subject to detailed pedagogic and scientific analysis, students' background considerations could be included in this analysis.

5. CONCLUSION

Within the context of higher education institutions, quality management systems implementation is difficult, given the variability in students' backgrounds and the ambiguity in the definition of the quality of the "end product", the graduate student. This difficulty becomes even more apparent within the core teaching-learning process, the interface between students' and teachers' effort to reach adequate success levels; therefore, caution is needed to prevent the gap between espoused practice and in-use practice.

This study argued that biased behaviours (towards QMS implementation) are avoided when:

- The link between quality management and external accreditation pressure is less significant and "inner needs" are used to drive QMS implementation;
- Quality management relies on reliable performance indexes, meaningful to all stakeholders; and, finally,
- Quality management is grounded on the community, on the organisational inner setting, as opposed to enforced from top management.

For a gentler use to quality management in HEIs, it is proposed that QMS implementation is preceded by an initial stage that seeks to embed the organisation with a shared belief, one worth fighting for, and to provide clear information about the whole process. During the actual design/ development of these cultural intervention procedures, aimed at creating a unified shared belief worth fighting for, a deepening and an intensification of the identifying and strategic characteristics of the organisation will take place. That is, QMS will effectively contribute to a stronger organisational culture, one that differentiates in a unique form each HEI, and, simultaneously, enables and promotes a universal, civilisation wide, culture of excellence and of work and effort gratification/ motivation.

The present paper ascertains that, within HEI contexts, the promotion of academic success, evaluated by objective indexes, is itself a good candidate for a unifying shared belief at organisational level. It is also argued that QMS that accept variability and diversity are better able to create the necessary and optimising conditions for organisational change to take place. These conditions occur throughout the whole value chain process, at the different, and interrelated, core and supporting processes. The stronger the change culture that is embedded into the organisation, the larger will be the resilience of the QMS. Therefore, the QMS is itself an effective mechanism for creating a trustworthy atmosphere, conducive to organisational excellence, through motivating, stimulating and gratifying behaviour that may lead to organisational success. As has been discussed, this success becomes visible namely via academic success, which is a plus collectively, to the organisation as a whole, and individually, to both students and, indirectly, to each member of the academic and administrative staff.

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BIBLIOMETRIC ANALYSIS ABOUT SUBJECT "QUALITY IN HOTEL SERVICES"

Lima, T.G.1, Nascimento, D.C.2 and Shimoda, E.3

- ¹⁾ Universidade Estácio de Sá 1
- ²⁾ Universidade Federal Fluminense 2
 - 3) Universidade Cândido Mendes 3

ABSTRACT

This article aims to conduct a bibliometric study of quality hotel services in order to seek information and readings that will contribute to the theoretical framework, assistance in the development of research and dissertations and lifting criteria for assessing the guests 'satisfaction regarding quality of services in hospitality. Through this technique, you can get a selection of articles for a 'starting core "consisting of more relevant articles, authors, chronological distribution, and periodicals published languages. The results showed eleven publications on the subject researched, eight in the Spanish language, within an average of two articles published per year in the 2009-2012 period. The criteria for evaluating the satisfaction of the most common guests identified are related to behavioral skills of employees, value, comfort and perceived quality.

Keywords: Hospitality1, Quality2, Services3, Bibliometrics4

Paper type: Research Paper

INTRODUTION

The service sector has earned an important space in recent years. According to the Brazilian Institute of geography and statistics (IBGE), the service sector in Brazil showed an evolution of 9.6% in September 2013, compared to the same month of 2012, higher than the rates observed in August (6.6%) and July (9.1%).

After a decline in 2009, the tourism sector in Brazil has been recovering, primarily for the domestic market, which is evidenced by record numbers of landings at airports from domestic flights. The entrance of the low-income class consumer market, should also contribute to growth prospects in the internal market (PORTAL of the MINISTRY of TOURISM, 2010).

In relation to the means of hosting many factors have contributed to boosting the increase in supply in Brazil, as the river 20 what happened in 2012, the World Cup in 2014 and the Olympic Games, scheduled for 2016, schedules that arouse interest in and investors interested in tourism (BNDES, 2012).

Within this context the Leisure and entertainment segment stands out with the tourist trips. According to the data of the Ministry of tourism organizations operating in the tourism sector have invested in 2012 on average 13% of revenues in evolution. A survey conducted between this Ministry and the Fundação Getúlio Vargas, for business tourism, travel intentions rose from 32% to 33.5% and willingness to travel the country grew from 70.4% to 76%, is considered the month of October 2012 and October 2013. Castelli (2001) have highlighted that for the practice of these activities, the hotel industry, which is comprised of service providers, is a vital support.

Hoffman and Bateson (2003) define how services actions, or performances, efforts that have intrinsic characteristics that differentiate the products as: intangibility (cannot be seen, tasted or touched), inseparability (customer engagement in the production process), heterogeneity (varied quantity of service providers) and perishability (impossibility of storage).

Fitzsimmons, Fitzsimmons (2004) defines services as a perishable, intangible experience, developed for a consumer who plays the role of a co-producer. Albrecht (1992) to conceptualize, services shows that the quality felt by the client is the main driving force that generates the functioning of organizations.

Hospitality is used by hotel developments to meet customers, adding value to the business and ensure high quality services. Raja (1994) stresses the importance of having a systemic view of everyone involved (shareholders, customers, suppliers, employees and the community) in the production process to achieve quality in providing services.

For Wolves (1993) the performance factors (raison d ' être of the service), customer service (Act of service) and cost (amount to be paid by the customer) are attributes often used by customers for evaluation of services. However, it is very common to find companies that devote themselves more to one factor and ignoring the others, which are fundamental to the strategic alignment of business.

Note that the service providers have an important role to ensure a memorable experience, for customers to realize the quality level and assign value to add to the services purchased. In the case of Hospitality, responsibility for quality and excellence in the services is shared among all employees of an enterprise, since guest interaction is not limited to a single Department or the developer. Albrecht (1992) signals the importance of leaders understand, support and contribute to the essence of the services to be disseminated throughout the organization.

For Young (2005) the concept of quality of services and customer service, became one of the leading indicators that contribute to how well or poorly a company makes in its market. Ganguli and Roy (2010)

consider the quality of the service, such as the comprehensive evaluation of customer service. Jun and falls (2001) believe that the perception of quality of services by clients is influenced by factors such as the interaction with the staff, facilities and other tangible elements, as well as interpersonal interactions and not humans with service providers.

The hoteliers are very committed to improving the quality of the services we offer, therefore, are dealing with an increasingly demanding clientele and within a competitive scenario, each time more aggressive commercially (CANDIDE; VIEIRA, 2003). The high level of customer requirement provides an extreme competitiveness within the hospitality industry, where excellence becomes a priority concern and a critical success factor. In an environment as dynamic, it is not exaggerated to say that only the best hotels can thrive over the long term (LARKIN, 2009). In the world of hospitality guests has a sensory contact with the services, they feel, live and interact and the moments of truth, are exactly when occur contact with the client (WALKER, 2002).

The behavior of officials in this customer contact shapes the perception of it, about the quality of service. Employee services performance is very related to the behaviors of serving and helping customers, which should result in satisfaction and customer retention (CAMPBELL et al. 1993). The interaction of the customer in the hotel venture happens most often with the teams, which are formed by messengers, receptionists, chambermaids, waiters and attendants. The leaders have the role to lead and prepare such professionals to develop a work with the highest level of quality possible, throughout the cycle of services.

Albrecht (1992) defines a cycle of services such as the continuous chain of events in which the client passes as they experience the service provided by the developer. During the stay of a client in the hotel, the same will undergo several cycles of services such as check-in at the hotel, which starts with the greeting by Captain Porter, passes through the Messenger, receptionist, until the customer is directed to your apartment.

As the cycle of check in, other cycles of services take place in the hotel at each point of service (room service, sauna, bars, Convention Centre, etc.). To Castelli (2011) the services cycles once established, constitute a tool for the development of training activities, training and education of teams.

Notice that the level of preparation of the teams, is a factor of direct impact on positive or negative customer perception. In this sense, training processes aligned to professional reality and under the gaze of the client, we seem to be more effective, because the knowledge of every moment experienced by the client tends to contribute to minimize possible failures in processes and strengthen the fundamental aspects able to reflect on the excellent service and impact on the expectations of the customers.

Téboul (1999) considers it essential that the employees have autonomy to serve the best customers, since most of the employees are in interaction with guests. The author points out that in the process of serving customers is very important that professionals in the hospitality industry adjust intuitively its powers and its behavior, in order to deliver a unique service and according to the expectations of each customer. According to Castelli (2001) for employees to live that autonomy is important to allow them to have some authority over the process, own initiative, responsibility, they can achieve necessary goals, to the satisfaction of the people who depend on their work, besides producing excellent quality services to satisfy the need of the people.

One can see that autonomy is a key feature for the teams to reach the expectations of customers, however, often only the managers and leaders, using this type of resource. In the case of many hotel chains are standardized processes, which requires a common language of employees, minimizing this way the opportunities to act outside of the previously determined processes, to ensure the level of quality. Kondo (2000) considers the standardization of production processes, products and services as essential factor for ensuring quality and suggests it to be documented workflows, so that employees can act in accordance with the operational procedures of the company.

Fields (1994) States that the standard is a basic tool for routine management therefore presents the goal (purpose) and procedures (means) for execution of activities, so that each employee can take responsibility for the results of your actions. It is observed that exercise autonomy and develop the activities through the standardization, is a way of allowing teams to develop their activities, without compromising the quality, which is essential to achieve the expectations of customers.

Berry and Parasuraman (1995) guarantee that customers 'expectations play a central role in the evaluation of the services of a company, therefore, customers assess service quality by comparing what they want or expect with what you actually receive. In this context it is expected that the customer satisfaction about the experience with the services are superior to your expectations, therefore, must analyze the gap between impressions and expectations, so that the results are positive for business.

Hoffman and Bateson (2003) reinforce that customer satisfaction is analysed in the short term, while the quality of service can be evaluated through a long-term diagnosis, which can differentiate a business from its competitors.

This article aims to conduct a bibliometric study of quality hotel services in order to seek information and readings that will contribute to the theoretical framework, assistance in the development of research and dissertations and lifting criteria for assessing the guests 'satisfaction regarding quality of services in hospitality. Through this technique, you can get a selection of articles for a 'starting core "consisting of more relevant articles, authors, chronological distribution, and periodicals published languages.

1.2 RESEARCH METODOLOGHY

The methodology consisted in the development of techniques of Bibliometrics for deepening of studies, research and collection of theoretical framework on the topic (quality in hotel services) to students and researchers. Second Tague-Sutckiffe (1992), translated by Soft-Chapula (1998), it is possible to conceptualize the Bibliometrics as: "[...] the study of the quantitative aspects of the production, dissemination and use of registered information. The Bibliometrics develops mathematical models and standards to measure these processes, using their results to make predictions and support decision making ". Among the possibilities for implementing the use of Bibliometrics, we can highlight:

- Identify trends and growth of knowledge in a particular discipline.
- Study of dispersion and obsolescências scientific fields.
- Measure the impact of publications and dissemination of information services.
- Estimate the coverage of scientific journals.
- Identify authors and institutions more productive.
- Identify the core magazines of each discipline.
- Adapt policies for acquisition and disposal of publications.

For the development of concepts on the Bibliometrics, was necessary to search on a scientific basis, there are many options, however in this work, the Foundation researched was the Capes Portal, through its journal, available at the electronic address www.portalcapes.gov. The access is given on the day 14 January 2014.

The search phrase to the search was on the theme "quality in hotel services" was defined according to the author's interest and relevance of the topic recently. In this work we decided to search on the term in the Portuguese language.

1.3 RESULTS AND DISCUSSION

1.3.1 Starting Core

The search began in the first moment with the search phrase "service quality". After you have searched the term in English, and then was executed some filters, which has the results in table 1:

Table 1 – Search Results

Keyword	Initial Result	Term filtered	Final result
Qualidade em serviços	2.225	-	-
Qualityservices	1.145.004	-	-
Quality hotel services	45.021	Hotels	361
Quality hotel services		Hotellerie	51
Qualidade em serviços hoteleiros	11	-	-

Source: Own

Of this analysis, the topics in English language feature more publications, fact that could harm the search for articles "core" for the high amount of information, a search phrase, but not specifically about the subject.

In this work, we decided to develop the Bibliometrics using the keyword "quality in hotel services" without making use of filters, the specificity of the term and the author's interest. From the result of this search, the amount of 11 results, Bibliometric analysis was initiated consisting of results suggested as "core" to the browser start your reading and theoretical works.

The results "core" are presented in table 2.

Autores	Artigo selecionado	Periódicos
Fabiana Leticia Pereira Alves Steoca; Michele Severo Gonçalves; Fabiane Tubino Garcia; Luis Pelipe Dias Lopes.	Qualidade em serviços Hoteleiros: um Estudo do Clima Organizacional por Meio da Análise de Correspondência	Cadernos do IME: Serie Estatistica, 2010, Vol.29, p.17.
Feitosa De Araujo, Enos; Queiroz Pereira, Alexandre.Ra'e Ga, Jan, 2011, Issue 21, p.78(27)	O turismo e a valorização do litoral metropolitano: espacialidade turística em Caucaiace	Ra'e Ga, Jan, 2011, Issue 21, p.78(27)
Avrichir, Ilan; Cunha De Almeida, Victor Manoel; Andreassi, Tales.	Caso WebBusiness: vender ou não vender, eis a questão. (Casos de Ensino em Administração)	110 E
Medeiros, Mirna De Lima; Machado, Danielle Fernandes Costa; Passador, Joao Luiz; Passador, Claudia Souza.	Adopting LEED certification in lodgingfacilities: greeningthehospitalityindustry/Adoção da certificação LEED em meios de hospedagem: esverdeando a hotelaria?/Adopcion de lacertificacion LEED em medios de hospedaje em verde ciendo La hoteleria?	RAE, March-April, 2012, Vol.52(2), p.179(14)
Toaldo, Ana Maria Machado ; Sobrinho, Zaki Abel ; Camargo, Shirley Miranda	Layout design process in conventionalBraziliansupermarkets/Processo de formulação de layouts em supermercados convencionais no Brasil/Proceso de formulacion de layouts en supermercados convencionalesen Brasil.	Revista de Gestão USP, Oct-Dec, 2010, Vol.17(4), p.451(19)
Corte, Maria Romana Da Soares, José Miguel Aragão Celestino 2009	A qualidade dos serviçoshoteleiros na ilha do Porto Santo	Repositório Científico de Acesso Aberto de Portugal
Tiago SaviMondo ; Daniel Augustin Pereira ; Jane Iara Pereira Da Costa	Sponsored links as a tool toattractcustomers in the hotel industrydoi:10.5585/remark.v10i1.2185 links patrocinados como ferramenta para captação de clientes na hotelaria doi:10.5585/remark.v10i1.2185	Revista Brasileira de Marketing, 2011, Vol.10(1), p.26
Andrade, Jose Celio Silveira	Programa Berimbau: iniciativa politico-institucional de regulacao de conflitos socioambientais na Area de influencia de costa sauipe-BA	RAC-Electronica, Sept-Dec, 2008, Vol.2(3), p.426(23)
Goncalves Gandara, Jose Manoel ;FraizBrea, Jose Antonio ; Manosso, Franciele Cristina	Calidad de laexperienciaenloshotelestermales de Galicia, Espana: unanalisis a traves de lareputacion online	Estudios y Perspectivas en Turismo, July, 2013, Vol.22(3), p.492(34)
Fernandes Guzzo, Renata ; Machado Do Nascimento, Luis Felipe	Practicasambientales y desempeno organizacional enlahoteleria: unestudio de sus relaciones enlaciudad de Porto Alegre, Brasil	otivas e
Carvalho, Denise	Ela quer um socio: sem folego para crescer sozinha e pressionada por novos e ageis concorrentes, a empresária ChiekoAoki, dona da rede de hoteis Blue Tree, procura um investidor.(NEGOCIOS: investimentos)	Exame, Oct 7, 2009, Vol.43(19), p.56(3)

Fonte: Própria

Table 2-starting Cores

1.3.2 Withdrawal of key attributes of quality hotel services

With the purpose of complementing the work, was made a search for possible attributes of quality perceived by the customer in hotels and what authors cited such attributes, this required a new search in the bases, whose result is in table 3.

Table 3 – key attributes of quality hotel services

	Quality Hotel Services
Availability of dry cleaners	Shops
Internet	Security
Location	Comfort
Price of services	Speed of service
Adequacy of methods of payment	Accuracy of the account
Requested the staff attitude	Knowledge and Service Manager
Parking space	Quality of care
Quality of service	Tranquility of roundness
Reply to claims (post-sales)	Range of service
Uniformity of appearance of employees	Hotel infrastructure
Room service	Quality of breakfast
Accuracy of reserves	Hall space
Internal and external space of the hotel	Availability of parking lots
Room space	Courtesy
Pleasantness	Decoration
Architecture	Organization
Elevators	Sustainability and Social responsibility

Source: Own

It is observed that was identified in the polls a significant volume of quality attributes in hotel services, which emphasizes the need to identify the essentiality according to the profile of the project and target audience. The table 4 demonstrates the key attributes cited according to the authors.

Table 4 – Attributes by Author

Authors	Items cited						
TINOCO, M. A.; RIBEIRO, J. L.	Corporate image, perceived quality, cost.						
CADOTTE, E. R.; TURGEON, N.	mplaints, post sales, praise, courtesy, quietness, variety of services.						
FARIAS E SANTOS	FARIAS E SANTOS Services for the elderly, cleanliness, pleasantness, comfort, cleanliness, safety, price, infrastructure, location.						
GONZÁLEZ, M. O. A.; RAMOS, R. E.	Quality of room, friendliness, courtesy, quality and price.						
CHAN, E. S. W.; WONG, S. C. K.	Reservations, security, conduct of staff, quiet environment, cleaning services.						
AKAN, P.	Courtesy, competence, physical appearance, speed, internal and external appearance, ease of access, variety of products, accuracy of reserves, troubleshooting						

Source: Own

1.3.3 Chronological Distribution

The 5 table these quantitative publications in chronological order.

Table 5 – Chronological Distribution of the amount of publications per year

Until 2009	Until 2010	Until 2011	After 2012
3	2	4	2

Source: Own

1.3.4 distribution by languages

In the selection of 11 articles, it was verified that 8 articles are in Spanish language and Portuguese language 3 only.

1.3.5 Distribution by Author

Was evidenced through the search, that all authors have published only one article.

1.3.6 Topics to Refine the Search

The topics presented by the table 6 are used as a tool to refine the search according to the sub areas of interest in research as a way to filter the specific contents.

Table 6 – Results by Topics

Topics	Amount of results
Qualidade	2
Marketing Communication	1
Gaps	1
Tangibilidade do Serviço	1
Quality	1
Hotel Quality Service	1
Santa Catarina State	1
Varejo	1
_ Hotelaria	1
SupermarketChains	1
Análise Multivariada	1
Clima Organizacional	1
Qualidade Serviço Hoteleiro	1
Desempenho	1

Supermercado	1
Layout	1
Hotels	1
Marketing	1
Sponsored Links	1
Tangibility Of Service	1

Source: Own

The results of the Bibliometrics feature a sort of "core" that would be the results that the researcher should prioritize in their readings, but it is necessary to emphasize that other bases should be consulted for a more precise, because the results are different from one base to another. In the present study, the scientific basis used was the Capes Portal, through his journal. The key word used was "QUALIDADE EM SERVIÇOS HOTELEIROS". This search produced 11 results, including Bibliometric analysis was performed.

CONCLUSIONS

The use of Bibliometric technique presented in this article is of great value to researchers and students who wish to promote your domain by content, expand the literary collection and have theoretical basis in their research. Though unheralded, Bibliometrics has been widely used in academia. Through a theme or keyword, it is possible to consult the scientific basis with content available for free on the internet.

The choice of the base is determined by subjective criteria of the researcher. However, it is necessary to define in advance what the topic of interest, keywords and perform the filters to refine the results by most relevant articles by authors, by chronological order or by language. The results of the Bibliometrics feature a sort of "core" that would be the results that the researcher should prioritize in their readings, but it is necessary to emphasize that other bases should be consulted for a more precise, because the results are different from one base to another.

In the present work, the scientific basis used was the Capes Portal, through his journal. The key word used was "Quality in hotel services. This search produced 11 results, including Bibliometric analysis was performed and it is noteworthy that the largest volume of publications focus on Spanish language, specifically 8 one of the 11 publications. It was observed that the number of publications per year from 2009 and still fairly limited, on average, two articles per year, except in the year 2011 that was evidenced publications 4.

In relation to the items identified in the publications of quality of hotel services, though, found a variety of items, note that behavioral abilities related items employees like friendliness, courtesy and pleasantness linked items at affordable prices, comfort and perceived quality in common between the publications.

The identified items serve as a basis for production and creation of questionnaires to guests of hotels. The application of questionnaires contributes towards customizing the essential criteria according to each hotel guest profile venture. For validation of the content of the search you can use the method of Lawshe (1975), which extracts the items considered essential at the point of view of the client.

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VALIDITY OF QUESTIONNAIRE ITEMS FOR CUSTOMER SATISFACTION EVALUATION OF HOTELS

Lima, T.G.1, Nascimento, D.C.2 and Shimoda, E.S.3

- 1) Universidade Estácio de Sá 1
- ²⁾ Universidade Federal Fluminense 2
 - 3) Universidade Cândido Mendes 3

ABSTRACT

The service sector in Brazil won a very important space in the economy in recent years. Similarly, we observe the evolution of the tourism sector and, in this context, the hotel constitutes an indispensable support, for the growth of tourism in the country. This work aims to identify the main criteria to evaluate the services of a hotel in the city of Macaé. In order to achieve that, we carried out a literature review and the application of a questionnaire to 59 guests in the venture, which was analyzed and developed through the Lawshe methodology, pointing the essential criteria by the public surveyed. The survey identified 12 criteria to evaluate the quality dimensions in hospitality and upon completion of research, it was calculated the content validity rate (Content Validity Ratio – CVR) of each criterion. The results yelded showed 52 criteria considered essential (valid) by hotel guests in the study, and security criteria considered to be the most relevant, for the studied sample.

Keywords: Criteria1, Quality2, Services3, Hospitality4

Paper type: Case study

INTRODUTION

For Tan and Raj (2007) the determinants of customer satisfaction differ according to each type of service. Thinking of hospitality, for some guests, brand can be considered essential, for others the quality and can still find customers who regard the price as an essential element. González, Ramos and Amorim (2005) developed a survey in the city of Natal (RN), whose objective was to identify the key attributes of quality in hospitality services. The research had as public 381 guests and among the main attributes, was quality of hotel, friendliness of staff, and price paid compared to the quality received, which won by 56% of customer satisfaction with the hotel.

In the same vein, Chan and Wong (2006) have researched about the attributes that have influenced customers implement a hotel Enterprise reserves, through a sampling consisting of 570 travellers at the Hong Kong International Airport and the results showed that convenient location and quality service are the main attributes that influence consumer choice. In this sense it is necessary to find all elements considered essential according to each customer's profile.

Tan (2006) reinforces the need to identify the criteria that consumers evaluate the excellence of service, which enables managers prioritize efforts to focus on attributes, considered essential by clients. Castelli (2001) said that in the services, the value is in the reaction of the customers in front of an experiment, which is a subjective value, including the emotional state consisting of the client. To understand the quality of experience for each guest, you must analyze and assess the same sensation when makes use of a service. Kotler and Keller (2006) defined the the satisfaction as the feeling of pleasure from client to confront perceived performance of a product with your expectations.

According to Schneider (1990) has also argued that where a company can evaluate and establish service practices that facilitate inclusive reward excellent service, the probability of "climate for the service" popup will increase. This climate should contribute to the improved performance in services and finally, will affect customer satisfaction (BORUCKI, BURKE, 1999; JOHNSON, 1996).

Before the above, note that the customer experience is very particular and that some factors including subjective influence on the level of satisfaction and perception of the quality of services received. The evaluations carried out from the point of view of the customer and with attributes that represent a level of significant importance to the guest are an excellent tool to collect data about these experiences, which through tabulation and analysis, are able to generate information that can be used in the strategic repositioning of services activities and ensure a competitive advantage relative to its competitors.

This work aims to identify the main criteria to evaluate the services of a hotel in the city of Macaé. In order to achieve that, we carried out a literature review and the application of a questionnaire to guests in the venture, which was analyzed and developed through the Lawshe methodology, pointing the essential criteria by the public surveyed.

1.2 LITERATURE REVIEW

1.2.1 Quantitative Model for Validation of Content: The Proposed Lawshe

Lawshe (1975) proposed a model that organizes content on the scoreboard, which is formed by specialists in the task of evaluating (skills, knowledge, or other distinguishing feature of the ability of a subject

being assessed), which should have a copy of the test or set of items to be analyzed, in which will apply its look in the categories: (1) not important (2) important, but not essential (3) and (N) do not know.

Lawshe (1975) signals that these categories are associated with skill, knowledge or competence as measured by item to develop the task. Once the lecturers punctuate your opinion about each item in the categories (1) not important (2) important, but not essential (3) and (N) do not know, determines the number of matches in the essential category and it is expected that the major agreements between the participants have, in fact, more than 50% of agreements must occur between participants in this category to consider that item has certain degree of content validity. To set the consensus of the Panel members in the category of "essential", in that the method proposed Lawshe rate validity of content for each item of the questionnaire, in English CVR (Content Validity Ratio) defined by equation 1.

Equation 1

$$CVR = \frac{(n - \frac{N}{2})}{\frac{N}{2}}$$

Source: Lawshe (1975)

n: Indicates the amount of experts who considered the criterion as "essential".

N: Considers the total amount of experts who assessed the criterion.

This expression is magnified by Lawshe with the intention that it might be interpreted as a correlation, to take the +1-1 values; for CVR is negative if the deal occurs in less than half of the participants; CVR is null if it has exactly half the panelists agreements and finally the CVR is positive if there is more than half of the agreements. Moreover, it should be thought that it is not just that CVR positive, but statistically significant. Due to the existing anomalies in the tables of minimum values CVR Lawshe (1975) defined, was considered to be the minimum value of CVR for each criterion according to the research by Wilson et al. (2012).

Freitas (2013) in their studies with this approach sought to identify criteria that may be used in the evaluation of the successful implementation of ERP systems (Enterprise Resource Planning) in large Brazilian companies and after lifting of 34 criteria found through the literature review, it has been calculated the rate of content validity (Content Vality Ratio-CVR) of each criterion , with 25 criteria were considered valid by the participants.

1.3 RESEARCH METODOLOGHY

The case study was carried out in a hotel enterprise of the city of Macaé. A survey has been developed in the following stages:

- Selection of the items in the questionnaire;
- Survey questionnaire construction;
- Collecting data;
- Presentation and analysis of results.

1.3.1 Selection of Items to Compose the Questionnaire

A literature review was conducted between the months of January and September 2014, based on the work of Freitas et al. (2013).

- 1. The selection of the Scientific Bases for research;
- 2. Choose the keywords and search phrase;
- 3. Research in the bases;
- 4. Review of the abstracts of all records of articles identified in the research;
- 5. Selection of articles with complete texts;
- 6. The selection of articles with greater adherence to it.
- 1.3.2 Building Research Survey.

For the preparation of the questionnaires, the assessment criteria identified $N^{\circ}s$ 11 articles chosen were initially grouped by areas catering enterprise as: reception, apartments, restaurants, events, social areas, the team hotel and other items, as shown in Table 3.

Table 1: Criteria for article

ITEMS	Art. 1	Art. 2	Art. 3	Art. 4	Art. 5	Art. 6	Art. 7	Art. 8	Art. 9	Art. 10	Art. 11
Reception											
Booking service	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Check-in service	Х	Х	Х	Х	Х	Х	Х	Х			Х

Check out service		x	x	x	x	x	х	х			x
Conditions of social areas	х	X	X	X			X	X	Х	Х	^
Reception service	X	X	X	X	Х	Х	X	X	X	X	Х
Apartments	^	^	^	^	^	^	^	^	^	^	^
Cleaning	х	Х	Х	Х	х	х	х	х	Х		
Hope chest	^	^				^				X	Х
Conditions of the apartments		V	X	X	Х		X	X	X	X	
Conditions of the bathroom		X	X				X	X	X	X	Х
Mini bar		Х	X	X	X		Х	X	Х	X	
Gastronomy			Х	Х	Х			Х			
Hotel restaurants and bars											
Gastronomy	Х	Х	Х	Х	Х	Х	Х	Х	X	Х	Х
Conditions for bars and restaurants		Х	Х	Х	Х				X	Х	
Room Service		Х	Х	Х	Х		Х		Х	Х	
Events		Х	Х	Х	Х			Х			
Conditions of the event room											
A&B services			Х	Х			Х	Х	Х	Х	
Social Areas			Х	Х				Х	Х	Х	
Kids Club											
Swimming pools			Х	Х				Х	Х	Х	X
Blocks			Х	Х				Х	Х	Х	X
			Х	Х				Х	Х	Х	X
Academies			Х	Х				Х	Х	Х	Х
SPA and beauty salon			Х	Х				Х	Х	Х	Х
Leisure care	Х		Х	Х		Х	Х	Х	Х	Х	Х
The Hotel team											
Efficiency	Х	Х				Х	Х	Х			Х
Sympathy	Х	Х			Х	Х	Х	Х			Х
Personal Presentation	Х	Х					Х	Х	Х	Х	Х
Other items											
Availability of parking lots	Х	Х	Х	Х				Х			Х
Availability of dry cleaners	Х		Х	Х			Х	Х			ļ
Shops			Х	Х				Х	Х	Х	
Internet	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Security	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Location	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Comfort	Х	Х	Х	Х	Х	Х		Х	Х	Х	Х
Price of services	Х	Х	Х	Х	Х				Х	Х	х
Speed of service	Х					Х		Х			х
Adequacy of methods of payment					Х	Х			Х	Х	
Accuracy of the account					Х	Х			Х	Х	
Requested the staff attitude	Х	Х	Х	Х	X	X	Х	Х			
Knowledge and Service Manager	^	^	X	X	X	X	X	X			
D 1:		Х	X	X	^	^	^	X	х	Х	
Parking space								. ^			
Quality of care	Х	X	Х	Х	Х	Х	Х	Х	Х	Х	x

Tranquility of roundness	x		x	x		x	x		х	x	X
Reply to claims (post-sales)	X					X	X	х			
Range of service	X					X	^	X			Х
Uniformity of appearance of employees	X					X	Х	Х	Х	Х	
Hotel infrastructure	х	Х	Х	Х				Х	Х	Х	Х
Room service			Х	Х	Х	Х		Х			
Quality of breakfast		Х	Х	Х	Х	Х			Х	Х	Х
Accuracy of reserves		Х				Х	Х	Х			Х
Hall space			Х	Х				Х	Х	Х	
Internal space of the hotel			Х	Х	Х			Х	Х	Х	
External space of the hotel			Х	Х				Х	Х	Х	
Room space			Х	Х	Х			Х	Х	Х	Х
Courtesy		Х	Х	Х	Х	Х	Х	Х			Х
Pleasantness		Х	Х	Х	Х	Х	Х	Х			Х
Decoration			Х	Х	Х			Х	Х	Х	Х
Architecture			Х	Х	Х			Х	Х	Х	
Organization	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Elevators			Х	Х				Х	Х	Х	
Sustainability and Social responsibility	х	Х									Х

Source: own Elaboration.

1.3.2 Compiling the Final Questionnaire

The second time, the items were redistributed by dimensions in the model questionnaire to be applied. The final dimensions of Group of items were: external area, reception, reservations, rooms, food, events, social areas (area of leisure and entertainment), hotel staff, other services, payment and sustainability and social responsibility.

The dimensions were evaluated according to the criteria of Lawshe (1975) (1) not important, (2) important, but not essential; (3) essential and (N) do not know. In addition to contemplate the information with respondent profile that will be used to analyze the customer perception in relation to essential items, according to the following criteria: frequency of going to hotels (round trips per year) goes with how many more people, number of children (less than 10 years), type of activity, how do you usually spend on daily hotel (Average Ticket per person), gender, marital status; age range, income range (minimum wages) and education, according to the model of the questionnaire completed in the Appendix of this paper.

1.3.3 Data Collection

In order to obtain a sample of clients who could evaluate the criteria raised, customers who were approached, are guests of the hotel enterprise of the upper level of the city of Macaé/RJ which is object of study.

According to the law 11,771/2008 – Art. 23, hosting means the enterprises or establishments, regardless of their form of Constitution, intended to provide temporary accommodation services, offered in single frequency units and exclusive use of the guest, as well as the hosting services, through the adoption of contractual instrument, Tacitus or express and daily collection.

The hotels differ from the top-level hotels, by virtue of providing aggregated services hosting. For this work, the project object of study more than 100 apartments and complete structure of leisure, food and drink, events and hosting with diversifying categories of apartments, in addition to having prime location (proximity to the beach and business centers) in the town of Macaé, favoring access to oil companies, airport and the city's Convention Center.

The application of the questionnaire was carried out by the receptionists of the hotel, during the process of closure of the account by the guest, that in the hotel environment, this process is called check out. The survey was conducted between May and September 2014. To delimit the search sample was conducted a survey about the average amount of check outs per week which resulted in 78.6 guests/week. This way, 59 guests were addressed during the closure of the account. Before performing the application effectively, the questionnaires were presented to 10 guests, in order to conduct a pretest in the questionnaire, without any chance of improvement indicated, the same was applied to the other guests.

After collection, all questionnaires were transferred to a spreadsheet in Microsoft Excel 2010. To check the criteria was held a general analysis based on the total number of interviews and analysis according to the profile of the respondent which were bounded as follows:

- Frequency up to 10 times
- Frequency more than 10 times
- No Childrens
- Have children
- Work
- Leisure Travel
- More than 100 real
- Less than 100 real
- Female

- Male
- Single
- Married
- Until 29 years
- 30 years or more
- Until 5 salaries
- More than 5 salaries
- Until to high school
- Technician
- Degree

In this way, was developed to analyze customers ' perception General in relation to the items considered essential and the analysis of customers ' perception regarding the quality assessment items considered as essential by guest profile. In this second review delimited customer profiles were crossed with their respective dimensions in order to identify the quality of custom attributes.

1.4 RESULTS

1.4.1 Profile of Respondents

The question regarding the frequency of going to hotels (round trips per year), shows that 51% of respondents were hosted more than 10 times. What is quite common in the city of Macae, because many guests are the work and operate offshore, therefore, it is necessary to stay the night before embarkation.

In relation to children, it was found that 63% of guests interviews have children, though the children accompany the hosting parents only when the reason for the trip is leisure. Thus, although a significant percentage of customers have kids doesn't mean that they participate in the hosting experience.

The main reason for the trip of respondents is the trip to work (78%). This fact is quite realistic, business tourism in the city of Macaé is the main reason for the offsets. Mainly due to oil activities that move

the companies and the economy of the town. Although the city of Macaé offers options for leisure, tourism and entertainment, leisure tourism is still little developed.

In relation to clients 'expenses for daily hotel showed that 66% of the guests spend less than 100 real, whereas the company pays daily and meals. In this way, customers 'spending for consumption-related daily extras not paid by companies, such as phone calls, laundry, etc. The project has a total turnover of enterprises up to 100% of the consumption, in this case guests not present in their daily expenses.

As for the genre, it is evident that the men are still the majority with 66% of the total. It has been increasingly common to find in the middle of hosting women who are developing activities in the oil sector, however, men still take a major slice of the positions in oil and offshore segment.

In relation to marital status, 54% are married and 46% of the guests are single. This is quite reasonable since this market professional qualifications is a priority. As for the percentage of guests by age group, 54% of interviewed guests have 30 years or more. In relation to income range of the guests noted that 68% of respondents receive up to 5 minimum wages. Guests are mostly oil and professionals in this market wages are very competitive, however, this income tends to focus between top-level or professionals with managerial function.

On the education level and found that 66% of them have until high school. In this sense, it is possible that there is difficult to engage critically with regard to hotel services, limited to opine with security services that are utilized with normally.

1.4.3 General Analysis of Perception of Items Considered Essential by Clients/Guests

In table 2, you can check the overall result of the perception of items considered essential by clients/guests, and note the items that could be deleted or kept. This table is very important for presenting a vision of the whole, which shows what you might consider as essential for public scrutiny.

Dimensions	Item	Ne	N	%Ne	CVR	CVR _{crit}	Situation
_	Location	39	58	67,2%	0,345	0,168	Keep
	Tranquility of roundness	36	57	63,2%	0,263	0,170	Keep
External area	Parking facility	46	58	79,3%	0,586	0,168	Keep
	Security	55	58	94,8%	0,897	0,168	Keep
	Architecture/Façade	30	57	52,6%	0,053	0,170	Delete
	Check-in service	55	58	94,8%	0,897	0,168	Keep
Reception	Check out service	54	58	93,1%	0,862	0,168	Keep
	Personal Customer Service	53	58	91,4%	0,828	0,168	Keep
Reservations	Booking service	49	58	84,5%	0,690	0,168	Keep
	Conditions of social areas	38	57	66,7%	0,333	0,170	Keep
	Hall space	28	58	48,3%	-0,034	0,168	Delete
Social areas	Lobby	23	57	40,4%	-0,193	0,170	Delete
	Decor (ambiance)	24	57	42,1%	-0,158	0,168 0,170 0,168 0,168 0,170 0,168 0,168 0,168 0,168 0,170 0,168 0,170 0,168	Delete
	Architecture (constructive structure)	30	58	51.7%	0.034	0.168	Delete

Table 2 – Perception of items considered essential by clients/guests

	Organization	48	58	82,8%	0,655	0.168	Keep
	Elevators	39	58	67,2%	0,345		Кеер
	Room space	34	58	58,6%	0,172		Кеер
	Cleaning	53	58	91,4%	0,828		Кеер
	Hope chest	45	58	77,6%	0,552	0,168	Keep
	Conditions of the apartments	49	58	84,5%	0,690	0,168	Keep
	Conditions of the bathroom	53	57	93,0%	0,860	0,170	Keep
Apartments	Mini bar	32	58	55,2%	0,103	0,168	Delete
	Security	53	58	91,4%	0,828	0,168	Keep
	Comfort	47	57	82,5%	0,649	0,170	Keep
	Decoration	28	56	50,0%	0,000	0,171	Delete
	Architecture	27	58	46,6%	-0,069	0,168	Delete
	Organization	50	58	86,2%	0,724	0,168	Keep
	Hotel restaurants and bars	51	58	87,9%	0,759	0,168	Keep
	Gastronomy	46	58	79,3%	0,586		Keep
	Conditions for bars and restaurants	47	58	81,0%	0,621		Keep
Gastronomy	Room Service	40	58	69,0%	0,379		Keep
adotroning	Comfort	49	59	83,1%	0,661		Keep
	Decor (ambiance)	32	58	55,2%	0,103	'	Delete
	Architecture (constructive structure)	35	57	61,4%	0,228		Keep
	Organization	47	58	81,0%	0,621		Keep
	Conditions of the event room	31	58	53,4%	0,069	· ·	Delete
.	A&B services-Banquets/CoffeBreak	34	58	58,6%	0,172		Keep
Events	Equipment	36	57	63,2%	0,263	· ·	Keep
	Comfort	40	57	70,2%	0,404	0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,168 0,168 0,168 0,168 0,167 0,168 0,167 0,168 0,169 0,160 0,170 0,170 0,170 0,170 0,170 0,171 0,171 0,171 0,171 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 0,168 0,170 </td <td>Keep</td>	Keep
	Attendance at events	33	57	57,9%	0,158		Delete
	Kids Club	21	57 57	36,8%	-0,263		Delete
	Swimming pools	26 22	57 53	45,6%	-0,088	'	Delete
	Sauna Blocks	19	56	41,5% 33,9%	-0,170 -0,321		Delete Delete
Social areas	Academies	21	56	37,5%	-0,321		Delete
Social aleas	SPA and beauty salon	21	56	37,5%	-0,250	· ·	Delete
	Leisure care	31	56	55,4%	0,107		Delete
	Security	52	58	89,7%	0,793		Keep
	Comfort	49	57	86,0%	0,719	· ·	Кеер
	Efficiency	54	58	93,1%	0,862		Кеер
	Sympathy	52	57	91,2%	0,825		Кеер
	Personal Presentation	50	58	86,2%	0,724		Кеер
	Speed of service	50	57	87,7%	0,754		Кеер
	Requested attitude of officials (own-initiative)	50	56	89,3%	0,786		Кеер
The hotel team	Quality of care	52	58	89,7%	0,793	0.168	Кеер
	Quality of service	54	58	93,1%	0,862		Кеер
	Reply to claims (post-sales)	46	58	79,3%	0,586		Кеер
	Accuracy of reserves	46	58	79,3%	0,586		Кеер
	Courtesy	39	57	68,4%	0,368		Keep
	Pleasantness	44	58	75,9%	0,517		Keep
	Availability of dry cleaners	36	57	63,2%	0,263	0,170	Keep
	Parking lot	49	57	86,0%	0,719		Кеер
	Shops	28	57	49,1%	-0,018		Delete
Outros serviços	Internet	50	58	86,2%	0,724		Keep
	Room service	34	57	59,6%	0,193	0,170	Кеер
	Quality of breakfast	50	58	86,2%	0,724	0,168	Кеер
	Range of service	38	58	65,5%	0,310	0,168	Кеер
	Price of services	51	58	87,9%	0,759	0,168	Кеер
Payment	Accuracy of the account	50	58	86,2%	0,724	0,168	Кеер
	Adequacy of methods of payment	50	57	87,7%	0,754	0,170	Keep

Sustainability and	Existence of sustainable practices						Keep
social responsibility		44	58	75,9%	0,517	0,168	

Compiled By: Own

Through the if Table 4 identified the items/facade architecture, hall, lobby space, decor (ambiance), architecture (constructive structure), decor (ambiance), room conditions, attendance at events, kids club, swimming pools, sauna, courts, gyms, SPA and beauty salon, recreation, service shops, were considered as non-essential items to be used as criteria for evaluation of the perception of the customers regarding the quality of hotel services.

The location, the enterprise profile and the profile of the guests very customer profile influence that attending the media hosting. This survey was conducted in the city of Macaé, one can consider with a business in which the displacement of people is mostly to meet the needs of businesses. According to ADNAN (2000) the concept of business tourism can be defined as "a set of travel, lodging, food, and leisure activities practiced by business travelers for the various sectors of the commercial or industrial activity or to establish contacts or to meet markets. Note that the reason for the trip—is the—main—criterion for conceptual discussions. With approximately of 3000 beds, distributed in about 100 hotels and guesthouses, the municipality of Macaé has the largest hotel in the State.

The business tourism sector that grows from 6% to 9% per annum, corresponding to 71% of the sector and 10% of GDP, because of this, Macaé was contemplated by Embratur with the golden seal of tourism. In this scenario, is located, the object of study, as we reported is classified as upper level hotel, with more than 100 apartments and complete structure of leisure, food and drink, events and hosting with diversifying categories of apartments, where the public mostly consists of guests who are in the job or business.

For this audience is observed in the following chart, which among the first 10 items considered essential include security (external dimension), check-in service (reception), attendance at check out (reception), efficiency (staff), quality of service (staff), attendance people (reception), security (size), bathroom conditions (apartments), cleaning (apartments), quality of care (staff) are included among the most important items to customers 'quality perception regarding the hotel services.

ln this context it should be noted that security was considered as essential twice (external area dimension and apartment) strengthening the degree of importance this item, three items linked to the reception dimension, three items linked to the dimension (including security) and three items linked to the size of the team hotel. It is observed that 50% of the items are related to attitudes and behaviors of employees, which reinforces the concepts of (CAMPBELL et al., 1993), by stating that the employee's behavior with customers shape the perception of it, about the quality of service. Employee services performance is related to the behaviors of serving and helping customers, which should result in satisfaction and customer retention.

Figure 1 demonstrate the items according to their degree of importance. In this way, it can be observed that among the items considered essential who were more present in the perception of the customers, are related to the attendance of the team be it the service at check out, the personal service or expressed through quality service, beside the Security item be of it outside or in the apartments. In relation to the last item, it is known that firms located in Macaé, most of strict in relation to the safety of its employees, them multinationals, are having to meet international security policies or that are governed by contracts with Petrobrás. this sense the hotel complexes undergo inspection by safety technicians and engineers of the companies so that they can be registered as service providers.

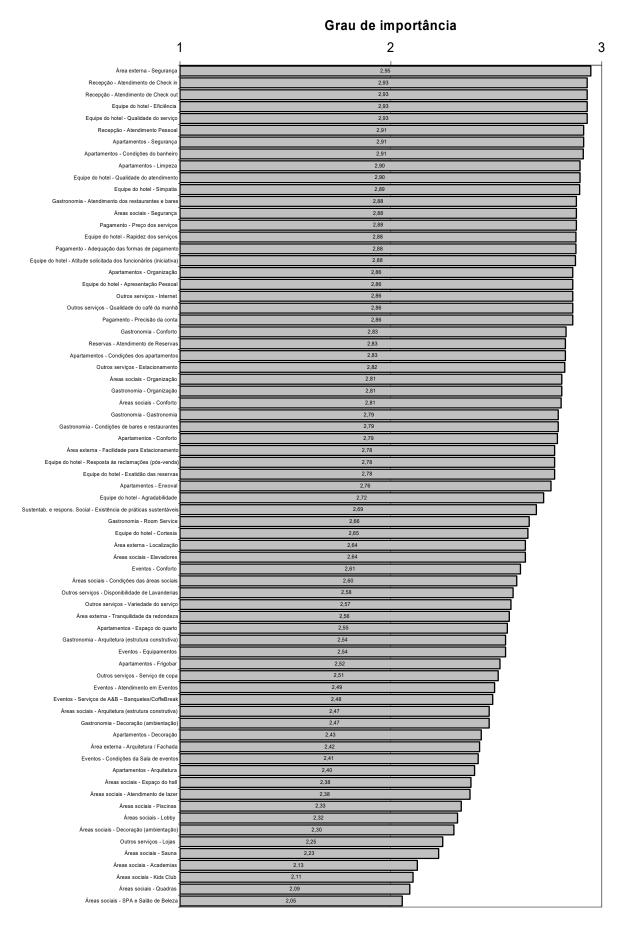


Figure 1 - Degree of importance Compiled By: Own

1.4.4 General Analysis of Perception of Items Considered Essential by Clients/Guests for Profile

According to table 2 of general perception of items considered essential by clients/guests per profile makes it possible to understand the items flagged essences by the various guests who participated in the survey, this result allows the development of strategies in accordance with each audience.

Table 2: General Analysis of perception of the items considered essential by clients/guests per profile.

Dimensions	ltem		Fre	au a	Ch	ildr n	Act	tive	Tic	ket	Ge		Est arii			ge oup	n	co ne nge	S	choo	le
		General	Until 10	> 10	No	Yes	Work	Leisure	Until 100	> 100	Female	Male	Single	Married	Until 29	30 or more	Until 5	2.	To high	ician	
	Location			<u>,</u>																	Х
	Location Tranquility of roundness	X		Х		Х	Х	Х	Х			Х		Х	X			Х		Х	X
External area	Parking facility	X	х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	X	Х	Х	х		v	X
Literrial area	Security	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Х		X
	Architecture/Façade	^	^	^	^	^	^	^	^	^	^	^	^	^	^	^	^	^	^	^	
	Check-in service	Х	х	х	х	х	Х	х	Х	Х	Х	Х	Х	Х	Х	х	Х	х	Х	v	Х
Reception	Check out service	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		Х
кесерион	Personal Customer Service	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Reservations	Booking service	X			X			X	X	X	X		X		X	X	X	X	Χ		X
Reservations			X	Х	X	X	Х	Х		Х		Х	Х	X		X	Х	Х		Х	X
	Conditions of social areas	Х	Х			Х			Х		Х			Х	Х						Х
	Hall space	1																			\vdash
Casial areas	Lobby	1		<u> </u>												<u> </u>				<u> </u>	
Social areas	Decor (ambiance)	1																			\vdash
	Architecture																				-
	Organization	Х	Х	Х	Х	Х	Χ	Χ	Х	Χ	Χ	Χ	Χ	Х	Χ	Х	Х	Х			Х
	Elevators	Х		Х	Х		Х			Χ		Х		Х	Х		Х			Х	Х
	Room space	Х		Χ			Х						Χ		Χ						<u> </u>
	Cleaning	Х	Х	Х	Х	Х	Х	Χ	Х	Χ	Χ	Χ	Χ	Χ	Χ	Х	Х	Х			Х
	Hope chest	Х	Х	Χ	Х	Χ	Х	Χ	Χ	Χ	Χ	Χ	Χ	Χ	Χ	Χ	Χ	Χ			Х
	Conditions of the apartments	Х	Х	Х	Х	Х	Χ	Χ	Х	Х	Χ	Χ	Χ	Χ	Х	Х	Х	Х		X X X	Х
	Conditions of the bathroom	Х	Х	Х	Х	Х	Х	Χ	Х	Χ	Χ	Χ	Χ	Χ	Χ	Χ	Х	Χ	Х		Х
Apartments	Mini bar	-		Х			Х														
	Security	Х	Х	Х	Х	Х	Х	Х	Х	Х	Χ	Χ	Χ	Х	Χ	Х	Х	Х	Х	Х	Х
	Comfort	Х	Х	Х	Х	Х	Х	Х	Х	Х	Χ	Χ	Χ	Χ	Χ	Х	Х	Х		Х	Х
	Decoration																				
	Architecture																				
	Organization	Х	Х	Х	Х	Х	Х	Χ	Х	Х	Χ	Χ	Χ	Х	Χ	Х	Х	Χ	Х	Х	Х
	Service of restaurants/bars	Χ	Х	Х	Х	Х	Х	Х	Х	Χ	Χ	Х	Χ	Χ	Χ	Х	Х	Χ	Х	Χ	Χ
	Gastronomy	Х	Х	Х	Х	Х	Х	Χ	Х	Х	Χ	Χ	Χ	Χ	Χ	Х	Х	Х	Х	Х	Х
	Conditions for bars and restaurants	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Χ	Х	Х	Χ		Χ	Χ
Gastronomy	Room Service	Х		Х	Х		Х			Х	Χ		Χ		Χ		Х				
dastronomy	Comfort	Х	Х	Х	Х	Х	Х	Х	Х	Х	Χ	Χ	Χ	Х	Х	Х	Х	Х	Х	Х	Х
	Decor (ambiance)																			x x x x x x x x x x x x x x x x x x x	
	Architecture (constructive structure)	Х												Х				Х			
	Organization	Х		Х	Х	Х	Х	Х		Х	Χ	Χ	Χ	Х	Х	Х	Х	Х	Х	Х	
	Conditions of the event room										Х										
	A&B services	Х													Х						
Events	Equipment	Х									Х				Х						
	Comfort	Х	Х		Х			Х	Х		Х		Х	Х	Х		Х				Х
	Attendance at events							Х			Χ				Х						
	Kids Club																				
	Swimming pools																				
	Sauna																				
Social	Blocks																				
areas (area of leisure and	Academies																				
entertainment)	SPA and beauty salon																				
····· ·· · · · · · · · · · · · · · · ·	Leisure care																				
	Security	Х	х	Х	Х	х	Х	Х	Х	Х	Х	Х	Х	Х	Х	х	Х	х	Х	х	х
	Comfort	X	X	X	X	X	X	Х	X	X	X	X	X	X	X	X	X	X	^		Х
The hotel team	Efficiency	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Х		X

	Sympathy	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Χ	Х	Х	Х	Х	Х	Х
	Personal Presentation	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Χ
	Speed of service	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
	Requested the staff attitude	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
	Quality of care	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
	Quality of service	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
	Response to complaints	Х	Х	Х	Х	Х	Х	Х		Х	Х	Х		Х	Х	Х	Х	Х	Х		Χ
	Accuracy of reserves	Х	Х	х	Х	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Х	Х	Х			Χ
	Courtesy	Х		х	Х	Х	Х			Х		Х	Х	х	Х	Х	Х				Χ
	Pleasantness	Х	Х	Х	Х	Х	Х			Х	Х	Х	Х	Х	Х	Х	Х	Х		Х	Х
	Availability of dry cleaners	Х		Х			Χ			Х					Х						
	Parking lot	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
	Shops																				
Other services	Internet	Х	х	х	Х	х	Х	х		х	х	Х	х	х	Х	х	х	Х	х	х	Х
	Room service	Х				х				х											
	Quality of breakfast	Х	Х	х	Х	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Х
	Range of service	Х		х		Х	Х				Х			х				Х		Х	
	Price of services	Х	Х	х	Χ	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Χ
Payment	Accuracy of the account	Х	Х	х	Χ	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Х
	Adequacy of methods of payment	Х	Х	х	Χ	Х	Х	Х	х	Х	Х	Х	Х	х	Х	Х	х	Х	х	Х	Х
Sustainability and social responsibility	Existence of sustainable practices	х	х	х	Х	х	х	х	х	х	х	х		х	х	х	х	х		х	

Source: own elaboration.

On statistical analysis in order to identify the evaluation criteria of quality in hospitality, will be shown below the main points observed, according to each dimension and profile of the client. The dimensions are: external Area delimited, reception, reservations, social areas, apartments, restaurants, events, social areas (area of leisure and entertainment), hotel staff, other services, payment, sustainability and social responsibility.

The external dimension was divided into location, tranquility of the neighborhood, parking facility, security, architecture and façade. In this dimension, it was observed that security is considered essential for all guest profiles, in fact this receives a differentiated attention in the offshore market, the national and multinational companies are very strict regarding all aspects related to security, ranging from safe behavior offshore installations. Worth pointing out also that the contracts of companies that provide services to Petrobras, have contracts that are extremely based on safety regulations and non-compliance with the clauses, transported in fines and penalties.

The parking facilities, item was also considered essential for virtually 99% of profiles except for customers with education until high school. Logistics personnel services of Macaé usually include transfer to employees who go out of the companies, airports and bus stations and hotels, in many cases, if it makes unnecessary the parking lot. It was observed that most guests stay in the venture on the eve of the shipment, which means that they will be working offshore for certain periods on average revolve around 14 days, making the car stay in lodgings.

On the other hand, parking is considered essential by most, however, note that the enterprises have provided fewer and fewer openings in parking and parking in regions where the hotels are installed becomes a practice increasingly difficult. The project studied more than 100 apartments and offers parking spaces for approximately 30% of its guests.

The item tranquility of roundness was considered essential to customers who seek the leisure development, 29 years and have the complete higher education. For the rest of this item was not considered essential.

During the visits to the venture, the receptionist commented that many guests prefer to be hosted in regions where the bars are concentrated and the nightlife is more agitated, however, companies have opted increasingly peaceful location, in order to make the rest, minimize delays in the shipment and guarantee security in the length of stay in the city. The location was considered essential for virtually 50% of customer profiles, especially for guests with children, who get more than ten days, which are hosted on business, with average ticket less than 100 dollars, but with income above five minimum wages and technical training or higher. Architecture and façade were not considered essential by clients.

On the reception it was observed that the services of check in, check out and personal service are essential criteria for evaluating the quality of services in hotel management. It is worth mentioning that such services are used by all clients and are regarded as key moments of interaction between the guest and the hotel, since in the process of input and output of the project, is almost obligatory passage for receiving and contact with the team.

The reserve was composed by item dimension attendance in reserves and considered essential for virtually 99% of customers, except for those with education up to high school. The project researched has as main audience, customers who are to work in the city, in this sense, reservations are requested by the companies, either directly or via tourist agency. Possibly the customer profile that does not consider the attendance in reserves with essential criterion for evaluation of the quality, has no interaction with the Department, since the reserves are not requested by the guest, minimizing the perception of this dimension.

CONCLUSIONS

The research made it possible to identify that there are many criteria for the evaluation of quality in hospitality that can be framed in approximately 12 dimensions. The dimensions identified are: external area, reception, reservations, rooms, food, events, social areas, staff, other services, payment and sustainability and social responsibility. For external area dimension can cite the items location, tranquility of the neighborhood, parking facility, security and architecture/front. For reception dimension can include service items of check in, check out service and personal attention.

For dimension reservations include reservations service. For size social areas, can cite policies of social areas, hall, lobby space, decor (ambiance), architecture (constructive structure), and elevators. For apartments dimension can cite the space of the room, cleanliness, trousseau, the conditions of the flats, the conditions of the bathroom, mini-bar, safety, comfort, decoration, architecture and organization. For gastronomy dimension, one can cite, the restaurants and bars, gastronomy, bars and restaurants, room service, comfort, decor (ambiance), architecture (constructive structure) and organization.

For dimension events include the conditions of the event room, A&B services (food and beverages)-banquets/coffee break, equipment, comfort and attendance at events. For size social areas include Kids Club, swimming pools, sauna, blokes, academies, SPA, beauty salon, leisure care, safety and comfort. On the hotel

staff include efficiency, friendliness, personal presentation, speed of service, attitude of the staff requested (initiative), quality of care, quality of service, response to complaints (aftermarket), accuracy of the reservations, courtesy and pleasantness. In the other services were allocated the following items, laundry, parking availability, shops, internet, room service, breakfast quality and variety of the service.

On the payment can cite the items price of services, accuracy and adequacy of the forms of payment. Finally, on the sustainability and social responsibility, was allocated the item, existence of sustainable practices.

According to the data treatment, carried out by means of the methodology of Lawshe, in that items may be considered as not important, important but not essential and essential, after calculated the rate of content validity (Content Validity Ratio-CVR) of each criterion, showed 52 criteria considered essential (valid) by guests of the hotel, being the security criteria, considered the most relevant to the sample studied.

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Research opportunities in Production Engineering: a diagnosis instrument proposal

NEVES, S.M.¹⁾, PAIVA, E.J.¹⁾, PINTO, J.A.¹⁾, NEVES, I.F.M.¹⁾ and D'ELBOUX, T.V.¹⁾

¹⁾ Federal University of Itajuba, Campus Itabira, Itabira/MG-Brazil

ABSTRACT

Purpose - The University-Industry Relationship presents itself as an important factor for the socio-economic development, whether municipal, regional or national. So the goal of this article is to propose an instrument for the diagnosis of research opportunities in Production Engineering in the commercial sector at the Brazilian city of Itabira (MG).

Design/methodology/approach - The research method was the theoretic-conceptual, through a bibliometrics analysis, obtained on the basis of Web of Science. Articles were assessed from knowledge areas required by the Brazilian Association of Production Engineering (ABEPRO) and published in 2014 and 2015.

Findings - The diagnostic instrument was drawn up from a bibliometrics analysis and validated by experts' opinion, professors from Federal University of Itajubá (UNIFEI). A pilot test has also been accomplished with 4 (four) companies, members of the Commercial, Industrial, Services and Agricultural Association of Itabira (ACITA). As the main result, the test has indicated that the priority area for research is the Economic Engineering in the commercial sector of Itabira.

Originality/value – This paper proposed a new diagnostic instrument. Also, encouraged skills related to the development of a research and the practical application of knowledge, identified possible Production Engineering research areas and a higher knowledge and interaction with the local economy. Identified of possible internship unit's grantors.

Keywords: Production Engineering, Commercial sector, University-Industry relationship, Bibliometrics.

Paper type: Literature review.

1 INTRODUCTION

Itabira (MG) is a center of production and consumption of goods and services with an economic, social and cultural nature. Known as the poet Carlos Drummond de Andrade's birthplace, and headquarters of one of the biggest mining companies in the world, the VALE company, its importance goes beyond: according to data from Geographic and Statistics Brazilian Institute (IBGE, 2015), Itabira is the municipality with the largest Gross Domestic Product (GDP) in Minas Gerais state.

There is, installed in the municipality, a significant amount of micro and small enterprises. According to the Commercial, Industrial, Services and Agricultural Association of Itabira, from the total of associated companies (323), 205 belong to the commercial sector, representing a 63% portion (ACITA, 2016).

Economic growth depends on the creation and exploitation of knowledge. Provided by the universities, the advancement and creation of new techniques, if transferred to the commercial sector, help to innovate and survive in today's market (Lorentzen, 2015). In 2008 it had been held a public-private partnership among the city of Itabira, the mining company Vale, the Ministry of Education and the Federal University of Itajubá (UNIFEI), so it was possible the creation of a new Campus in Itabira. At this Campus, the Production Engineering course has been searching for a differentiate approach in relation to the more than 350 universities, providing such a course in Brazil (FOLHA DE SÃO PAULO, 2014). In addition to the mechanical emphasis, there has been a stimulus to practical activities, as well as the focus on innovation and entrepreneurship.

According to the Brazilian Association of Production Engineering (ABEPRO, 2012), the Production Engineering includes the following operating areas: Operation and Processes Production Engineering, Logistics, Operation Research, Quality Engineering, Product Engineering, Organizational Engineering, Economic Engineering, Working Engineering, Sustainability Engineering and Educational Engineering. The Educational Engineering area reflects issues related to the development and insertion of Superior Education in Production Engineering. This one, however, won't be reviewed in this article, once it isn't applicable to the commercial sector.

One can see all these areas as different opportunities for research, as they can be individually reviewed, or relate them to each other. In addition, they require specific knowledge and skills that exist at the academy and offered by UNIFEI to the community at large, as they are available. Once there is a demand from the community and that knowledge and skills are available, the insurgent doubt is: **what are the issues, related to the knowledge areas in Production Engineering (PE), are priority for the companies from the commercial sector of Itabira?**

Trying to answer this question, it has been proposed, in this research, the development of an instrument to diagnose what kind of transfer, from the PE knowledge areas, are priorities for the companies from the commercial sector of the city of Itabira (MG). To do so, it has taken some activities: to identify the main area, in PE knowledge, to draw up a bibliometrics analysis, taking into account the knowledge areas and to develop the research tool, based on the bibliometrics analysis and experts' opinion.

The article is structured as follows: section 1 presents the introduction, involving the justification for carrying out the research, the research question and objectives; section 2 covers the theoretical framework; section 3 presents the methodological procedures; section 4 covers the results and discussions and, finally, section 5 presents the research findings, limitations and suggestions for future survey.

2 THE CREATION OF KNOWLEDGE IN THE UNIVERSITY-COMPANY PARTNERSHIP

The knowledge management is a field that assists in the knowledge and creation process, related mainly to information, technology and innovation (Madeira, Vick and Nagano, 2013). To minimize earlier forms of privatization, in the early 80s, it began developing partnerships between the private and public sector

(ROBERTSON, VERGE, 2012) with the introduction of public-private partnerships (PPP) for different nature problems solution. PPP is "as long term contract between a private part and a government agency, to provide a public benefit or a public service, where the former is the responsible for risks, as well as for the management" (World Bank Institute, 2012, p 11).

The relationship between the Company, Government and University is important for the social-economical process, mainly in the current scenario. This relationship has been defined in the halfway of the 90s decade as the triple helix, a pivotal factor for the 20th Century new innovation strategies (Etzkowitz and Leydersdorff, 1955; Luengo and Obeso, 2013).

Among the three actors of the triple helix their responsibilities and limitations are different in the existing relationship. The main incentive for the University is the acquisition of financial resources for educational and survey projects, besides a possible working possibilities for the students. On the other hand, the motivation for industry is to have access to the infrastructure and knowledge of the universities, aiming to expand the current technology, increasing its competitiveness (Chang and Hsu, 2002).

3 MATERIALS AND METHODS

The nature of the used research method was a theoretical-conceptual (Miguel, 2010), which is "the production reflections from a phenomenon observed or reported by literature (bibliographical review), ideas and opinions compilation from different authors or even simulation and the theoretical modeling" (Berto and Nakano, 1998). It has been used, as a tool for structuring data for analysis, the bibliometrics technique. According to Araújo et al. (2000) this kind of study aims to observe the literature evolution and the knowledge produced over the years. The research covers the period from 2014 January to 2015 October, for the purpose of obtaining the latest articles.

Initially, in order to find the latest articles with topics related to every subarea based on Web of Science, a research has been carried out using words related to those PE areas. Table 1 shows the identified articles amount.

Area	Number of publications	Area	Number of publications
Operation and Processes Production Engineering	898	Organizational Engineering	348
Logistics	442	Economic Engineering	860
Operational Research	364	Working Engineering	567
Quality Engineering	230	Sustainability Engineering	635
Product Engineering	602		

Table 1 - Identified publications based on Web of Science data.

After obtaining the data, one used the program VOSviewer to build and show the bibliometrics connections. This software did a survey of the most used words in the abstract and titles of the articles. For obtaining the Bibliometrics it has been considered the binary terms repeating at least 7 times. The software itself calculates the relevance of these terms, selecting only the 60% more important. So, through this procedure, it has been generated a map, containing the most cited terms. The terms highlight is proportional to the number of the terms repetition. The lines and colors show the relationship between them.

The interaction among the researchers and community occurred from a questionnaire. This questionnaire is a tool that helps the researchers to identify perceptions, expectations and opinions in several areas (Ergang et al., 2012). This diagnosing tool has, as its main goal, "to translate the needs of information of the researcher in a specific set of issues, the respondents are willing and able to respond" (Malhotra, 2009). This issues can be of open or closed type.

With regard to the analyses of the closed answers, they can transform into quantitative data, through the definition of scales. Some of the more used scales are: Likert Scale, numeric and Guttman (Tracteberg et al., 2012; Bertram, 2013). As soon as the kind of question is chosen, the result modeling analysis should, the best way, read the collected information. In the present scales, the main one, and most used for closed question, in the Likert Scale, the one used in this survey.

4 RESULTS AND DISCUSSION

This section shows the results from the theoretical-concept analysis for two of the areas in PE (Operational Research and Quality Engineering). Based on the characteristics of each area, it has been used the Bibliometrics technique for obtaining primary data from the research tool. The analyses were carried out in conjunction with experts, incorporated entirely by professors. These analyses allowed the validation of the obtained results.

4.1 Operational Research

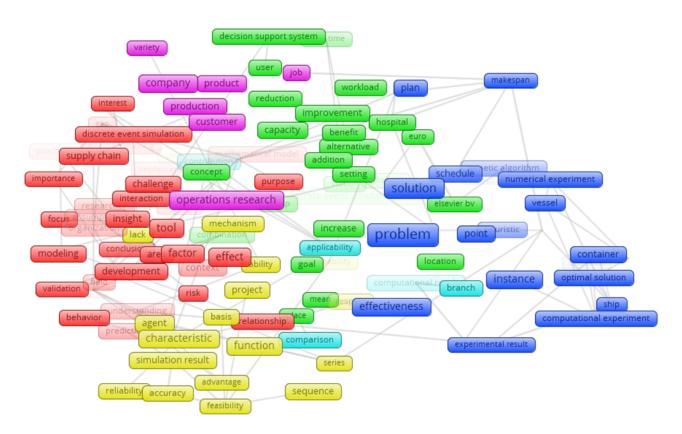
Performing the procedures described in Bibliometrics (section 3), one obtained the Table 2 data.

Table 2 - Values obtained in bibliometrics of Operational Research area

Articles found	Terms found	Binnary terms repeated at least 7 times	Terms with at least 60% of relevance
364	9.067	209	125

Figure 1 shows the map provided by the software with the most cited terms.

Figure 1 - Cloud of most recurrent terms in Operational Research.



It has been carried out some inferences with the words that appear the most (Table 3).

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Table 3 - Recurring ter	me in tha l'inarations	al Racaarch ac di	atinad hi/ avnartc

Terms	Expert Description
Algorithm	Conditions and procedures for limitation of mathematical systems troubleshooting.
Solution Problem solving, uncertainties and difficulties	
Operational Research problem	Production area involving problem drafting of mathematical models for solving and support of decision-making forms.
Effectiveness	Every model should have its effectiveness proven.
Simulation model	Mathematical abstraction (or graphic, which allows different scenario to be generated and tested, without interference in the real system.
Supply chain	Many supply scenarios are reviewed using mathematical models.
Decision-making	Operations research model provide data and values that generally are used to assist in decision-making.
Optimal solution	The best solution for a given problem.
Variability	It indicates the ability to respond to changes.
Viability	Used to refer to solutions and/or viable implementation models.

Figure 2 shows the themes of higher occurrence, according to the results obtained by the VOSviewer software and the prioritization by the experts.

Operational Research 25% 80 21% 70 17% 20% 60 16% 15% 15% 55 53 40 9% 10% 30 6% 5% 20 4% 5% 3% 3% 10 10 11 0% Algorithm Solution Operations Effectiveness Simulation Supply Chain Decision Optimal Variability Feasibility Model Making Solution Research

Figure 2 - Chart of terms of higher occurrence in Operational Research.

According to the analysis, the graphic, the image map and considerations by the experts, four questions arose for the questionnaire. These questions can be viewed in Appendix A (issues from 11 to 14).

4.2 Quality Engineering

With respect to the Quality Engineering area, the data obtained are shown in Table 4.

Table 4 - Values obtained in bibliometrics of Quality Engineering area

Articles found	Terms found	Binnary terms repeated at least 7 times	Terms with at least 60% of relevance
230	5.193	192	115

In Figure 3 one can see the map, provided by the software, containing the most cited terms.

tqm implementation structural equation modelling research model findings design methodology approach structural equation construct total quality management practical implication business link validity lack relation type reliability autho purpose objective empirical study adoption custon use strategy flexibility benefit iso chang application information certification indicator value article topi product sme right method standard edium sized enterprise interview challenge humber problem risk

Figure 3 - Cloud of most recurrent terms in Quality Engineering.

Based on Figure 3, some inferences were carried out, related to recurring terms (Table 5).

Table 5 - Recurring terms from the Quality Engineering area, according to the definition by experts.

Terms	Expert Description
Total Quality Management (TQM)	They are strategies used by companies to develop a cultural quality related to their processes and services. They cover the practices, impacts, models, tools, systems, performance evaluation, among other subjects.
ISO	Regulatory models are still the focus of important researches. Many studies report the benefits of certifications (covering, for example, the periods of before and after).
Product	Jobs that involve evaluation quality in products/services. This term reflects the importance of quality planning in the product development.
Case study	Indication that lots of research in this area use the case study method.
Advantages	It may involve the benefits of implementation of quality improvement methods (there is also a lot of research regarding the advantages and disadvantages of some methods, applications, and so on).
Client	One of the goals of the implementation of quality/process is to enable customer's satisfaction (costumer's focus is a fundamental principle of quality management).
Service	The service sector is always registering a growth over the years. It becomes, therefore, an important target of study (which is the matter of the survey portrayed in this article). The evaluation of quality in services is also a relevant theme.
Standardization	It involves the development and implementation of standards. It is also one of the main benefits of certifications, helping in the organization of companies and an important managerial tool.
Empirical study	Those studies that are based on practical application and living experiences.
Sigma	Publications on this theme usually consist of articles that use this methodology to determine and mitigate the variability of process or concerning the management and selection of the projects.

Figure 4 presents the themes of higher occurrence, according to the results generated by the VOSviwer software and the priorization by experts.

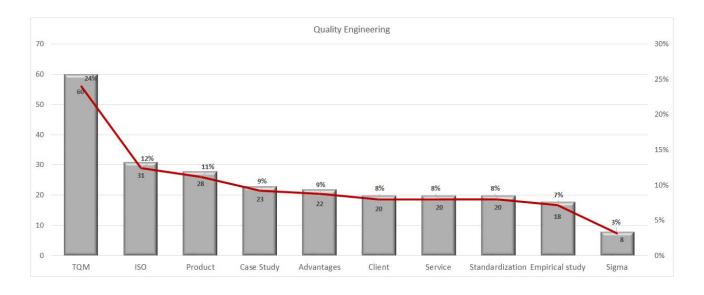


Figure 4 - Chart of terms of higher occurrence in Quality Engineering.

According to the analyses, the chart, the image map and the expert's considerations, 7 questions were considered for the questionnaire. The questions are shown in Appendix A and they represent the questions from 15 to 21.

The bibliometrics analysis and the assessment of experts were carried out for all the knowledge areas (Operation Engineering and Production Processes, Logistics, Product Engineering, Organizational Engineering, Economical Engineering, Working Engineering, Sustainability Engineering). The result of this analysis was include in the obtained research instrument (Appendix A).

4.3 Pilot Test Result

The questionnaire was sent, in October 2015, to 8 (eight) commercial sectors companies of Itabira. For a better understanding, an elaborate description for each term has been carried out. 4 (four) companies replied the questionnaire by electronic means, using the QuestionPro, which is a world reference in softwares used in surveying. Figure 5 includes, on the *y* axis of each graph, the average interest for topics in each area (corresponding to 47 issues). The maximum grade of interest corresponds to 5 (five).

Based on the answers of the pilot test, it was possible to spot the interest in researches of PE areas, according to the group average, being: 1- Economical Engineering (3.45); 2- Organizational Engineering (3.25); 3- Operation and Production Processes Engineering (3.05); 4- Logistics (2.90); 5- Operational Research (2.88); 6- Sustainability Engineering (2.80); 7- Quality Engineering (2.79); 8- Product Engineering (2.70); 9- Working Engineering (2.70).

Q

With respect to research topics of the greatest interest, the 8 (eight) first in order were: 1- Perform indicators (3.75); 2- Cost management (3.75); 3- Evaluation of the provided services quality (3.5); 4- Strategic and organizational management (3.5); 5- Human Resources management (3.5); 6- Risks analysis (3.5); 7- Pricing (3.5); 8- Financial Market structure (3.5).

In the case of other certification types (question 21), none of the companies displayed interest in other types of certification in addition to ISO 9001.

Regarding the matters relating to the companies interest to offer internship for PE course students (questions 48 and 49) only half of them showed interest in hiring PE trainees.

Those that showed interest rated their priorities in accordance with the following areas: Quality Engineering, Logistics, Economical Engineering, Operation and Product Processes Engineering, Product Engineering, Sustainability Engineering, Working Engineering, Operations Research and Organizational Engineering.

OPERATIONS ENGINEERING AND PRODUCTION PROCESSES LOGISTICS 3.25 2.5 2.5 0 Q Q QUALITY ENGINEERING OPERATIONAL RESEARCH 3,25 2,75 2,5 Optimization Simulation 17 15 Q 14 11 12 Q 16 19 ORGANIZATIONAL ENGINEERING PRODUCT ENGINEERING 3,25 3,25 2.5 23 Q 32 31 Q WORKING ENGINEERING ECONOMIC ENGINEERING 3.5 3.5 3.5 2 25 is deske. 0 Market financial structure Cost Q SUSTANABILITY ENGINEERING 3,25 2,75 2,5 2,5 Water rational use Waste Management Energetics efficiency Renewable energies - solar and wind power Smart grid

Figure 5 - Levels of interest in accordance with themes of the Production Engineering areas.

The operators also got in touch with the companies for a more careful evaluation. The final questionnaire can be viewed in Appendix A.

5 CONCLUSION

This article had, as its main goal, to develop an instrument to diagnose what types of knowledge transfer, in PE areas, are priorities for companies from the commercial sector of the city Itabira (MG). The identification of the main knowledge area in PE, the preparation of bibliometrics analysis and the experts' opinion allowed, this way, this goal to be reached.

The pilot test provided the level of question understanding to be evaluated, as well as the research instrument improvement. It also provided the acquisition of some preliminary analysis (and limited to the number of respondents): The Economical Engineering, as the group of the greatest research interest, the interest of companies (50%) to offer internships and the themes Performance Indicator and Cost Management as the greatest interest of the companies.

This research belongs to an Opportunities Research Identification Project at the commercial and Industrial sector in the city of Itabira that, as results, intends: to stimulate skills related to the development of a research and the practical application of knowledge, to identify possible PE research areas, a higher knowledge and interaction with the local economy and identification of possible internship units' grantors.

The research instrument application will provide, this way, the knowledge exchange between the Faculty Board and the University students with the companies of the commercial sector of the city, allowing the sharing of experiences that can be enriching for all of them.

With respect to the elaborated research instrument, some limitations can be listed: data collection for Bibliometrics analysis in only one database (however, it is a sufficiently comprehensive database); each EP area has been evaluated by only one expert (it's possible that any expert can accomplish different inferences in the generated maps from the Bibliometrics analysis). Due to limitations of the text, only the most cited words have been included; however, all the other words have been reviewed, also being important sources for research and inference. Despite the described limitations, this work allows the strengthening of the University-Company relationship, as well as it allows to relate the PE areas with the reality of the city of Itabira.

It is suggested, for a future research, the application of the questionnaire at other cities with EP courses and that would like to identify research opportunities to improve the University-Company relationship.

ACKNOWLEDGEMENTS

The authors need to express their acknowledgements to Commercial, Industrial, Services and Agricultural Association of Itabira (ACITA) and all interviewees.

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APPENDIX A - Questionnaire

Identification of research opportunities in Production Engineering

This questionnaire is part of a project that aims to strengthen a University and the Commercial Sector relationship in the city of Itabira. So, the diagnose instrument will make possible the identification of possible research in the commercial sector and the analysis of the interest of the company to offer an internship. The series is divided in 11 parts, involving the main Production Engineering performing area. The main question involving the questionnaire is: What's your interest in deploy/perform researches about the following issues in your company?

The answer may vary on a scale of 1-5, where:

1	2	3	4	5
No interest	Future interest	Interest	Much interest	Extreme interest

	1. OPERATIONS ENGINEERING AND PRODUCTION PROCESSES						
N°	Theme	1	2	Scale 3	4	5	
1	Production Control System						
2	Layout						
3	Performance indicators						
4	Inventory control						
5	Management tools and techniques						
	2. LOGISTICS						
6	Supply chain						
7	Partnership reliability						
8	Transport logistics						
9	Warehousing and stock handling						
10	Lead Time						
	3. OPERATIONAL RESEARCH						
11	Decision-making tools						
12	Simulation						
13	Optimization						
14	Demand forecasting						
	4. QUALITY ENGINEERING						
15	Total Quality Management – TQM						
16	5S program and other improving programs (like Benchmarking)						

17	Quality evaluation of provided services					
18	Seis Sigma.					
19	Metrological Equipment Quality					
20	ISO 9001 Certification					
	Would you have interest in other certifications?					
21	() I have interest in another certification. Specify.:					
	() I don 't have interest in other certtifications					
	5. PRODUCT ENGINEERING					
22	Product/Service Planning and Project					
23	Product/service Development Management					
24	Clients needs identification tools					
25	Used tools in product/service development process					
26	Product/services reliability analysis					
	6. ORGANIZATIONAL ENGINEERING					
27	Knowledge Management					
28	Information Management					1
29	Strategic and Organizational Management					1
30	Human Resources Management					1
31	Projects Management					1
32	Technology and innovation					
	7. ECONOMIC ENGINEERING					
33	Investment feasibility analysis					
34	Cost Management					1
35	Risks analysis					
36	Pricing					
37	Market financial structure					
	8. WORKING ENGINEERING					
38	Muscleskeletal illness					
39	Working enviroment analysis					
40	Ergonomic working stations conditions					
41	Deployment study breaks					
42	Laboral working gymnastics					
	9. SUSTANABILITY ENGINEERING					
43	Energetics efficiency					
44	Renewable energies - solar and wind power					
45	Smart grid					
46	Water rational use					
47	Waste Management					
	10. THE INTERNSHIP IN YOUR COMPANY	I		C -		
Ν°	Question	Scale Yes No				
48	Would you be interest in hiring interns from UNIFEI/ITABIRA Production Engineering course in your company?	_	, 03	\dagger	-110	
49	Is so, number the interest areas according to your preference (1-Higher preference):					_

Proceedings of the 2nd ICQEM Conference, Guimarães, Portugal, 2016

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Quality Management Practices and Continuous Improvement in Desiccated Coconut Millers

Dr. Lalith Nimal Senaweera

PhD, MBA, BSc (Hons), FASQ(USA), FCQI –CQP(UK), FRSS(UK), ISO DEVCO Chair, Director General/ CEO – Sri Lanka Standards Institution

Priyantha Saman, BSc

Abstract

This study investigated the relationship of Quality Management practices and Continuous improvement in the desiccated coconut industry of Sri Lanka. Researcher noted that the regulatory authority for Desiccated Coconut Millers in Sri Lanka, the Coconut Development Authority has made Good Manufacturing Practices (GMP) as a basic requirement to register as a Desiccated Coconut Miller. Considering that the Researcher decided to investigate the quality management practices of the Industry. Researcher conducted exploratory analysis using a conceptual model developed based on the literature review such as Top Management Commitment, Customer Focus, Employee Involvement. . In this context, Researcher used a cross-sectional survey methodology, and convenience sampling method to select the sample for the study. The sample was selected from the registered Desiccated Coconut Millers available at the Coconut Development Authority which is the responsible Institution in Sri Lanka to monitor the operational progress of Desiccated Coconut Millers in Sri Lanka. For the study the Researcher selected 20 Desiccated Coconut Millers based on the above methodology for this study. Researcher used a questionnaire developed using Likert Scale to obtain the data from the millers selected using the convenience sampling method. All Millers have responded positively with a satisfactory response rate of 100 percent and the analysis was done using Pearson coefficient, descriptive statistics and linear regression analysis. This study has shown that there are no significant relationship with the above independent factors and the continuous improvement. However, study revealed that different QM practices in the desiccated coconut millers require due attention to have a significant continuous improvement.

Key words- Top Management Commitment, Customer Focus, Employee Involvement, Continuous Improvement

1. Introduction

Desiccated Coconut Industry is one of the leading and oldest industries in Sri Lanka. Sri Lanka was the pioneer in the export of coconut products to the world. Over the years the industry faced different issues and with the current world developments and stiff competition where customers are more choosy this industry also has to undergo changes to meet these challenges. The demand for Desiccated Coconut then was largely from the European countries which utilized it for cake-making and confectionary products. Foreign markets reached a peak towards Desiccated Coconut during the year-ending months and the festive season culminating in Christmas and New Year. Though Sri Lanka was the first to export Desiccated Coconut with 60,000 tons in 1900, over the years, competitors have overtaken Sri Lanka. In 2013, export of Desiccated Coconut from major exporting countries was as given in the below table

Table-1 EXPORT STATISTICS OF DESICCATED COCONUT - MAIN COUNTRIES

Country	Quantity in tons
Philippines	116,115
Indonesia	75,930
Sri Lanka	33, 273

Source- Export Statistics Data published by Export Development Board

The above indicates the present position of the Sri Lankan Export situation in the Global markets. Customer needs and wants are ever increasing and changing with the dynamics of global environmental changes. Before the competition address the issue of acquiring customers, retaining the customers, building relationships with customers and discover ways of being more valuable to the customers, the organizations need to determine how these issues are handled and that this the major challenge that organizations are faced (Quirke, 1995). Considering this perspective, quality becomes a basic business strategy in an increasingly competitive global marketplace (Kotler, 1991). A quality image, once created, can improve an organization's ability to compete and its long-term opportunity for success (Benson, 1993). Many authors have indicated that Japanese manufacturers' success is the ability to convert quality focus into a competitive advantage (Hayes and Clark, 1985; Reitsperger and Daniel 1990a). Moreover, one main factor for the decreasing share of U.S. manufacturing in the global market is due to the neglect of Quality (Deming, 1992; Crosby 1979; Tenner and DeToro 1992). Organizations are looking for new ways to improve the quality of products in order to survive on the market and maintain the competitiveness. Organizations that use a quality management strategy focus on achieving and sustaining a high quality outputs using management practices as the inputs and quality performance as the outputs (Flynn, Schroeder, & Sakakibara, 1994).

Deming is the main agent in supporting the Japanese to reorganize their business and management systems during the post-war period to stabilize the Japanese economy (Saylor, 1992). His book *Out of the Crisis* demonstrates the theory of chain reaction in business management and the relationship between quality and improved productivity (Wayhan et al., 2010). Furthermore, Deming adapted Shewheart's statistical quality control ideas through a series of lectures to Japanese engineers and CEOs of the largest Japanese organizations (Deming, 1986). Furthermore, the organization can profit from the positive impact of the knowledge that it is providing high quality goods and services (Rabinowitz and Vilela, 2012; Aguilar-Save'n, 2004). More satisfied customers and employees, reduced costs, improved financial performance, enhanced competitive and increased productivity (Zu, 2009; Kaynak, 2003; Deming, 1986).

Many scholars study indicates relationships among Quality Management (QM) practices and examines the effects of these practices on performance, but the finding inconsistencies and conflicting results were shown among scholars. These findings indicate that a positive relationship exists between the QM practices or TQM and firm performance and between other variables such as product quality, product and process performance, perceived quality, quality drivers, reduced cost, more satisfied customer and improve financial performance. In general, A large body of literature highlights the positive impact of QM practices on performance (Zu, 2009; Kaynak, 2003; Ahire, Golhar, & Waller, 1996; Kaynak & Hartley, 2005; Sila & Ebrahimpour, 2005; Anderson, Rungtusanatham, Schroeder, & Devaraj, 1995; Flynn, Schroeder, & Sakakibara, 1995; Ho, Duffy, & Shih, 1999; Prajogo & Sohal, 2003; 2006; Terziovski & Samson, 1999; Choi & Eboch, 1998), but others have not found a relationship between QM practices –TQM- and performance (Nair, 2006; Agus, 2003).

2. The relationships between Quality Management Practices and Improvement

2.1 Top management commitment

The management of any organization falls within a board spectrum with "autocratic" management at one end of the spectrum and "Participatory" management at the other. The crucial question is whether or not management is ready to bring their workers into sharing in the decision making process. Commitment and communication by top management also influence fundamental beliefs, values, and attitudes necessary for employees' empowerment and commitment to quality and service (Quirke, 1995; Robertson, 2003). The main factor 'top management commitment support' is cited by most researchers. Strong commitment from the top management is vital in quality management and leading to higher quality performance. Most of the researchers consented to this argument (Saraph et al., 1989; Flynn et al., 1994; 1995; Ahire et al., 1996; Juran, 1988; Anderson et al., 1995). Management style - management commitment is critical success factor. There are many ways in which the required and commitment can be developed. Education is important, but it is not in itself enough. Managers must be skilled in managing people. They must be visible alongside their staff seeing what problems they experience, and alongside their customers understanding their needs and problems. Juran & Gryna (1993), identified the roles of top management as: Establish quality policies, establish and deploy quality goals, provide resources, provide problem-oriented training, and improvement. A major challenge is to managers' to change from being administrators and technologists into being quality leaders. Of course, business needs managers with the vision and ability to think and work strategically and of course they need managers with the intellectual skill and techniques to evaluate complex problems and take good business decisions.

But none of these talents is any good unless managers have some more fundamental abilities. The ability, for example to commit themselves emotionally to the importance of customers and how to care for them or the ability to manage people by providing leadership and helping them to do their jobs better. As per the previous research findings there is very strong evidence that the Top Management Commitment factor is relevant in a quality management such as Top management accepts quality responsibility; evaluated on quality; participate in quality improvement efforts; makes strategies and goals for quality; alignment of IS strategy with business strategy; considering market demands and consumer needs; and organizational performance and profitability (Saraph et al., 1989; Flynn et al., 1994, 1995; Ahire et al., 1996; Anderson et al., 1995; Black & Porter, 1996; Crosby, 1979; Deming, 1986; Juran & Gryna, 1993; Kaynak, 2003; Powell; 1995; Prajogo & Sohal, 2003; Rao et al., 1999; Sila & Ebrahimpour, 2005; Wilson & Collier, 2000).

2.2 Customer focus

Deming defined quality as "multidimensional to produce a product and/or deliver a service that meets the customer's expectations to ensure customer satisfaction" (Deming, 1986, P.54). Anderson defined Customer satisfaction as the degree to which a firm's customers continually perceives that Customers' needs are being met by the firm's products and services (Anderson et al., 1994). An organization needs to identify Customer relationship to Measure customer needs and expectations; involve customers in quality improvement; determine customer satisfaction (Prajogo & Sohal, 2003; Sila & Ebrahimpour, 2005; Flynn et al., 1994, 1995; Powell, 1995; Ahire et al., 1996; Black & Porter, 1996). An organization must recognize, throughout its ranks that the purpose of all work and efforts to make improvements is to provide a better service for its customers. This means that it must always know how well its outputs are performing, in the eyes of the customer through measurement and feedback. The most important customers are the external ones who purchase products or services, but the "Quality chain" can break down at any unit in the flows of work. Ross (1995, p. 208) define Internal Customers' as "the people, the activities, and the functions within the company that are the customers of other people, activities, or functions". Internal customers, therefore, must also be well served if the external ones are to be satisfied. There is an emphasis in this element on the belief that the customers are the central focus of the organization as these are the individuals who will purchase the manufactured goods or services being offered by that organization (Edwardsoft, 2011), and hence, their expectations must be met. Prajogo and Cooper (2010) argue that quality customer service is one of the most important aspects of Total Quality Management (TQM) because in any customer-oriented business the customers are the organization's main stakeholders. However, it is interesting to note that many scholars mentioned to the importance of customer satisfaction; based Deming work as The consumer is the most important part of the production line, Quality should be aimed at the needs of the consumer, present and future' (Deming, 1986, p. 32).

2.3 Employee Involvement

Everyone in the organization, from top bottom, from offices to technical service, from headquarters to local site, must be involved. People are the source of ideas and innovation and their expertise, experience knowledge and co operation has to be harnessed to get those ideas implemented. TQM is not simply an ideology, but a sophisticated ongoing process demanding the absolute commitment of everyone in an organization (Edwardsoft, 2011; Joiner 2007). In the book entitled *In Search of Excellence, authors* distinguished eight key factors that explained in some detail, the interactive relationships between management and staff that contributed to the overall high level of performance in these companies. This was accredited to the complete dedication of all involved in the quality process within the organizations concerned (Peters and Waterman, 2004).

When people are treated like machines work becomes uninteresting and unsatisfying. Under such conditions, it is not possible to expect quality services and reliable product. Eskildsen and Dahlgaard (2000) argue the issue of employee contribution and loyalty to the organization, indicating that this represents another variable in the equation because in the absence of these positive emotional and physical inputs from employees, the fundamental objectives of any quality initiative are not likely to be met. Holjevac (2008) considers that all the employees in the organization have a role to play in the QM approach starting from the most junior levels right up to the general manager. It was from this interaction that took place between Atkinson (1990) and Holjevac (2008) that different theories of continual development and the modern image of dynamic management emerged. The rate of absenteeism and of staff turnover is a measure that can be used in determining the strengths and weaknesses of management style and worker morale in any company. A vital factor to achieve goals in

firms is Workforce management, Workforce management is emphasized on recognize employee performance on quality; encourage team working; provide training; involve employees in quality decisions (Saraph et al., 1989; Kaynak, 2003; Prajogo & Sohal, 2003; Anderson et al., 1994; Flynn et al., 1995; Powell, 1995; Ahire et al., 1996; Black & Porter, 1996; Wilson & Collier, 2000; Sila & Ebrahimpour, 2005). The organization needs to ensure that an organization-wide training program is available in order to provide employees with the proper skills (Kaynak, 2003; Anderson et al., 1995; Flynn et al., 1995; Rao, Solis, & Raghu-Nathan, 1999).

2.4 Continuous improvement

In 1987 Peters explored the idea of constant change within the business environment, publishing the book *Thriving on Chaos* as a means of disseminating the ideas and beliefs in this respect. Peters (1987) argued that companies should not become complacent as 'excellence' was an 'ideal' that could never be achieved, and hence, management must constantly adapt to the ongoing innovation within the daily economic environment. Never - ending or continuous improvement is probably the most powerful guide in the management of change. It is a term not well understood in many organizations, although that must begin to change if those organizations are to survive. To maintain a wave of interest in quality, it is necessary to develop generations of managers who not only understand but are dedicated to the pursuit of never – ending improvement in meeting external and internal customer needs. The concept requires a systematic approach to quality management technique.

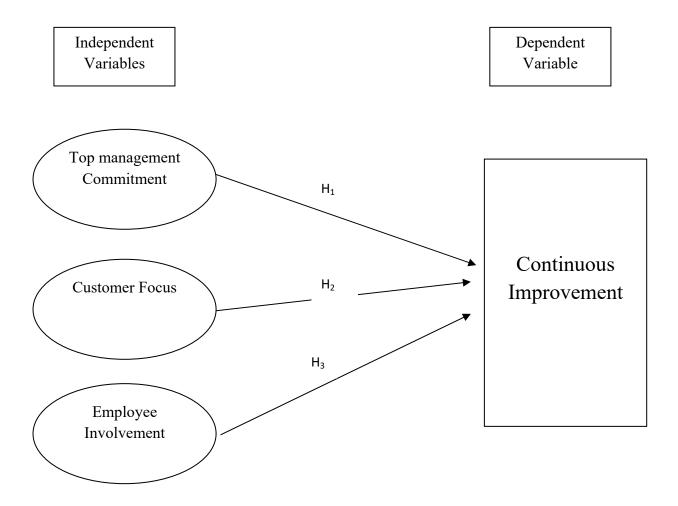
Never- ending improvement ensures that the organization learns from results, standardizes what it does well in a documented quality management system, and improves operations and outputs from what it learns. The emphasis must be that this is done in a planned systematic and conscientious way to create a climate a way of life that permeates the whole organization. Therefore this article explores the contribution of the above factors for Quality Improvement in desiccated coconut industry in Sri Lanka. Four hypotheses related to Quality Improvement are tested using the data collected from 20 desiccated coconut mills to evaluate the level of importance placed on four key components used in the implementation of quality management systems in Sri Lanka Desiccated Coconut manufacturing mills.

3. Conceptual Framework

3.1 Conceptual Model

The relevant literature is reviewed to describe the relationship among variables in the model. Based on the literature reviewed, the following Conceptual Model is proposed and it shows the relationships between the independent and dependent variables.

3.2. Fig 01 - **Conceptual Model**



- 3.2 Based on the above model the following hypotheses are proposed.
- 3.2.1 H1a: Top Management commitment is not related to Continuous Improvement
 - H1b: Top Management commitment is related to Continuous Improvement
- 3.2.2 H2a: Customer focus is not related to Continuous Improvement
 - H2b: Customer focus is related to Continuous Improvement
- 3.2.3 H3a: Employee Involvement is not related to Continuous Improvement
 - H3b: Employee Involvement is related to Continuous Improvement

3.3 Operationalization

Concept	Measurement Indicator(s)	Measurement method (Likert)	Relevant Questions
Top Management	Document Policy for Quality	1-5	

Commitment	Provide Resources Review Quality Activities		Q1- Q7
	Enhance communication for		
	quality Measurement and Key		
	Performance		
	indicators(KPIs)		
	Procedural adherence Make strategies for Quality		
		1-5	
	Resolution of Customer Complaints		
Customer Focus	Responsiveness		Q8- Q12
	Customer relationship Concerns on Price		
		1-5	
	Cross functional Teams		
Employee Involvement	Training & development Rewards & Recognition		
	Career Development		Q13-Q17
	Involve in quality Decisions	1-5	
	Law Draduct recalls		
	Low Product recalls, Increase Revenue		
Continuous	Use of quality Tools &		
Improvement	Techniques Techniques		018 022
	Technology Development Quality Auditing		Q18- Q22

4. Research Methodology

4.1 Measurement and Instrument

The instrument used to collect the sample information was a questionnaire containing of 25 opinion statements. In developing this instrument Quality Management literature was carefully reviewed, and the outcome is the questionnaire.

4.2 Population and Sample

The sample was selected from the list of 58 active operational Desiccated Coconut (DC) Millers available in the Coconut Development Authority and the Total (58) DC Millers is considered as the population of the study. The sample of 20 desiccated millers was selected using convenience sampling method. It was observed that all the Millers have adopted Quality Management practices such as Good

Manufacturing Practices (GMP) and some of the millers have obtained ISO 9001 certification in addition to GMP.

4.3 Data Collection Process

The questionnaire was administered among the 20 Desiccated Millers selected using convenience sampling method. Respondents were asked to indicate perception regarding different attributes of quality with five-point Likert scales used to measure the responses by circling the appropriate number. Twenty questionnaires were mailed to the Desiccated Millers in the sample, and were followed up by telephone and fax inquiries. All questionnaires were returned, representing 100% response rate. Since the sample was convenient rather than random, the results should be interpreted accordingly.

4.4 Data Analysis

The Minitab version 17 has been used to analyze the data. The major statistical measure of the relationship is the correlation coefficient. Correlation analysis is primarily concerned with finding out whether a relationship exists and with determining its magnitude and direction (Saunders et al., 2007; Hair et al., 1998). In order to know the most contributory of this relationship between the variables, the linear regressions was conducted. The data were further analyzed using Karl Pearson correlation coefficient, Descriptive statistics, and cross tabulation were used to test the results. Briefly, the Karl Pearson product-moment correlation coefficient (sometimes referred to as the PPMCC or PCC or Pearson's r) is a measure of the linear correlation between two variables X and Y, giving a value between +1 and -1 inclusive, where 1 is total positive correlation, 0 is no correlation, and -1. Also statistically significant tests are performed to validate the Hypotheses, using p-value of 0.05 or less.

5. Results

Table 1- Out Put Regression Analysis: Continuous Improvement versus Top Management Commitment

The regression equation is Continuous Improvement = 2.842 + 0.1244 Top Management Commitment

S = 0.298872 R-Sq = 1.5% R-Sq(adj) = 0.0%

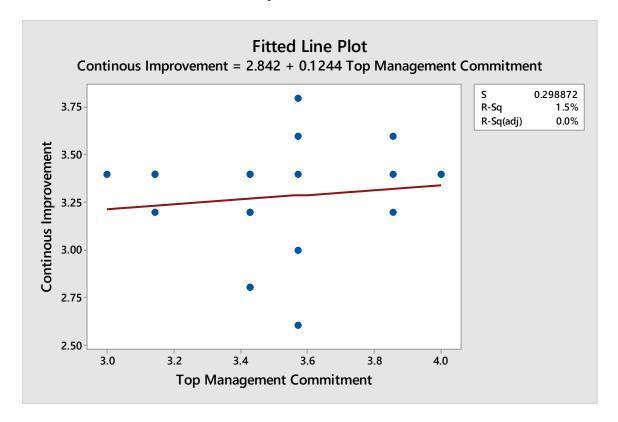
Analysis of Variance

Source DF SS MS F P
Regression 1 0.02416 0.0241620 0.27 0.609

Error 18 1.60784 0.0893243

Total 19 1.63200

Figure -1 – Fitted Line Plot for Top Management Commitment & Continuous Improvement



Source: Survey data

Correlation: Top Management Commitment, Continuous Improvement

Pearson correlation of Top Management Commitment and Continuous Improvement = 0.122 P-Value = 0.609

As per Table 1 output a linear regression established that Top Management Commitment statistically insignificant to predict Continuous Improvement, F(1, 18) = 0.27, p > .0005, and Top Management Commitment accounted for 1.5 % of the explained variability in Continuous Improvement. The regression equation was: predicted Continuous Improvement = $2.842 + 0.124 \times (Top Management Commitment)$.

Moreover, Pearson correlation value of Top Management Commitment and Continuous Improvement = 0.122 indicates that there is a very weak positive relationship between these two variables. However, since p(>) greater than 0.05 H1a, the null hypothesis has to be acceptable at the 0.05 significance level.

Table-2 Descriptive Statistics: Q 1, Q2, Q3, Q4, Q5, Q6, Q7

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Maximum
Q 1	20	0	3.050	0.198 0.887		2.000	5.000
Q2	20	0	3.500	0.154 0.688		2.000	5.000
03	20	0	3.300	0.179 0.801	2.000	5.00	00

Q4	20 0	3.650 0.196 0.875	2.000 5.000
Q5	20 0	3.600 0.134 0.598	3.000 5.000
Q6	20 0	3.950 0.170 0.759	3.000 5.000
Q7	20 0	3.600 0.152 0.681	3.000 5.000

Descriptive statistics table indicates that for Q1 and Q3 the sample mean value was three. That inferred with regard to the availability of a documented Quality Policy and the participation of top management in reviewing of Quality activities related work, the opinion of the respondent was not decided. The other than that for all other questions the sample mean value is closed to four and that means the opinion of the respondents in the sample is on the agreement side.

Table 3- Out Put Regression Analysis: Continuous Improvement versus Customer Focus

The regression equation is Continuous Improvement = 3.005 + 0.07488 Customer Focus

S = 0.286380 R-Sq = 9.5% R-Sq(adj) = 4.5%

Analysis of Variance

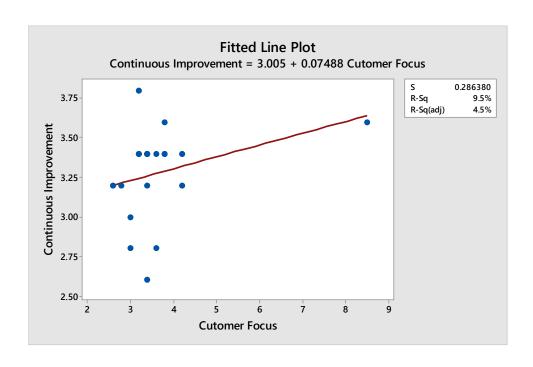
Source		DF	SS	MS	F	Р
Regression	on	1	0.15575	0.155752	1.90	0.185
Error	18	1.47625	0.08201	4		

Total 19 1.63200

Correlation: Customer Focus, Continuous Improvement

Pearson correlation of Customer Focus and Continuous Improvement = 0.309 P-Value = 0.185

Figure -2 – Fitted Line Plot for Customer Focus & Continuous Improvement



As per Table 3 output a linear regression established that Customer Focus statistically insignificant to predict Continuous Improvement, F(1, 18) = 1.90, p > .0005, and customer Focus accounted for 9.5 % of the explained variability in Continuous Improvement. The regression equation was: predicted Continuous Improvement = $3.005 + 0.074 \times (customer Focus)$.

Moreover, Pearson correlation value of Customer Focus and Continuous Improvement = 0.309 indicates that there is a weak positive relationship between these two variables. However, since p value 0.185(>) greater than 0.05 H2a, the null hypothesis has to be acceptable at the 0.05 significance level.

Table 4- Descriptive Statistics: Q8, Q9, Q10, Q11, Q12

```
Variable N N* Mean SE Mean StDev Minimum Q1 Median Q3 Maximum
      20 0 3.350
                  0.167 0.745 2.000 3.000 3.000 4.000
                                                      5.000
Q9
      20 0 3.650
                  0.182 0.813
                              2.000 3.000 4.000 4.000
                                                      5.000
Q10
      20 0 3.350 0.209 0.933
                                                      5.000
                              2.000 3.000 3.000 4.000
      20 0 3.300 0.179 0.801 2.000 3.000 3.000 4.000
                                                      5 000
Q11
Q12
      20 0 3.450 0.170 0.759 2.000 3.000 3.500 4.000 5.000
```

Descriptive statistics table 4 indicates that for Q8, Q10, Q11 and Q12 the sample mean value was three. That inferred with regard to the availability of a sound mechanism to solve customer complaints, relationship with customers, and affordable price of products and the consideration of market situation for deciding price for products, the opinion of the respondent was not decided. For Q9 the sample mean value is closed to four and that means the opinion of the respondents in the sample is on the agreement side.

Table 5- Out Put Regression Analysis: Continuous Improvement versus Employee Involvement

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The regression equation is
Continuous Improvement = 3.004 + 0.08534 Employee Involvement
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S = 0.280772 R-Sq = 13.1% R-Sq(adj) = 8.2%
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Analysis of Variance

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Source DF SS MS F P
Regression 1 0.21301 0.213007 2.70 0.118
Error 18 1.41899 0.078833
Total 19 1.63200
```

Fitted Line Plot Continous Improvement = 3.004 + 0.08534 Employee Involvement 0.280772 3.75 R-Sq 13.1% R-Sq(adj) 8.2% Continous Improvement 3.50 3.25 3.00 2.75 2.50 ż 3 4 5 6 8 **Employee Involvement**

Figure -3 – Fitted Line Plot for Employee Involvement & Continuous Improvement

Correlation: Employee Involvement, Continuous Improvement

Pearson correlation of Employee Involvement and Continuous Improvement = 0.361 P-Value = 0.118

As per Table 5 output a linear regression established that Employee Involvement statistically insignificant to predict Continuous Improvement, F(1, 18) = 2.70, p > .0005, and Employee Involvement accounted for 13.1 % of the explained variability in Continuous Improvement. The regression equation was: predicted Continuous Improvement = $3.004 + 0.085 \times 10^{-2}$ (Employee Involvement).

Moreover, Pearson correlation value of Customer Focus and Continuous Improvement = 0.361 indicates that there is a weak positive relationship between these two variables. However, since p value 0.118(>)greater than 0.05 H3a , the null hypothesis has to be acceptable at the 0.05 significance level.

Table 6- Descriptive Statistics: Q13, Q14, Q15, Q16, Q17

Variable	Ν	N*	Mean	SE Mean	StDev	Minim	um (Q1 Medi	an Q3	Maximum
Q13	20	0	2.800	0.236 1	.056	1.000	2.000	3.000	3.750	5.000
Q14	20	0	3.250	0.143 0	.639	2.000	3.000	3.000	4.000	4.000
Q15	20	0	3.200	0.186 0	.834	1.000	3.000	3.000	4.000	4.000
Q16	20	0	3.000	0.192 0	.858	1.000	2.250	3.000	4.000	4.000
017	20	Ω	2.750	0.176	.786	1.000	2.250	3.000	3.000	4.000

Descriptive statistics table 6 indicates that for Q13, Q14, Q15 , Q16 and Q17 the sample mean value was three. That inferred with regard to the availability of cross functional teams , training and

development, rewards & recognition schemes, availability of career path for employees and decisions are based on employee consultation, the opinion of the respondent was not decided.

6. Discussion, Research Implications, and Conclusions

6.1 Discussion of the Analyses

The study has found that Top Management Commitment, Customer Focus, and Employee Involvement are not significantly related to Continuous Improvement. Moreover, the study has found that for different Quality Management Practices the sample respondents' opinion on average basis was not decided.

The analysis further revealed that with regard to the availability of a documented Quality Policy indicating the direction by the Top Management for Quality and the participation of Top Management in reviewing of quality practices are the areas that the Desiccated Coconut(DC) millers need to be considered to further strengthen the quality focus within the Mills. However, It has been found that providing of sufficient resources, enhance communication, participation in setting key performance indicators (KPIs), encourage to adherence to follow procedures and making strategies for Quality by Top management are taking place in an acceptable manner.

The study results revealed that having a mechanism for solving customer complaints, maintain of a relationship with customers, setting an affordable price and consideration to the market situation in changing price are the areas to be considered for improvement by the DC millers. If a DC miller knows the needs and expectations of the customers accurately and on time via frequent communication with and feedback from the customers, the miller can produce high quality, reliable, and timely delivered products or services. Systematic measurement of customer feedback and its use in the product/service or process improvement can increase customer satisfaction. When a miller knows the customers' current and future needs, expectations, and complaints accurately and on time, the miller can invest in profitable areas and improve its sales, market share, and total profitability. Moreover, DC millers can consider the response for enquiries effectively as a function for further improvement. When a DC miller has effective response system on customer enquiries, it provides to build up a good rapport with the customers in a very successful manner.

It has been found from the analysis that use of cross functional teams to solve quality issues, due consideration for training and development, use of practices of rewards & recognition schemes, having a career path for employees and consultation of employees appropriately in making decisions are the areas that DC millers can give consideration for improvement. Especially, the providing of appropriate training to employees creates a situation of improving the skill levels of employees paving the way to carry out their duties in an effective manner whilst having a career path provides employee retention and motivation. Providing firm resources to training on quality pays off as professional employees know concepts of quality, basic characteristics of their industry, and the structure and processes of the firm. Furthermore, treating employees as a valuable resource increases their loyalty to the organization, motivates them and makes them proud of their jobs, improves the work-related performances, decreases absenteeism, and reduces intentions to quit. Moreover, employee related rewards and recognition schemes can trigger new development within the DC mills.

The results suggest that DC millers need to focus in many areas for the purpose of Continuous improvement. Results also have shown that there is no significant contribution for Continuous improvement from the Top Management, Customer Focus and Employee Involvement.

6.2 Research Implications

6.2.1. Managerial Implications

There is no significant relationship between Continuous Improvement and Top Management Commitment, Customer Focus and Employee Involvement shows that it is due to non practicing of many important areas by the DC millers. The reasons of these factors of implementations may guide managers on how to motivate employees in these applications in order to improve DC mills performance. Discovering the barriers to Continuous Improvement can be used for the DC mills to implement the ISO practices in a very sound manner as at present DC millers are in the planning or early stages of implementing ISO practices or its principles.

6.2.2. Future Research Implications

Strategic Planning, Operational performance are the major tenets of Continuous Improvement and these factors can be included in future studies. Insignificant relationship between Continuous Improvement and Top Management, Customer Focus and Employee Involvement can indicate existence of indirect relationship or any other relationship that is nonlinear. Insignificant relationship between the Continuous Improvement and other variables may imply meditational relationship and this area can be investigated. Enterprise resource planning, ISO certification, firm age, and firm size can also be included as moderating variables in future studies. The reasons of and the barriers to Continuous Improvement practices and the reasons for such barriers can be investigated by using a proper categorization of DC mills as the technology uses in the Mills are different.

6.2.3. Research Limitations

The study used subjective statements and measures of performance which may not give accurate information to test the hypotheses. Moreover, on the other hand, survey did not ask for the names of the mills and respondents which caused which firms belong to which category such as the mills will differ based on the technology used. Anonymity of the mill and respondent in the survey may improve accuracy and completeness of the responses. Furthermore, for the study the sample size selected was very small (20) and it may not be sufficient to do a proper analysis to get a sound picture. Moreover, the method used to select the sample was convenience sampling where the sampling error and sampling bias are very high and those factors are having a contribution for the study results. Furthermore, the study asked for perceived data about actual practices and measures, but the respondents might have given desired data, which made brings up the mills to an elevated level. Sometimes the most of the respondents were non managers, who might not understand and answer the questions accurately. In addition, the sample does not selected to represent the whole Dc mills in the country and this would raise concerns about generalizability, reliability, and validity of the study.

6.3. Conclusion

The findings of this research need to be taken into consideration by giving due attention to the research limitations discussed under clause 6.2.3. However con It can be concluded that; factors like having a documented Quality Policy, reviewing of quality activities by top management, resolving of customer complaints effectively, maintains a rapport with customers ,price of products , cross functional teams, training and development, rewards and recognition schemes , creation of career paths for employees and consultation of employees when making crucial decisions are the areas need to be considered for improvement by the DC millers to have a continuous improvement within the DC mills.

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Table 7- DATA TABLE

												Data	Shee	et for Anal	ysies	5										
Respondent	То	p man	nagem	ent c	ommit	ment	5	Avg	-	Custome		r Focus		Avg	Employee Envolvement		Avg	continues improvement			Avg					
Respondent	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Avg	Q8	Q9	Q10	Q11	Q12	Avg	Q13	Q14	Q15	Q16	Q17	Avg	Q18	Q19	Q20	Q21	Q22	Avg
1	2	4	3	4	3	5	4	3.6	3	4	4	3	3	3.4	1	3	2	2	1	1.8	3	3	2	2	3	2.6
2	3	3	4	5	3	5	4	3.9	4	5	5	3	4	4.2	2	4	1	1	1	1.8	4	4	2	2	4	3.2
3	3	4	4	4	4	4	5	4.0	3	4	5	4	5	4.2	3	3	3	2	2	2.6	5	3	1	3	5	3.4
4	4	5	2	3	3	4	3	3.4	2	3	3	2	4	2.8	2	3	2	2	3	2.4	3	4	2	4	3	3.2
5	2	3	3	4	3	4	3	3.1	3	4	3	4	3	3.4	3	2	4	3	3	3	5	3	2	3	3	3.2
6	3	4	3	4	4	5	4	3.9	4	4	2	5	4	3.8	3	4	3	4	3	3.4	3	4	3	4	3	3.4
7	4	3	4	3	5	3	3	3.6	5	3	4	4	3	3.8	4	3	4	3	2	3.2	4	3	3	4	4	3.6
8	3	4	3	2	3	4	3	3.1	4	4	2	4	2	3.2	3	3	4	2	2	2.8	3	4	3	3	4	3.4
9	2	3	4	3	4	4	4	3.4	3	2	4	3	3	3	2	3	3	4	3	3	3	3	2	3	3	2.8
10	2	4	3	4	3	5	3	3.4	3	4	3	2	4	3.2	2	4	4	4	3	3.4	3	4	2	4	4	3.4
11	3	4	3	4	4	4	3	3.6	4	5	3	3	4	3.8	1	3	3	3	4	2.8	3	4	3	3	4	3.4
12	2	3	4	3	4	5	4	3.6	3	4	2	3	3	3	2	4	3	3	3	3	4	3	3	2	3	3
13	4	4	2	2	3	4	5	3.4	3	2	5	3	4	3.4	2	3	4	3	3	3	3	4	3	3	4	3.4
14	3	3	2	4	3	4	3	3.1	3	4	4	3	3	3.4	3	2	3	4	3	3	2	4	4	4	3	3.4
15	2	2	3	4	4	3	3	3.0	4	3	3	4	4	3.6	4	3	4	3	3	3.4	3	3	3	4	4	3.4
16	4	3	3	3	4	3	4	3.4	4	4	3	3	4	3.6	3	4	4	4	3	3.6	4	3	3	2	2	2.8
17	5	4	3	3	4	3	3	3.6	3	4	3	3	3	3.2	4	3	3	3	3	3.2	5	4	4	3	3	3.8
18	3	3	4	4	4	3	3	3.4	2	4	3	2	2	2.6	4	3	4	4	4	3.8	4	3	3	3	3	3.2
19	4	4	5	5	3	3	4	4.0	3	3	3	4	4	3.4	. 5	4	3	3	3	3.6	3	3	4	4	3	3.4
20	3	3	4	5	4	4	4	3.9	4	3	3	4	3	8.5	3	4	3	3	3	8	4	4	3	3	4	3.6

Figure 1 - Survey Questionnaire

Instructions: The following questions are designed to assess the approach to product quality. Please answer all questions based on facts on you know them, using informed opinion only when you don't have sufficient information.

How much you agree or disagree with each of the following statements? Circle the appropriate number

SD -	Strongly Disagree	D – Disagree	N/D- Neither Agree or Dis	agree								
A-	Agree	SA - Strongl	- Strongly Agree									
	Top Management			SD	D	N/D	Α	SA				
1.	Top management has do	ocumented a policy for qual	ity									
2.	Top management provid	es sufficient resources to in	nplement quality practices									
3.	Top management partici	pate in reviewing of quality	activities.									
4.	Top management has quality activities of the o	-	to enhance communication for									
					ı	ı						
5.	Top management part indicators for quality.	icipates in setting measu	rement and key performance									
6.	Top Management ensur for quality	es for procedural adherenc	e like follow of written practices									
7	T							1				
7.	Top management makes	s strategies for quality										
	Customer Focus											
8.	Company has a sound n	nechanism to resolve custor	mer complaints									
					1	T	ī					
9.	For any customer enqui	y company response promp	otly									
10.	Company maintains a go	ood relationship with custon	ners									
11.	Company considers the	price of products be afforda	ble.									
					•	•						
12.	Company ensures to co product	nsider the market situation	when changing the price of the									

		SD	D	N/D	Α	SA
13.	Company encourages for cross functional teams to solve quality issues					
14.	Training and development is an ongoing activity of the organization					
15.	Company practices rewards & recognition schemes.					
16.	Company organization structure provides sound career path for employees					
17.	Company always obtains the support of the employees when making decisions for quality related problems.					

Employee Involvement

	Continuous Improvement			
18.	Product recalls were in the decreasing trend.			
19.	Company revenue has increased during the last three years			
20.	Company uses quality tools & techniques in solving quality problems			
21.	Company has improved the production processes by adopting new technologies			
22.	Company uses quality auditing as a technique to identify problems and to initiate actions.			

Thank you for your cooperation & support.

ISO 20000 service management standard:

Motivations and key factors to implement

Cots, Santi 1) and Casadesús, Martí 2)

santi.cots@udg.edu
 Universitat de Girona
 Servei Informàtic.

marti.casadesus@udg.eduUniversitat de Girona

Departament d'Organització, Gestió Empresarial i Desenvolupament de Producte

ABSTRACT

Purpose - ISO 20000 (approved in 2005 and revised in 2011) defines the requirements for implementing a standardized service management system, adopting a form similar to the pre-existent general quality management standards while adapting its contents to standardize Information Technologies Service Management (ITSM) practices, although there is nothing to impede it being used in other service management fields. This article analyses the motives for and key factors in implementing the ISO 20000 Service Management Standard.

Methodology - This paper employs methodologies that have been previously used to study other standards (Casadesús et al., 2001; Gotzamani and Tsiotras, 2002). This way, the research is based on a survey that was answered by 105 ISO 20000 Spanish certified organizations. It enables the profile of these organizations, as well as their main reasons and key factors when implementing the standard, to be characterized.

Findings - Motives are divided into external and internal factors and, as such, reveal the predominance of external reasons when deciding to implement the certification. Furthermore, some key factors in successfully implementing the standard are highlighted, especially in terms of management and staff involvement. Moreover, other specific factors have also been analysed: such as the norms with those are it integrated, as well as the reasons as to why some organizations abandonment the certificate.

Originality/value - This article is the first one in the literature that two fundamental issues related to the implementation of ISO 20000 standard: the reason behind implementing the standard and what its adoption key factors are.

Keywords: ISO 20000, ITIL, ITSM, Management standards.

Paper type Research paper

INTRODUCTION

Most of the value delivered by Information Technology (IT) to users takes the form of services (Bitner et al., 2000), regardless of the definition of value that each decides to adopt (Davis et al., 2011). When IT services are produced by organizations, the management of those services becomes a necessity (Radovanovic and Sarac, 2011), at least for those who want to deliver them with quality.

Some organizations choose a formal and documented approach to their management activity through implementing a formal management system. Moreover, if the management system follows the requirements of a standard, it could be said that the organization has or owns a standardized management system. The benefits of standardized management systems have been broadly studied for the most widely-used standards; specifically ISO 9001 and ISO 14001 (Buttle, 1997; Casadesús et al., 2001; Gotzamani and Tsiotras, 2002; Casadesús and Karapetrovic, 2005; Psomas et al., 2011).

The service management standard ISO 20000 adopts a similar form to that of pre-existent general quality management standards, but adapting its contents to standardize the IT Service Management (ITSM) practices, by defining the requirements to implement such standardized service management systems.

As the standard has rapidly reached a mature level of diffusion (Cots and Casadesús, 2015) and in order to gain a deeper understanding into its impact, it would seem relevant to now analyse the motivations and the key factors of deploying IT service management systems by organizations who have actually obtained ISO 20000 certificates. To this end these aspects are analysed in this article.

The study is organized as follows: first, in section 2, ISO 20000 is introduced and contextualised within the framework of norms and standardisation, after which the research questions are posed in section 3. The methodology designed is described in section 4, and the results obtained are presented from section 5 onwards: in section 5 the motivations for implementing the standard are analysed, in section 6 the key factors in its implementation process are explained and in section 7 how ISO 20000 is integrated with other standardised management systems is examined. The conclusions of the study are presented in section 8.

STANDARDISATION AND ISO 20000

The phenomenon of 'Management Standards' has been widely diffused as exemplified by the widespread use of ISO 9001, aimed at defining the characteristics of a standardized quality management system, and of ISO 14001 which focuses on environmental management systems (Marimon et al., 2006; Castka and Corbett, 2015).

Beyond general purpose management standards represented by, but not limited to, the standards mentioned above, a growing collection of sectorial or specific standards aimed at guiding more specific aspects of management, standards such as ISO 26001 (Corporate Responsibility Management System), ISO 50001 (Energy Management System), etc., have been developed.

Additionally, a common threat of most management standards is that they are auditable. This auditability characteristic means that anyone qualified can check an actual management system against the standard's requirements by using a procedure called 'audit', and, in need be, declare compliance with the standard.

Thus, independent organizations specialized in carrying out these audits, ruling on compliance and issuing the so-called "certificates" have emerged. It is important to stress how a certificate relies on the prestige of the issuer and that it is only issued when compliance with the standard is complete i.e. certifying "partial" compliance is not possible.

Within this framework, ISO 20000 is the international standard that defines a service management system. The standard originated in the desire to establish a management model for Information technology (IT) services, meaning it could be referred to, at least in its beginnings, as a sectorial standard. However, there is widespread opinion that ISO 20000 also seeks to define a model that is applicable to many other sectors, to

transform itself from a sectorial standard to a specific but multi-sectorial one for management services beyond IT (Cots and Casadesús, 2013).

ISO 20000, which was based on the pre-existing British norm BS 15000, was officially approved by ISO in 2005. The latter was adapted to become an international norm using the procedure known as 'Fast-track', which allows the test period to be shortened under certain conditions.

Since the first document, ISO 20000 has been progressively extended with the editing of different documents or parts. Of these, only the first establishes the requirements needed for a management system and so is the only one that serves as a basis for a certification audit. Table 1 shows the current set of documents that conforms the whole ISO 20000 standard.

Table 1 Current documents of ISO/IEC 20000 series

Document	Name
ISO/IEC 20000-1:2011	Part 1: Service management system requirements
ISO/IEC 20000-2:2012	Part 2: Guidance on the application of service management systems
ISO/IEC 20000-3:2012	Part 3: Guidance on scope definition and applicability of ISO/IEC 20000- 1
ISO/IEC TR 20000-4:2010	Part 4: Process reference model
ISO/IEC TR 20000-5:2013	Part 5: Exemplar implementation plan for ISO/IEC 20000-1
ISO/IEC TR 20000-9:2015	Part 9: Guidance on the application of ISO/IEC 20000-1 to cloud services
ISO/IEC TR 20000-10:2015	Part 10: Concepts and terminology
ISO/IEC TR 20000-11:2015	Part 11: Guidance on the relationship between ISO/IEC 20000-1:2011 and service management frameworks: ITIL®

ISO 20000 IN SPAIN AND RESEARCH QUESTIONS

Historically, Spain has been a leader in implementing management standards, such as ISO 9001 and ISO 14001 (Casadesús et al., 2001, 2008) and, in a similar way, ISO 20000 (Cots and Casadesús, 2015). Given that this article is based on the analysis of certified companies in Spain, it is important to briefly set in context the specific characteristics of this country in relation to the standard under study.

First, the fact that in Spain, like in other countries, there is a company whose various roles include carrying out functions of normalisation (the creation of standards) must be taken into account. This company represents the Spanish position and proposals in relation to ISO, and at the same time acts as a certifying entity in the market. In the case of ISO 20000, it can be easily estimated that the quota of certifications issued by the aforementioned company is more than 50% of the total issued in Spain. Another important factor, which could differentiate Spain from other countries, is that for some years there were official programmes that facilitated obtaining certification, which could have encouraged companies who would otherwise not have opted for achieving certification to do so.

In all, it seems that a thorough study of the motivations and key factors in implementing ISO 20000 in Spain is sufficiently representative and can be extrapolated to other markets once the differential characteristics have been considered.

It would seem even more salient, then, to pinpoint and highlight the fact that at the time this study was undertaken, the standard had been in force for just eight years, during which time its diffusion had been rapid but limited (Cots and Casadesús, 2015).

Regarding the motivations and key factors in implementing a specific standard like the ISO 20000, even though they are the same of mature global standards, the degree of influence of each of them may be different for that of this young and specific standard must be considered. Furthermore, they may even have varied according to the evolution of society itself or to the phenomenon of standardisation.

Thus, studying the motivations and key factors in implementing a standard like ISO 20000 could provide information not only on the standard itself, but also on the standardisation of management in general and its evolution.

Finally, one valuable characteristic of some management standards is the possibility of integration or integrated installing (Karapetrovic et al., 2006; Simon et al., 2012) in which a single and holistic management system conforms to several standards by fulfilling all their requirements.

As integration has a lot of advantages, ISO is currently in the process of reviewing all its management standards so that they will share a common form, which will make them much easier to integrate and assist integrated audits. While most of the previously cited standards have undergone this revision process and have already taken on the new structure, ISO 20000 will have to wait until its next revision, scheduled for about 2018, to do so. It is within this framework that questions about how this standard is currently integrated, or not, with others that are implemented within the organisation must be asked.

EMPIRICAL STUDY: METHODOLOGY

The main contribution of this article is based on field work that aimed to discover the motivations and key factors in implementing ISO 20000 through the experience of certified companies. To do so, the methodology previously tested by (Casadesús et al., 2008) is used.

To investigate the perceptions of the organisations that have obtained a certificate based on ISO 20000, it was decided that those responsible for it within the companies should be surveyed. To this end, after having revised the existing literature on ISO 20000, a research framework and specific questionnaire were designed. Only one previous study with a comparable objective and methodology, although rather more limited in scope, was found (Disterer, 2012). Existing studies on ISO 9000 and ISO 14000 were also considered to be basic references (Buttle, 1997; Corbett et al., 2003; Karapetrovic et al., 2006, 2010).

In order to decide which concepts would be analysed and which questions would be formulated, all of the questions posed in the research of Buttle (1997), Corbett et al. (2003) and Disterer (2012) were systematically gathered. In this way, a relationship between the questions and categories to be analysed regarding motivations, implementing the standard and obtaining a certificate were established. Those that concerned similar, identical or globalised concepts were grouped together to create a new, unified list of questions which, in one way or another, included all of the concepts from the references. A Likert-type 1-5 unipolar scale of categories (Cañadas and Sánchez, 1998) was used to collect the answers.

In order to study its integration with other standards, those that were considered to be relevant to ISO 20000 (ISO 9001, ISO 14001, ISO/IEC 27001, ISO 22301, ISO 31000, ISO 38500, COBIT, ITIL) were selected, including the most widely-diffused standards worldwide and also the main ones from the IT sector or this area (security, continuity).

It was decided that the questionnaire would be conducted through the individualised web formula where a personalised link is sent to each participant using a web platform. That way, the status of each answer could be monitored while ensuring that nobody outside the selected population could input questions into the system.

Once an initial questionnaire was designed, a panel of 8 reputable experts were selected to validate the content of both the questionnaire and the platform. Three of these were academics who had carried out similar studies on other standards at some time previous, and the other 5 were experts from itSMF Spain and distinguished members of the sector with excellent knowledge of the norm in question.

For the study, the aim was to send the questionnaire to a discerning individual in a position of responsibility (CEOs, CIOs, quality assurance managers, or similar) in each of the companies that had obtained an ISO 20000 certificate in Spain at some point.

Table 2 outlines the data of this study, highlighting the answer ratio of 70% that represents the 105 questionnaires answered out of the 149 sent, which is probably a reflection of the participants' interest in the matter and of our insistence sending reminders by email and making personal phone calls. The gap between the estimated population and the study sample comes from the impossibility of contacting with some companies or even because some formerly certified companies no longer exist. The maximum error of +6,32% assuming normality, based on the approximated population and the number of answers with 95% reliability received, confirms the representability of the results.

Table 2 Characteristics of the study

Date	May to July 2013 (3 months)
Population (estimated)	186 companies
Study sample	149 questionnaires sent
Valid answers received	105 answers received
Answer ratio	70.46%
Maximum error (p=q=0,5)	± 6.32%

Finally, note that during the data treatment process (September-October 2013), several of the participants were contacted via email to verify data that, a priori, seemed to be incoherent (such as dates that did not tally). Where participants answers were able to clarify one of the aforementioned inconsistencies, the register was corrected accordingly.

MOTIVATIONS FOR IMPLEMENTING ISO 20000

To find out the level of agreement regarding the possible motives that lead the companies surveyed to seek and obtain ISO 20000 certification, a list of motivations grouped into related concepts and based on the literature were proposed to them.

Figure 1 is a summary of these motivations ordered according to the average of the answers received for each, on a Likert 1-5 scale. The average value for each of the answers gives us a good idea of what the predominant motivation for most organisations were. Observe how only audits have a below average agreement value (low to medium).

Figure 2 is a graphic overview that gives us a deeper understanding of how the answers are distributed. For example, it shows that although user satisfaction and competitive advantage have valuation averages that are virtually the same, in the first there is a higher consensus as nobody expressed no or very low approval, whereas there were some opinions of this kind when participants were asked about competitive advantage as a motivation.

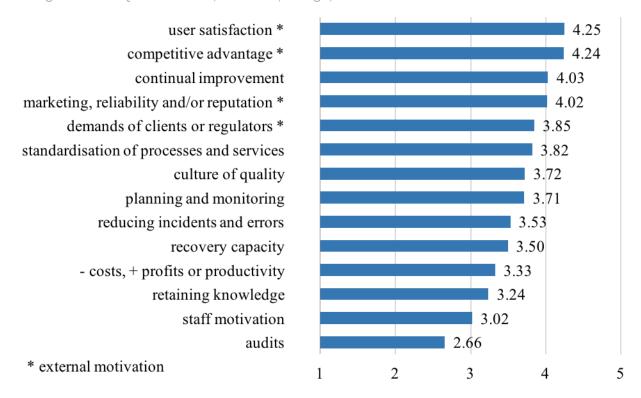


Figure 1 Motivations

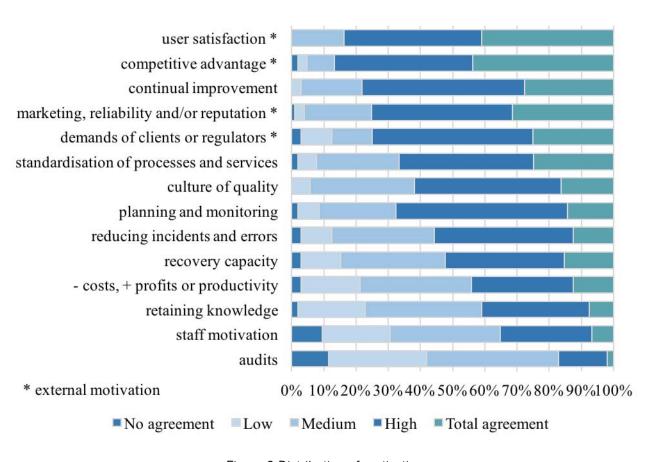


Figure 2 Distribution of motivations

A usual classification of motivations, and one that was used previously by Buttle (1997) to study the motivations for implementing ISO 9000, suggests grouping them into internal and external motivations. Internal motivations are those that are directed towards making development and improved organisation possible, whereas external motivations refer to promotion and marketing, pressure from clients or other entities or increases in market shares, to give some examples.

Although, of course, participants were not informed about this classification, and neither was a specific order followed or grouping made in the questionnaire, the external motivations were marked with a "*" in this paper figures.

While one type of motivation is as legitimate and respectable as another, it is usual for companies to have their own mix of the two types of motivations. It is also true that the list of internal motivations suggested is longer than the list of external motivations, as it was in the reference studies used.

Starting the analysis of motivations with the external ones, it can be seen how user satisfaction just has the highest consensus. The very nature of the norm and the services is sufficient to explain why user satisfaction is a key motivation, if not the main one, in taking a decision like implementing a standardised management system for managing the company's services. There is almost the same degree of consensus for competitive advantage. It seems reasonable to assume that the relative youth of the norm at the time of the study fostered a much more accentuated perception of competitive advantage among the first companies to adopt it than there would have been in a more mature market where most of the sector had already implemented it. Thus, if the implementation of the norm becomes generalised, as have enormously successful standards such as ISO 9000, the motivation of competitive advantage would be expected to be progressively substituted by the demands of clients or regulators, which currently features as the last of the external motivations (while still way ahead of most of the internal ones).

In any case, the four affirmations that encompass external motivations feature among those with the highest agreement, allowing us to confirm that, in general, the initial motivations for obtaining ISO 20000 certification are external.

At the opposite extreme, the least valued motivations were found to be those linked to staff motivation and especially audits.

IMPLEMENTATION OF ISO 20000: KEY FACTORS

It is pertinent to analyse the key factors involved in successfully implementing the management system and its later external certification. Tacitly identifying obtaining certification with success, as all of those surveyed represent certified companies, we can assume that they have been successful in this area. Thus, their opinion, based on experience, must represent the factors that are key to success.

Figure 3 shows the average opinions of participants with respect to seven success factors. The degree of concordance for all of them is quite high, such that they can all be confirmed to be success factors. Most of the factors have a degree of agreement within the range of 3.5-4, on a scale of 1 to 5.

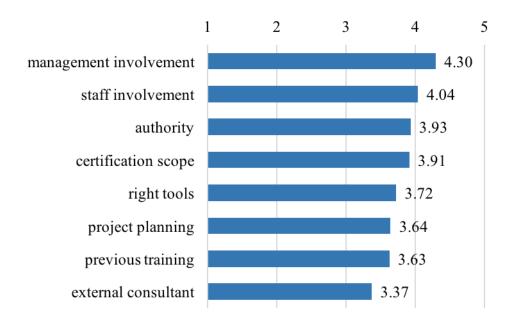


Figure 3 Key factors for successful implementation

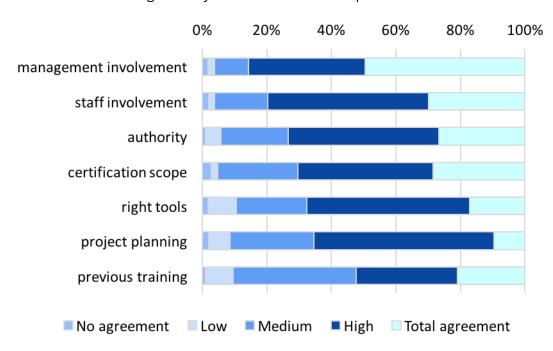


Figure 4 Distribution of key factors for successful implementation

Staff, and especially management, involvement stand out with a very high degree of concordance. In fact, it can be seen in the distribution shown in Figure 4 how approximately 50% of participants totally agree that management involvement is a key factor.

Regarding the need for a good consultant to undertake the project, even though on average it appears to be a less determinate factor than the rest, it is important to note the dispersion of the answers here. The fact that there are certain companies that successfully achieve certification without turning to external consultants for assistance makes the average for this success factor quite low. On the other hand, many participants either totally agreed or highly agreed with this factor, more so in fact than for previous training. It must be pointed out that in the open field of the questionnaire a couple of participants highlighted the role of consultants or

auditors as key success factors, thus recognising the importance and value of these figures in their specific cases.

It can also be observed that staff involvement is considered to be key to success in this type of project, despite staff motivation not being one of the objectives that stand out for obtaining certification.

INTEGRATING ISO 20000 WITH OTHER STANDARDISED MANAGEMENT SYSTEMS (SMS)

The joint and simultaneous use of different systems in a single management system is generically known as integration or integrated implantation. Additional benefits are normally obtained from this type of integrated system thanks to the synergies and optimisation of the management itself (Karapetrovic et al., 2006; Bernardo, 2012). The use of integrated management systems is a form of efficient organisation that is highly beneficial to those who use them (Casadesús et al., 2011).

The capacity to integrate with certain ease is a characteristic required by all standards. It adds value to some standardised management systems and is actively pursued by organisations like ISO who facilitate integration with each successive version of the norms. Consequently, many standards increasingly tend to use more common and/or compatible structures as they are revised and/or reedited.

At the same time, integration itself, or the knowledge and eventual use of other standards, can indirectly serve to characterise different organisations. There are organisations that are more clearly inclined towards standardised management, that feel comfortable following this type of norm and consider them to be part of their arsenal, while other companies do not display this tendency or have only recently started up and are in the process of maturation. Evidently, not all of the standards offer the same value, nor are they applicable to all organisations. Each potential user must be aware of what standards are available and decide which of them will provide solutions that meet their individual needs.

Thus, in a scenario where different standards, reference frameworks, etc., could be used, organisations can take different stances. For the purposes of this study, it was decided that these would be graded from one end of the scale whereby the organisation ignores the existence of standards (either because they do not know about them or as a conscious decision) or simply considers that their area of application has no place for them, to the other end of the scale whereby the organisation decides to make fully integrated use of them and obtain certification in the same standardised management system, as has been done for ISO 20000.

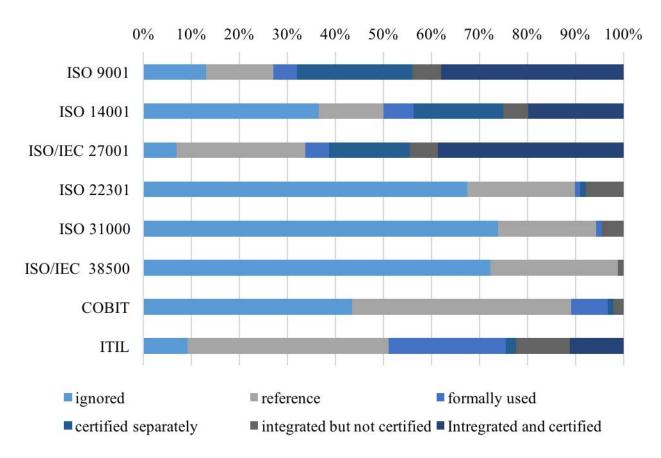


Figure 5 Integrations with ISO 20000

Somewhere on the scale a position can be found where the norm is used as a reference (that is, it is taken into consideration in some way). Another position can be found where the norm is used formally but without certification, another where a standardised management system has been implemented and separately certified, another where the norm is formally integrated with the ISO 20000 management system, but no certification is sought for the additional norm, and finally, another where both (or more) are integrated and certified together.

To find out the state of integration, a list of norms and common standards in the sector was proposed: ISO 9001, ISO 14001, ISO/IEC 27001, ISO 22301, ISO 31000, ISO/IEC 38500, COBIT and ITIL.

However, not all of the standards proposed in the study are certifiable. Answers for all of the categories of integration and standards were admitted, although some of the possibilities were not formally possible. In fact, the number of answers that affirmed formally unviable degrees of integration for some standards is significant and requires an analysis of the specific causes. Apart from the odd erroneous answer, some participants may not have been completely clear about the concept of integration or the market (consultants) may even have fomented a specific idea of the non-certifiable standards, which would have contributed to this confusion.

In any case, leaving aside the 'false integrations' it can be affirmed, as illustrated in FIGURE 5, that there are a large number of organisations that use ISO 9001, ISO 27001 and, to a lesser degree, ISO 14001 in an integrated way with ISO 20000, or who maintain separate certificates. The use of ITIL is also very widespread, as was expected given its popularity in the sector and its close relationship with ISO 20000.

Finally, in an attempt to find out which norms are used in the sector and, at the same time, to better identify companies with a normal experience, participants were asked to identify which other standards they use. These are shown in Table 3.

Table 3 Other standards used

Standard or norm	Answers
ISO 15504	7
CMMI	7
UNE 166002	3
EFQM	2
UNE-EN ISO 14006	1
PECAL 2110 y 2210	1
OHSAS 18001	1
PMBOK	1
MOF	1

As can be seen, the standards most often mentioned correspond to the field of software development, while among the special cases some very specific standards or norms can be found, such as military regulations.

CONCLUSIONS

First, it must be stated that a wide vision of the motivations and key factors in implementing ISO 20000 has been offered in this study, by means of comparing it with other standards.

Apart from the large number of answers received, and taking the existing population into account making the data highly reliable, the first conclusion concerns the motivations in implementing ISO 20000. It can be concluded that external motivations are key in the decision to initiate the process of implementing a standardised service management system. In other words, motivations related to service users, image and competition.

Regarding the implementation process through which those who manage to achieve certification pass, the importance of the human factor, in the form of management involvement and in particular staff involvement, must be mentioned. The strong relationship between ISO 20000 and ITIL also seems to be foremost for those that implement the standard, although this could become a weakness when ISO 20000 is implemented in other sectors outside IT.

This relationship with other standards becomes particularly pertinent when we see that more than half of companies with ISO 20000 certification also have ISO 9001 and/or ISO 27001 certification, mostly in an integrated management system. 35% have ISO 14001 certification, half of them integrated.

Clearly, this high percentage of companies with other certifications allows us to define two types of organisations according to their experience or relationship with other standardised management systems. Without doubt, this study is a reflection of a certain moment in time, of a norm that is still very young, thus allowing the findings made here to serve as a reference for future developments in this field.

In any case, the last conclusion is, in fact, to state that this is an open area of research and knowledge and it is hoped that this small contribution, along with others, will serve as a springboard for future advances that will allow us to continue to widen our knowledge within the field of service management and standardisation.

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Exploring TLS approaches: A review

Dias, R.1,2) and Tenera, A.2,3)

1)Industrial Engineering PhD Student and Operation Manager of Amorim&Irmãos, S. Maria de Lamas, Portugal.

2) Faculdade de Ciências e Tecnologia (FCT), Universidade NOVA de Lisboa (UNL), Lisbon, Portugal 3) UNIDEMI, Department of Mechanical and Industrial Engineering, Caparica, Portugal

ABSTRACT

Purpose

This paper gives an overview on the three methodologies of Continues Improvement, Theory of Constraints, Lean and Six Sigma designated in the literature by TLS models discussing the identified different integration frameworks developed at this moment.

Design/methodology/approach

A literature review of Theory of Constraints, Lean and Six Sigma was conducted to provide a comprehensive understanding of each approach. Current integration models were then identified studied and discussed, This discussion enabled the identification of some weaknesses and the imposed further work on the development of a new proposed framework, later tested through a case study.

Findings

The research work reveal differences and convergence points between Theory of Constraints, Lean and Six Sigma continuous approaches. Seven different integration models were identified and discussed revealing the opportunities for integration improvement. This paper presents a different improved integration framework

Originality/value

This paper present an overview of the current TLS frameworks highlighting major convergence points and current weaknesses and discusses the main current integration models presenting a hands-on new approach, simple, flexible and capable to improve integration and companies results

Keywords: Business and Management, Theory of Constraints, Lean, Six Sigma, TLS integration models and Frameworks

1. INTRODUCTION

Over the years, the markets have become more competitive due to its globalization, the boomed development of technology and knowledge, as consumers become more and more demanding for consistent quality of products and services, priced according to what they were willing to pay, requiring not quality but also variety from products, process delivery and services.

Therefore over the years organization have been trying to give answers to these requests and even often anticipating the expectations of its customers. From this needs three management philosophies stand outs on manufacturing and service systems, namely: Lean Manufacturing (Womack, 1990), Theory of Constraints (Goldratt, 2004) and Six Sigma (Nair et al, 2011).

Theory of Constraints (TOC) introduced by Goldratt and Cox (2004) postulates that every organization has at least one constraint which limits the organization's overall performance according to its goals. Six Sigma (Nair et al, 2011) originally addressed the company's chronic problems of meeting customer expectations in a cost-effective manner, focused on the variation elimination in order to achieve immediate cost savings. Lean Manufacturing (Womack, 1990) received public attention advocating a systematic focus on the elimination or at least on the reduction of all sources of organizational "MUDA" e.g. elimination of all possible ways of waste.

In recent years there have been several academic and professional efforts to combine these three management philosophies using different models and based frameworks commonly known as TLS systems that will next be introduced and discussed. This work present an overview what has been the integration efforts, exposing and discussing seven identified frameworks and models and to proposed an hands-on way to improve TLS integration results.

2. THEORY OF CONSTRAINTS, SIX SIGMA AND LEAN MAIN CORE CONCEPTS

2.1. Theory of Constraints (TOC)

The basic concept of TOC is often introduced through the chain analogy, where the chain is only as strong as its weakest link. So, any improvement that does not improve the performance of the weakest link most likely will not improve the system and can be considered waste. Many claim that TOC is just common sense, but it is not so common practice. Introduced in the mid 80's (Goldratt, 2004) the TOC advocates that TOC is more than a system to finding bottlenecks being mostly about how to improve and manage the system constraint performance in the global context, trying to achieve overall system improvement and not just localized improvements. So, TOC is about system focus, first on the system's leverage points and then on how all parts of the system impact the operation of the leverage points. TOC applies its owned visual logical thinking processes based on classical sciences logic – cause and effect – to understand and improve systems of all types, but particularly, organizations, using for system diagnosing and change a three core questions logic, namely: 1) What to Change, 2) What to Change To, 3) How to Cause the Change.

Therefore, TOC methodology uses five classical steps in system improvement (Kasemset, 2011):

- 1. Identify the constraint: The constraint is identified through various methods.
- 2. Exploit the constraint: Once the constraint is identified, the process is improved or otherwise supported to achieve its utmost capacity without major expensive upgrades or changes.
- 3. Subordinate other processes to the constraint: When the constraining process is working at maximum capacity, the speeds of other subordinate processes are paced to the speed or capacity of the constraint.
- 4. Elevate the constraint: If the output of the overall system is not satisfactory, further improvement and changes are required. Changes can involve capital improvement, reorganization or other major expenditures of time or money.

5. Repeat the cycle: Once the first constraint is broken, another part of the system or process chain becomes the new constraint. Now is the time to repeat the cycle of improvement.

2.2. Six Sigma (6Sigma)

From the business world, six sigma, born at the end of 80's in Motorola is defined as a 'business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer's needs and expectations. First applied in manufacturing operations rapidly expanded to different functional areas such as marketing, engineering, purchasing, servicing, and administrative support, once organizations realized its benefits, mostly when organizations were able to articulate the benefits of six sigma presented in financial returns by linking process improvement with cost savings. (Antony and Banuelas, 2002b)

Like TOC, Six Sigma also includes a five process improvement logic steps known as the DMAIC Cycle:

- 1) Define (D): Typically in this stage a team is assembled, a project charter is developed, customer Critical to Quality requirements is defined and a process map is created. The charter will clearly define the business case for doing the project, state the problem, define the scope, set goals and milestones and spell out the roles and responsibilities of team members. In identifying the *Critical to Quality issues (CTQ's)* customer characteristics that have the most impact on quality must be define. Then, the process map, called SIPOC (Suppliers; Inputs; Process; Outputs; Customer), defines a high level process map of the project focus).
- 2) Measure (M): In this step we define what to measure develop a data collection plan and perform a baseline capability study to calculate the baseline sigma.
- 3) Analyze (A): It is important not to jump to improve before verifying why the problem exists. So, the main areas to look for causes of defects are identified by Data Analysis; Process Analysis and ultimately Root Cause Analysis.
- 4) Improve (I): This step takes all the data from the D, M and A steps and develops, selects and implements solutions that will reduce the variation in a process.
- 5) Control (C): Sustains the new process through an expected robust monitoring plan.

2.3. Lean

Lean approaches has move from original Ohno (1998) perspective of removing non value added waste operations, or MUDA to its five classical principles (Montgomery, 2010) :

- Specify Value: The critical starting point for lean is value. Determination is usually made from the internal and external customer standpoint. Value is expressed in terms of how a product meets the customer's needs, at a specific price, at a specific time.
- 2) Identify the value stream: Value Stream Mapping is a process to detail and analyze the flow of material and information to bring a product or service to the customer. We need identify activities that add and not add value. In this step we need eliminate activities not add value, this activities is something that takes time, resources or space and does not add value to the product, and thus adds no value to the customer.
- 3) Create Smooth Flow: Flow is the uninterrupted movement of product or service through the system, to the customer. Creating smooth flow can dramatically reduce lead time and waste.
- 4) Pull Flow: Pull is the opposite of Push. Pull work with the demand of costumer, we product only when de costumer want, and what he want. Not before, not after.
- 5) Pursue Perfection: The process of improvement never ends. We need every time analyses the processes, cut no add value activities and satisfy customers.

The lean approaches also use some core system assumptions (Montgomery, 2010):

- People value the visual effect of flow.
- Waste is the main restriction to profitability.
- Many small improvements in rapid succession are more beneficial than analytical study.
- Process interaction effects will be resolved through value stream refinement.

3. TLS MAIN INTEGRATION EFFORTS

The importance of the three introduced management approaches come mostly from standalone base implementation obtained gains and successes accomplished, creating the need to explore their complementarity and gaps in order to further improve further productive systems performance results. These efforts, more than just assess convergence and complementarities, sought essentially to its integration in a more consistent framework. In Table 1 the convergence and complementarities assessment main results available are synthesized and exposed.

Table 1 - Six Sigma, Lean and TOC comparative results (Sproull, 2010; Stamm et al, 2009; AGI – Goldratt Institute, 2009;

Pirasthe and Farah, 2006)					
Program	Six Sigma	Lean Maufacturing	Theory of Constraints		
Theory	Reduce variation	Remove Waste	Manage Constraints		
Origen	Smith Motorola and General Electric	Toyota (Toyoda, Ohno and Shingo) and NUMMI (Womack and Jones)	Goldratt		
	1. Define	1. Identify alue	1. Identify constraints		
	2. Measure	2.Identify value stream	2. Exploit constraints		
Aplication Guidelines	3. Analyze	3. Flow	3.Subordinate processes		
	4. Improve	4.Pull	4. Elevate constraints		
	5. Control	5.Perfection	5. Repeat cycle		
Focus	Problem focused - Redution of variation	Flow focused - value (material and information)	Systems constraints		
	A problem exists	Waste removal will improve	Emphasis on Speed and		
Assumptions	Figures and numbers are valued	business performance	volume		
Assumptions	System output improves if variation	Many small improvements are	Uses existenting systems.		
	in all processes is reduced	better than systems analyses	Process interdependence		
Primary effect	Uniforn process output	Reduce flow time	Fast Througput		
	Less Waste	Less variation	Less inventary/Waste		
	Fast Througput	Uniform output	Througput cost		
	Less inventory	Less inventory	accounting		
Secondary effects	Flutuaction - Performance	New accounting system	Througput - performance		
	measures for managers	Flow- performance measures	measurement system		
	Improved quality	for managers	Improved quality		
		Improved quality			
Criticism	System interation not considered	Satatiscal or system analysis	Minimal worker imput		
Criticisiii	Process improved independently	not valuated	Data analysis not valued		
Finantial Impact	Reducing operating costs	Reducing inventory and operating costs	Improve Througput		
	Organizational struture with	Pull, takt time, heijunka, one			
Distinguishing and value adding	improvement experts(black belt and	piece flow, value stream mapping,	Focus mechanism on constraints		
contribution	grean belt), project oriented,	respect for people	, Totas mechanism on constraints		
	quantification of cost saving	respect for people			
Implementation	Medium difficulty	Less difficulty	Major dificulty		
Management level	Middle management and technical level	Workers	Top Management		
Effect on the variation	Reduces	Reduces	Absorbs		
Aspects of the process	Accurate statistics tolls. Specific	Management of the workflow by	Specific metric accounting. Systematic		
Aspects of the process	terminology. Specific experts estruture	JIT. Optimization	focus on constraints		
Lot sizes	Does not mention	Small batches in the whole system	Larger lots for contraints and smaller for no bottlenecks		
Control of production	Does not mention	Kanban triggers the release of product	The Drum-buffer-rope methodology is used to release materials		
Production planning	Does not mention	Detailed planning of the final output. The other operations are	Detailed planning for the restriction and less detailed for no bottlenecks		

According to Nave's work (Nave, 2002) continuous improvement methodologies using common concepts and tools aimed at common objectives. However, the approach to the problems is made from different perspectives. For this author as reached the secondary effects of each program, the secondary effects of the one are similar to the primary effects or Focus of the other. Extending the fundamental philosophy through each methodology's primary, secondary and tertiary effects, it might be concluded that each strives to achieve similar results. Even along the journey, each continuous methodology incorporates the primary effects of other improvement programs. Sproull (2010) utilizes the same approach of Nave but add a financial impact. Stamm, Neitzert and Singh (Stamm et al, 2009) give an overview of the origins, the focus and the aspects that are in the opinion of the authors distinctive, based on the analyzed body of literature and own experience. Pacheco (2011) based on Naves analysis complements it introducing specific productive aspects from production system. Later, Moura (2012) introduces the complementarity between the various approaches which is presented in the form of aid thus visualizing how each of the programs can help close the gaps of each other.

From the antagonistic perspective there are also several aspects that if not handled carefully diminish the gains the organization can achieve from their improvement efforts (AGI Goldratt Institute, 2009). For example Dettmer (2001) analyzing the differences between Lean and TOC classify them as major and minor differences and, highlights as major differences: a) how each treats variability and uncertainty; and b) how each treats the costs. For minor differences (considered easier to reconcile) highlights that: lean approaches incorporates major elements of what has come to be known as "Total Quality Management (TQM) principles and concepts, emphasizing product and process "perfection" or quality. But wherever TOC doesn't address quality, per se, assumes either: a) quality is not the overriding constraint of your system at the moment; or b) quality will be identified as the overriding constraint in the first of the Five Focusing Steps.

Other main differences recorded between Lean Manufacturing and TOC, in particular, relates to the production rate. Lean utilizes Takt time, the rate at which you need to produce to meet customer demand, and then attempt to balance resources and equipment to that rate. On the other hand the TOC approach believes that there is a constraint in every system, and the constraint dictates the output of the organization. So, TOC approaches have some sprint or protective capacity on non-constraints to ensure that the constraint can be exploited to the fullest extent possible.

Another subtle difference in applying TOC or LSS to a system is how material is released into a system. Both systems are pull systems based on responding to customer demand. The main difference is that the TOC signaling method is based mostly on time while the LSS method is based on inventory. So, TOC uses a Drum- Buffer-Rope (DBR) (Figure 1) method in which a signal is sent to the constraint for scheduling purposes to meet a shipping request, and a signal is sent from the constraint to the beginning of the line (production control) for timing the release of material. In LSS approaches the signal to produce is called Kanban which sends an upstream link by link as material is pulled to satisfy and protect customer requirements until all supermarkets needing replenishment are filled (Figure-2).

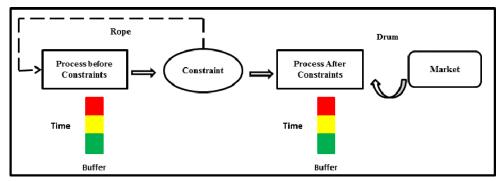


Figure 1: TOC Drum Buffer Rope (DBR)

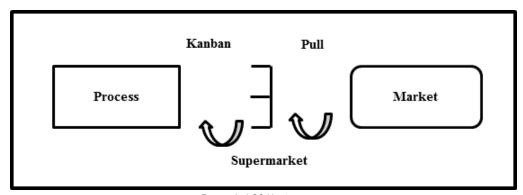


Figure 2: LSS-Kanban

Another understated difference between TOC and LSS is in the size determination of raw material and finished parts inventories and in the mechanism for triggering the need to resupply them. In a traditional replenishment system the size of the parts inventory is based on a min or max type of system with the reorder point to resupply based on a pre-determined physical quantity remaining often known in LSS systems as reorder point. TOC sizes the buffers based on demand patterns during the Time to Reliably Replenish (TRR). The TRR includes a fixed reorder time interval (e.g. once a day, once a week, etc.) and that time interval is the signal to resupply the parts inventory with what has been consumed.

Nevertheless these aspects there are many synergies between the approaches as exposed. They are all customer focused and want to provide the best value for the customer (AGI – Goldratt Institute, 2009). As also stressed these three business improvement approaches are not totally exclusive of each other and are, mainly, complementary. The Constraints management approaches are systems based way of thinking to determine where the organization should focus its efforts, and in short can be used to focus on the right problem and the right solution at the right time in the right place. Lean and Six Sigma tools and techniques can then applied where they will drive the most benefit—eliminating waste and reducing variation at the constraint (Stamm et al, 2009).

Industrial improvement efforts over the past 20 years have been handicapped by quarrels concerning the relative merits of the different approaches and of the supposed incompatibilities or fundamental differences among them. TLS (TOC, Lean and Six Sigma) view considers, on the contrary, that we should seek to combine them thereby creating a system that contains the best aspects of each movement (Kwak and Anbari, 2006). No individual improvement methodology has the definite cure for all organizational diseases. So, a solution is needed that combines the best contributions from each of them (Pacheco, 2011) and a hybrid system of the three approaches should be potentially more robust and more productive than either one alone. Consequently, the TLS process should solves the problems with continuous improvement programs and enables the tools to work together harmoniously to get the bottom line results demanded by management. The goal of TLS continuous improvements process is to make the CI organization a source of profit, engaged with the organization 's goal and strategies designed to create improvements that matter to the health and competitiveness of the organization (Woeppel, 2009).

4. TLS FRAMEWORKS DISCUSSION

The origin of TLS (TOC, Lean and Six Sigma) designation could be attributed to Pirasteh and Farah (2006). Since that work several books on TLS have been published and currently exists several other TLS supporters and developers around the world (Sproull, 2010; Pacheco, 2011; Sproull and Nelson, 2012; Moura, 2012). Although Nave (2002), does not worked on developing a framework for the integration of methodologies, he took the first steps to make this possible by recommending a series of procedures that facilitate this integration work. In the area of business consulting, many companies are already working with TLS systems using some of framework now developed and add some particular

innovation, as presented and discussed in following sections. In order to enable the integration of different methodologies, Nave (Nave, 2002) proposed a model that identifies a hierarchy of cause and effect relationships. First, identify the primary theory. What is the core emphasis of the program or methodology? This core emphasis is usually a few words or a short phrase: Six Sigma's is variation reduction, lean's is waste reduction and TOC's is constraint reduction.

Then identify the relationship between the primary theory and the primary focus of the tools and methodology. This relationship indicates how the primary theory manifests itself in tangible results —what I call the primary effect. This is an if/then type of relationship:

- For Six Sigma: "If we focus on reducing variation, then we will have more uniform process output."
- For Lean: "If we focus on waste removal, then flow time will improve."
- For TOC: "If we focus on constraints, then throughput volume will improve."

The next and last level of the model identifies secondary effects. Secondary effects can be described by using an if/theory and primary effect/results type statement. While the primary theory to primary effect relationship is usually one-to-one, the secondary effects are several-to-many, including:

- For Six Sigma: focus on reducing variation and achieving uniform process results in less waste, less throughput time and less inventory.
- For Lean: focus on waste and flow time results in less variation, uniform output and less inventory.
- For TOC: focus on constraints and increased throughput results in fewer inventories and a different accounting system.

Each improvement methodology appears to be driving toward common tools and concepts. However, different methodologies begin the journey from different perspectives. At the secondary effects level of the model, the results from each methodology start to look similar. Many of the secondary effects of one methodology look similar to the primary effect or focus of another methodology.

The selection of the main process improvement approach is dependent on the culture of your organization, for example:

- If your organization values analytical studies and the relationships of data, charts and analysis, Six Sigma is a perfect program for you to start with.
- If your organization values visual change and right now time, then lean thinking might be the way to go.
- If your organization values a systems approach where total participation is not desired and if it values the separation between worker and management, then TOC might be a good way to start.

4.1. The iTLS Model

The iTLS method (Figure-3), presented by Pirasteh and Fox (Pirasthe and Fox,2010) combines various aspects of the TOC, Lean, and Six Sigma processes. This method emphasizes long-term improvement by first identifying the main problem, measuring possible success, highlighting specific aspects, and finally, committing to a solution.

iTLS takes certain aspects from the TOC, Lean, and Six Sigma methods and combines them into a single unified method which results in better financial results than the three methods done separately. TOC can identify which problems are the biggest and, when fixed, can result in the greatest profit. Lean methods focus on removing waste from a system, using more efficient and safer practices. Six Sigma techniques aim for the perfection of the system, limiting the variability in it and therefore creating a more consistent environment. By integrating all three, iTLS catalyzes results, obtaining much larger benefits than each would bring separately.

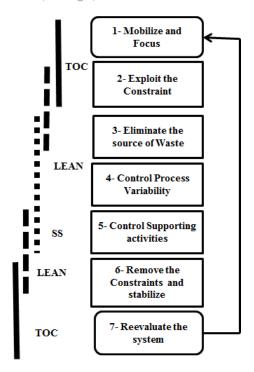


Figure-3: iTLS Model [Adapted from Pirasteh and Fox (23)]

4.2. The Pinnacles Strategies – TLS Model

This model (Woeppel, 2009) is very similar to iTLS Model developed by Pirasteh and Fox (Pirasthe and Fox, 2010), the big difference is an incorporation a project governance structure and a mechanism for deployment a Continuous Improvement (CI) teams aligned with the goals and strategies of the organization.

Like a iTLS this model is blend of Theory of Constraints, Lean and six sigma improvement methods. The goal of this TLS continuous improvement process is to make the Continuous Improvement organization a source of profit, engaged with the organization's goals and strategies and supports different situations with specifics tools for that situation. In this model the strategic deployment of the three improvement methods to achieve results that matter to customers and shareholders are dominant.

- TOC is applied to create systemic alignment and focus on the leverage points to achieve maximum throughput.
- Lean techniques are applied to reduce waste at the leverage point to reduce the lost opportunity that waste represents.
- Six Sigma tools are deployed to reduce variation at the leverage point processes and ensure consistent results.

The model (see Figure-4) uses the following logic:

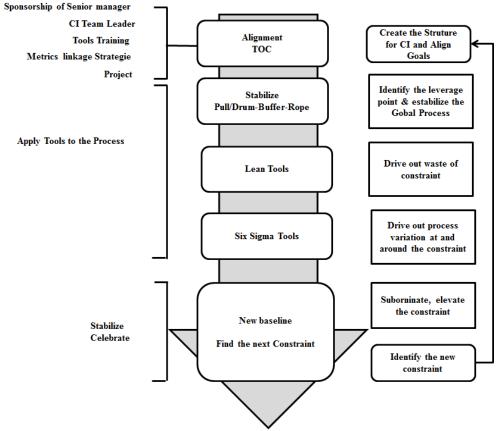


Figure - 4: TLS Model [Adapted from Pinnacles Strategies (20)]

So, implementing TLS begins with building the machine for results. The first step is to follow the process and align CI process with business and its objectives, and the process is roughly: 1) Create the alignment, 2) Apply the Tools, 3) Complete the Success, and then 4) Work on the Next Project.

4.3. The UCI Model (Ultimate Improvement Cycle)

In this model Bob Sproull (Sproull, 2010; Sproull and Nelson, 2012) proposes three cycles of process improvement represented by three concentric cycles (see Figure-5).

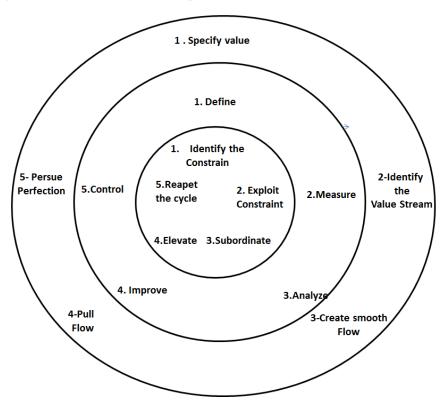


Figure-5: UCI Model [Adapted from Bob Sproull (22)]

The inner or core cycle represents the TOC process of on-going improvement which will provide the necessary focus that is missing from Lean and Six Sigma process improvement initiatives. Based on his experience and results, the key to successful process improvement initiatives will be focusing the process improvement efforts on the right area, the system constraint, because the constraint dictates the throughput rate, which ties directly to bottom-line process improvement. The second circle represents the Six Sigma roadmap and your DMAIC. The outer circle depicts the Lean improvement cycle. Both Six Sigma and Lean should be absolutely necessary for UCI model to work. To implement the model some chosen tools and actions will be needed but not all constraint improvement processes will be the same and the type of tool or action required and the usage order could be different. In the end, the UCI model has four step: 1) Identify, Define, Measure and Analyze the process; 2) Stabilize; 3) Create flow and pull and 4) Control the process to sustain the system throughput.

4.4. The TOCLSS Model

This model (see Figure-6) had its origin in the AGI (AGI Goldratt Institute, 2009; Cox and Schleier, 2010), and was developed because:

- 1. The methodologies were viewed as "tools in a tool box", where each tool was perceived as best for particular uses.
- 2. Expertise in all methodologies was not available making true integration impossible.
- 3. An effective integration process for the three methodologies was not developed.

In this model the most powerful way to integrate TOC, Lean, and Six Sigma begins with Strategy. The strategy provides the strategic roadmap to improve business results. The strategic roadmap provides the direction for the areas of the organization that can most benefit the total system by applying improvements first. The system design of the first area provides predictable and stable system performance by focusing on protecting and managing the constraint(s) of the total

system. Once this is achieved, process improvement efforts can be applied in a focused way to provide even more bottom line results for the organization. Finally the improvements must be sustained in order for the organization to achieve real bottom line results over time.

The Velocity Roadmap to continuous business success has two major parts: the Constraint based System Architecture and the TOCLSS Improvement Architecture, and the model has 5 steps: 1) Strategy, 2) Design, 3) Activate, 4) Improve and 5) Sustain.

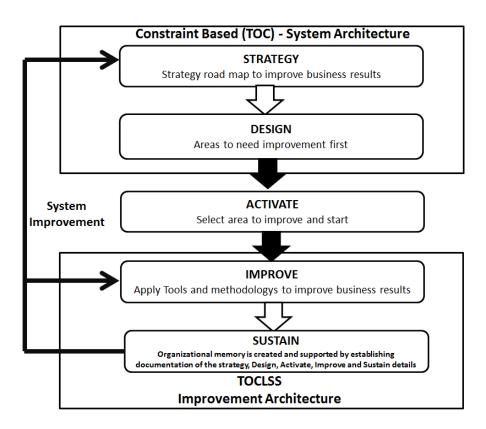


Figure-6: TOCLSS Model [Adapted from AGI (6)]

4.5. The 360° excellence Model

This model (see Figure-7) was proposed by Moura (2010) and combines TOC, Lean and Six Sigma with Business Process Management (BPM). This model intends to use the BPM methodology, so that the model is applied to the entire organization and does not become a tool that contributes to the departmentalization of the organization.

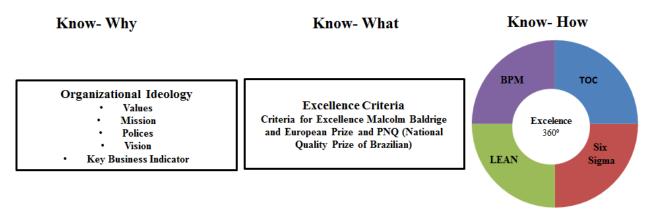


Figure-7: 360° Excellence Model [Adapted from Moura (24)]

Starting from the current situation of the company, TOC identifies and prioritizes vital and pressing issues that need immediate treatment. Many of these problems identified by the TOC can be treated using its tools but also directing projects Six Sigma, Lean or BPM. The BPM creates a dynamic structure that allows processes more effectively deploy strategic and tactical guidelines indicated by the TOC. From this same structure to incorporate business system the best contributions of other approaches, its use in standardizing work processes. For example, a planning process and strategic deployment using the TOC "Thinking Process" (TP), can establish and then its improvement projects can be standardize using the "DMAIC" improvement process from Six Sigma, and finally the use of Lean tools such as work cells and visual control can be considered to simplify and streamline a process. The Lean System involves the entire workforce with simple tools and powerful continuous improvement, creating a participatory environment and a culture focused on efficiency. Also, Six Sigma, and their specific improvement projects, with its powerful analytical tools can provide stability to certain processes within a value chain that will be deal with.

Apart on the exposed know-how frame, in order to ensure Systemic knowledge that promotes high impact changes requires this model suggest to add two other important elements: the know-why and the know-what The Know-why will be the set of basic values, the long-term vision, the mission of the company, factors critical to mission accomplishment and indicators of the overall performance of the business, that will explains and justifies the organizational know-how.

4.6. TLS Model in accordance of corporate strategy

The construction of this model (Pacheco, 2011) was based on the analysis and study of different integrated models, TOC, Lean and Six sigma, statistic treatment of surveys was carried out, at different experts on the themes and a production strategy to develop. This model (see Figure-8) makes several new assumptions regardless of whether the constraint is internal or external:

- Assumes that the corporate strategy is predefined;
- Assumes that the synergy between the TOC, Lean and Six Sigma generates superior results to the individual use of each approach
- Assumes that the manufacture can and shall be used as a competitive weapon in modern organizations;
- Assumes that the manufacture monitor the production bottlenecks and Capacity Constraint Recourses;
- Assumes that the continuous improvement of results and improvement of the model, compared to the context of the company, are given from application cycles.

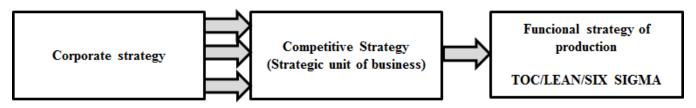


Figure-8: TLS Model in accordance of corporate strategy [Adapted from Pacheco (16)]

4.7 - TLS - Lean

This model was developed and implemented in a cork stoppers factory during Silva's (2015) master's Research work under companies Industrial Director supervision and co-author of this article. The unit where the model has been applied has been running since some years with Lean Manufacturing program with stabilized and visible results called Cork Mais. At the time the industrial unit needed to increase our production due to market demand, two alternatives emerged: invest in news equipment's or improvement and optimization its processes, which was the decision made.

The logic followed in the design of the model was to adapt the TOC model of five steps developed by Goldratt, and completed with the logic that seem to be missing the original model. The exploitation of existing TLS models, one that had to be more beneficial and may complete some gaps in the TOC model of the five focus moves is the Ultimate Improvement Cycle model, developed by Sproull.

It was the combination of these two approaches the first strictly TOC and the second in the logic of integration that emerged this model, more simple, more logical and based it's dynamic essentially in the decision process take in to two different steps of the model; during Exploit Constraint phase and later at the stage of revaluate Constraint and Elevate Constraint's performance, before starting a new cycle of continuous improvement.

A sketch of the proposed TLS model is presented in Figure 9.

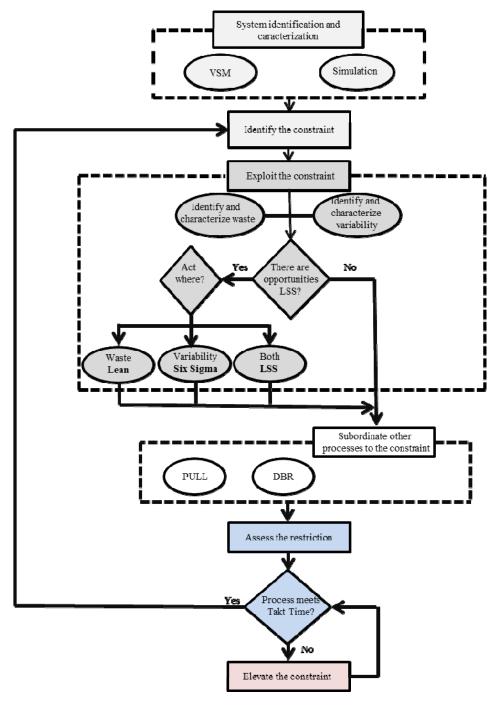


Figure 9: TLS-Lean [Adapted from (Silva, 2015)]

The model is divided essentially in five stages:

A. Analyse system and identify constraint

After identifying the system and his frontiers, the leader responsible for the implementation of TLS project should characterize it thoroughly in a way to obtain full knowledge about its operation and to get Constraint's identification.

After the Constraint's identification, all the efforts and improvement focus must stay in the Constraint.

B. Exploit Constraint

On this step of the proposed TLS model firstly is necessary to identify and measure Waste (*Muda*) and simultaneously it's necessary to characterize and identify variability in the constraint. Now it's possibly to answer the question "If there are LSS improvement opportunities?". In case of the system being already too exploited, the solution is to go to next step of the model and subordinate the others processes to the constraint. Otherwise depending on the opportunities found before, it's chosen where to act which correspond to the second question. In case of finding improvement opportunities that can help reduce waste and variability they are required to use the most appropriate Lean and Six Sigma tools.

C. Subordinate System to the Constraint

After implementing Lean or Six-Sigma improvements the next step is to check if DBR and Pull are already applied correctly in the system. If the tools correct, are in use than it's necessary to make the whole system use them properly. The Kanban and Buffer before constraint should get improved in a way that the bottleneck stays always feed with materials to avoid unnecessary stoppages.

D. Revaluate Constraint and Elevate Constraint's Performance

At this step the Constraint needs to be revaluated. In case the process now fulfils Takt Time this means that is capacity is superior to the current demand rate than it closes the first continuous improvement cycle. In this transaction between cycles it's important to keep active the improvement and critical attitude to avoid deterioration of the good practices achieved. To identify new constraint of the second improvement cycle it can be made an actualization of the VSM or another simulation with the new parameters of the current situation.

In other hand if the constraint still can't keep up with Takt Time it's require so pass to step E of the model.

E. Elevate constraint's

To elevate constraint's performance at this moment, monetary investment can became the only solution. These investments can be done through:

- Buying new machines and equipment;
- Hiring more operators;
- Changing plant layout;
- Solving external factors to the system;
- Search for better technology and innovation

The first results of the proposed framework implementation model in the cork stopper plant resulted in significant improvement in the productivity in the constraint, namely:

- Increase of OEE by 14, 9%.
- Decrease of tak time from 39,09 to 26,8 sec/piece.
- Decrease of stoppages time due to malfunctions the 91h30 to 14h15/month.

So, this TLS-Lean proposal model result of the work done in the cork stoppers factory showed to be flexible, adaptable and compatible with Lean system then applied, our in future in others application in different types of industries compatible to others continuous improvement systems.

5. MAIN RESULTS AND CONCLUSIONS

The management philosophies for continuous improvement more wide-spread and used by companies and organizations are Lean, Six Sigma or Theory of Constraints based.

This paper proposes a travel for these methodologies and presents a state of art of TLS, an integration of these three approaches, including a new TLS proposal the TLS – Lean model that showed, to produce improved operational results and to be flexible, adaptable and compatible with Lean system, which is currently being further explored by the authors.

The TLS - Lean is a model easy to apply, based in the five steps of TOC and in the Sproull (2010) Ultimate Cycle

Improvement which based it's dynamic essentially in the decision process take in to two different steps of the model; during Exploit Constraint phase and later at the stage of revaluate Constraint and Elevate Constraint's performance, before starting a new cycle of continuous improvement.

The implementation of TLS-Lean in a cork stoppers industry are resulted in increase of the OEE, decrease of tak time and stoppages time due to malfunctions in the constrain step.

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Kaizen-Green. An opportunity for sustainable continuous improvement

Suárez-Barraza 1, M.F.¹⁾ and Rodríguez-González 2, F.G.²⁾

¹⁾ Business Management Department,

Universidad de las Américas Puebla (UDLAP)

Puebla, Mexico.

2) EGADE Business School

Tecnologico de Monterrey

Ciudad de Mexico, Mexico

ABSTRACT

Purpose - Organizations today are always looking to generate Green management mechanisms that allow their enterprises to generate environmentally focused products and/or services. At the same time, they apply and implement Kaizen initiatives (continuous improvement) to improve and innovate their day-to-day operations. Both initiatives share certain similarities in their operational practice. As such, the purpose of this article is to conduct a literature review of both the Green approach and the Kaizen philosophy. During this process, compatibilities, similarities and differences at the moment of implementation in organizations among both initiatives were looked for.

Design/methodology/approach - The employed methodology was a systematic literature review (SLR) of the said research topic. It's worth mentioning that both academic and practitioner literature was used to analyze implementation cases from both approaches.

Findings - Findings reveal that both initiatives show certain convergent points, especially in a problem solving solution centered in the PDCA cycle. Likewise, there are some key similarities in both Kaizen and Green initiatives that can generate a unique and united framework.

Research limitations/implications- Of course, the limitation is that it is a theoretical analysis, but future research will take into account empirical work.

Practical implications- The research will provide shcholars to develop a deeper and richer knowledge on the simultaneous deployment of green and Kaizen improvement iniatives and help managers to create practical solutions.

Originality/value (Mandatory)- This research could be one of the first contributions that unite both Kaizen and Green management initiatives. Besides the potential benefits to applied both approaches.

Keywords: Green Management, Kaizen Philosophy, Literature Review

Paper type: Literature Review

INTRODUCTION

Today's organizations seek at all times to generate mechanisms of Green management so that their companies generate products and services oriented to the environment. At the same time, they apply and implement Kaizen (continuous improvement) initiatives to improve and innovate their day-to-day operations. Companies have always centered their focus on generating profits and grow their business. However, recently there is strong regulation by Governments on environmental issues that has made companies to green their processes (Mohanty et al., 1999). So, the requirement to enforce environmental regulations and the scrutiny of society every day is much higher (Digalwar et al., 2013).

On the other hand, Kaizen is still a philosophy focused on the continuous improvement of the processes of the organizations (Imai, 1998). The improvement of processes, eliminating waste (Muda in Japanese), and the participation of employees in the resolution of problems are vital in the application of Kaizen in the Organization (Suárez-Barraza and Ramis-Pujol, 2010). In such a way, that the resolution of problems and the elimination of Muda appear to be methods close to green management. Indeed, eliminating Muda in all areas of the company also involves eliminating waste, focusing on the environmental issues of the Organization's processes. Therefore, the combination of Kaizen with Green seems obvious. As such, the purpose of this article is to conduct a literature review of both the Green approach and the Kaizen philosophy. During this process, compatibilities, similarities and differences at the moment of implementation in organizations among both initiatives were looked for.

The literature sheds few studies to understand this relationship (Kaizen-Green). Rather, studies have focused on an approach similar to Kaizen, Lean Thinking, that some authors consider it to be part of Kaizen while others indicate that the Lean is immersed in Kaizen (Suárez-Barraza, 2007, Hines et to the., 2004). To understand thoroughly the possible similarities, synergies and of course the differences between them, it is necessary to analyze the possible integration of both terms. Understanding that different studies have tackled the relationship Lean-Green (King and Lenox, 2011), Kainuma and Tawara, 2006, Carvalho et al., 2011; Garza-Reyes, 2015). Few authors and researchers have explored the possibility of conceiving conceptually an integrated approach (Dues et al., 2013).

Lean manufacturing is a concept taken from the Toyota Production System (TPS) developed by Taiichi Ohno and Shigeo Shingo in the bosom of the Toyota operations in the 1960s (ozone et al., 2008). Their applications focused in the Just in Time (JIT) were generated for the simple reason of not being able to compete with the mass production system (push system) of the North-American manufacturers. Therefore, the reduction of waste (Muda) in space, resources, time, and workers was vital (Sawada, 1995). Moreover, Kaizen is a derivation of two ideograms (kanji) Japanese meaning: KAI = change, ZEN = good (to improve); In short, continuous improvement or principle of continuous improvement (Lillrank and Kano, 1989, p. 28). In terms of business, Imai (1986) defines it as: "the process of gradual and incremental improvements in order to seek perfection in business activities". Suárez-Barraza (2009) defines it as: "a comprehensive philosophy of life, personal, work, family, community, incrementally searching development enhancements and innovations that impact on the activities that we perform on a daily basis, i.e., our operational processes, and as a result must lead us to a spiral of improvement and innovation of both the person and the Organization in which it should

not pass any day that they do not think about "keep changing and growing". Both terms coincide in core features such as the organization and order rather than work, standardization of operations, improving the processes and the active participation of the employees in the form of teams and of course, the intensive use of the improvement cycle of Plan, Do, Check, Act (PDCA) for the resolution of operational problems (Berger 1997; Ortiz, 2006; Suarez-Barraza et al., 2009).

On the other side, Green management has taken a leading role in the management of the companies. The main purpose of Green management is to reduce the environmental impact of products and services that are delivered to the consumer without generating losses for shareholders (Sarkis, 1998). Other authors have focused on the certification of processes that manufacture these products such as the ISO 14000 (environmental ISO standard) or the OHSAS 18001, an internationally recognized standard that deals with all aspects of health and safety at the workplace (Association for Manufacturing Excellence (AME), 2008;) Carvalho et al., 2011). In both cases, both processes for green operations focused on Green product management seek at all times to recycle, reuse, and re-manufacture. The total approach is therefore to focus on sustainable development and the reduction of ecological impact of industrial activities through elimination of resource waste and pollution (Dues et al., 2011).

In general terms, the study presents, analyses and discusses the possible relationship that exists between the practice of Kaizen and Green management. To find similarities and differences between both approaches at the level of an analysis of a) purpose, b) approach, c) process of implementation, and d) techniques and tools (Carvalho and Cruz-Machado, 2009; Rao and Holt, 2005); Zhu et al., 2008). Supported by the RQ: is there a possible link between the Kaizen approach and Green Management? In addition, the study presents a first framework that identifies the possible links of Kaizen and Green management, as well as their possible limitations, closing with a conclusion that allows to find the paths for future research proving it to empirical level.

RESEARCH METHODOLOGY

In line with the purpose of the research the methodology used in this research was a systematic literature review of research on the subject. A systematic literature review (SLR) approach is a specific method that explores in a rigorous, explicit and detailed way the research of a subject matter to explore potential areas of construction of theory (Kitchenham and Charters, 2007). For this specific research, four specific steps were carried out that focus on the method selected. These steps were: 1) design review, 2) selection of found literature, 3) found literature analysis, 4) main findings.

For the first phase, the phase of the design of the literature review, the concepts of Kaizen and Green management were reviewed separately in order to understand more fully their specific characteristics in the literature. This was to look for similarities and differences between both approaches in the literature. Also, at this stage of the review design, finding information in digital databases with times and dates was also planned. This phase was carried out from September 2nd to September 25, 2015.

On the other hand, the sample taken from articles found in the literature selection phase 2 was based on the search for articles in electronic databases. Databases used for this research were: Emerald (emeralinsight.com), EBSCO (ebscohot.com), ISI Web of Science (workinfo.com), Google Scholar (scholar.google.com), and Taylor & Francis (taylorfrancis.com). During the selection, sampling was done by reading the abstract and the findings of the full article in order to ignore those that were not relevant to the purpose of the investigation (Briner and Denyer, 2012). Thus, for this investigation, the authors only considered peer-reviewed scientific articles of both journals and conferences. Another type of source such as books, articles in newspaper or another medium of disclosure were not considered. Finally, the keywords that

were used for the concept of KAIZEN were: Kaizen, continuous improvement, Lean-Kaizen, productivity improvement, and Kaizen teams. In the case of GREEN Management, the keywords were: Green-Kaizen, Green-Lean, Environmental-Kaizen, Kaizen-Lean Kaizen, eco-efficiency and eco-sustainability. The words helped the process of exclusion and inclusion of selected articles. The final sample consisted of 38 items identified with reference to Kaizen and Green Management aspects. 21 articles were rejected because they were not in line with the possible relationship between Kaizen and Green management.

In phase 3, the analysis of the found literature was conducted. The method of thematic synthesis was applied to the 38 articles. It represents a focused method of the thematic analysis (Lingham, 2007). This method was selected due to its effectiveness in finding recurrent themes through a structured methodology that can address a lot of issues. To do so, the NVivo computer software was used in order to encode the results and establish the issues encountered in a network analysis (Thorpe et al., 2005). It was indicated that the similarities and differences between the approaches of Kaizen and Green Management were the point of reference for the thematic synthesis.

Finally, in phase 4 the main findings are described. During this phase, the writing and reporting of the results found in the analysis of the issues were done. The method of Systematic Literature Review (SLR) has many advantages over other methods of revision of literature as the classic narrative, review by description among others, in the sense of structure and the disciplined method that provides. Own network analysis allows to synthesize common themes that helps build the final structure of the report. Thus, the SRL allows to write the results by reducing to a minimum the possible bias the researcher may have at the time of the data. Therefore, the data making emphasis on the structure of introduction, method, results and discussion-conclusions, as well as the structure of the macro-topics (topics covering other topics in network diagram) in the section on results were drafted. An example of this was the "Kaizen-Green Drivers".

RESULTS

The thematic synthesis of the Systematic Literature Review showed the following results of the comparison of 38 items. In order to structure the research findings described below in four different categories the following is presented:

Similitudes Kaizen-Green

When one analyzes the common themes in both approaches a common element becomes repetitive and constant for both approaches. This common factor is the elimination of waste. For Green Management it is the elimination of industrial waste of the own production processes; While for Kaizen it is denoted as processes waste or MUDA, i.e., activities that do not add value and consume resources. In Kaizen, MUDA types identified by Ohno (1978) are seven types: overproduction, inventory, waiting, processing, transport, movement and rejection or failure.

Another common theme found in the analysis of networks was that companies are trying to solve problems in both approaches bringing similarities even closer between Green Management and Kaizen. Thus, we have that in Kaizen strategic focus is the reduction of costs of operation by removing Muda; while in Green Management the focus is on sustainable development for the reduction of the environmental impact of industrial processes. On the other hand, Kaizen, seeks to follow the PDCA (Plan, Do, Check, Act) cycle for the resolution of operational problems; While Green Management seeks the assessment of the life cycle of products, to recycle, reuse, re-manufacture and redesign any of the manufactured products. Carvalho and Cruz Machado (2009) and Dues et al., (2011) found various similarities in the literature pertaining to other elements of the company such as customer requirements, lead time, the product design, raw materials, suppliers among others.

Mollenkopf *et al.*, (2010) at the conclusion of his article points out that the companies that work with Lean in their supply chains, which develop and apply techniques of Kaizen appear to be sensitive to the actions of Green Management innovation. Therefore, the application of the PDCA cycle and the reduction of Muda or waste are common themes in both approaches. Thus, different authors have exemplified in the following table the possible link between Kaizen and Green Management through certain Kaizen Muda:

Table 1 – Similarities between Green Management and Kaizen approaches through Muda

MUDA Type	Kaizen Approach	Green Management Approach	
Over Production	Produce much more than what the customer requires.	Excessive consumption of electric power or other used machines and equipment beyond what is necessary.	
Inventory	All parts, work-in-progress- and finished goods not being processed. It causes excessive costs for storage, as well as hiding production problems.	Excess inventory requires having more space to store them and therefore higher energy consumption of light, ventilation among other resources.	
Excess Transportation	The movement of materials not required to perform the process.	Excess of consumed fuel, therefore higher emissions of CO2 into the atmosphere.	
Defect	All work associated with identifying and correcting defects.	All waste products that can not be reprocessed causes damage and environmental impact by having to dispose these defective products.	
Waiting	Excess of unnecessary waiting of the process flow.	Any waiting process flow consumes electric power, water, gas, among others.	
Excess Motion	People or equipment walking or moving more than necessary to perform the process.	If it is about movements involving machines, there is consumption of electrical energy and other consumption excess.	
Over Processing	Doing things that add no value for the customer, excess of activities that do not add value during the process performance.	In the same, it way consumes energy, occupation of unnecessary spaces and even more emissions of toxic gases into the atmosphere with certain equipment and machines.	

Source: Carvalho *et al.*, 2011; Franchetti *et al.*, 2009; Duarte and Cruz Machado, 2013; Dues *et al.*, 2013; Dues *et al.*, 2011; Garza-Reyes, 2015.

Kaizen-Green Differences

As indicated in the previous section where several similarities of Kaizen and Green Management can be located, in which the literature seems to confirm the combination of both approaches, it is necessary to verify certain elements which differ in both approaches. According to Duarte and Cruz-Machado (2013) the element that is at the same time a point of convergence is the topic "waste" above all when it is put into practice. In practical terms, when one delves into the network analysis performed at a more micro level of the meaning of each term. For Kaizen, in terms of Muda, waste refers to any activity that consumes resources and does not add value to the process. For example, reducing the time cycle of activities' operations, physical inventory and inventory in process space, and even the reduction or rearrangement of operators, lack of standardization,

lack of flexibility in lines and workloads (Pettersen 2009; Suarez-Barraza et al., 2009). For Green Management, waste, refers specifically to the concept of the 3R's (reduce, reuse, and recycle) any element of a production process that can be considered as waste. Similarly, the following can be considered as Green management practices: re-work, re-manufacture, and reverse logistics. At this level, both definitions of waste are different.

Another element that surfaced using network analysis which can be considered a difference is the conception of customer. For Kaizen, the customer is the priority of any improvement project focused on the reduction of Muda, and at the same time costs and the lead - time for delivery of the product or service (Berger, 1997;) Aoki, 2008). In this sense, the concept of Kaizen from the "next process is your customer" regards the element of a specific internal client. In the case of Green Management, the customer is any inhabitant of the Earth who buys a product or consumes a service from a company and this product or service is completely friendly to the environment inhabited by this person (Mollenkopf et al., 2010). In this sense, the focus of customer is much more macro than in Kaizen.

Techniques and tools have also differences on the approach and the effectiveness of its application. In Kaizen, tools such as Kaizen teams, quality control story, 7 tools of quality, value stream mapping, and the flow charts for the redesign of processes (Brunet and New, 2003;) Aoki, 2008) are used. Each and every one of them have been tested in the improvement of processes of organizations for at least five decades. Furthermore, Green Management techniques and tools such as the 3R's or Life Cycle Assessment are beginning to prove its effectiveness (Kainuma and Tawara, 2006).

Finally, at this level the link between both terms is not simple; while the literature is enthusiastic in the union of both, not only with Kaizen, but also with the term of Lean Kaizen (Sarkis, 2003;) Garza-Reyes, 2015), there is still the need to generate a deeper analysis of both approaches and their possible linkage.

Kaizen-Green Drivers as an integrated approach

The main driver to achieve an integrated approach found in the analysis of networks is the PDCA cycle. The reason is that recycling, reusing and redesigning industrial products can be viewed as Kaizen projects in the form of environmental problems. In other words, any element or situation that causes a deflection of environmental order can be treated as a problem or improvement opportunity. For this reason, this situation is visualized as a Kaizen project that has the following characteristics that fit the PDCA cycle:

- PLAN PHASE. it identifies the environmental situation (Green Situation), which is treated as a
 problem or improvement opportunity. It may be an issue for recycling, reusing, re-manufacturing or
 redesigning a product. It can also be the treatment of industrial waste, material transport, storage of
 products, consumption of energy, water treatment, among others. From each problem what is looked
 for are the effects or consequences of every environmental problem, as well as their root causes.
 Therefore, with all of this deep research of the problem we are forming the base of the Kaizen-Green
 Project.
- 2. DO PHASE. during this phase, all the improvement actions are built to solve the Kaizen-Green Project. It occurs in the form of an improvement plan and managers, resources and dates for the implementation of each activity are settled down. Also, during this phase the plan implementation should be included in its entirety.

- 3. CHECK PHASE. in the verification phase, all environmental improvement actions are validated so that they will meet the requirements according to the Kaizen-Green Project. At this stage it is essential to validate that the impact or level of any environmental problems, must be low or must be made to disappear completely. In this phase, the Kaizen-Green Project must measure that impact in order to verify that the environmental improvement actions are having the effect we are looking for.
- 4. ACT PHASE. in the case that the environmental improvement actions do not produce the impact we are looking for, they should be corrected and proposed again in the improvement plan. On the other hand, if the improvement actions are working, with the expected environmental impact, then they should be standardized as green practices of the Organization, as part of the Kaizen-Green Project.

Kaizen-Green Limitations as an integrated approach

As it has been stated previously, in the literature there is very little empirical evidence of the effective adoption of Green Management practices and Kaizen in its Lean component (Pampanelli et al., 2014; Garza-Reyes, 2015). Furthermore, the relationship between Green management and Kaizen in the literature is practically nil. However, some authors like Kitazawa and Sarkis (2000), Dues et al., (2011); Dues et al., (2013); Garza-Reyes, (2015) mentioned that those organizations that carry out a joint effort between Green and Lean-Kaizen can get higher operational performance.

The main limitation for an integrated approach between Kaizen and Green Management is the lack of a link between strategy and operation. In other words, Green projects require high initial investments for its implementation (a simple example can be hot or cold greenhouses and solar cells among others), and often senior management does not envision a specific strategy of cost reduction, especially in the short term. There are some projects that have a slow return on investment (Joseph, 2014). Therefore, Kaizen projects by nature seek to eliminate Muda, reducing operating costs from the moment of their implementation (Brunet and New, 2003; Aoki, 2008).

In this way, this limitation is a complicated situation in the sense that company's strategies are always focused on investment projects that reduce costs or that quickly recover the financial investment, so Green projects are seen as long-term investments that generate profits for the organization in the long-term (Bendell 2010).

Figure. PDCA GREEN-KAIZEN ACT (A) PLAN (P) Correct actions not A problem or work in the Greenopportunity for Kaizen project, and / improvement to or possibly the recycle, reuse some standardization of product practices areen. CHECK (C DO (D) All actions are All improvement validated actions are built to environmental solve the Greenimprovement are met Kaizen project. according to Green-Kaizen project. Fuente:Adaptado de Imal, Massaki. (1998). "Gemba Kalzer", McGraw-Hill, p. 5.

Figure 1 – PDCA Green-Kaizen.

CONCLUSIONS

Environmental sustainability and continuous improvement in organizations represent two imperatives elements of today's organizations. Therefore, the search for efficiency, productivity and quality of products and services are vital to their operation. In this research, the purpose was to find the possible link between Kaizen and the Green practices of the organizations. The results of the analysis of the literature review tells us that certain elements are similar to the time of their execution. However, there are also differences both in their implementation and in the design of certain elements of the management of organizations that relates to both Kaizen and Green practices. The three strongest elements that they have in common are:

- Their orientation to eliminate and minimize waste.
- Their focus on improvement and change to improve the operational efficiency and the reduction of industrial waste.
- Their use of the PDCA cycle to solve problems in both approaches.

It is difficult to directly conclude the possible link of both approaches in this literature-supported research. On the other hand, finding a synergy between both approaches and its possible value as combined managerial practices is still an open intellectual challenge. There are at least three points for a future research agenda:

- It is necessary to validate a possible theoretical construct attached and linked to Kaizen-Green, all through a quantitative study with a statistically significant sample.
- In the same way, a more detailed study must be found as well as a qualitative case study together
 with the literature of a possible theoretical framework of the elements that would link the KaizenGreen.
- Finally, build a detailed definition, the characteristics, similarities and differences of the Kaizen-Green.

However, understanding our limitations, both authors believe that it is possible to link Kaizen and Green, even more so than Lean thinking and managerial practices for one simple reason: Kaizen is an approach that has simplicity as a principle which fits perfectly with the simple ideas of recycling and other green practices. With more research, it can be demonstrated that the continuous improvement of efficiency and environmental performance can be achieved through Kaizen-Green.

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RISKS IN QUALITY MANAGEMENT SYSTEMS: What does ISO 9001:2015 intend?

Boanerges do Amaral Couto, D.Sc. 1), Renato Pedroso Lee, M.Sc. 2),
Marcello Guimarães Couto, M.Sc. 3), Marcelo Ferraz, M.Sc. 4)

- ¹⁾ Universidade Federal Fluminense
 - 2) ABNT/CB25
- 3) HGB Consultoria e Gestão Ltda.
 - 4) Petróleo Brasileiro SA

ABSTRACT

This paper deals with the concept of risks introduced in the 2015 version of ISO 9001 standard, which substitutes a single preventive actions clause for a comprehensive approach throughout the Quality Management System, called risk-based thinking. It is based on decades of experience of the authors in Quality Management Systems for several organizations and the participation in standardization in ISO/TC176/SC2, ISO/TC176/SC3 and ABNT/CB25 (Brazil).

A major challenge in the management of companies is to improve their results continually and consistently. Classic management systems based on the Plan-Do-Check-Act (PDCA) cycle contain the incremental improvement when, at each cycle, correct the causes of the difference between what has been planned and the actual processes. The proactivity happens when, with risk-based thinking instilled in the culture of the organization, situations that could potentially put at risk the achievement of the goals at any level (strategic, tactical and operational) are prevented. The situations, in which advantages of opportunities for improvement, not necessarily related to situations of risk, are also considered.

Keywords: Risks. Quality Management. Opportunities for improvement.

1. INTRODUCTION

The systematic approach for the risk-based thinking established in ISO 9001:2015 standard is based on proactive actions for a continuous improvement. These actions are conducted in all the phases of an organization's life, from its strategic planning to the project and operation, culminating with the improvement of the organization's performance.

The risks should be evaluated, treated and monitored along all the Quality Management System leading to preventive attitudes that have an impact on the organization's performance, where risks become an integrating part of the process approach.

In parallel to the risk-based thinking, ISO 9001:2015 standard frequently refers to "risks and opportunities" adding one more component in this proactive search for continuous improvement.

There are three components for the continuous improvement in a Quality Management System:

- Corrective actions: to remove the causes for nonconformities and real unwanted situations to prevent reoccurrence.
- Risk management: it is directly related to the classical preventive actions, similar to the previous ones, except that, in this case, nonconformities and unwanted situations are potential and have not occurred yet.
- Improvement opportunities: they can become improvement projects where, by definition, these initiatives should bring benefits.

Performance improvement is a permanent objective of the organizations, which should be expressed through indicators for following up and reaching the performance goals. In this context the risks are the effect of uncertainty about an expected result and the focus is the deviation of reaching the objectives. This deviation can be negative or positive.

In ISO 9001:2015, risk is the effect of uncertainty. An opportunity is related to when a particular situation makes it possible to do or reach something. Thus, on treating both of them, risks and opportunities, a proactive basis is established for the increase of the effectiveness of the Quality Management System, obtaining better results and preventing unwanted ones.

Opportunities can come up as the result of a favorable situation to reach an expected result. A positive deviation as a result of a risk can provide an opportunity, but not all the positive effects of risks result in opportunities.

As the objectives may not be fully reached, there are always a great number of risks and opportunities in the processes of the organizations. Thereof the need to classify and prioritize the risks and opportunities in function of the pre-defined significance criteria to bring about plans of action in quantity and quality that can be managed in the form of a group of projects on punctual improvements, whose success will be the improvement of the organization's performance.

The improvement can be obtained in the reactive form by means of corrective actions or in the proactive form, as proposed in ISO 9001:2008 in a single clause on preventive actions. The difference between one and the other was wether the nonconformity or unwanted situation had

effectively occurred or if this occurrence was potential. With its use, the universe of the preventive actions of several Quality Management Systems included more than potential nonconformities; it also included improvement opportunities. It is worth noticing that the common denominator to all these corrective actions, preventive actions and improvement opportunities are plans of action that minimally describe actions, responsibilities, resources and schedules.

In ISO 9001:2015 a single clause treating preventive actions ceases to exist and the standard considers the risk-based thinking, which permeates all the items and requisites of a Quality Management System from strategic actions (the organization's context) to the final results (improvement).

Risks are not only negative and relative to events but become positive or negative relative to achieving objectives. Some examples of these objectives are:

- The company: strategic objectives, accomplishing the mission;
- Context: attending the needs and expectations of the client and the relevant interested parts;
- The Quality Management System: quality objectives, conformity to the product, client satisfaction;
- The processes: process objective, process mission;

All of these decisions have doses of uncertainty, which is related to the quality of the data being analyzed and the future time horizon considered. Better data and short term projections usually lead to more reliable decisions.

The risk process analysis can lead the organization to three kinds of decisions:

- Avoid unacceptable risk situations. Not to continue in that way because of the great risk involved in terms of the probability of the occurrence, or the damage it can cause, or the combination of these two factors. Here, company close branches, give up making investments, exchange business, adopt other technologies for processes, which can be preferable to see their results dwindle to an irreversible loss.
- Treat the risks that can be managed. Take them into account reducing the probability of occurrence and/ or reducing its impact on the objectives in question either eliminating its source or sharing the risk with other actors (suppliers, clients, competitors, etc.). Usually the actions adopted in this case are known as "risk control measures".
- Take acceptable risks. Move on without doing anything, just keeping the monitoring of risk in the cases of the combination of low probability of occurrence with low impact on the objectives of business or the process being review.

The potential deviation of a desired situation for the better or for the worse is an effect to be investigated. The tools and methods of investigation are already known by quality people when dealing with corrective and preventive actions in the organizations. Similarly to corrective and

preventive actions, a structure and process should be established: responsibilities, accountability, methods and tools, forms of follow up of the actions, etc.

2. RISKS IN ISO 9001:2015

This part of the paper comments the ISO 9001:2015 clauses directly related to the concept of risk-based thinking.

The standard establishes requirements for an organization to understand its context¹ and determine risks as a basis for planning². This means the application of risk-based thinking on planning and implementation of the Quality Management System Processes³.

The concept of preventive actions is expressed through the use of the risk-based thinking in the formulation of the Quality Management System requirements, where prescriptive requirements for preventive actions were substituted for requirements based on performance.

The risk-based thinking enables an organization to determine factors that could divert its processes and the Quality Management System of the expected results and take preventive actions and controls to minimize negative effects as well as maximize opportunities when they come up.

The treatment of risks and opportunities establishes a basis to increase the effectiveness and even the efficiency of the Quality Management System, achieving better results and preventing negative effects.

Opportunities can come up as the result of a favorable situation to reach an expected result, for instance, circumstances for the organization to attract clients, develop new products and services, reduce waste or improve productivity, maximize profits and increase positive perception of the client. The determination if a requirement of the ISO 9001 is not applicable to the Quality Management System shall consider the nature of the risks involved.

Although in Clause 6.1 the standard determines that the organization shall plan actions to treat risks, no formal methods or documented processes are required by the Standard. The organizations may decide the methodology to adopt.

Clause 4 (Context) requires that organization determine internal and external issues which affect its ability to achieve intended results of its Quality Management System. The organization determines the risks that can affect the achievement of the Quality Management System objectives. Yet, the organization shall determine the processes needed to address the risks and opportunities as determined according to Clause 6.1.

Clause 5 (Leadership) requires that top management assures that Clause 4 is followed. Top management shall demonstrate leadership through the promotion of the use of the process approach and risk-based thinking as well as demonstrate their leadership and commitment to

¹ Clause 4.1 – Understanding the organization and its context.

² Clause 6.1 – Actions to address risks and opportunities

³ Clause 4.4 – Quality management system and its processes

dealing with risks and opportunities that can affect the conformity of the products and services, and the satisfaction of client.

Clause 6 (Planning) requires that the organization plans the processes needed to address risks and opportunities. In the planning of the Quality Management System the organization shall determine risks and opportunities and plan actions to deal with them.

These actions should be proportional to the potential impact on the conformity of products and services. Alternatives to deal with risks such as avoiding the risk, taking the risk into account to pursue an opportunity, eliminating the source of the risk, changing the probability or consequence, etc, are usually called "risk control measures."

Opportunities can lead to the adoption of new practices, such as: launching new products, opening new markets, addressing new customers, building new partnerships, using new technologies.

Clause 7 (Support) requires that the organization determine and provide necessary resources⁴ to carry out the actions planned according to Clause 6.

Clause 8 (Operation) requires that the organization implement the actions determined in Clause 6 in its operations and processes.

Clause 9 (Performance Evaluation) requires the organization to monitor, measure, analyze and evaluate effectiveness of actions taken to address the risks and opportunities.

The organization shall analyze and evaluate relevant data and information obtained through monitoring and measuring the efficiency of the actions taken to deal with risks and opportunities.

Clause 10 (Improvement) requires that the organization determine and select opportunities for improvement and implement any necessary actions to meet customer requirements and enhance customer satisfaction. This includes correct, prevent or reduce undesired effects and improve the Quality Management System.

The organization is required to update the risks and opportunities determined during planning, if necessary, in case of nonconformities and complaints.

3. UNDERSTANDING THE RISK TREATMENT PROCESS

Initially, reflections on the realization of the approach to risks in Quality Management Systems are presented. Next will be treated the process of risk assessment and finally their treatment. Risk being the effect of uncertainty on objectives, the organization may be exposed to threats, opportunities, or both. These uncertainties can come from internal or external environment.

3.1 Decision making process and uncertainties

⁴ risk is implicit whenever "suitable" or "appropriate" is mentioned in the standard.

The output of the risk evaluation process is the decision about the treatment to be given to a particular risk. The decisions are based on assumptions, so always reflect some degree of uncertainty. Thus, risk management deals constantly with uncertainties.

Even seeking to base the decisions on the best information available, it is uncommon to be able to make evidence-based decisions.. The highest incidence is to use available information and take uncertainties and risks due to the reliability and accuracy of the information and data adopted. To reduce such effect the situation should be monitored periodically to update (ratify or rectify) the decisions taken. With time, and the application of the methodology, statistical data of performance can be used to provide a better basis for the efficacy of these evaluations.

3.2. Direct application of risk-based thinking in quality management system

There are several decision making activities in application of the Quality Management System processes. Besides the risks to the strategic objectives, their are natural sources of risk in activities as hold points, process monitoring, project notable stages (projects) as feasibility analysis, budget, planning, implementations, etc.

3.3. Opportunity for improvement

Although opportunity is related to risk and attends to the same management processes, it is not its positive aspect. While risk is the effect of uncertainty, an opportunity is a set of circumstances that makes it possible to do or reach something.

Triggers to the identification of improvement opportunities can be in the strategic planning, in the analysis of the external and internal context of the organization, in its processes, relationship with interested parts, and others.

Once prioritized, the portfolio of opportunities for improvement highlights the improvement projects or action plans that are more viable (and profitable!) To be realized. After prioritized, the opportunities for improvement portfolio highlights the improvement projects or action plans that are more viable of being carried out.

These plans of action can change, eliminate or include activities in a process or even create a new process or product.

In the case of processes, the motivation of improvement projects can include speeding of process performance by:

- Eliminating activities that do not aggregate value
- Simplifying
- Reducing production/ execution time cycle
- Rearranging lay out
- Standardizing
- Automating

An example of opportunity detected in the Strategic Planning phase is when an opportunity (external context) is identified in a theme that the organization has a weakness (internal context).

For example, the organization cannot act in a profitable market because its personnel do not have the necessary skills (adequate knowledge of an additional language, of a technology). To achieve this opportunity the organization will need migrate from the quadrant Opportunity + Weakness to the quadrant Opportunity + Strength. This is an opportunity identified in the organization's strategic planning phase, as expected by ISO 9001:2015.

The same way, if the organization is strong in a situation that represents a threat, it should work on transforming this threat into opportunity.

Often entrepreneurs' invest in crises. "When the limited duration of the event of an unfavorable scenario justifies the investment in training, new technologies, methodologies or processes that are preparing the company to take up a more comfortable competitive position in the post-crisis, when their competitors are less qualified and less able to compete.

3.4. Risk treatment process

The complete treatment process can be seen in the following sequence:

- i. Establishing context
- ii. Risks assessment (identify, analyze and evaluate risks)
- iii. Treating risks
- iv. Monitoring risks

3.4.1. Establishing context

The formal risk approach starts with the establishment of context, which defines the basic parameters for managing risks, essentially considering:

- a) The <u>external context</u> that involves the environment in which the organization and the system operate and the external interested parts' needs.
- b) The <u>internal context</u> that involves the organization's policies, processes, and capacities, including its decision making processes and the internal interested parts.
- c) The <u>risk management process context</u> includes the definition of accountability and responsibility, the risk evaluation process methodologies, and the risk criteria.

For the risk criteria, it is necessary to establish parameters or guidelines to subsidize the decision process when a risk is acceptable and/or tolerable, and the parameters by which it will be decided when a risk needs treatment. The risk criteria must be consistent with the organization's objective and aligned with its risk attitude.

The risk criteria can include decisions about:

- nature and kinds of consequences to consider and how they are measured;
- how to determine a risk level;
- criteria do determine when a risk needs treatment;
- criteria to decide when a risk is acceptable or tolerable;

how it is going to consider risk combinations.

It is worth pointing out that the context must be monitored to identify eventual changes. With these changes in context, new risks can come up and the existing ones can change or even disappear.

3.4.2. Risk Assessment Process

The risk evaluation process identifies how the objectives can be affected and analyzes the risks in terms of consequences and probabilities to decide whether some additional treatment is required. This process consists of considering the consequences and the probabilities to determine the nature and kind of impact that can occur in the objectives of the interested parts.

Thus, the risk evaluation process tends to answer the following questions:

- what can happen and why?
- what are the consequences?
- what is the probability to occur?
- are there factors to mitigate the consequences or reduce the risk probability?
- the risk level is tolerable or acceptable and requires additional treatment?

The three moments of the risk evaluation process in detail:

- i. The risk identification comprehends finding, recognizing, reporting risks as well as identifying what can affect the achievement of the objectives. It also includes identifying causes and sources of risks (dangers), events, causes that can impact the objectives and the nature of this impact.
 - As a guide, strategic, operational, process and project objectives should be considered.
- ii. The objective of the risk analysis can be summarized in understanding risks. The result of the analysis includes the decision whether risks need to be treated, and the risk treatment strategies and methods. It considers:
 - causes and sources of risks;
 - consequences;
 - probability
- iii. The risk evaluation utilizes the understanding of risk obtained in the risk analysis to make decisions about the future actions. These decisions can include:
 - if a risk needs treatment;
 - the priorities for the treatment;
 - if any activity should be carried out:
 - how many alternative ways should be taken;

The boundaries between which risks should be treated and which do not need treatment depends on the cost/ benefit ratio. It is possible to decide to treat an intolerable risk, or even decide for no treatment for a risk considered insignificant.

The risk evaluation aims to provide information (based on evidence and analysis) to make decisions about how to treat specific risks and how to select alternatives.

The output of the risk assessment process is a portfolio which considers the situations and premises adopted, the organization's risk criteria and context.

In short, the risk assessment process deals with:

- Identifying and defining risk situations.
- Classifying risk situations among acceptable, unacceptable or those to be treated.
- Among those which decided to take risk treatment plans, it may be necessary to adopt a prioritizing criteria due to its significance to generate further contention actions.

The tools used in the risk evaluation process can be so simple as presented in Table 1.

Tool	Identification	Analysis	Evaluation
Brain storming			
Check List			
SWIFT (and, if)	V	V	$\sqrt{}$
Scenarios	V		
Root Cause Analysis		V	$\sqrt{}$
FMEA		$\sqrt{}$	\checkmark
Failure Tree		V	
Cause and Effect Analysis		V	
Bow Tie		V	

Table 1 - Examples of tools⁵

3.4.3. Risk Treatment

The treatment of risks aims to implement one or more options for changing the probability of occurrence, the risk effect or both.

Risks are treated after going through the filter that decides about what risks are acceptable, which are inacceptable, which should be treated.

The plans of action to treat risks are projects that should correspond to questions 5W2H:

- What?
- Why?
- Where?
- Who?
- When?
- How?
- How much?

⁵ Source: ISO 31001:2012, p. 18, Table A.1

Strategies for the management of the portfolio should be established, as well as if the fact that mitigation actions can generate other risks should be considered.

3.4.4. Monitoring Risks

Monitoring and review ensures that the organization monitors risk performance and learns from experience.

It is frequent the data unavailability or the impossibility of projecting the future with basis on the past, which justifies the frequent monitoring the conditions and premises adopted in the decision making process.

The risk monitoring depends on the long-lasting follow up of the scenarios and should respond the following questions:

- are the premises still valid?
- are the internal and external contexts still valid?
- are expected results being achieved?
- is the risk treatment effective?

Given that the context and other factors vary with time, the better knowledge of the data permits refining the risk evaluation process. The same applies to improving the efficiency of the controls to be used in risk analysis. These actions are recommended for the end of each life cycle phase of the activity, project, product, or at regular intervals.

It is recommended that key risk indicators are adopted, which serve as alarms for the risk management process. Some examples:

- premises adopted in the strategic planning;
- external financial factors as exchange rate variations;
- regulatory and compliance requirements;
- products and processes performance;
- media impact on the company's reputation;
- risks in associations and partnership;

4. Conclusion

One of the changes in the 2015 version of the ISO 9001 standard is the establishment of systematic approach to consider risks in substitution for an isolated requisite for the treatment of preventive actions.

Called risk-based thinking, as seen along this paper, these proactive actions are now spread in all stages of the organization's quality management system, from strategic planning to culminating in the organization's performance improvement.

The risk treatment process contains, intrinsically, a degree of uncertainty that demands long lasting follow-up on the adopted premises in the organizations' strategic process.

The tools for the risk management process are the same already adopted for corrective and preventive actions, which permits anticipate a small degree of difficulty for the adoption of this

approach by organizations, except those which still present low degree of adherence and implementation of preventive analysis processes. None the less, top management commitment can be taken as a critical factor for its success.

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EQUASS Assurance Certification: The View of Pioneer Adopters

Melão, Nuno¹⁾, Amorim, Marlene²⁾, Marimon, Frederic³⁾ and Alegre, Inés³⁾

- ¹⁾ School of Management and Technology of Viseu and CEGE, Polytechnic Institute of Viseu, Viseu, Portugal, email: nmelao@estgv.ipv.pt
- ² Department of Economics, Management, Industrial Engineering and Tourism, University of Aveiro, Aveiro, Portugal, email: mamorim@ua.pt
- ³ Department of Economy and Business Organization, Universitat Internacional de Catalunya, Barcelona, Spain, email: fmarimon@uic.es, ialegre@uic.es

ABSTRACT

Purpose – The paper examines from a practitioner's perspective the European Quality in Social Services (EQUASS) Assurance standard, a certification programme for European social service organisations to implement a sector-specific Quality Management System. In particular, it analyses the adoption motives, the internalisation of the standard, the impacts, the satisfaction and the renew intentions.

Design/methodology/approach – This study uses a cross-sectional, questionnaire-based survey methodology. From the 381 organisations emailed, 196 responses coming from eight different European countries were considered valid (51.4%). Data from closed-ended questions were analysed using simple descriptive statistical techniques. Content analysis was employed to analyse practitioner's comments to openended questions.

Findings – It shows that social service providers typically implement the certification for internal reasons, and internalise EQUASS principles and practices in daily usage. EQUASS Assurance produces benefits mainly at the operational and customer levels, whereas its main pitfalls include increased workload and bureaucracy. The majority of respondents (85.2%) are very satisfied or satisfied with the certification, suggesting that it meets their expectations. Certification renewal intentions are also high but some respondents report that the final decision depends on several factors. The insights gained through the qualitative data are also described.

Practical implications – It can be helpful to managers, consultants and Local License Holders working (or planning to work) with this standard. It can inform the work of the EQUASS Technical Working Group in the forthcoming revision of the standard.

Originality/value – This is the largest survey conducted so far about EQUASS Assurance in terms of number of respondents, participating countries and topics covered.

Keywords: EQUASS Assurance, Quality Management System, Social Services.

Paper type: Research paper

INTRODUCTION

The ISO 9000 Quality Management (QM) standard was published in 1987 and since then, different modifications have been released. The diffusion of the standard among different countries and activity sectors vouched for its efficiency (Llach et al., 2011; Marimon et al., 2006 and 2009). Although it is applicable to any kind of organization, regardless it is focused in the manufacturing of a product or in providing a service, each actualization of the standard has added more focus on customer needs and at the same time, it is more suitable to both, manufacturing and service organizations.

Currently, the latest available version was released in 2015. The scope of the standard has not changed. However, the structure and core terms were modified to allow easy integration with other international management systems standards. It also brings many challenges for implementation, transition, and maintenance, as enhancement of the process approach and PDCA cycle, decentralization of the system and spread of responsibilities for the QM standard throughout the organization, greater involvement of the top management in the QM standard, introduction of risk-based thinking in the QM standard and higher emphasis on performance monitoring.

Nevertheless, there is an awareness of the need for a specific standard for the service sector. In this vein, the European Quality in Social Services (EQUASS) is an initiative of the European Platform for Rehabilitation (EPR) that is concern about to tailor a specific QM standard for social services organizations (SSO). Thus, EQUASS is a quality assessment system developed as a sector-specific approach (Melão et al., 2016) and "aims to enhance the personal services sector by engaging service providers in quality, continuous improvement and by guaranteeing quality of services to service-users throughout Europe" (EQUASS, 2016a).

The latest version of EQUASS was published in 2012, and as of April 2015 there were more than 650 certified organizations in Europe (Melão et al., 2016). These authors are pioneering the research in this standard, providing a case study of four SSO that adopted the standard in Portugal.

The objective of this paper is providing insights from the practitioner point of view, in order to give an assessment about the EQUASS Assurance certification. Particularly, the paper provides analysis about six points: 1 motives to adopt; 2 internalization of the standard; 3 impacts; 4 pitfalls; 5 satisfaction; and 6 renew intentions. It has to be noted that the results presented come from the analysis of the pioneer adopter organizations and some bias is embedded due to this fact. According to Rogers' theory, the innovators and early adopters take some risk in the adoption process and act as stimulators of other organizations. These innovators are especially motivated and have a specific profile that has to be taken into account in order to draw conclusions from their experience.

LITERATURE REVIEW

Organizations in the third sector have been facing increasing pressures to deliver excellent service levels and to pursuit operational efficacy (Al-Tabbaa et al., 2013, Herman and Renz, 2008). Such context has contributed to accelerate the adoption of quality management practices leading to the implementation of Quality Management (QM) and Excellence programmes in non-profits and SSO. This tendency is, to a great extent, a natural follow-up on the practices that have been observed in the private sector, and are backed up by research results, supporting, in a fairly consistent manner, the positive impacts of QM in operations performance and quality (Antunes et al., 2008).

Quality and Excellence practice in perspective: motives, impacts and consequences

Scholars and QM practitioners have been involved in an extensive debate about what are the effective long-term contributions of quality assurance standards for the improvement in quality and customer satisfaction levels (Martínez-Costa et al., 2009). The debate has been fairly polarized around two views: a positive

perspective, that stands for the positive influence of standards adoption for the implementation of Total Quality Management practices; and a contrary view that puts the tone on the aspects related to the burden that conformance practices, and the reverence to documentation requirements, may put on organizations, and the possible negative effects on the firms capabilities to innovate in order to meet the evolving customer requirements. Nevertheless, some consensus exists on the role that the adoption of standards can have on the initiation of systematic internal organization practices and on the contribution for substantial improvements in employees' awareness towards quality issues. Moreover, several research results have suggested that companies engaged in QM and Excellence programs exhibit superior communication practices, both internally and towards their external counterparts. For many organizations, standard QM Systems offer a first structured approach to initiate internal change, and to drive (through practice) the commitment of top management (and resources) in continuous improvement (Rubio-Andrada et al., 2011).

The generalized adoption of QM and Excellence programs across business sectors, together with the proliferation of dichotomous voices about its benefits, has motivated multiple research efforts to unveil with more detail the motives leading to implementation, as well as to explore the diversity of the impacts of certified quality systems. Overall, the motives for engaging processes of quality certification have been described in two strands: settings where certification efforts emerge from an aspiration for improvement that is inherently internal to the organization; contexts where it results from a response to market (external) pressures or demands (Zaramdini, 2007). Whereas research results indicate that organizations tend to be more driven by external reasons (Martínez-Costa et al., 2009), empirical evidence suggests that those that engage in QM practices for internal motives are more likely to achieve better results (Prajogo, 2011).

A variety of benefits have been associated with quality certification in large and small organizations, namely reduction in the volume of customer complaints, and associated benefits in terms of customer awareness, satisfaction and preference (Briscoe et al., 2005). Quality adoption has also been linked to improvements in productivity, notably by means of improvements in process monitoring and the opportunity to identify latent service problems (del Alonso-Almeida et al., 2015). Overall, although QM and Excellence programs are acknowledged to be lengthy and resource demanding endeavors, empirical evidence consistently brings forward its potential for inducing important internal benefits such as increased process efficiency, reduced costs, errors and defects, together with greater employee involvement and job satisfaction, and improved user orientation (Heras, 2006).

Quality and Excellence in context: the case of social services

The importance of QM and Excellence has extended across different private business sectors, gaining also increased attention in the third sector, and naturally, reinforcing the debates about their efficacy and the nature of their impacts (Chesteen et al., 2005). Moreover, the willingness of nonprofit organizations to engage in quality programs has further extended the debate to the investigation of the adequacy of the prevalent standard and programs to such context specific conditions (Baruch and Ramalho, 2006). Despite this scenario, most of the existing research is still focused on the private, for-profit sector (Liao et al., 2014), with some exceptions, including Melão and Guia (2015), Al-Tabbaa et al. (2013), or also Cairns et al. (2005), that have investigated the impacts of different quality approaches on the performance of third sector organizations.

The prospective scenario seems therefore to be one where new, and in many cases sector specific, approaches will to continue to emerge. As such, it is necessary to prompt the development of renewed research lenses to understand, and to put into perspective the different quality approaches, and their impacts.

The EQUASS certification is a particularly important sector-specific approach, developed by the European Platform for Rehabilitation (EPR), as a quality standard for SSO. EQUASS enables both the implementation of a QM System and Excellence in SSO, and in April 2015 has more than 650 certifications across different European countries (Melão et al., 2016). It is therefore a two-level certification program that SSOs can adopt to certify their compliance with European quality requirements. The first level – EQUASS Assurance – certifies

that the provider meets the fundamental requirements of a QM system in social services, whereas the second level – EQUASS Excellence – is employed to certify the excellence on the European quality principles and criteria for social services. Level 1 requires the compliance with 50 criteria (built from 10 quality principles), and involves the conduction of an internal audit (supported by a questionnaire addressing key performance indicators), and an external audit. Level 2 builds also on the same 10 quality principles, but requires and evaluation to be conducted from three perspectives: approach, deployment and results; that needs to be accompanied by a self-evaluation report to evidence continuous improvements in two performance indicators for each criterion (in a period of the last three years), as well as a comparison between such results and those of other SSO, a defined policy for all quality principles, and an external audit.

The implementation of EQUASS is relatively less extensive, and resource demanding, journey than other prevalent QM and Excellence programs (e.g. ISO 9001, EFQM, etc.), in aspects such as the documentation requirements, something that is often referred as difficulty for the implementation of those programs in contexts such as services or small business. Managers also often point out as particularly appealing the fact that EQUASS addresses specific features of SSO, notably devoting key importance to the analysis of the competencies of staff and volunteers that have key responsibilities in quality, consistency and reliability in the specific context of service organizations. Likewise, it encompasses aspects specifically related to the protection of the rights of vulnerable users, to confidentiality, privacy and other ethical issues. This receptiveness toward EQUASS, and the scarcity of context specific research, makes it clear that there is a need for a deeper examination of the motives for its implementation, as well as of its impacts for the operations, users, social workers and other stakeholders of SSO.

METHODOLOGY

This research aims to investigate the implementation motives, internalization, impacts, pitfalls, degree of satisfaction, and renew intentions of EQUASS Assurance. To achieve this, a cross-sectional, questionnaire-based survey methodology was employed. The population consists of all organizations with an EQUASS Assurance certification. The source of the sample frame was the online database of EQUASS Assurance certified organizations (EQUASS, 2016b) at the closing date of January 14th, 2016. This database lists all SSO that have a valid EQUASS Assurance certificate, including information about the organization name, country, logo, postal and website addresses, certification and expiration dates, the contact person name and email. The contact person is a representative who can provide further information about the SSO to the EQUASS certifying body. This representative is typically a person with a managerial position (i.e. director/president/CEO, quality manager or middle manager), and, therefore, is knowledgeable with the QM system. Some organizations listed in the database are certified in multiple sites and have the same contact person listed across such sites. To avoid receiving multiple replies from the same person, these multiple copies of contact persons were eliminated, leaving 381 out of a total of 415 records.

This study was preceded by a literature review, which informed the survey design. The final instrument was a self-administered, web-based questionnaire and consisted of twelve sections: organization profile; reasons for implementation; implementation process; operational impacts; people impacts; customer impacts; society impacts; economic impacts; pitfalls; satisfaction with the certification; certification renewal; and other comments.

The questions about the implementation process were adapted from Nair and Prajogo (2009) so as to determine the internalization of EQUASS Assurance. The study of Melão et al. (2016) on EQUASS certification was used to inform the questions about the reasons for implementation, impacts and pitfalls. Five questions on certification renewal were adapted from Heras-Saizarbitoria et al. (2015) so as to analyze certification renewal intentions. The majority of the questions were closed-ended and their responses had a 5 point Likert scale (for the implementation process, from 1 – strongly disagree to 5 – strongly agree; for the reasons for implementation, impacts and pitfalls, from 1 – none to 5 – very high; for the satisfaction with the certification,

from 1 - very dissatisfied to 5 - very satisfied). However, a few open-ended questions were included to complement or shed light on the responses given by participants in closed-ended questions.

The questionnaire was first drafted in Portuguese, and then translated into English. From this version, two English lecturers back translated into the original language and comparisons were made. Small differences were identified but they had no impact on the meaning of the original text. The instrument was pretested with one academic and one practitioner with expertise in the study area, and small improvements were made accordingly.

The questionnaire administration was carried out in groups of countries, and was followed-up twice to increase the response rate. Also with this aim in mind, a website link to the questionnaire form was sent along with a cover letter, confidentiality assurances, an offer of a report summarizing the findings, and a monetary incentive. The first group of emails was sent in late January and the last one in early March. From the 381 organizations emailed, a total of 243 responses were submitted, of which 47 were deleted for being incomplete. The final response rate was 51.4%, as can be seen from Table 1, which is higher than is often the case.

Quantitative data was analyzed using simple descriptive statistical techniques. Content analysis was employed to analyse qualitative data in three stages: first, all replies to a given question were read several times and an initial set of categories were defined; second, pieces of text were assigned to categories; third, the categories and assigned text were refined until they were deemed appropriate.

Table 1 – Distribution of responses per country and response rate.

Country	Valid certifications	Valid responses	Response rate (%)
Estonia	38	28	73.7
Germany	8	6	75
Italy	1	1	100
Lithuania	2	2	100
Netherlands	1	1	100
Norway	256	99	38.7
Portugal	68	53	77.9
Slovenia	7	6	85.7
Total	381	196	51.4

RESULTS

Sample profile

Table 2 summarises the main features of the sample. The majority of the sample consists of medium-sized (42.3%) and small (39.3%) SSO, followed by micro (12.8%) and large (5.6%) SSO. They are located in eight different European countries, including Norway (50.5%), Portugal (27%), Estonia (14.3%), Slovenia (3.1%), Germany (3.1%), Lithuania (1.0%), Italy (0.5%), and Netherlands (0.5%). Most of them obtained the first EQUASS Assurance certification between 2011 and 2013 (58.2%), whereas the remainder obtained it before 2011 (26.5%) and between 2014 and 2015 (15.3%). In addition to EQUASS Assurance, some SSO also have ISO 9001 (7.7%), DGERT (4.1%), Eco-lighthouse (2.6%), HACCP (1.5%), ISO 14001 (1%) certifications, among others. The positions of respondents are mainly Director/CEO (48.0%) and Quality Manager (40.3%). A few respondents are middle managers (8.7%) and social workers (3.1%).

Table 2 – Sample features.

Characteristics	Number	%
Organization size		
Large (>250 employees)	11	5.6
Medium-sized (50-250 employees)	83	42.3
Small (10-50 employees)	77	39.3
Micro (<10 employees)	25	12.8
Year of the first EQUASS certification		
-2010	52	26.5
2011-2013	114	58.2
2014-2015	30	15.3
Other certifications		
ISO 9001	15	7.7
DGERT	8	4.1
Eco-lighthouse	5	2.6
HACCP	3	1.5
ISO 14001	2	1
Other	9	4.6
Position of respondents		
Director/CEO	94	48.0
Quality manager	79	40.3
Middle manager	17	8.7
Social worker	6	3.1

Reasons for implementation

Figure 1 displays the mean score for each implementation reason. According to respondents, the motives with the highest degree of importance on the organization's decision to implement EQUASS Assurance are improvement of service quality, focus on continuous improvement and improvement of processes and practices. On the other hand, the motives respond to pressures from customers and from other stakeholders obtained the lowest mean score. Overall, the results suggest that social service providers were mainly driven by a genuine interest to improve quality and processes (i.e. internal motives) in their effort to implement the certification rather than to address market and other external pressures (i.e. external motives).

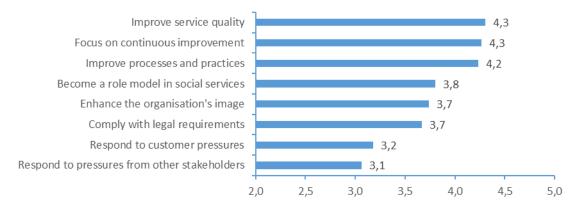


Figure 1 – Reasons for implementing EQUASS Assurance (n=196).

Respondents were also asked to indicate other relevant implementation reasons, and a summary of the results is shown in Table 3. Of the 33 additional reasons given, 18 are human or organization related (internal motives), while 15 are related with social and environmental pressures (external motives).

Table 3 – Other relevant implementation reasons.

Reasons	Mentions
A requirement from our governmental customer	4
To strengthen the focus on quality in our organization	3
To standardize practices across different locations	2
Improve service performance	2
To innovate service delivery	2
To improve customer's quality of life	2
Other reasons	18
Total	33

Implementation process

To ascertain whether SSO have adequately adopted EQUASS principles and practices in daily usage, the instrument included five questions about the internalization of QM system. Figure 2 shows the mean score of agreement with the respective statements. Respondents indicate that they generally agree that their organizations internalized EQUASS principles and practices in daily usage. When compared with the other elements, the training of all employees in quality management/EQUASS, and the consistency between documented and daily practices are integrated in a more superficial way.

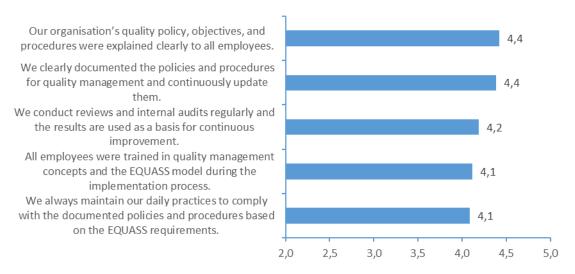


Figure 2 – Internalization of EQUASS Assurance in daily usage (n=196).

Implementation impacts

Figure 3 displays the mean scores of certification impacts on several operational elements. The findings indicate that EQUASS Assurance has a high impact on structuring and standardizing processes, as well as on promoting internal reflection and continuous improvement. The impacts on the clarification of employee responsibilities, enhanced internal organization, and eased identification/analysis of service failures are also relatively high. The benefit of improved internal communication has the lowest mean score on the operational impacts category.

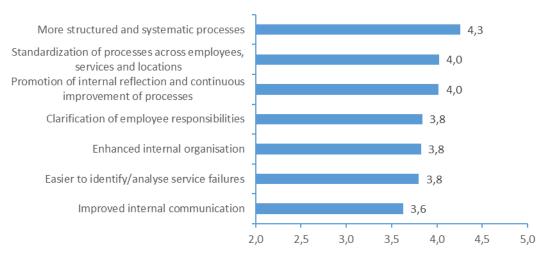


Figure 3 – Operational impacts of EQUASSS Assurance (n=196).

Figure 4 shows the mean scores of certification impacts on several employee aspects. Apart from a relatively high impact on improved employee knowledge and competencies, respondents rate the impacts on employee satisfaction, motivation, and productivity as rather moderate.

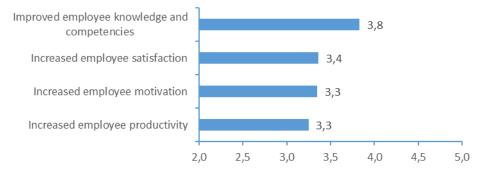


Figure 4 – Employee impacts of EQUASS Assurance (n=196).

The certification impacts on various customer related aspects along with their mean scores are shown in Figure 5. According to respondents, EQUASS Assurance has a high impact on dedicating greater attention to ethical and customers' rights issues and on improving service quality. This is followed by relatively high impacts on the involvement/participation of customers, improved quality of life of customers, and higher customer satisfaction. The impact on reduced number of complaints is only considered to be moderate.

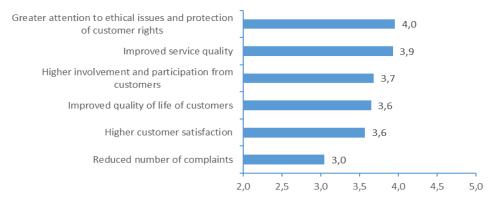


Figure 5 – Customer impacts of EQUASS Assurance (n=196).

Figure 6 displays the mean scores of certification impacts on society related aspects. Respondents rate the impact on improved organizational image as relatively high, whereas the impacts on higher external recognition/prestige and improved trust from agencies/governmental authorities are rated in the midpoint between moderate and high. The mean score of the other aspects are slightly below the midpoint between moderate and high.



Figure 6 – Society impacts of EQUASS Assurance (n=196).

Figure 7 exhibits the mean scores of the economic impacts of EQUASS Assurance. Respondents score the impacts on increased customer acquisition and retention in the midpoint between low and moderate. The results also show that the impacts on increased revenues, cost reduction, and increased fundraising are low.

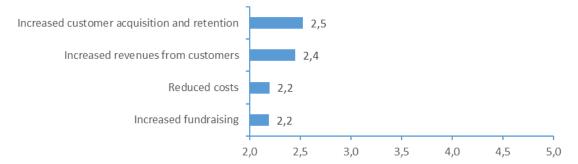


Figure 7 – Economic impacts of EQUASS Assurance (n=196).

If the different categories of impacts are compared by calculating their grand means, the results suggest that the implementation of EQUASS Assurance delivers relatively high benefits at the operational and customer levels, as it can be seen from Figure 8. The society and employee benefits are somewhat in the midpoint between moderate and high. On the other hand, the economic benefits are viewed as low.

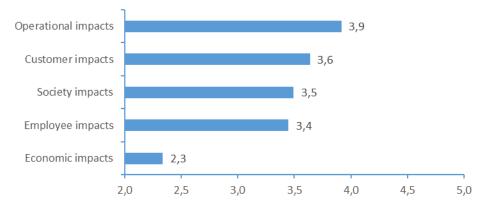


Figure 8 – Comparison among categories of certification impacts (n=196).

Implementation pitfalls

Figure 9 shows the mean scores of the implementation pitfalls. Respondents deem the pitfalls associated with increased top management workload and increased bureaucracy in the midpoint between moderate and high. The high costs with the initial implementation and maintenance of the certification, the higher workload of social workers, and the difficulties in defining measurable objectives are rated as rather moderate pitfalls. The lowest mean score pertains to the lack of external auditors from the social services area, which is in the midpoint between low and moderate.

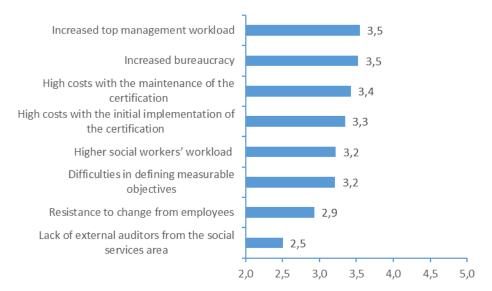


Figure 9 – Implementation pitfalls of EQUASS Assurance (n=196).

Respondents were also asked to indicate other pitfalls than those previously listed and the results are summarized in Table 4. The number of additional pitfalls indicated by respondents was rather low, perhaps suggesting that the pitfalls previously listed already provide an ample coverage of all pitfalls potentially applicable to EQUASS Assurance. These include too many requirements for small organizations, time and cost related issues, increased staff responsibilities, lack of training and experience on QM, and language difficulties with the standard.

Table 4 – Other relevant implementation pitfalls.

Pitfalls	Mentions
EQUASS is too comprehensive for small businesses	2
Considerable time taken to implement the standard	1
High training costs in quality management	1
Increased staff responsibilities	1
Lack of experience/training from management	1
Lack of internal auditors	1
The Norwegian translation of EQUASS does not cover the types of services we	1
provide and, therefore, is difficult to understand and implement	
The time dedicated to the aspects of certification, which sometimes have nothing to	1
do with quality of life, is taken away from the work with users	
Total	9

Satisfaction with the certification

Figure 10 shows the degree of satisfaction of respondents with EQUASS Assurance. 85.2% of respondents are very satisfied or satisfied, 11.2% have a neutral opinion, and only 3.6% are dissatisfied.

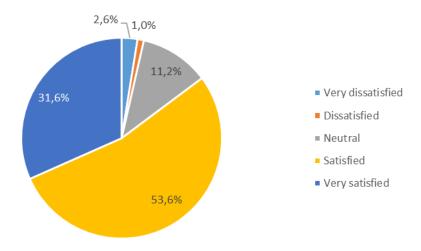


Figure 10 – Degree of satisfaction with EQUASS Assurance (n=196).

When asked to justify their degree of satisfaction, respondents contributed many insights, providing a rich dataset for further qualitative analysis, whose results are summarized in Table 5. Some respondents highlight and elaborate on the positive impacts mentioned earlier in the implementation impacts section. Interestingly, the role of the certification on improving organizational learning, as well as the use of EQUASS practices as planning and management tools are also mentioned.

Other respondents comment on the increased costs as a result of the implementation and maintenance of EQUASS Assurance, increased staff workload, and bureaucracy. While these pitfalls were already identified in the preceding section, further detailed comments were provided. For instance, respondents from micro and small organizations reveal that EQUASS Assurance is too time consuming, complex or has too many requirements and, accordingly, make calls for a simplified, cheaper version of the certification.

A small number of comments refer to general criticisms (e.g., no significant impacts on fundraising), improvement suggestions (e.g., the need to clarify further key concepts such as empowerment, self-

determination and others), the dissatisfaction with the external auditor's work, and the lack of visibility of EQUASS.

Table 5 – Reasons for the degree of satisfaction.

Categories	Mentions
Benefits	27
Excessive requirements for small organizations	14
Increased costs, workload and bureaucracy	12
Criticisms and suggestions	8
Auditors and Audits	6
Low/lack of visibility of EQUASS	4
_ Total	71

Certification renewal

This section asked estimates about the initial implementation cost (including training, process change, consultant fees, documentation, certification, etc.) and the annual maintenance cost (including the cost of internal and external audits) of the certification. Table 6 shows the descriptive statistics of the initial implementation cost per employee and the annual maintenance cost per employee.

Table 6 – Descriptive statistics of the EOUASS Assurance costs.

	Implementation	Annual maintenance
	cost per employee	cost per employee
Mean	837.73€	292.74€
Standard deviation	1565.75€	479.04€
Minimum	2€	1€
Maximum	12500€	3846€
	(n=140)	(n=133)

The mean of the initial implementation cost and annual maintenance cost is approximately 838€ and 293€ per employee, respectively. However, there is a considerable variation around these values. Not surprisingly, a more detailed analysis reveals that micro and small SSO support the highest mean implementation cost per employee. In addition to having a lower number of employees, they are also less likely to have human resources with the necessary expertise to implement and maintain the certification, and, thus, they may depend heavily on the assistance of external consultants, raising the implementation and maintenance costs.

This section also asked respondents about the percentages of the initial implementation cost and the annual maintenance cost that were directly funded by external entities. Figure 11 displays the histogram of the percentage of the initial implementation cost that was directly supported by a public grant, subsidy or European program. From the 155 responses, 36 (23.2%) SSO implemented the certification with full external financial support, whereas 84 (54.2%) SSO did not obtain any kind of direct external support.

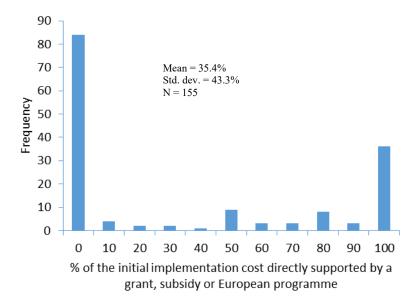


Figure 11 – Histogram of the percentage of the initial implementation cost directly supported by external entities (n=155).

Figure 12 depicts the histogram of the percentage of the annual maintenance cost that was directly supported by a public grant, subsidy or European program. Clearly, the vast majority of SSO (86.6%) does not receive any kind of external funding to cover the annual maintenance cost.

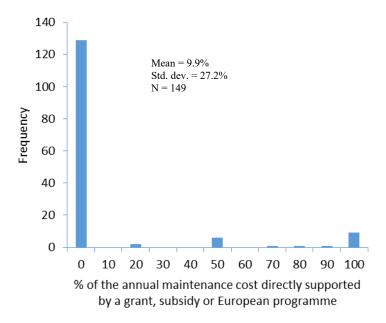


Figure 12 – Histogram of the percentage of the annual maintenance cost directly supported by external entities (n=149).

Another question asked respondents to provide an estimate of the certification renewal probability, whose results are presented in Figure 13. From a total of 162 responses, 133 (82.1%) respondents indicate that their organizations are likely to renew the certification (i.e. probability superior to 50%), 19 (11.7%) are undecided (i.e. probability equal to 50%), and 10 (6.2%) are unlikely to renew the certification (i.e. probability inferior to 50%).

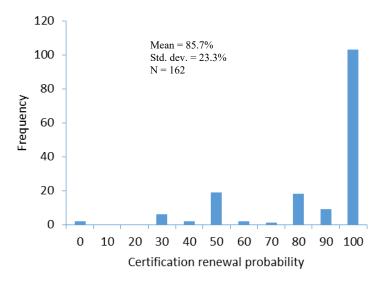


Figure 13 – Histogram of the certification renewal probability (n=162).

Finally, this section requested respondents to justify their answer on the certification renewal probability. Again, the replies were very rich and insightful. To ease their interpretation, they are separated into three tables. Table 7 summarizes the reasons for those SSO that are likely to renew the certification (i.e. probability superior to 50%). The highest cited reason is that it is required by governmental authorities. Other reasons are because the certification enables the organization to continuously improve quality, it is best suited to social services, or because it is part of the organization's philosophy, mission, strategy, among other reasons. In addition, respondents mention reasons based on several certification benefits (also included in "Other") identified in earlier sections. Interestingly, they also took the opportunity to make their voices heard, emphasizing once again some pitfalls (included in "Other") mentioned in the previous two sections.

Table 7 – Reasons for organizations that are likely to renew the certification.

Reasons	Mentions
It is a requirement from governmental authorities/customer	26
Keeps us in a process of continuous improvement of quality	13
EQUASS is best suited to our needs/social services	8
It is part of our philosophy/mission/strategy	8
It is important to keep the levels of knowledge acquired	7
Renewal already approved and scheduled	6
Pleased with results in quality improvement	4
Still undecided between EQUASS and ISO 9001	4
Depends on the costs/economic possibilities/management's decision	3
Renewal will be hopefully upgraded to EQUASS Excellence	3
Will renew if there is financial support	3
Because of image	2
EQUASS helps us to focus on client involvement and quality of life	2
EQUASS is an indispensable tool for daily management	2
We are considering the cost-benefit relationship	2
Other	24
Total	120

Table 8 – Reasons for organizations that are undecided about certification renewal.

Reasons	Mentions
We are looking for other certification possibilities	5
Renewal dependent on superior authorization	2
If does not lead to advantages, recertification certification is unlikely because	1
costs are too high in relation to benefits	
It depends on cost, subsidies	1
Depends on the requirements of the ministry of labor	1
We will renew if there is support from government or some project	1
It is costly and not recognized by state	1
Implementation costs are huge every time EQUASS changes their questions	1
and seeks new answers	
It took so much time to put it all together	1
Total	14

Table 8 lists the reasons for organizations that are undecided whether to renew the certification (i.e. probability equal to 50%). Five respondents state that they are searching for other certification alternatives, while two respondents declare that recertification depends on authorization from top management. The remaining reasons are cited only once and they explain that renewal is contingent on several factors, including, for example, its cost, availability of funding, cost-benefit relationship, and requirements from governmental authorities.

Table 9 reveals the reasons that respondents gave for unlikely to renew the certification. As can be seen, most reasons are related to cost or lack of funding issues, or to the low visibility of the certification.

Table 9 – Reasons for organizations that are unlikely to renew.

Reasons	Mentions
The decision depends on institution's policy and the motivation of key personnel	1
The weak influence of EQUASS Assurance certification in this area	1
Financial difficulties	1
There is no extra funding for QM, we see it as going concern	1
There should be a longer time between the audits to keep the costs lower	1
We are searching for a much smaller and cheaper quality system	1
_ Total	6

Other comments

The final question asked respondents to add other comments not previously mentioned. Table 10 shows the themes that emerged from the content analysis. As can be seen, no novel insights emerged on this stance. Nevertheless, it reinforces the importance that these themes have for some respondents.

Table 10 – Other comments.

Categories	Mentions	
Benefits	5	
Excessive requirements for small organizations	5	
Increased costs	1	
Lack of visibility of EQUASS	1	
Recertification is too often	1	
Other	2	

Total	15
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CONCLUSIONS

SSO implement EQUASS Assurance for various reasons, but the results indicate that they are mostly motivated by internal reasons rather than external ones. This is consistent with other research (Melão and Guia, 2015; Melão et al., 2016).

Respondents largely agree that SSO have internalized EQUASS principles and practices in daily usage, although some elements have been more superficially internalized than others (notably, the training of all employees and consistency between daily practices and documented policies and procedures).

EQUASS Assurance generates benefits mainly at the operational (i.e. more systematic and standardized processes, and promotion of internal reflection and continuous improvement) and customer (greater attention to ethical and customer rights' issues, improved service quality) levels. This finding is in accordance with previous studies on EQUASS (Melão et al., 2016) and ISO 9001 (Melão and Guia, 2015).

Respondents consider the economic impacts of EQUASS Assurance to be low. The study of the effects of the implementation of QM systems on the economic performance of SSO remains largely an unchartered territory. In the wider literature, the empirical results are mixed, suggesting that their effects on economic benefits are weaker than operational benefits and not always significant (Sousa and Voss, 2002).

Increased workload and bureaucracy are two important implementation pitfalls for SSO. Surprisingly, respondents perceive the high costs associated with the implementation and maintenance of the certification as rather modest pitfalls. This may be because the majority of SSO received some kind of financial aid to implement the standard, as well as because EQUASS Assurance is a requirement in some countries (notably, in Norway). Respondents identify other relevant pitfalls, including too many requirements for small and micro organizations, long implementation time, short time interval between certification renewals, and lack of visibility of EQUASS. With the exception of the latter two, these are implementation pitfalls also found in the context of other QMS like ISO 9001 (Heras et al., 2008; Melão and Guia, 2015).

Approximately 86% of respondents are very satisfied or satisfied with EQUASS Assurance, which suggests that the certification largely met their expectations of process, quality and continuous improvement. However, several respondents also identify some issues/difficulties that need to be addressed, some of which are specific to EQUASS Assurance.

Micro and small SSO incur the highest initial implementation cost and annual maintenance cost per employee. Not surprisingly, various respondents commented on this, making calls for a simplified, less expensive version of EQUASS Assurance. Indeed, this may be a sensible option, especially if one considers that more than half of this sample refers to these type of organizations, that SSO often operate in resource constrained environments, and that the availability of financial assistance (notably, through the European Social Fund) may has been an enabling factor for implementing EQUASS Assurance in the first place.

Around 82% (n=162) of respondents indicate that their organization is likely to renew EQUASS Assurance. This figure should be interpreted with some caution, though, since 17.3% (n=196) are non-respondents and because the final renewal decision depends, as respondents pointed out, on the availability of funding, government requirements, and other factors. It is also clear from this study that many SSO incorporated successfully EQUASS Assurance in their daily work, gained significant benefits, and, consequently, remain loyal users. Like any other QM system, EQUASS Assurance should be seen as a tool for continuous improvement rather than merely a vehicle for securing funds.

One limitation of this empirical study is that it reports mainly the perspectives of top management and quality managers. In order to obtain a fuller picture of the impacts of EQUASS Assurance on SSO it would be important to study the perspectives of other employees, customers and other stakeholders.

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Tailor made Excellence - Systemic analysis using sensitivity model

Bolboli, S.A.¹⁾ and Reiche, M.²⁾

¹¹ PhD Student, Research Group "Product Safety and Quality Engineering", University of Wuppertal, Wuppertal, Germany

²⁾ Founding President, Quality Experts Consulting, Nuremberg, Germany

ABSTRACT

Purpose - Despite of the proved effect of implementation of Business Excellence (BE) models on organization's performance, more than 70% of BE projects fail. This paper aims to investigate BE implementation barriers in order to identify the main requirements for successful deployment of BE models. Moreover, this paper focuses on the gap in practice of BE concepts by comparison of existing BE implementation frameworks and consequently propose a novel framework for tailormade design of BE measures.

Design/methodology/approach – The so-called "malik sensitivity model" has been deployed in this study to analyze the main influencing factors in operationalization of BE models and identify the main requirement for successful selection of BE measures. A comprehensive review of literature led to identification of a sample of existing implementation frameworks.

Findings - Based on the sensitivity analysis, main requirements for successful design and implementation of BE models were identified. These were classified into two groups; "BE specific requirements" and "general requirement". Considering the identified requirements and using qualitative comparison, the suitability and applicability of existing BE implementation frameworks were assessed and the gap was identified. The results highlight the need for adoption of BE measures to existing corporate culture and maturity level of organization when realizing BE models. Considering the identified gap, a new framework for tailor-made design of BE measures was introduced.

Practical implications- The findings offer guidance to those organizations wishing to realize BE adopted to their firms specific requirements.

Originality/value- This research presents a new framework for design of BE measures based on existing culture and maturity level and applies Vester's sensitivity model to investigate BE implementation barriers for the first time.

Keywords: Business Excellence, Corporate culture, Sensitivity model.

Paper type: Research paper

INTRODUTION

The fourth and currently last paradigm shift in quality management is "total quality management" or "business excellence", which takes all external and internal stakeholders into account and is fully visible in the last 10 years (Weckenmann et al., 2015). The BE approach or TQM, based on ideas of the quality pioneers Deming, Feigenbaum, Ishikawa and Juran (Zairi, 2013), was developed mid-1980s. It is since the 1990s, the central concept of many successful companies (Mias, 2005). The term "excellence" (lat. Excellere) stands for outstanding quality of an object, a capability or performance (Schneider and Geiger, 2008).

Various models have been developed as theoretical framework for designing BE. So far about 100 BE (price) models are developed in 82 countries (Talwar, 2011), including 30 in 24 EU countries. In this study 81 BE models from 72 countries were investigated. About 80% of the investigated BE models are based on Malcolm Baldrige National Quality Award (MBNQA), Deming, EFQM or a combination of these three BE models. Approximately 59% of the investigated BE models based on EFQM, 30% on MBNQA, 9% on Deming. In summary, the analysis of BE models shows the large spread of the EFQM model, particularly in Europe, where more than 80% of the developed quality price models build on it. Therefore, the EFQM model were used in this study as a reference model for the design of BE concepts.

A number of studies have focused on the expected impact of implementing BE. The published study by Boulter et al. (2013) "A comparative analysis of the performance of European Excellence Award winners" in 2013 is the successor to the long-term study "The impact of TQM on Financial Performance Evidence from Quality Award Winner" by Hendricks and Singhal in 1997 to assess the effect of designing BE concepts on business success. These studies clearly show that the successful design of BE concept has a positive impact on business results. Both studies follow a similar research design and consider the developments of the BE award winner companies with comparable number of companies from the same field over a period of ten years (five years before obtaining a quality prize and five years after implementation of BE). The examined BE award winner companies in the study of Hendrick and Singhal (1997) showed a 44% higher share price gain, a 48% higher growth in the operating result and a 37% higher sales growth than the comparison group (Reiche, 2011). Similar results have been provided by Boulter et al. (2013) in their study "impact of the implementation of BE concepts on the economic results". They have analyzed the development process of the BE award winners and the comparison companies before and after the design of the BE concept. As the figures below show, the study shows positive developments, namely one to five years after designing the BE concept.

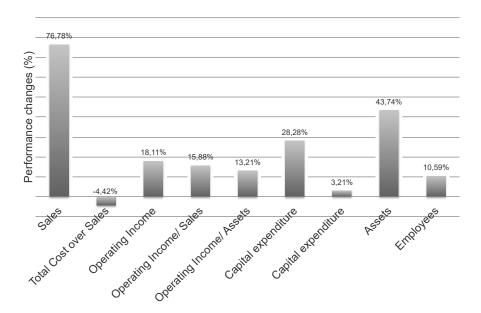


Figure 1- Performance Change the price winners and the comparison companies in a period of six years, namely one year before and five year after the design of the BE-concept (Boulter et al. 2013)

However, the practice shows great difficulties in implementing the BE concept. It has been reported by many authors (Conti 2011; Cao et al. 2000; Boulter et al. 2013) that more than 70% of BE projects fail. Therefore, the failure factors will be analyzed in order to identify the requirements for developing a new framework for tailor made design of BE.

THEORETICAL FRAMEWORK

In order to investigate the barriers in the design and implementation of BE concepts and to identify the main requirement for BE implementation framework, the malik sensitivity model has been applied, which was developed in the late 1970s by Frederic Vester and Alexander von Hesler on interdisciplinary research on complex systems and published for the first time as part of a UNESCO study 1980th. The model is a comprehensive set of instruments and can be used as working platform to capture complex systems and issues in management, business, administration, planning and research, analyze and plan (Malik, 2014). The use is particularly suitable in case of problems with a variety of factors and links (Burkhard, 2007). The sensitivity analysis (Vester, 2012) is divided into nine structured and cumulative steps.

- 1. System description,
- 2. variable set,
- 3. criteria matrix,
- 4. influence matrix,
- 5. system role,
- 6. effect system,
- 7. partial scenarios,
- 8. simulation and
- 9. system evaluation.

The necessary steps for this study, namely the identification of main requirements for BE implementation framework can be achieved with the first six steps. The analysis of the partial scenarios, simulation and system evaluation (steps 7-9) will provide further results, which are not necessary according to the intention of this study. Therefore, only the first six steps will be conducted.

In the second part of this research existing BE implementation frameworks in literature have been identified and seven most cited frameworks were selected for further analysis. These frameworks are Radtke (1997), Ghobadian (2001), Zhang (2000), Zairi and Alsughayir (2011), Asif and Searcy (2014), Chin and Pun (2002) and Abdallah (2014). The aim is to analyze how far the existing frameworks meets the main requirements for designing BE, which have been derived from sensitivity analysis. In this part the actual gap in designing BE concepts will be identified. Considering the identified requirements and the highlighted gap, a new framework "Tailor made Excellence (TMEX)" will be introduced.

RESEARCH METODOLOGHY

Based on the sensitivity model following steps have been conducted to identify the main requirement for successful design of BE concept.

Step 1 (System Description): With the first step of the sensitivity analysis, the problem area will be presented as a whole. This includes the description of problem or a system question or objective, for example, sustainable development of a company. Then the definition of partial objectives and detailing the problem area will be done with the participation of relevant stakeholders (Freisl 2011, p 117; Burkhart 2007, p 46; Vester 2012 S. 192). In this work, the system description directs to "design of BE concepts" out. First, the relevant factors or variables will be identified that play a role in the system behavior. Numerous studies (Bhat and Rajashekhar, 2009; Jun et al. 2004; Kanji, 1995; Lakhe and Mohanty, 1994; Liu, 1998; Macdonald, 1995; Rahim and Whalen, 1994; Rothlauf, 2010; Sebastianelli and Tamimi, 2003; Tamimi and Sebastianelli, 1998; Soltani et al., 2005; Zink, 2004; Talib et al., 2011; Frehr, 1994; Toepfer and Mehdorn, 1995; Oess, 1993; Gunasekaran, 1999; Hicks and Matthews, 2010; Amar and Zain, 2002; Masters, 1996; Ngai and Cheng, 1997; Salegna and Fazel, 2000) have examined the difficulties in the design of BE concepts. More than 50 empirical studies in the period from 1980 to 2010 have been studied by Mosadeghrad (2013) in his meta analysis and finally 56 barriers in the design of BE concepts have been identified (see annex 1). These serve as potential variables of the system "design of BE-concepts" in this study.

Step 2 (variable set): The second step concerns the reduction of data to important system-relevant key variables (Vester, 2012). According to Vester (2000) the number of system variables have to be limited to about 20-40 variables. Therefore, identified barriers by Mosadeghrad (2013) were discussed and prioritized in a workshop with BE experts from the German industry in terms of its relevance and importance. Resulting from the workshop a preliminary set of 21 variables could be filtered out, that play a role in the behavior of the system under investigation (see table 1).

Table 1: List of selected BE barriers in the workshop

Nr.	Selected barriers
1	Unjustified Business Excellence programme
2	Lack of company specific adoption
3	Unrealistic expectations
4	Lack of top management support
5	Middle management resistance
6	Inappropriate planning
7	Lack of constancy of purpose
8	Lack of a vision and clear direction
9	Lack of adaptability to existing maturity level
10	Lack of non-personnel resources
11	Lack of employee commitment and involvement
12	Employees' resistance to change
13	Lack of training and education regarding BE
14	Lack of recognition and reward for success
15	Lack of adaptability to existing corporate culture
16	Difficulties in changing organisational culture
17	Poor and ineffective communication
18	Lack of evaluation and self-assessment
19	Incompetent change BE Project Manager
20	Ineffective BE measures
21	Lack of resources, financial support, cost of implementation

Step 3 (Criteria matrix): In the third step of the sensitivity model, the systemic importance of the variable is checked against a criteria matrix. The matrix consists of 18 criteria by which it can be ensured that all relevant aspects for the holistic collection and presentation of the system are detected (Burkhard, 2007). Thus, in this step selected variables were checked with regard to all related system aspects.

As the table below shows, the fulfillment of the criteria by each variable was examined and then respective points were given (1 point = fully applicable, 0.5 points = partially applicable, 0 = not applicable). The set of variables has been revised so long until the reality aspects and system criteria were reasonably represented (Vester, 2012).

			Sec	tor of														
	Sector of life			Physical criteria Dynamic crite						ia System relations								
Applicable 0,5 Partly applicable Not applicable	Stakeholder	Processes/ Activit./ Functions	Area	Preception	Resourses / Environment	Communication	Internal structure	Material	Energie	Information	Flow determinant	Structural determinant	Temporal dynamic	Spatital dynamic	Opens system to input	Opens system to output	Endogenous	Exogenous
Unjustified Business Excellence programme				1		0,5	1			1	0,5	0, 0		1	1		1	
Lack of company specific adoption		0.5	0,5	1	0,5		1				1				1			0,5
Unrealistic expectations				1						1		0,5		1	1		1	
Lack of top management support	1	1			0,5		0,5	1	1		1					0,5	1	
Middle management resistance	1	1	0,5	1			0,5	1	0,5	1	0,5			1			1	
Inappropriate planning		1	1				0,5				1						0,5	
Lack of constancy of purpose					0,5	0,5	0,5								1			0,5
Lack of a vision and clear direction			1			1	0,5				0,5					0,5		
Lack of adaptability to existing maturity level					0,5							1						1
Lack of non-personell resources					1							1					1	
Lack of employee commitment and	1			1		1			0,5	0,5	0,5			0,5	0,5		0,5	
Employees' resistance to change	1			1					0,5	1	0,5		1	0,5	1			0,5
Lack of training and education regarding BE										1		0,5		0,5				1
Lack of recognition and reward for success																0,5		
Lack of adaptability to existing corporate culture			1	1			1			0,5	1			0,5	1			1
Difficulties in changing organisational culture		1	1	0,5						0,5	1		0,5		1	0,5		1
Poor and ineffective communication		1	0,5			1				1	0,5			0,5	0,5	0,5		
Lack of evaluation and self- assessment		1					0,5				0,5		1	0,5	1			
Incompetent change BE Project Manager	1	0,5						1	0,5						0,5	0,5	0,5	
Ineffective BE measures							0,5						1	0,5		1		
Lack of resources, financial support, cost of implementation					1			1	1						1	1	1	
	Excellence programme Lack of company specific adoption Unrealistic expectations Lack of top management support Middle management resistance Inappropriate planning Lack of constancy of purpose Lack of a vision and clear direction Lack of adaptability to existing maturity level Lack of non-personell resources Lack of employee commitment and involvement Employees' resistance to change Lack of training and education regarding BE Lack of recognition and reward for success Lack of adaptability to existing corporate culture Difficulties in changing organisational culture Poor and ineffective communication Lack of evaluation and self-assessment Incompetent change BE Project Manager Ineffective BE measures	Unjustified Business Excellence programme Lack of company specific adoption Unrealistic expectations Lack of top management support Middle management resistance Inappropriate planning Lack of constancy of purpose Lack of a vision and clear direction Lack of adaptability to existing maturity level Lack of mon-personell resources Lack of employee commitment and involvement Employees' resistance to change Lack of recognition and reward for success Lack of adaptability to existing corporate culture Difficulties in changing organisational culture Poor and ineffective communication Lack of evaluation and self-assessment Incompetent change BE Project Manager 1 Ineffective BE measures Lack of resources, financial support, cost of implementation	Unjustified Business Excellence programme Lack of company specific adoption Unrealistic expectations Lack of top management support Middle management resistance Inappropriate planning Lack of constancy of purpose Lack of a vision and clear direction Lack of adaptability to existing maturity level Lack of employee commitment and involvement Employees' resistance to change Lack of training and education regarding BE Lack of adaptability to existing corporate culture Difficulties in changing organisational culture Difficulties in changing organisational culture Difficulties in change BE Project Manager Incompetent change BE Project Manager Lack of resources, financial support, cost of implementation Incompetentation Incompetentation	Unjustified Business Excellence programme Lack of company specific adoption Unrealistic expectations Lack of top management support Middle management resistance Inappropriate planning Inapprop	Unjustified Business Excellence programme Lack of company specific adoption Unrealistic expectations I 1 Lack of top management support Middle management resistance I 1 0,5 1 Inappropriate planning I 1 1 Lack of constancy of purpose Lack of a vision and clear direction Lack of adaptability to existing maturity level Lack of employee commitment and involvement Employees' resistance to change Lack of recognition and reward for success Lack of adaptability to existing corporate culture Difficulties in changing organisational culture Poor and ineffective communication Lack of evaluation and self-assessment Incompetent change BE Project Manager Lack of resources, financial support, cost of implementation	Unjustified Business Excellence programme Lack of company specific adoption Unrealistic expectations Unrealistic expectations Lack of top management support Middle management resistance 1 1 0,5 Inappropriate planning 1 1 1 Lack of constancy of purpose Lack of a vision and clear direction Lack of adaptability to existing maturity level Lack of employee commitment and involvement Employees' resistance to change Lack of training and education regarding BE Lack of of adaptability to existing corporate culture Lack of adaptability to existing organisational culture 1 1 0,5 Poor and ineffective communication Lack of revources, financial support, cost of implementation 1 1 0,5 Lack of resources, financial support, cost of implementation	Unjustified Business Excellence programme Lack of company specific adoption Unrealistic expectations Unrealistic expectations Unrealistic expectations Unrealistic expectations 1	Unjustified Business Excellence programme Lack of company specific adoption O.5 0,5 1 0,5 1 Unrealistic expectations Lack of top management support Lack of top management resistance 1 1 0,5 1 0,5 0,5 0,5 0,5 0,5 0,5 0,5 0,5 0,5 0,5	Unjustified Business Excellence programme Lack of company specific adoption Unrealistic expectations 1	Unjustified Business Excellence programme	Unjustified Business Excellence programme	Unjustified Business Excellence programme	Unjustified Business Excellence programme	Unjustified Business Excellence programme Lack of company specific	Unjustified Business Excellence programme	Unjustified Business Excellence programme Lack of company specific adoption 0.5 0.5 1 0.5 0.5 1 1 0.5 1 1 0.5 1 1 0.5 0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Unjustified Business Excellence programme Lack of company specific adoption O.5 0.5 1 0.5 1 1 0.5 1 1 0.5 1 1 0.5 1 1 0.5 1 1 0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Unjustified Business Excelence programme

Step 4 (system effect): In the next step of the sensitivity analysis, the focus is on the analysis of the effects of variables in the system context. Here the pairwise connection between the selected variables were compared and between 0-3 points were given (see table 3). No points were given when a variable change showed no impact on other changes in the system and no clear

relationship were identified. If the strong change in one variable caused a small change in other variables one points were given due to the weak relationship. An average approximately proportional relationship is likely if strong change in one variable with a similarly significant change in the other variable is visible. Here two points were awarded. In the case of a very strong correlation (strong, above-average relationship) between the variables three points were awarded. With the analysis of interactions using the influence matrix, among other things, the so-called active sum (AS) and passive sum (PS) could be calculated for each variable. While the active sum of a variable reflects the strength of the effect of the variables on the rest of the system, the passive sum shows the sensitivity of the reaction of the respective variables to changes in the system. The active sum is calculated by adding the numbers in a row from left to right. The passive sum was calculated by adding the numbers in a column.

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	e 3: Results of system effect a	ISSE	essn	neni																			Active	Danaire	AS/PS x	
	2.050.5.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	sum	Passive sum	100	AS x PS
	*																						AS	PS	Q-Value	P-Value
1	Unjustified Business Excellence programme		1		3	3				1		3	3									1	15,0	35,0	42,9	525,0
2	Lack of company specific adoption	3			2	3		1		2		3	3			2	3				3		25,0	28,0	89,3	700,0
3	Unrealistic expectations		1		1	1	2		1	1		2				2	3				2		16,0	22,0	72,7	352,0
4	Lack of top management support	1	1	1		3		1	2	1	3	3	2	1	3	1	1					3	27,0	35,0	77,1	945,0
5	Middle management resistance	3	3	1	3		1	1	1	1	2	3	3		1	3	3	1			1	1	32,0	41,0	78,0	1312,0
6	Inappropriate planning				2	1		2	3	2		1	1	1		1	1				3		18,0	20,0	90,0	360,0
7	Lack of constancy of purpose			1	2	1	3		3	1						2	2				1		16,0	16,0	100,0	256,0
8	Lack of a vision and clear direction			1	2	1	3	3		1						2	2				1		16,0	19,0	84,2	304,0
9	Lack of adaptability to existing maturity level	3	3	2	2	2	1	1	1			2	3			3	3				1		27,0	26,0	103,8	702,0
10	Lack of non-personell resources	1		2	2	3						3									1	3	15,0	6,0	250,0	90,0
11	Lack of employee commitment and involvement	2	1	1		1	1						3			3	3	2			1		18,0	43,0	41,9	774,0
12	Employees' resistance to change	3	3	1	1	1	1					3				3	3	1			2		22,0	38,0	57,9	836,0
13	Lack of training and education regarding BE	2	1	1	1	1				3		1	2			1	1				2		16,0	5,0	320,0	80,0
14	Lack of recognition and reward for success	2				3				1		3	3										12,0	8,0	150,0	96,0
15	Lack of adaptability to existing corporate culture	3	3	1	2	3	1	2	1	3		3	3				3	1			3	3	35,0	31,0	112,9	1085,0
16	Difficulties in changing organisational culture	3	3	1	2	3	1	2	1	3		3	3			3		1			3	3	35,0	34,0	102,9	1190,0
17	Poor and ineffective communication	3	3	3	3	3			3	1		3	3			2	2			1	3		33,0	9,0	366,7	297,0
18	Lack of evaluation and self-assessment		2	2	1	1	3	1	2	3		1	1			1	1				1		20,0	2,0	1000,0	40,0
19	Incompetent change BE Project Manager	3	2	1	3	3	2	1	1	2		1	1	1		1	1	3			1	2	29,0	4,0	725,0	116,0
20	Ineffective BE measures			1		1		1				2	2		2	1	1		1			1	13,0	31,0	41,9	403,0
21	Lack of resources, financial support, cost of implementation	3	1	2	3	3	1				1	3	2	2	2		1		1	3	2		30,0	17,0	176,5	510,0
	Passive sum:	35	28	22	35	41	20	16	19	26	6	43	38	5	8	31	34	9	2	4	31	17				

As the table shows, the variable 14 ("Lack of recognition and reward for success") for example, has a small active sum that shows the need for a great change in this variable for affecting the system. The relatively high active sum of variable 15 ("Lack of adaptability to existing corporate culture"), shows that small changes in this variable act relatively strong in the system. The variable 11 ("Lack of employee commitment and involvement") has with 43 points a very high passive sum that shows this variable varies greatly when something changes in the system. The low passive sum in variable 18 ("Lack of evaluation and self-assessment") means that in the system a huge change is required to influence this variable.

From the analysis of the interaction of the variables of the system, using the influence matrix, a table of the impact strengths has been created that allows a different perspective on the results of the impact matrix. The figure below shows which variables have the greatest effect on the system, which are most affected and which have these both characters in the system. In this context, the important variables can be identified that are particularly jut out to both left (passive) and to the right are (active). These include for example the variable V4 ("Lack of top management support"), V5 ("Middle management resistance"), V15 ("Lack of adaptability to existing corporate culture"), V16 ("Difficulties in changing organisational culture") that influence the system strongly with their change, on the other hand react strongly to any system change (see. figure 2). These variables are therefore described as critical factors.

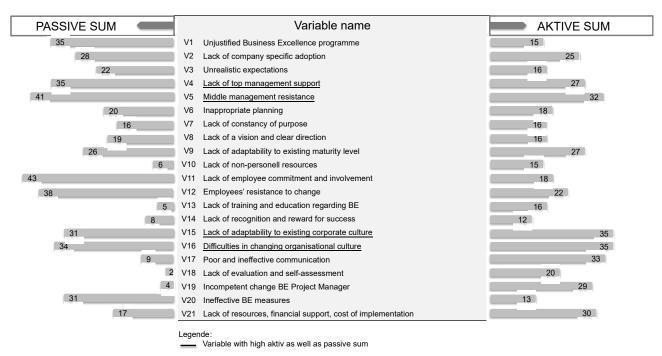


Figure 2: Impact strengths

Step 5 (System role)

The mere knowledge of the active and passive sums is not enough to provide answers to further questions (e.g. identification of control lever). Here, the ratio of active (AS) and passive sum (PS) based on the quotient (Q)-value is analyzed, to reflect the active or reactive character of the respective variables (see. figure 3). Based on the Q-value and independent of the variable intensity can be analyzed how the affected variable in a system behaves (Vester 2012). The high Q-value of the "V13, V17, V18, V19" in figure 3 shows that these variables express themselves clearly in the system. When it comes to analyze the interaction of the elements in the whole system and their participation in the event, the informational value of the quotient is not sufficient. To this end, the representation of the individual product is made of the active and passive sum (product or P-value = AS x PS).

Regardless of whether the respective variables are more active or passive, the size of the P-value shows if the variable has a critical nature (high participation on system behavior) or a buffering character (low participation

on system behavior). The high P-value of the "V4, V5, V12, V15, V16" in figure 3 shows the high level of participation of these variables in the system behavior.

ACTIV · · · · REACTIVE	Q Value	CRITICAL····BUFFERING	P Value
Highly active	1000	Highly critical	4040
V18	1000	V5	1312
V19	725	V16	1190
V17	367	V15	1085
V13	320	V4	945
Active		V12	836
V10	250	Critical	
V21	176	V11	774
V14	150	V9	702
V15	113	V2	700
V9	104	Slightly critical	
V16	103	V1	525
Slightly active		V21	510
V7	100		310
	100	Neutral	
Neutral		V20	403
V6	90	V6	360
V2	89,3	V3	352
V8	84,2	V8	304
Slightly reactive		Slightly buffering	
V5	78	V17	297
V4	77,1	V7	256
V3	72,7	V19	116
V12	57,9	V14	96
V1	42,9	V10	90
V20	41,9	V13	80
V11	41,9	V18	40

Figure 3: Impact index

Through the joint consideration of P and Q value, the variables get a systemic characteristic. They turn out to be active, critical, buffering or reactive. With the positioning of variables in two areas of tension - the one between active and reactive, the other between critical and buffering - can be determined how to deal with the system. This positioning and the role of the variable can be displayed in a two-dimensional graphics "system roles" (see figure 4).

As the allocation of roles shows, the variables V4, V5, V9, V12, V15 and V16 in the yellow region are the critical points of the system. They are suitable as control levers for the system. Vester (2012) describes variables in this area as accelerators and catalysts, which are useful as initial spark to get things ever in motion, and the utmost caution in the system demand. The variable in the top-left are according to Vester (2000) effective lever by which the system can be stabilized again after changes taken place (plastic stability). These include the variables 17 and 21. The variables in the lower right (V1 and V11) are according to Vester (2012) indicators for controlling interventions that lead only to treatment of system symptoms (Vester, 2000). Other variables in the neutral range between active, reactive, buffering and critical are not further investigated further because the system with these variables can be controlled poorly.

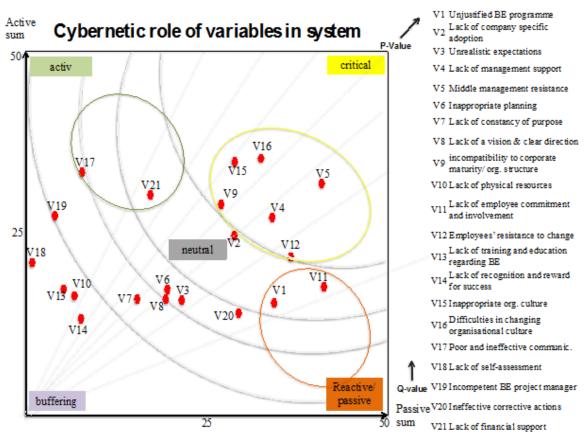


Figure 4: Role of variables in the system

Step 6 (effect system): With the previous steps, in particular the evaluation of the impact matrix and allocation of roles, clear indications for use of the system (design of BE concepts) can be derived. However, these instructions are limited to the "genetic background" of the system, without clarifying what is active on these investments under the real conditions and how is their expression in the system behavior. In order to clarify the current dynamics of the system "design of BE concepts", a two-dimensional interactive structure is built. Here the input of the relationships between variables is different from the impact matrix. In the influence matrix the different thickness of the potential impact has been studied; this could be triggered by changes in the output variables. With investigation of the overall network, it is possible to analyze only actual currently active relationships of variables. The interactive structure is therefore independent and not build based on the impact matrix. As the figure 5 shows, dotted or solid arrows are used to construct the interactive structure. If the respective variable rises or falls upon the rising or falling in the output variables, so it is a rectified relationship. A solid arrow shows this character. In contrast, a dotted arrow is drawn at an opposite relationship. In the case of interdependence between two or more variables is spoken of feedback (Vester, 2012). Due to the suitability of the variables V1 ("unjustified BE Project"), V4 ("insufficient support by the top management"), V5 ("resistance of middle management"), V9 ("missing passport ability to maturity"), V11 ("lack of commitment and insufficient involvement of employees"), V12 ("resistance of employees"), V15 ("missing passport ability to corporate culture"), V17 ("poor communication"), V21 ("inadequate funding and lack of personnel", these factors "design of BE-concepts" derived as essential control levers of the system.

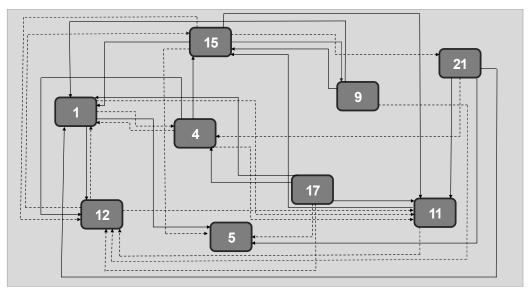


Figure 5: System interaction of selected variables

RESULTS

Resulting from the sensitivity analysis, the shortcomings in the design of BE concepts have been systematically investigated and their role in the system behavior has been clarified. The analysis indicates that a lack of cultural and maturity compatibility are the most important causes for the failure of BE projects. Furthermore, the following causes are critical for the design of BE concepts: "Unjustified Business Excellence programme", "Lack of top management support" Middle management resistance", "Lack of employee commitment and involvement", "Employees' resistance to change", "Poor and ineffective communication", "Lack of resources, financial support, cost of implementation".

Despite the close link between business excellence and corporate culture (Moll and Kohler, 2013) the prevailing corporate culture is not sufficiently considered. Therefore, the implementation of BE measures require a massive cultural change. This is the reason why most of BE projects cannot be implemented smoothly. Often associated with BE cultural changes are the growing power structures in the line organization (Maul, 2002).

A standardized measure recommendation usually requires a significant cultural change and is an important cause of the failure. Furthermore, it is difficult to analyze the suitability of existing maturity level in order to derive an appropriate implementation strategy. Due to the uncertainty of the starting point and the complexity of the implementation approach, the implementation of BE concept without any external support is hard to imagine. However, this would increase the cost. So individualized approaches and solutions are needed, which are adapted to the company's situation. Often the focus of BE frameworks is on the first steps of implementation. Thus, the companies are neglected, that are in the further implementation phase. This leads to a lack of generality and to a limited group of framework users. The systematic observation of the maturity level is therefore a critical factor in the design of BE. Most frameworks for designing BE concepts aim primarily to improve the structure of the company, without involving the culture. With this in mind, this study follows the idea to integrate the two aspects (corporate culture and maturity) in the design of BE concepts systematically. This requires a framework by which the consideration of the corporate culture and the level of maturity within the design of BE projects can be operationalized. The design of BE concepts takes place in several successive phases. Therefore, it should be specified in which phase, the information regarding existing corporate culture and the maturity level need to be incorporated.

In order to further clarify the idea of this study for developing a framework for designing BE concepts considering the existing maturity level and the corporate culture, relevant requirements for achieving the above-mentioned objective need to be defined. These requirements will be used on the one hand to evaluate the existing BE implementation frameworks. In this context, the main phases of development of BE concepts

are identified and the problem is concretized. On the other hand, the requirements serve as the basis for the new framework for the design of BE concepts, which it is necessary to close the gap. Based on the findings of the sensitivity analysis, in particular the allocation of roles in step 5, nine requirements for the design of BE concepts have been derived (see. Table 4). These are defined as BE specific requirements.

Table 4: BE-specific requirement for successful design and implementation of BE models

Requirements	Variables in the		
	sensitivity analysis		
A: Ensuring the alignment between BE measures and corporate culture	Variable 15 and 16		
B: Ensuring the alignment between BE measures and maturity level	Variable 9		
C: Highlighting the importance of justifying BE Initiative	Variable 1		
D: Highlighting the importance for commitment and the involvement of	Variable 11		
employees			
E: Contribution to overcoming the resistance of the employees to change	Variable 12		
F: Highlighting the importance of intensive communication	Variable 17		
G: Highlighting the need for top management commitment	Variable 4		
H: Contribution to overcoming the resistance of the middle management	Variable 5		
I: Highlighting the need for provision of necessary resources	Variable 21		

In addition general requirements are defined which need to be considered when developing a new BE framework. These are derived from the literature review and reflected in the below table.

Table 5: General requirements for successful design and implementation of BE models

Requirements	Reference in the literature
J: practical orientation: operationalization of implementation steps based	Andernach 2006, S. 86;
on a practical guide	Reiche 2007, S. 61
K: cost-benefit efficiency: simple handling, low time and cost	Kalpande 2012; Reiche 2007, S. 61
L: Flexibility: adaptable approach, ability to company-specific design	Radtke 1997, S.18; Reiche 2007, S. 61
M: Independence: applicable in different sized companies and different organizational forms	Reiche 2007, S. 61
N: knowledge base: open, dynamic and extensible	Kalpande 2012; Reiche 2007, S. 61

Based on the comparison of existing frameworks, following main phases for the design of BE concepts have been identified:

- Sensibilization
- Designing of measures
- Realization
- Overall evaluation

The comparative analysis in the figure 6 shows that the existing frameworks mostly do not fulfill the requirement A, B, E, H.

						BE		lementation mework
 not applicable Legende:	/0	adire	1991 1991 1991	hard 1	on and a	sudra settle	Spirit &	TA CO TA
BE specific requirements								ĺ
A: Ensuring the alignment between BE measures and corporate culture	0	0	0	•	0	0	0	
B: Ensuring the alignment between BE measures and maturity level	•	0	0	0	0	0	0	
C: Highlighting the importance of justifying BE Initiative	•	0	•	•	•	•	•	
D: Highlighting the importance for commitment and the involvement of employees	•	•	•	•	•	•	•	
E: Contribution to overcoming the resistance of the employees to change	0	0	0	•	0	0	0	
F: Highlighting the importance of intensive communication	•	•	•	•	•	•	0	
G: Highlighting the need for top management commitment	•	•	•	•	•	•	•	
H: Contribution to overcoming the resistance of the middle management	0	0	0	•	0	0	0	
I: Highlighting the need for provision of necessary resources	•	•	•	•	•	•	•	
general requirement								
J: practical orientation: operationalization of implementation steps based on a practical guide	•	•	•	•	•	•	•	
K: cost-benefit efficiency: simple handling, low time and cost	•	0	•	•	0	•	0	
L: Flexibility: adaptable approach, ability to company-specific design	•	0	•	•	•	0	•	
M: Independence: applicable in different sized companies and different organizational forms	•	•	0	•	•	•	0	
N: knowledge base: open, dynamic and extensible	•	0	•	•	•	0	•	

Figure 6: Evaluation of existing frameworks regarding the level of requirements fulfilment

Thereby these existing frameworks lack of dealing with the main failures in BE projects (adapting BE concepts to the corporate culture and the maturity). So the proposed BE measures in existing frameworks will either require a direct change in the corporate culture and its detailing level do not always fit to the existing maturity level. This leads to a lack of acceptance of actions by staff and thus to failure of the BE project. An isolated view on corporate culture without distinction to the business excellence concept would not be meaningful because of the complexity of corporate culture and maturity analysis. One way to deal with this fact is the conception of BE measures for a BE models such as the EFQM model and the multi-dimensional view of the adoptability of BE to the existing culture and maturity. In order to specify the gap, the requirements are subsequently assigned to the BE design and implementation phases (see table 6).

Table 6: Evaluation of existing frameworks regarding the level of requirements fulfilment in connection with BE implementation phases

Main phases for desiging BE concepts	Allocation of requirement to main phases	Requirement fulfillment
Phase 1: Sensibilization -Information of Top Management -Initiation and planning of BE projekt -Convincing mid management -Discussion of success factors and barriers	BE specific: C, D, F, G, I general: J, K, L, M, N	Fullfilled (see Radtke 1997, Chin and Pun 2002, Zairi and Alsughayir 2011)
Phase 2: Design of measures -Company specific design of BE measures based on corprate culture and maturity level	BE specific: A, B, H, E general: J, K, L, M, N	Not fullfilled
Phase 3: Realization -Planning of measures -Linking to individual target setting -implementation -Tracking and progress analysis	BE specific: D, F, I, G general: J, K, L, M, N	Fullfilled (see Radtke 1997, Chin und Pun 2002, Zairi and Alsughayir 2011)
Phase 4: Overall evaluation -Analyzing effects -Evaluation of overall programm -Discussion of Lessons Learned -recognition of success	BE specific: C general: J, K, L, M, N	Fullfilled (see Chin andPun 2002)

With the analysis and mapping can be stated that the respective requirement for the sensibilization, realization and overall evaluation phase are fulfilled by existing frameworks and therefore need no modification or development. However, the requirements regarding the second phase are not fulfilled and a new framework for this phase is required to close the identified gap in this study. The idea is to integrate these two aspects, namely, the corporate culture and the maturity level, in the design of BE measures systematically. The table below shows selected requirements from table 4 and 5 that could be assigned to the second phase (design of measures) and thus serve as a basis for the development of the new framework.

Table 7: Selected requirement for developing a new framework for culture and maturity based design of BE measures

BE-specific requirements							
A: Ensuring the pass ability of measures to Be corporate culture							
B: Ensuring the pass ability of BE measures to maturity							
E: make contribution to overcoming the resistance of the employees							
H: make contribution to overcoming the resistance of the middle management							
General requirements							
J: practical orientation: operationalization of concrete action on the basis of a practical guide to							
action							
K: cost-benefit efficiency: ease of handling, low time and cost							
L: Flexibility: no uniformity of approach, ability to company-specific design							

M: Independence: applicable in different sized companies and different organizational forms

N: knowledge base: open, adaptive, dynamic and extensible

The following figure shows the main steps of a new framework (Phase 2 of the design of BE concepts) with the newly developed framework and the associated tools (tool for maturity determination, culture detection instrument, cultural maturity measures matrix, prioritizing portfolio, principles for application of RADAR). The closed scheme consists of consecutive steps:

- 1. Determining existing maturity level
- 2. Identification of prevailing culture
- 3. Culture and maturity based selection of BE measures
- 4. Prioritization and adaptation
- 5. RADAR-based concretization

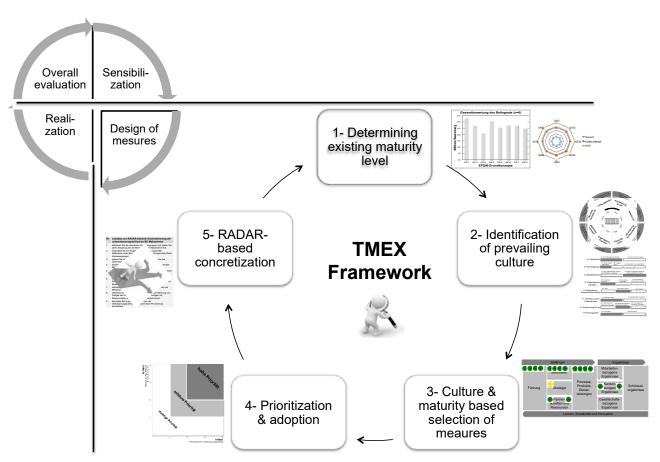


Figure 1: TMEX framework (see also Bolboli and Reiche 2014, 2015)

The framework offers companies various tools to capture data regarding the prevailing corporate culture and the existing maturity level, to identify the company-specific BE measures, and to concretize them in terms of the RADAR logic. Thus, a tailor-made design of measures will be possible. For an easy handling, an IT tool has been developed. This enables companies to capture their culture with little effort individually and specifically for the design of BE concepts and determine the existing level of maturity. While the consideration of the existing maturity allows optimal access and a company-specific definition of the BE concept, the consideration of existing culture leads to the acceptance of the measures by the parties and consequently increase the probability of success in BE projects.

CONCLUSIONS

The successful design and implementation of the BE concept leads to significantly improved performance (Boulter et al. 2013). However, more than 70% of BE projects fail in practice. To investigate this high rate of failure, the sensitivity model of Vester was used and the gap has been specified. The findings show that cultural aspects and the maturity level of an organization find too little attention within BE projects. Resulting from sensitivity analysis, requirements for a new framework have been developed. This requirement were used to assess existing BE implementation frameworks and specify the existing gap. Finally a new framework was introduced to close the gap. Following the proposed idea will lead to increase the acceptance of BE measures by the involved parties and increase the probability of success of BE projects. The framework is named TMEX (Tailor-Made-Excellence) and is supported by an IT tool for easy application. Considering the results and findings of this paper, there is an effective relationship between the implementation of TMEX method and the successful design and implementation of BE models.

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Annex 1: Barriers in design of BE concepts (Mosadeghrad, 2013)

Variable name								
Unjustified Business Excellence programme	Employees' resistance to change	Bureaucracy and paperwork						
Business Excellence adoption barriers	Lack of good human resource management	Lack of evaluation and self- assessment						
Unrealistic expectations	Inadequate empowerment at all levels	Incompetent change agent or quality consultant (BE Project Manager)						
Deficient leadership	Employee shortage and	Poor coordination						

	increased work load						
Poor management	Lack of training and education regarding BE	Lack of innovation					
Lack of top management support	Lack of employees' motivation and satisfaction	Political behaviours					
Management turnover	High employee turnover	Diversity of workforce					
Middle management resistance	Time shortage	Mindset barriers					
Inappropriate planning	Lack of recognition and reward for success	Lack of process focus					
Lack of constancy of purpose	Inappropriate organisational culture	Placing a poor priority on quality improvement					
Lack of long-term view	Difficulties in changing organisational culture	Lack of government support					
Lack of a vision and clear direction	Lack of team orientation	Political uncertainty					
Conflicting goals and priorities	Poor and ineffective communication	Lack of employee interest					
Experience of previous failed change initiatives	Lack of employee trust in senior management	Ineffective corrective actions					
Inappropriate organisational structure	Problem-solving mindset	Incompetent employees					
Lack of physical resources	Lack of proper process management	Time consuming quality improvement efforts					
Lack of information systems	Lack of customer focus	Lack of organisational flexibility					
Lack of employee commitment and involvement	Lack of supplier involvement	Lack of financial support, cost of implementation					

Measuring Final Inspectors' Discrimination Ability of Metal Structures in the Automotive Industry

Alvelos, H.¹⁾, Gonçalves, S.²⁾ and Xambre, A.R.³⁾

¹⁾ CIDMA/DEGEIT - University of Aveiro, 3810-193 Aveiro, Portugal

²⁾ DEGEIT - University of Aveiro, 3810-193 Aveiro, Portugal

3) CIDMA/DEGEIT - University of Aveiro, 3810-193 Aveiro, Portugal

ABSTRACT

Purpose – The main objective of this paper is to present an approach for understanding the discrimination ability of the operators responsible for the final inspection at a metal structures' production line in the automotive industry. Another important goal is to show how this type of analysis can help to improve the way quality inspectors carry out their daily activities.

Design/methodology/approach – The methodology followed consisted in selecting a sample of 30 metal structures (15 conforming and 15 non-conforming), over a time period of two months, and then asking 10 quality inspectors to classify each of the structures. Afterwards the performance of the inspectors was analysed using Receiver Operating Characteristic (ROC) Analysis.

Findings – The results indicate that inspectors are generally working efficiently and also that there is a low risk of rejecting conforming parts and of accepting non-conforming ones. These risks depend on the inspector that judges the structure so the differences between their individual performances were analysed. Improvement actions were then recommended and implemented.

Research implications – The work presented is an exploratory study and reports on the results of the proposed approach that underline the possibility of quantifying the discrimination ability of inspectors in industrial environments.

Practical implications — The quantification of the inspectors' performances of the company was completed. Afterwards, it was possible to plan and implement improvement actions regarding those performances. All the inspectors, as well as the production line responsible, felt comfortable with the results.

Originality/value – As the approach used has not been addressed by scientific literature, it is considered that the outcomes of the work are valuable for researchers on quality evaluation of inspectors. Additionally, this study may help practitioners implement the proposed method in other environments.

Keywords: Quality assessment, Inspection, Automotive industry, ROC Analysis.

Paper type: Research paper.

INTRODUCTION

Quality control is an activity that has a high level of importance throughout the supply chain in the automotive industry. This work was developed in collaboration with a second-tier supplier of various automotive manufacturers that produces, among other products, car seats and operates in the highly demanding context of the car industry.

Some of the characteristics of the car seats' metal structures are controlled by visual inspection at the end of the production line, a task that is executed by trained inspectors.

Inspection operations throughout a certain production process are used to address several issues, namely: (i) to distinguish between conforming (OK) and non-conforming (NOK) products; (ii) to determine if there were any changes in the production process; (iii) to measure a process' capability; and (iv) to categorize the product according to its quality. The most common of those alternatives is to verify if the product will be accepted or rejected by the client, whether it is an internal or external client.

The quality of the inspection is, thus, dependent on the decisions taken by the inspectors, which can be right (to detect a defect in a structure or to classify a flawless product as a good one) or wrong (to detect a defect that does not exist in a flawless product or to classify a product as a good one, when it has a defect).

Binary measurement systems are used quite often in industry and a common example is the visual inspection of products with the purpose of accepting or rejecting them (De Mast *et al.*, 2011). In this context the inspector can be regarded as a measurement instrument that visually checks the characteristics of the product and determines if it can be packed and shipped to the customer or if it should be rejected and, in that case, go through some rework or be scrapped.

Evaluating the performance of this measurement system is important in order to ensure the high quality standards required in this type of industry.

The main objective of this paper is to present an approach for measuring inspectors' performance in the final inspection workstation of a production line for car seats' metal structures, using ROC (Receiver Operating Characteristic) Analysis.

RESEARCH METODOLOGHY

The first step was to study the product and its production process with, naturally, a particular focus on the activities performed at the inspection station.

To support the work it was also necessary to study and evaluate the essential and more current literature regarding measurement systems, inspection processes and their importance, as well as methods to evaluate the discrimination ability of the inspectors, particularly ROC Analysis.

With the help of product and process specialists, and also considering problems' historic data and the workstation instructions, the sample size and the main defects to analyse, were then determined.

Additionally, the need for a specific location to storage defective and non-defective structures to serve as standards was identified, as well as the need for creating a replica of the inspection workstation. Once these physical conditions were fulfilled, it was possible to test the measurement system and so, all the inspectors were asked to analyse and classify the same set of structures twice, and the resulting data was gathered.

The final steps consisted in the data analysis, the suggestion of some improvement actions and the implementation of those actions, which resulted in the main outcomes of this work.

THEORETICAL BACKGROUND

This section is dedicated to a literature revision directed at the two main issues used in the practical study. The first sub-section focuses on concepts related to the activity of inspection, whereas the second one consists of an explanation of ROC Analysis and its fields of application.

Inspection

Historically, inspection is defined as the process or procedure of examining the attributes of a part or product in order to determine if they are in conformance with the predefined requisites (Newman, 1995 and Mital *et al.*, 1998). Testing and inspecting include measuring a certain output so as to determine if it complies with its specification (Gryna *et al.*, 2007).

According to AIAG (2010) the activity, usually called inspection, is the act of examining the parameters of the process, the components, subassemblies or final products, with the aid of adequate norms and measurement devices, in order to confirm if the process is working properly.

Inspection can be done to 100% of the parts produced or by using sampling methods. The first situation occurs when the defect or defects that are analysed can seriously affect the use of the product or the way it works. The second situation results on the inspection of a sample of the population and it's commonly used when it is impossible to check all the parts or when the inspection process results in the destruction of the part.

Planning and managing all the necessary resources for inspecting critical quality characteristics it's an important activity in any transformation industry but it consumes a lot of resources. The high associated costs are, however, compensated by the benefits of identifying faulty parts and removing them from the system.

Deciding the number and placement of inspection workstations is a responsibility shared between the people in charge of production process design and of quality control system specification (Inman *et al.*, 2013).

According to Gryna et al. (2007) the most common locations for inspection workstations are:

- Receiving inspection of goods from suppliers.
- After installing a production process, to ensure that defective batches are not produced.
- During critical or costly operations.
- Prior to delivery of goods from one department to the next.
- Prior to shipping finish goods to storage or to a client.
- Before performing a costly, irreversible operation.

According to Kopardekar *et al.* (1995) there are three different types of inspections: human inspection, automatic inspection and hybrid inspection.

Human inspection is performed by an inspector that evaluates the quality of a product taking into account a set of standard products and his/her own experience and know-how.

This type of inspection is used when the characteristics of the product under inspection cannot easily be measured by instruments and so, they have to be evaluated by human senses. Those are called sensory characteristics and, for evaluating them, human senses are used as measurement instruments.

Sensory characteristics can be related to the technological performance of the product (e.g. adherence of a protective coating), olfactory characteristics (e.g. smell of a perfume), taste (e.g. food), or others. An import

category includes the visual quality of certain characteristics that, usually, do not have very well defined written specifications since they are difficult to quantify (Gryna *et al.*, 2007).

Sensory analysis is traditionally used in the development of new products or when there is a need to compare a product to its competitors. However, it can also be used as a tool in quality control to check certain sensory characteristics. In this context, the final step is to decide whether or not to accept the product based on the analysis of the inspectors that can consider the intensity of the defects as well as the predefined tolerances associated with the different characteristics (Baudet *et al.*, 2013).

Several authors mention that subjectivity is part of human inspection and so its performance is influenced by factors related to the task itself, environmental factors, organizational factors, motivational factors and personal factors (Mital *et al.*, 1998). Evaluating the existence of a defect can then depend, among others, on the level of knowledge of the inspector, his/her know-how and his/her perception concerning the defect (Baudet *et al.*, 2013).

The other two types of inspections are: automatic inspection where the analysis and decision is performed by a computer or some other type of automatic controller (Newman, 1995); and hybrid inspection where human inspection is complemented or aided by automatic equipment (Mital *et al.*, 1998).

Wang *et al.* (1997) mention that when it comes to human inspection, and particularly visual inspection, there are two opposite strategies: random search or systematic search. The first strategy implies that the sequence of location inspected each time changes when the inspection is repeated and in a systematic approach that sequence does not change.

Wang *et al.* (1997) also mention that when there is some memory of the locations previously inspected, it results in a better performance of the inspectors. In this context, and since the search strategy is so important, inspectors should be trained so they can use the adequate strategy (Tetteh and Jiang, 2006).

It is thus important to train inspectors so they can use a systematic search strategy adequately designed for the product being inspected (e.g. use work instructions and/or visual aids placed at the workstation).

That are several factors that influence the complexity of the inspection operation, whether it's in the visual search stage, whether it's in the decision making stage. Some of the most common complexity factors are: the number of types of defects, the complexity of the standard defects, the probability of defects occurring, and the defects' distribution.

Gallwey and Drury (1986) state that: (i) if there is a need to search for different types of defects the performance is worse than when the search is for just one type of defect; (ii) the higher the number of locations or areas inspected the worst the performance; and (iii) the complexity of the standard defects used for comparisons has no influence for the search stage but impacts the performance on the decision-making stage.

The probability of human error is higher if the working conditions are not adequate and if, during the decision-making process, subjective factors or factors such as available time and cost constraints are involved (Sylla and Drury, 1995).

ROC Analysis

The Receiver Operating Characteristic Curves Analysis (ROC Analysis) is a technique (first developed in Signal Detection Theory) that has been used in many areas, like Health Sciences (Metz, 1978; Rifkin *et al.*, 1990; Haanes *et al.*, 2015; Waterland *et al.*, 2016; Avcioglu and Sezer, 2016), Sensory Analysis (O'Mahony, 1992; Bi *et al.*, 2000; Lee *et al.*, 2007; Paredes-Olay *et al.*, 2010) or Finance (Irwin and Irwin, 2013; Liang *et al.*, 2016) to compare the performance of diagnosis equipment, or to decide in the case of dubious circumstances (Alvelos, 2002). This technique can be used when the characteristic or decision under study has a binary

nature (like "approved" or "not approved" or "sweet" or "unsweet") and is evaluated using rating tests. Its output is usually represented by a curve – the ROC curve, being the area under this curve a measure of the discriminating power of the system (e.g. a diagnosis equipment, a taster or an inspector).

When applied to sensory evaluation, it provides a sensitivity measure to a stimulus or to a difference between stimuli. Ishii, Vié and O'Mahony (1992) describe and compare some of the tests and the scales that are applied more frequently in this area, and O'Mahony (1992) illustrates the use of ROC Analysis in measuring tasters' discrimination capacity between "sweet" and "unsweet" cookies.

Traditionally, in Sensory Analysis, the experiment used for applying ROC analysis is the "A-Not A" test, in which it is initially presented to each taster a sample of the product under analysis (A), followed by a series of other samples that tasters have to classify as "A" or "Not A".

As, for drawing the ROC curve, it is necessary that tasters associate to each decision ("A" or "Not A") a degree of certainty, so there are frequently used four levels of certainty. Tasters are asked to use one of the following answers for each sample: (i) "I am sure the sample is different from A", (ii) "The sample seems to be different from A, but I am not sure", (iii) "The sample seems to be equal to A, but I am not sure", or (iv) "I am sure the sample is equal to A" (Alvelos, 2002).

The ROC curve is a chart that represents the proportion of "true positives" (p_{rp}) versus the proportion of "false positives" (p_{rp}) for the various criteria, and, as Metz (1978) points out, it "(...) indicates all possible combinations of the relative frequencies of the various kinds of correct and incorrect decisions". The criterion is changed by explicitly changing the decision threshold and reinterpreting the results of the products' judging. In the case of the "A-Not A" test, when using the "strict criterion" it is assumed that the taster decides that product is "A" only in the cases he/she is sure about it, and when using the "lax criterion", it is assumed that the taster decides that the product is "A" in all the cases except when he/she is sure it is "Not A". The usual interpretation of the test (to assume that the taster decides that product is "A" in the cases he/she rates it as "sure it is equal to A" or "seems equal to A, but not sure") corresponds to the "moderate criterion". Then, for each criterion, resulting proportions (p_{rp} and p_{rp}) are calculated.

The ROC curve is obtained using the referred scale and joining the resulting points by straight lines. If the taster distinguishes at least between some of the "A" and the "Not A" products, the intermediate points on a ROC curve must be above the lower left to upper right diagonal of the ROC space. This diagonal is the ROC that corresponds to a taster rating the samples randomly. Exemplifying with the point (0.5, 0.5), it can be seen that it corresponds to the situation where the taster rates 50% of the "Not A" samples as "A" (p_{FP}), and, simultaneously, correctly rates 50% of "A" samples (p_{TP}). This is clearly a situation where the taster is simply guessing and has no sensitivity to the difference between the products. The opposite situation occurs when the taster always detects the "A" product and corresponds to a horizontal line which ordinate is equal to 1 (p_{TP} = 1).

The area under the ROC curve (A), when the points referred above are joined by straight line segments, has an important statistical meaning: it is a conservative estimate of taster *i* choosing the "A" sample when compared with the "Not A" one, in a single comparison between them (Alvelos, 2002). Additionally, it must be noted that this area is independent of the criterion used by the taster to "Approve" or "Not Approve" the sample. It measures the sensitivity of the taster to the difference between the two products.

PROBLEM CONTEXTUALIZATION AND RESULTS

This work was developed at a second tier supplier of the automotive industry that produces car seats' metal structures.

The production department includes four autonomous production units and, within each one, there are several production lines that manufacture products for different car's brands and models. There are also several

manufacturing processes like, arch welding (MAG – Metal Inert Gas), painting, riveting, screwing, among others.

This work focused on the production of a specific metal structure (Product X) which is manufactured in four different, but identical, lines. However, just one of those lines was considered: the Model Line, where welding and assembling are the basic processes used.

The manufacturing process begins with automatic welding, done by a MAG welding robot that includes two sub processes. In the first one the main, and more expensive, components are combined and, in the second stage, smaller tubes and beams are welded to connect the rest of the components. Afterwards components are sent in batches to the painting section. The components return to the production line, after being painted, around 2.5 hours later, so the final components can be assembled.

Lastly, a final inspection is done so any eventual problem or defect is detected before the product is packed and shipped to the client.

Nonetheless, both at the welding workstation and the assembly workstation visual and/or functional control is done by the workers in order to assess the quality of the operation they have just performed.

The final inspection is the final operation and differs from the auto-controls done in the previous workstations because: (i) it focuses on the characteristics of the final product (for example, functional or dimensional controls) and not on the quality of a specific operation; and (ii) the number of points to inspect is larger so the complexity of the task is higher as is the mental strain on the inspector.

When planning the workstation dedicated to final inspection operations, ergonomic factors that affect the performance of the inspectors were considered: (i) because it is a mentally demanding task, the number of points to check were taken into account and rotation throughout the day between the inspectors was implemented so that a person is not inspecting for long periods of time (no longer than 2 hours); (ii) the movement of the part as well as of the inspector were defined so his/her posture is correct and the distance between the eyes and the part is adequate and facilitates the detection of eventual defects; (iii) environmental conditions such as noise level and temperature were controlled so as not to disturb the concentration of the inspector.

The main purpose of this work was to develop an approach for evaluating the discrimination ability of the operators responsible for the final inspection of product X at the Model Line.

The methodology adopted in the practical study consisted of five stages. First, a careful analysis of the production process of Product X was performed, in order to identify the critical quality characteristics. Following, some physical conditions were analysed and a space in the plant, where the products to be evaluated could be located, was created. The third stage consisted in the selection of the specific sample of those products, considering the defects to be detected (output of stage 1) and the available space (output of stage 2), and the fourth one comprised the planning and execution of the tests. Finally, the results were analysed and improvement actions were proposed and implemented. Following, the referred stages are detailed.

In the first stage the production process was analysed with a particular emphasis on the final inspection workstation and on the product.

Product X is a metal structure made of components united with welding seams done by automatic MAG welding and also the assembly of some components. Between those two stages, as mentioned previously, the subassembly is painted.

The main characteristics of product X that are inspected are: (i) the quality of the welding seams because those are the connecting elements that ensure the security of the structure; (ii) the dimensional requisites; (iii) the correct functioning and presence of all the assembled components; and (iv) the panting quality particularly on the visible areas.

The operations performed in the final inspection workstation are, therefore:

- -control of some dimensional characteristics through the use of calibres 'fit/does not fit';
- -control of the welding seams by evaluating their position and aspect;
- -verification of the presence of all the assembled parts;
- -visual analysis of the quality of the painting in the visible areas.

In the second stage a specific space was created with the purpose of storing the structures used in this study and creating a replica of the final inspection workstation similar to the one in the Model Line. This space was delimited with a red cabin which, due to space constrains, had a capacity to accommodate 30 structures (Figure 1). The use of red in the cabin was a requirement of the company since it contained defective structures and red is the colour used to signal non conformities. After being built, the structures were stored and the cabin was closed, with limited access.



Figure 1 - Test cabin.

The sample was made up of 30 units of product X, as was mentioned previously. It was defined that all of the sample parts should be analysed and classified by a specialist before they were inspected, repeatedly, by the inspectors. The sample was composed of 50% of defective units (NOK) and 50% of non-defective units (OK) as it is a good practice to have a balanced mix of OK and NOK parts, because if one type of parts is not as present it may influence the judgement regarding the inspectors' ability to classify that type of parts (AIAG, 2010).

The defective units included several cases of parts very close to the acceptance threshold. Four types of defects could be found, 3 regarding the welding seams and 1 related to the painting.

The 3 types of defects related to the welding seams were: porous welding seam, leaked welding seam, deviated welding seam.

The porous welding seam is due to bubbles of air that are trapped inside the seam or that are formed at the surface (Figure 2 a). A porous seam leads to a weaker welding and can be caused by the presence of impurities either on the base material or the adhesive, by lack of gas protection, by excessive tension in the electric arch or by excessive distance between the torch and the part (a lot of stick-out).

A leaked welding seam means that the welding pierces one of the sections and so the seam is incomplete (Figure 2 b). This is due to excessive penetration and can result from high current intensity, an incorrect position of the torch, slow welding speed, and incorrect trajectory of the robot.

A deviated welding seam is misplaced over the areas that it should connect (Figure 2 c). This problem occurs due to the incorrect trajectory of the robot, the incorrect placement of the parts, and accessibility problems of the robot to the joint to be weld.

The defect shown on Figure 2 d) is the lack of paint on a visible area.

The defective structures were collected over a 2 months period and were the result of problems and defects that occurred at the Model Line. Some of the structures could have been reworked and repaired and so it was necessary the collaboration of the production team until all the required structures for the cabin were collected. All the structures inside the cabin were signalled so as to identify their purpose.

As explained previously, in the final inspection workstation other characteristics of product X are evaluated. However, those were not considered in this study because, for those defects, the inspectors use calibres and non-visual inspection.









Figure 2 – Types of defects: a) porous welding seam, b) leaked welding seam, c) deviated welding seam, d) lack of paint.

The scheduling and execution of the tests were planned together with the inspectors, the line responsible, and with the rest of the production team so they could organize themselves and reduce the impact on the line whenever one element had to go into the cabin to inspect the sample. The test was done by ten inspectors of product X.

A form was created so the inspectors could register their evaluation of all of the structures in the sample. In that form they could identify themselves, identify the reference of the inspected structures, the date and type of inspection and the number of inspected structures. As far as answers they could register four possible categories: OK, I am sure; OK, but I am not sure; NOK, I am sure; NOK, but I am not sure. There was also a space to indicate the type of defect detected whenever the inspector classified a structure as NOK. Note that the OK (non-defective unit) corresponds, in the previously described "A-Not A" test, to the "A" product, while the NOK (conforming unit) corresponds to the "Not A" product.

Before any inspector did the analysis all the procedure was explained, as well as what he was expected to do and what the purpose of the study was. Also, any doubts he/she may had, were clarified.

Each inspector evaluated the structures twice and no questions were answered regarding the first inspection, before they had done the second one.

The discrimination ability of the inspectors under evaluation was then estimated using Receiver Operating Characteristic (ROC curves).

In this work inspectors are considered in the same way as tasters because they are used as measurement instruments capable of measuring characteristics that are not easily evaluated by conventional measurement instruments. So it was decided to use ROC curves for the inspectors as a way of estimating their discrimination ability between OK and NOK parts. In this context, the area under each inspector' ROC curve is an estimate of the probability of the inspector correctly identifying an OK part when it is presented together with a NOK part, in a simple test.

Table 1 summarizes the results of the tests done by two inspectors (A and B), using the scale already mentioned: NOK (I am sure the part is NOK); NOK? (I am not sure the part is NOK); OK (I am sure the part is OK), OK? (I am not sure the part is OK).

Table 1 – Results of the tests performed by two of the inspectors.

Inspector A						
Criteria	OK units	NOK units				
NOK	0	28				
NOK?	0	0				
OK?	0	1				
OK	30	1				
Total	30	30				

Inspector B						
Criteria	OK units	NOK units				
NOK	2	23				
NOK?	1	5				
OK?	2	1				
OK	25	1				
Total	30	30				

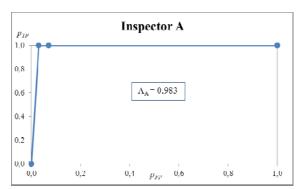
The results from the previous table were then used to build Table 2 that shows the proportion of false positives $(p_{_{TP}})$ and true positives $(p_{_{TP}})$ for those two inspectors and for the various criteria. Notice that three 'artificial' criteria were used: (i) the more restrictive corresponds to approving only the OK parts, (ii) the intermediate one corresponds to approving the OK and OK? parts, and (iii) the broader one corresponds to approving all the parts except the NOK ones.

Table 2 – Proportion of false positives and true positives for two of the inspectors.

Inspector A						
Criteria	$p_{\scriptscriptstyle TP}$	$p_{\scriptscriptstyle FP}$				
Approved – OK	1.00	0.02				
Not approved - OK?, NOK?, NOK	1,00	0,03				
Approved - OK, OK?		0.07				
Not approved - NOK?, NOK	1,00	0,07				
Approved - OK; OK?, NOK?	1.00	0.07				
Not approved - NOK	1,00	0,07				

$p_{\scriptscriptstyle TP}$	$p_{\scriptscriptstyle FP}$
0.02	0,03
0,83	
0.00	0,07
0,90	
0.02	0,23
0,93	
	<i>p</i> ₁₇ 0,83 0,90 0,93

The data presented in Table 2 correspond to the coordinates (x,y) of the points in the ROC curves for inspectors A and B. These curves, as well as the area under them, are presented in Figure 3.



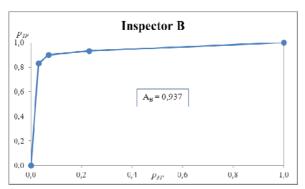


Figure 3 – ROC curves for two of the inspectors.

All the inspectors had curves above the diagonal [(0,0) (1,1)], and consequently, the respective areas are quite superior to 0,5 (all had values above 0,9) which indicates that all of them were capable of distinguish between OK and NOK units. It was also possible to detect that three inspectors (one of which is inspector A)

had bigger areas. Those results can be related to the knowledge the three of them have of the entire production process since they are capable of working in any workstation of the line. This helps them to know every detail of the product and, consequently, be more sensitive to any variations in the units that are part of the sample. Product and process specialists also agreed that this knowledge of the product was beneficial for the inspectors' performance.

Besides the evaluation of the inspectors' discrimination ability, the purpose of the work was also to determine, suggest and, if possible, implement some improvement actions in order to increase their analysis capacity and autonomy. In this context, two improvement actions were suggested and implemented: (i) the first one, directed at all the inspectors, was a presentation of the global results of the study; and (ii) the second one was only directed at the inspectors with worst performance and consisted of extra training.

The first action consisted in the presentation to each individual inspector of the mistakes they had done during the test. The first step was to identify, for each inspector, which units he/she had misclassified. Then, for each of those units a comparison with other units (OK or NOK) was done and mistakes were pointed out. It was also possible to clarify their doubts and the whole procedure was carried out from a training point of view, also with the help of product and process specialists.

For the inspectors with a not so good performance (for example inspector B) additional training was identified as a need. That extra training was provided to three of the inspectors, inspector B and two others, but it should be noticed that inspector B, for example, had very little experience as inspector.

This training was based on an existing tool, the defects panel, that consists of a 2m*3m panel where there are in display: defective components and subassemblies that represent all types of different defects; components and subassemblies on the threshold between OK and NOK with indications if they were accepted or rejected by the client; and detailed indications of the visible areas of the structure. The inspectors were invited to analyse this panel more carefully and so learn more about the client's requirements.

CONCLUSIONS

This work focused on the problematic of quality inspection in the manufacturing industry, particularly the situation where visual inspection, performed by workers, is the final inspection before products are shipped to clients.

With the procedure that was implemented it was possible to analyse in detail all the inspection process. The cabin created also helped because it was possible to get a reasonably sized sample (30 units) and also install an inspection workstation.

With ROC Analysis it was possible to quantify the inspectors' performance, and it was concluded that, overall, the discrimination ability of the ten inspectors is good and they are able to distinguish between OK and NOK units. Nevertheless, two improvement actions were suggested and implemented. The first one was to present to each inspector the structures that they misclassified and to clarify why those errors happened. The second one was to organize a specific training session for those inspectors that exhibited a less satisfactory performance.

The application of the proposed methodology to other products and other production lines was suggested and implemented, which was made easier by the know-how acquired in the development of this work and also by the fact that the necessary space had already been created.

For future work, it is suggested that inspectors repeat the tests so the new results can be compared with the current ones.

It is also suggested that some of the human inspection operations, particularly when calibres are used, are moved to earlier stages of the production process and, if possible, automatized.

Finally, it is considered that the outcomes of this work are valuable not only for researchers on quality evaluation of inspectors / judges, but also for the implementation of the proposed methodology in other industrial environments.

AKNOWLEDGEMENTS

This work was supported in part by the Portuguese Foundation for Science and Technology (FCT-Fundação para a Ciência e a Tecnologia), through CIDMA - Center for Research and Development in Mathematics and Applications, within project UID/MAT/04106/2013.

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The development of a management technology systems hospital production

AZEVEDO, B. M., ERDMANN, R. H., CAMARA, T. F., and CAMPOS, F. L. S.

Santa Catarina Federal University

ABSTRACT

Hospitals are complex organizations, submitted to the influence of economic theories and administrative to the achievement of operational effectiveness criterious. Although resources intended for industry have increased in recent decades in Brazil are still scarce, therefore, managers seek an equation able to balance the various demands and provide continuous improvement of services. Given the above, the objective of this study was develop a management technology systems hospital production capable of providing diagnostic and performance generation initiatives for improvements. Methodologically, it is a theoretical study held in empirical case study in three brazilians hospitals. As for technology generated, it sought to preserve the essence of the diagnostic tool developed by researches, however, adjustments were necessary. The collect data had the participation of a group of professionals with solid knowledge about organizational dynamics. As for results, the diagnosis production indicated subsystems such as, e.g. 'Cycle Time' that needed urgent action, therefore were not contributing effectively to achieve the result of factors. The instrument reveals interactions between constituent and representative areas of the system hospital production, indicating potential improvement actions, in line with complex thought inherent in this type of management. The improvement ideas converged for actions related to practical factors identified in the literature. In conclusion, this study says that is of significant importance to hospital area can count on aid of a performance management technology that assists managers in the formulation strategies and help them cope with greater assertiveness in the environment in which they compete.

Key-words: Hospital; improvement, management technology.

INTRODUTION

Production systems in health, such as hospitals, object of this study, are complex organizations that interact with multiple worker processes performed by multiprofessional teams. In addition, are subdued to the interests of social actors of great weight in the sanitary arena as the pharmaceutical industry, biomedical equipment industry, service providers with greater prestige and opinion formers. Therefore, they are considered organizations whose management is in a high level of difficulty.

In the view of the production process, the patient (or their State of health) is the intermediate product transferred from one stage to another in order to reach the desired end product, the improvement in the health status of the patient (VELOSO and MALIK, 2010). As Toro Restrepo (2000), healthcare organizations must provide health services in response to the obligations that States have to take care of its citizens. This implies to be subjected to the influence of the economic theories and administrative, with the need to optimize resources and reduce costs, ou seja/that means, do more with less.

The scope of the flexibility of the production process reflects the multidimensionality of this phenomenon, making more sense in trying to understand it by the optics of positivism. Thus, to understand and interpret the business reality in/of an interconnected and complex mode, the approach systemic-complex has been shown to be a theoretical framework relevant to this purpose.

It is sought, under the perspective of complexity theory, how the operations of hospitals can achieve results, both in terms of costs, as well market insertion? How the productive operations behave, that is, how their performances are reflected in the ability to compete? What are the practices adopted that express their sustainability? In order to enable a greater understanding of how relationships are established on a production system and better exploit the production environment from the perspective of complexity, the NIEPC (Group of Interdisciplinary Studies in Management of Production and Costs), sheltered by the graduate program in business administration at the Federal University of Santa Catarina (CPGA/UFSC), has developed an instrument for organizational analysis based on the assumptions of the theory of complexity that assumes that the organization is composed of various elements that interact with each other and with the environment.

Considers that organizations are composed of elements that interrelate, organizational analysis then is given by the ratio of 13 categories of analysis faced with 3 factors of result (cost, quality and flexibility) through assertions that must be answered in Likert scale, in which the note 1 amounts to a bad scenario and note 5, a great scenario.

Based on the interaction that exists between the organizational elements, and considering the categories of analysis as the subsystems that make up the management of production and the factors of results as the components that every organization seeks to achieve, the tool proposes to analyze how each category of analysis act with each of the factors of result.

The instrument consider that the factors of result is the reference to be achieved; the analysis categories correspond to the structure of the production system; the actions are given under the practical factors to achieve the results (which may be equated with "good practices"); as the system outputs the tool provides the ideas of improvement proposals by the members of the organization that will generate improvement projects; These projects need to be implemented and constantly checked by the feedback process.

The construction of this technology meets the ideas of Burns *et al.* (2001) and Viacava *et al.* (2004) about the importance of having an instrument of management and performance evaluation facing healthcare organizations that subsidize managers in the formulation of strategies and help them deal with greater assertiveness in the environment in which they compete. This confrontational and dynamic environment marked by uncertainty and urging the need to know the capabilities, as well as detect the limiting factors of organizational effectiveness, in order to be able to act in pursuit of the sustainability of the organization. To assess the operating performance, allows it to obtain subsidies to manage points of improvement.

The justification of this work is based on the assumption that help improve the case management of hospitals is a complex challenge. To Novaes (2000), the assessments in healthcare organizations, if they are in an area still in conceptual and methodological construction, can be found in the literature in a very diversify manner.

The construction of a technology of production management of hospital systems able to provide diagnostics, implement improvement projects and provide reference standards is, therefore, is of significant scientific and social relevance. Scientifically, it is proposed the construction of a diagnostic tool, response/intervention and tracking improvements in production processes, characterized, therefore, as a survey which aims/that seeks to fill a gap in scientific knowledge, for going beyond what most studies has been compromised. In terms of social relevance, it is expected that comparability and the possibility of a critical reflection about the organizational actions, made possible by the application of technology generated, have an instrumental and informational support that contribute to get managers the resources to/that support in decision-making.

THE HOSPITAL PRODUCTION SYSTEM AND ITS COMPLEX RELATIONSHIPS

To provide Health services, whether in a hospital, a clinic or doctor's office is a complex thing that involves a myriad of activities and challenges. Service providers must deal with contracts with health plans, negotiations of payment, compliance with regulatory requirements, assimilation of new medical technologies, improved customer service and recruitment and retention of personnel (PORTER and TEISBERG, 2007; VELOSO and MALIK, 2010).

Cunha (2011) points out that, although the resources allocated to the health sector have increased over the years in Brazil, they are still scarce and therefore imposes on managers, the urgent need to find an efficient equation, able to balance the diverse perspectives of healthcare organizations.

In the struggle for competitiveness, urge the need to add value to the production through the creation of differentials, obtained at the expense of innovation of products and processes. This new style of produce, in addition to requiring professionalization of management, requires employees flexibility and initiative to perform several concurrent tasks and complex, in addition to solving unexpected problems.

As Alemi and Sullivan (2007), for which the hospital organizations can perform in a very complex environment, it is necessary that managers seek management tools that have proven effectiveness in business. Guptill (2005) adds that, among the various existing tools, worth mentioning those related to the control of management and performance evaluation, that require the development of an efficient management and monitoring of performance indicators.

RESEARCH METODOLOGHY

The present study, as for the goals, is characterized as descriptive exploratory, to seek a little-known phenomenon, that is, the understanding of the production system from thirteen elements, and also for proposing to observe, record, analyze and correlate facts under it. When it comes to the approach, it is a qualitative research based on multicase study.

In terms of data collection, primary and secondary data were used. The primary data were obtained from observation during visits to hospitals and meeting for the implementation of the instrument. The secondary data, were from documentary and bibliographical research in books, monographs, dissertations, articles, national and international, with the search parameter the thirteen categories of analysis that represent the production system and the factors of competitiveness (NIEPC model).

The researchers assembled a group of professionals from each of the hospitals in three different times. The meetings aimed to discuss and assign a concept to each of the assertions made by the instrument. From these arguments, derived various findings and ideas for improvement. In the end, these ideas were converted

into project proposals, which were taken over by the people who have developed. The design of each project was made from the form A3 provided to the group by the researchers.

For data collection in the second hospital, there was a change in the search tool. When taken into account the five factors of result, it was noticed that the data collection process became slow and at times repetitive. Thus, the researchers decreased from five to three so that with the new configuration, the participants began to assess the 13 categories of production system from crossing of three factors of result: cost, flexibility and quality (incorporating features of reliability and quickness). At the end of the application, the discussions also converged into ideas for improvements and these were converted into proposed projects, and delegation management undertaken by professionals involved in the discussions.

By encouraging the participation and communication of the constituent elements of the organization, this tool has as a consequence the emergence of questions about the production processes carried out. Has that one of the guiding principles of this instrument is the questioning, capable of generating (a) a diagnosis more close to reality and (b) improvement ideas coming from people who are included in the context of the organization.

In relation to the organization, processing and analysis of data after it was collected were allocated in 13 categories proposed by the model and analyzed quantitative and qualitatively. So quantitatively, data were analyzed from its insertion in the excel software and SPSS (Statistical Package for Social Sciences), both were used for carrying out statistical descriptive analysis, as the sheets attached at the end of this report. With regard to the qualitative analysis, in each category, it has been proposed that a critical reflection about the actions taken by each of the hospitals, investigating how they contributed to each of the factors. It is worth mentioning that because this article size limit, the qualitative analysis will not be presented.

RESULTS

The presentation and discussion of the results is structured like this: analysis of each category and each result factor evaluated by groups of participants; and identification of points to be included in the projects of improvement.

THE ANALYSIS OF THE RELATIONSHIPS BETWEEN CATEGORIES AND FACTORS OF RESULT

The relationships between the categories of analysis and the factors of results of each hospital were measured as illustrated in table 1. It should be remembered that the scores in this regard indicate scenarios that could be interpreted as follows: unfavorable, classified with the grade 1 and 2, corresponding to red and pink colors, respectively. Favorable scenarios, classified with the grade 4 and 5, corresponding to the colors of green and blue, respectively. Brown color corresponds to the intermediate scenario, classified as 3.

Table 1: Relationships between categories and factors analysis of result of three hospitals

	Hospital HRSJ				Hospital SCMP			Hospital HST			
Categorias de Análise	Confiab.	Custo	Flexib.	Qualid.	Rapidez	Custo	Flexib.	Qualid.	Custo	Flexib.	Qualid.
Controle da Produção	2	2	1	2	2	4	5	4	3	4	4
Desenvolvimento de Novos Produtos	3	3	2	3	3	4	3	4	4	3	4
Desempenho Operacional	2	1	1	2	1	4	4	4	5	4	3
Equipamentos e Tecnologia	2	3	3	2	2	5	5	4	5	4	4
Fábrica (instalações)	1	1	1	1	1	3	3	4	3	3	4
Gestão Ambiental	2	2	1	2	2	5	5	5	3	4	4
Investimento	1	2	1	2	1	4	3	4	4	4	4
Organização e Cultura	2	1	2	2	2	3	3	4	3	3	4
Planejamento da Produção	2	2	1	1	1	4	4	4	4	4	4
Programação da Produção	2	2	2	2	2	2	3	3	4	4	4
Saúde e Segurança	2	1	1	2	2	5	3	3	3	4	4
Tempo de Ciclo	1	1	1	1	1	2	2	3	3	3	4
Qualidade	2	2	2	2	2	4	4	4	4	4	4

Source: the authors (2015)

Based on table 1, it is noticeable in the organizational analysis of HRSJ, that there are several aspects to improve, since only 11% of the assertive were classified as Brown, that is, as relationships that have considered scenarios. The categories of Production Control, Operational Performance, Factory, Environmental Management, Investment, Culture and Organization, Production Planning, Health and Safety, Quality and Cycle Time obtained only low grades, highlighting the need for improvement in the short term. The connotation of short term is justified, in case of cycle times, by the fact that is essential to the hospital organization to know and master their different production times and thus can rely on data that feed the indicators of their performance, as well as subsidize decisions concerning the planning of their actions and point out the investment needs.

In relation to the evaluation of the SCMP, one can realize that there is predominance in the favorable scenario, since only 1.17% of the assertive were classified as pink, that is, as relationships that have considered unfavorable scenarios. The categories of Production Control, Operational Performance, Equipment and Technology, Environmental Management, Production Planning and Quality attained only high grades, expressing so little need of improvement in the short term. Infers that the favorable performance in the predominance of the categories analyzed can be justified by the fact that this is a hospital believed it was pleading the last level of hospital accreditation. Therefore, the processes were already mapped and were well known to all; there were already deployed commissions and some improvement programs in place.

In the evaluation of the participants of the HST, predominates the favorable scenario, since none of the assertive was classified as red and/or pink, i.e/, that is, as relationships that have considered unfavorable scenarios. The categories of Equipment and Technology, Investment, Production Planning, Production Scheduling and Quality attained only high grades. Only the categories Cycle Time and Factory achieved predominance of items assessed as intermediate scenario. This evaluation reflects the need to get improvements in these dimensions. Knowing and mastering your different production times is essential to keep the remaining favorable scenarios. In addition, it is understood that the factory category takes a

significant importance in the hospital context assumes both the increasing flexibility of activities, as well as patient safety and its functional body.

PERFORMANCE OF EACH CATEGORY OF ANALYSIS IN RELATION TO FACTORS OF RESULT

The Production Control category expresses the idea that control production is the best way to ensure that the production process takes place as planned, as well as be able to identify, quickly and efficiently, points to improve. In this dimension, in HRJ, the flexibility factor received grade 1 and other factors (reliability, cost, quality and speed) received grade 2. In general, the participants realize that there are controls in different sectors of the institution, however, they are not reliable, because they occur in fragmentary form and not systematized. The lack of information has had repercussions in decision-making and planning.

In the SCMP, the flexibility factor received grade 5 and the other (quality and cost) received grade 4. Thus, the participants consider the existence of control patterns in the sectors of institution, but understand that there is still room for improvement in the extension of production controls. In this way, it is possible to infer that there are some forms of welldefined and standardized control capable of identifying points of waste in the hospital, but the same are not always effective because lack systematic so that the control can act as a tool to help manage their operations.

In the HST, the cost factor has received grade 3 and other factors (flexibility and quality) received grade 4. In general, the participants realize that there is a good awareness of the costs involved in the various activities and also there are controls of most of them. It is observed that the hospital has sought to have greater control of its activities and, consequently, maximize their results.

The category Development of new products (DNP) is intrinsically related to the innovation that is regarded as one of the competitive differentials. Thus, it is assumed that encourage professionals to seek new products and new production processes is a way to achieve the so longed continuous improvement.

In HRSJ, the flexibility factor obtained footnote 2 and other factors note 3, and therefore the dimension best assessed by respondents. That can be justified by the fact that the servers realize a number of initiatives and actions by institution as examples that have contributed to an improvement, even if incipient, performance and organizational image. Different evidence brought by the participants allow us to understand that in HRSJ there are several actions that contribute to innovation is product or process, but there is still strong resistance from the people to suit the changes.

In SCMP, the flexibility result factor obtained note 3 and other factors note 4, so the DNP dimension was considered by the middle of participants to favor the set of activities performed, however, there is room for improvement as opening initiation of studies and scientific research. This is justified by the fact that there is a great effort to develop new products as was the recent case of the implementation of protocols and security devices (safety syringe), and other initiatives for marketing, thus contributing to improved organizational image.

In HST, the flexibility factor obtained note 3 and other factors note 4. This may be due to the changes in recent years as a result of the current general management. Initiatives and actions are perceived by the institution as examples that have contributed to an improvement often evident from the performance and organizational image from the community using hospital services.

In the category Operational Performance is understood that the good operating performance provides the organization satisfactory results, a well-scaled production process and the achievement of established goals. Track operational performance is the way in which the organization knows it is on track or not.

In HRSJ, cost, speed and flexibility had grade 1, and the other, reliability and quality, grade 2; reflecting therefore the fragility of this category and the need to take actions to improve organizational results. The collected data confirm the negative evaluation obtained in the category production control. There is a

consensus among them that are no performance indicators in HRSJ servers, however, in some cases, they do not address the core needs of each sector or, being not part of the routine of all, just not generating reliable information and weaken planning decisions and necessary corrective measures.

In SCMP, the result in the category in question, reached unanimity on all factors evaluated note 4, therefore, is a favorable scenario, this fact can be attributed to the quality of history that the hospital has (level Accreditation II). Based on the evidence, it confirms the positive evaluation of the control of production. There is a consensus that there are performance indicators and an effort that costs are kept low.

With regard to the factors evaluated in the HST, the cost got full marks, 5, flexibility, note 4, quality, note 3. The pursuit of constant improvement in performance of its operations may be mainly due to the hospital's needs meet mandatory conditions of their nature of philanthropy.

Equipment and technology are a careful combination of information technology, communications, methods and related equipment, which allow the productive sector respond quickly, economically and integrated to significant changes in its operating environment. Together they provide a competitive advantage by allying quality and improve operational performance.

With regard to the result of factors evaluated in this category in HRSJ, it appears that the reliability, quality and speed the participants attributed Note 2 and the cost and flexibility, based 3. Note on the evidence, it is clear that a overall, while the hospital has updated and efficient equipment and technology, there are sectors where such materials and methods can not meet the demand, either malfunctions, obsolescence or lack of commitment by the people or issues bureaucratic that go beyond the purview of the institution.

In SCMP, the results of factors evaluated in this category of analysis indicated a positive scenario, since reliability and flexibility received grade 5 and, quality, note 4. The evidence of analysis to suggest that, in general, it is clear that methods and equipment acquired over the past few years reflect positively on the performance of the institution by ensuring ease of use and reliability, however, recognizes the need for staff training to use and continuous recycling.

Regarding factors evaluated results in this category HST, it is found that the cost was valued with the highest score, and 5, the flexibility and quality factors obtained, note 4. So this was one of the categories that showed a significantly favorable scenario. The evidence presented demonstrate the hospital's concern to rely on modern equipment as well as provide conditions for them to be operated efficiently and effectively.

The Factory installation category is directly related to the physical arrangement of the organization as well as with the layout, organization and cleanliness. When the physical structures and the provision of materials and workflow are organized harmoniously and well signposted, it saves time in the execution of processes, reflecting positively in lower costs and increased flexibility and system reliability.

When evaluated as a result of factors in relation to this category in HRSJ, all questions were negatively measured note 1, reflecting the urgency of immediate action that can contribute to an improvement in various aspects that directly impact the performance of operations and image institution. Many complaints involve greater investment and independent of the will of the institution, since it implies political order issues, legal and economic.

In SCMP, the factors cost and flexibility reached the intermediate scenario with note 3 and only the quality factor obtained note 4. This result reflects mainly the lack of planning and layout of the facilities. Based on the evidence presented, it is understood that the hospital has a favorable outlook regarding the quality factor, it appears that this may be a result of concern for the preventive maintenance of equipment.

When evaluating the result of factors in relation to this category in the HST, it was found that the cost resulting from factors and flexibility reached the intermediate scenario with note 3 and only the quality results obtained note 4. This result may be due to layout issues and maintenance process. Based on the evidence it is possible

to see that the physical structure of poor hospital and this has implications both in regard to capacity as for timeshifting waste.

Environmental management helps to integrate a planned approach, coordinated and organized actions for the management of the effects of their activities, goods and services that can bring impacts on the environment. Is the set of guidelines that guiding the definition / implementation of legal and institutional instruments of environmental planning and management.

In HRSJ in this category, only the flexibility factor obtained note 1, the other two factors were measured with note 2, thus expressing its low performance, even with an effort of some to consider this dimension as a goal to be pursued by all present there. The result is inferred is directly related to the need to disseminate information and to change the values and habits of people.

In SCMP, all factors had grade 5, this fact, thus expresses its high performance, even with an effort of some to consider this dimension as a goal to be pursued by all present there. The data analysis shows evidence that the hospital has production processes aimed at reducing energy consumption, water, waste of raw materials and other materials. Furthermore, there is an opening for the introduction of new environmental concepts since they follow the rules of hygiene and hospital safety such as the impossibility to adopt solar water and reuse of rainwater.

In the HST, the cost factor obtained note 3 and the flexibility and quality factors were positively evaluated note 4. We can say that, despite some problems, the environmental management is seen from a favorable scenario by the respondents. Based on the evidence, it can be seen that there is a consciousness of environmental requirements by the direction. In addition to the hospital to have structural problems, it is located in an area of permanent preservation, and this prevents the build adjustments.

Investments are made to increase and improve the production process to return in quality and operational performance. Regarding the result of factors weighted in HRSJ, flexibility, reliability and speed had grade 1 and the quality and costs note 2. Based on the data analysis, note again that there are those who realize that there is a concern in HRSJ make available to all, quality equipment. But nevertheless, the hospital has faced difficulties in acquiring them and this has generated a sense of disengagement on the part of health professionals, thus reflecting the need for recognition and valuation of workers employed there.

Regarding the result of factors evaluated in SCMP, cost and quality had grade 4 and grade flexibility 3. The analysis of the evidence indicates that there are opportunities for process improvement that can be obtained from recycling training program and routine institution for efficient execution of the work.

When evaluated the result of factors in the HST, all had grade 4, thus representing a favorable scenario and resulting in the investment category as one of the best evaluated, according to the group of participants. It is inferred that the hospital invests in both its technological resources and in human resources.

The Organization and Culture category can be illustrated as an organization identity of the panel, whose constitutive values of profile takes the form of images, stories, rituals, heroes and villains, conflicts of roles, areas of tension and resistance, behavioral dilemmas, references, leadership outbreaks, patterns of attitudes and other symbolic dimensions. It permeates all other categories and reflects the way people behave, what is tolerated to be perpetuated and persecuted by all.

When evaluated as a result of factors in HRSJ, only the cost obtained note 1, the rest were weighted as 2. The explanation for the negative evaluation of this category is diluted in complaints and weaknesses reported by the participants along the instrument application. The reports reflect the strength of the people to do different; the values commonly shared in the public area that all are treated equally, regardless of the degree of dedication are evident. Resistance to change and the difficulty of making it happen is directly related to the lack of leadership that will serve as an example and also a sense of team directed the achievement of objectives.

When evaluated the result of factors in SCMP just got quality note 4, other factors were weighted as 3. The reports presented reflect the perception of people to admit knowledge of scenery and opportunities for improvement. It shows up transparency and consensus with values and strategic planning of the organization. Finally, the hospital is aligned with the organization's culture guided by rational use of resources and commitment, value quality and encourage the search for improvements actively.

In the HST where has the cost resulting from factors and flexibility obtained the score 3 and quality, note 4. In general, this category was also characterized as an intermediate stage. Evidence of analysis allows us to infer that in the last decade as a result of changing the general direction of the hospital, we have perpetuated values as people, quality, efficiency and teamwork. Valuing people and investment in continuous improvement have contributed to the positive mood and self-image of the institution.

The Production Planning should be the first step of all organizational activities. In determining the plans and goals of the organization directs that all his future and possibilities of a set of actions aimed at achieving objectives.

In this category, the HRSJ, quality result of factors, flexibility and speed were evaluated with score 1, since the reliability and costs had grade 2. The evaluation reflects the negative performance of this size. The collected data support the idea that multiple actions are performed based on improvisation, that is, based on the knowledge of the people involved, with the aid arising from the relationship between informal organizations and, according to participants, with the dedication of a minority servers.

In this category, the SCMP, the cost resulting from factors, flexibility and quality were evaluated with score 4. Evidence reflect the view that the actions taken in the SCMP are the result of a systematic process of analysis. Thus, the data are used for planning and information allows decision-making, as well as provide flexibility as the demand comes in, increasing the quality of services provided.

In the HST, cost resulting from the factors, quality and flexibility were evaluated with note 4, reflecting the perception of a favorable scenario. Therefore, it can be said that the performance of the subsystem production planning has been perceived positively. The evidence can be inferred that there is a constant concern in making plans as a strategy to organize more efficiently the various actions, and to draw paths that enable the achievement of organizational objectives.

The Production Scheduling allows the organization to win a safer production process, with the time and resources well sized and your professional know how and when to act.

In HRSJ, the evaluated result of factors obtained all they note 2, also indicating a poor performance, a fact perceived as a direct reflection of low evaluation of production planning, investments, operational performance and organization and culture. The analyzed data can be inferred that the lack of proper planning, and unsystematic use of indicators to mark the decision-making end up having a direct impact on the production schedule, thus focusing in increased costs and waste from various sources that could be avoided.

In SCMP, the result of factors evaluated in this category have obtained the note 2 in cost and 3 for flexibility and quality, indicating an intermediate performance bad, and this was perceived as an indirect reflection of the existing gaps in the evaluation of the previous categories. Regarding the intermediate scenario, the analyzed data can be inferred that the production schedule of SCMP is suitable to features such as, for example, provision of materials and product. It also observes the existence of processes and methodologies that contribute to the immediate care demand (Manchester protocol).

In the HST, as in the previous category, cost resulting from the factors, flexibility and quality had grade 4, contributing to the perception of a favorable scenario. Understanding the employees that most of what was programmed happens satisfaction is expressed from the evidence that the management process is attributed due importance to reporting and its constant evaluation to maximize control of various operations natures.

Health and expressly Security category the set of actions of an organization that involves diagnosis and implementation of improvement and management innovation, technological and structural inside and outside the work environment, in order to provide full conditions of human development to and during the production work . When you have faults, become possible negative interference on income, productivity and quality of the process.

When evaluating the result of factors in HRSJ, cost and flexibility had grade 1, and other factors, speed, flexibility and reliability had grade 2. This category also got a negative evaluation, perhaps the collective perception that there is a significant number of work accidents with sharp, absenteeism and removal for health care. However, it is noteworthy that in the public sector is still incipient a health and safety policy work which contributes to the lack of a number of measures that could be adopted to prevent the occurrence of accidents and occupational diseases.

The evidence supports the idea that the health and safety of workers is not a value considered in HRSJ. It was mentioned that there are servers that have technical course in safety, but are not part of the team and could perhaps be used. Besides, no one could tell if anyone was responsible for the safety engineering. It is inferred that the actions related to this area happen in a bureaucratic-operating and non-strategic basis, thereby negatively influencing the worker's quality of life.

When evaluating the result of factors related to this category in SCMP, quality and flexibility had grade 3 and cost 5. The notes reflect a positive evaluation, seated in the collective perception that there is a significant number of accidents, the existence of working methods and their respective supervision. The evidence supports the idea that the health and safety of workers is a value considered in the hospital and, consequently, healthy and safe working environment found by people favors the production execution. Still, it is perceived, based on the evidence mentioned by the participants, there is a search for cultural improvement on the quality and flexibility, just by following strict procedures.

Regarding the assessment of the result of factors related to this category, the HST, cost obtained note 3 and flexibility and quality, notes 4. In general, it is also another subsystem which was evaluated as a positive scenario relation to its performance. Despite the positive assessment, it can be seen that the actions taken in relation to the conservation of the health and safety of staff are still incomplete. Respecting the legal requirements is the minimum that is expected from an organization that intends to have no problems related to industrial accidents, and to assess the causes of accidents is the first step to seek a culture of safety. Importantly, absenteeism due to depression problems is a common situation experienced by health professionals, especially nursing.

The cycle time category is related to the idea that determining the cycle time allows the production process to be controlled and improved more effectively, thereby reducing unnecessary time and increasing service capacity.

When evaluating the relationship of the result of factors with this category in HRSJ, it was found that the five factors had grade 1, thus reflecting the urgent need to take action to help change the situation presented. Evidence justify the perception that this is a category that has a poor performance and that this reflects the lack of systematization of indicators as a tool to support the planning, decision making and corrective actions that help the institution maintain its effectiveness.

It is inferred that the lack of different cycle times present in HRSJ reflects also the lack of systematization of the performance indicators of the different units, and some of these indicators are measured globally, compromising its reliability.

In the evaluation of SCMP, it was found that factors cost and flexibility had grade 2 and grade 3 quality obtained, thus reflecting the lowest grade among factors result and urgent need to take action to help change the situation presented. The analysis of data allows inferring that there is knowledge of the need to measure

different cycle times present in the hospital, but are not named with the exception of the major (longer) perceptible in the daily.

When evaluated as a result of the HST factors, it was found that cost and flexibility and quality had grade 3, 4. Therefore, in general, one can say that such a category has been evaluated from an intermediate stage, urging measures improvement to maximize their performance. Data analysis makes clear the idea that the hospital has knowledge of the time taken to perform part of its activities, however, his performance ends up being damaging for some variables defined by the participants as uncontrollable. It infers that lacks a systemic vision and commitment of all involved, directly or indirectly, to the achievement of results and operational efficiency.

Quality category concerns the ability of a particular good or service must meet, or even exceed, customer expectations, consistently. This term has been used, but not always correctly sought. Everyone wants quality goods and services, and organizations that do not take into account this desire tend to be less competitive. The relationship of this category with the five result of factors resulted in note 2 in all items evaluated by participants HRSJ.

In SCMP, the relationship of this category with three result of factors resulted in note 4 in all the variables evaluated. The analysis of the data reinforces the perception that the hospital there are tools and instruments that positively impact the different processes, in addition, we see the constant concern to improve the quality of service and reduce costs. The rapid flow of information, and good equipment trained staff, result in a significant quality control and high reliability supported by strong corporate culture in the organization.

In the HST, the assessment resulted in note 4 in all the variables evaluated, corresponding this way, a favorable scenario. The positive assessment of the quality category of performance can be demonstrated in the outcome of concern for constant improvement and reduction of waste. Therefore, we perceive a search for the standardization of product and process, to maintain the effectiveness of the communication process and teamwork. Investing in standardization, improve communication and develop teams are relevant concerns of those seeking excellence in management.

It is important to note that during the evaluation process of the thirteen categories with the three factors result, improvements of ideas generated by the group of participants from each hospital, were recorded by the researchers. Thus, after a critical analysis of each group in relation to the set of ideas raised, they picked up those who were considered most critical and most potential feasibility to then the improvement projects could be drawn.

In HRSJ, given the ideas proposed, the group was divided into three subgroups for analysis of thirteen points listed and select those considered most urgent and/or viable. So they were prepared three improvement projects involving the following areas: Reception and hospital discharge; Radiology and; Drugstore. In SCMP were developed three projects for: Production Scheduling; Training & Development and; Tecnologic innovation. With regard to the HST, it is clarified that the short time that was given to researchers to make the application of the instrument, it was not possible to reunite the group so that the improvement ideas listed were evaluated and thus could be designed the improvement projects need to be implemented.

CONCLUSIONS

For organizational HRSJ analysis, it was found that there were several areas for improvement since only 11% of assertions were placed in brown color as they had relations scenarios considered intermediate. The categories Cycle Time and Factory obtained only low notes, highlighting the need for improvement in the short term. It inferred that the short-term connotation could be justified in the case of cycle times, because it is essential that the hospital know and master their different production times and thus can rely on data that feed the indicators their performance and subsidize decisions regarding the planning of their actions and point the investment needs. In addition, it was found that structural and infrastructural aspects should also be the

focus of attention by the management, as represented critical points for better performance. In terms of improvements suggested ideas were developed of the three projects, we can mention: a reference to the Reception and hospital discharge; one on radiology and the third to Pharmacy.

Regarding the SCMP, could be perceived by organizational analysis that there was a predominance in the favorable scenario, since only 1.17% of the statements were classified as pink, that is, as relations had considered unfavorable scenarios. The categories Production Control; Operating Performance; Equipment and Technology; Environmental management; Production Planning and; Quality only achieved high grades, expressing thus little need for improvement in the short term. It is inferred here that the favorable performance in the prevalence of the categories analyzed could be justified by the fact that it is an accredited hospital that was seeking to obtain the final level of Hospital Accreditation. Therefore, the processes were already mapped and were well known to all; there were already established commissions and some improvement programs instituted. Based on these improvement ideas, the SCMP Group designed three projects related to areas: Production Scheduling; T&D; Tecnologic innovation.

Refering to the HST, the scene perceived by the participants was favorable, since none of the statements has been classified as red and pink, that is, as they had relations scenarios considered unfavorable. Only the categories Cycle Time Factory and obtained predominance of items assessed as intermediate scenario. It was inferred that such an assessment would reflect the need to seek improvements in these dimensions. It was understood that the category factory should assume significant importance in the hospital, both in regard to increased flexibility from operating activities, as well as patient safety and its staff.

It is known that the performance of the organization varies according to the activities, the equipment used and available resources, the environment in which it works and the characteristics of people there inserted. But above all, it depends on how reality is perceived and interpreted by the actors of the process. Confirms the idea that the proposed technology has the distinction, the possibility of increasing the perceptual range of involved and help them understand that the actions taken in the organization must be integrated harmoniously to the competitive factors can be achieved.

When contemplating a set of three hospitals to improve the management of technology proposed by the researchers, it is understood that the exchange of experiences between hospitals could take a benchmarking character, since it implies that something that has been designed and successfully tested in a particular unit, it may also be useful in another. It is assumed that comparisons between organizations should integrate the evaluation processes, as improvement plans can be made from contributions from the benchmarking and organizational partnerships.

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Hospital Disaster Plan: the experience of a Brazilian hospital

RACY, F. C.J.¹⁾, SMALETZ, D.¹⁾ MIZUTANI, J. K. S.¹⁾, SANTOS, T. C. G.¹⁾, AZEVEDO, B. M.²⁾ and CAMPOS, F. L. S.²⁾

1) Israelita Albert Einstein Hospital

²⁾ Santa Catarina Federal University

ABSTRACT

Every health institution needs to be prepared for a mass casualty event and some Hospital Accreditation programs ask for this preparedness. This article aims to propose a critical reflection on the development and implementation of a Hospital Disaster Plan from that premise. This hospital developed this one and uses periodic simulations to train its team. The Prevention and Disaster Response Committee is responsible for the review, update, disclosure, simulation and validation of the Plan, which remains available on the hospital's intranet. It is disclosed through an e-learning and trained by periodic Simulation with Debriefing at the end. This plan is triggered by the decision of the Local Command Center. The START method is used for triage. Green victims are advised to go to an amphitheater outside the emergency room. Red victims are placed in the Emergency Room and the yellow ones in a larger place. These different areas of care need an independent communication to the Central Crisis Management (CCM). The team organization, logistics and flow of care, as well as the organization of the CCM become better according to the repetition of the Simulations. It concludes that e-learning is an effective method of disclosure, the isolation of the green victims outside the emergency room avoids turmoil in the other areas of care, the flow of care needs to be unidirectional, Debriefing is an important tool to identify problems, the communication of different areas with CCM may work better with independent channels.

Keywords: Hospital Disaster Plan, Simulation, Catastrophe.

INTRODUCTION

The impact of quality management in different sectors can be linked to efforts of looking for improvement in products, processes and management of different sectors of the economy, including health institutions (SMITH; GORSKI and VENNELAKANTI, 2010).

There is consistent evidence that shows that accreditation programs improve the process of care provided by healthcare services. Moreno Júnior and Zucchi (2005) and Da Motta and Silvino Duarte (2012) pointed it. The Hospital Accreditation is a tool that contains criteria that collaborate and encourage quality improvement and provides visibility of innovations in health systems. Manzo, Brito and Correia (2012) say that the Hospital Accreditation can be seen as a strategy to improve the quality of health services.

Searching for quality, the hospitals direct their activities to the accreditation processes, such as ISO, ONA, Joint Commission International (JCI) and others, which may be markers of progress in improvement. The Joint Commission International, for example, requires for a Hospital Disaster Plan.

Natural or technological disasters create a large number of victims in a sudden and unexpected way. The initial approach to the victims follows a Pre-Hospital Care routine in order to carry out the evacuation effectively and efficiently. It is important for every employee to know how hospitals are organized to receive this large number of victims.

The Hospital Israelita Albert Einstein (Sao Paulo - Brazil) was the first hospital in America to obtain the JCl quality label outside the US and have developed the Hospital Disaster Plan to organize its team and structure to be prepared for a Mass Casualty Event (MCE), considering that every health institution needs be previously prepared for this situation, where the flow of care exceeds the usual amount. The communication of this Plan and periodic simulations are really important for staff training.

This disaster plan needs to be revised, updated, simulated and validated annually. Thus, this article proposes a critical reflection on the development and implementation of a Hospital Disaster Plan, from the experience of the Hospital Israelita Albert Einstein (Sao Paulo - Brazil).

This paper is relevant considering the hospital care in a Mass Casualty Event. The result is directly related to the organizational capacity of the institution. The disaster plan should be disclosed in order to reach all employees. Everyone needs to know their role in the crisis and to be familiar with the changes in their routine care.

METHODOLOGY

This study aims is characterized as exploratory and descriptive, for seeking to investigate a Disaster Plan and to observe, record, analyze the positives and negatives results from experiences: two simulations and a real experience (MARCONI and LAKATOS, 2007). It is a qualitative research, based on case study (MARTINS and THEOPHILUS, 2009; TRIVIÑOS, 1992).

The Prevention and Disaster Response Committee is responsible for the periodic review of the Hospital Disaster Plan, performing its update according to the hospital's physical plant changes or adding changes in its flow based on experiences and discussions after the Simulations (Debriefing). The purpose of the hospital disaster drills is to train hospital staff to respond to an MCE, to validate the readiness and effectiveness of this plan (DEPARTMENT of HEALTH and HUMAN SERVICES, 2000).

The Hospital Disaster Plan remains available on the Hospital's website (Intranet) and can be accessed by all employees of the institution. It is disclosed through an e-learning (Figure 1) and trained by periodic Simulation (twice a year).

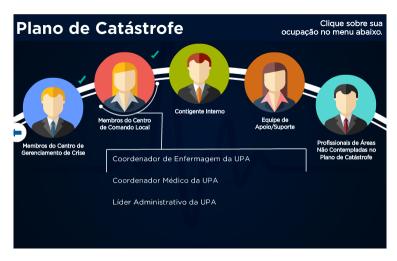


Figure 1 – E-learning: Hospital Disaster Plan.

According to JCAHO (2003), at least one exercise a year is escalated to evaluate how effectively the organization performs. It concludes that enough studies were available to suggest that hospital disaster drills were effective in training hospital staff to respond to an MCE, however, weaknesses in study design limit the strength of these conclusions (HSU *et al.*, 2015).

The Plan

The literature shows that in a disaster situation, the expected distribution of the victims is 80% Non-Emergency, 15% Urgency and 5% Emergency (Figure 2). The managers and leaders need to know that to estimate the expected demand at the time the number of victims is disclosed.

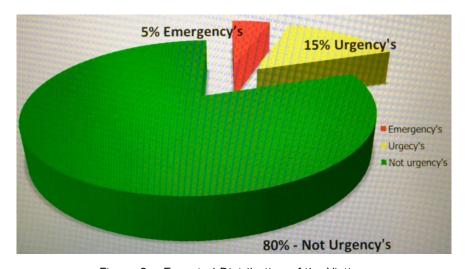


Figure 2 - Expected Distribution of the Victims

When the information of a Mass Casualty Event (MCE) comes to the Emergency Room (phone call, victims, etc.) the Hospital Disaster Plan may be triggered by decision of their leaders: Medical Coordinator, Nursing Coordinator and Administrative Supervisor, or their substitutes. These leaders form the Local Command Center (LCC). Next, the level should be set to create the corresponding organization to it, remaining alert the areas to be activated at the next level.

There are three levels as follows, according to Ribera and Damasceno (2012):

- **Level 1** Small scale (until 20 total victims and until 3 serious casualties): the number of victims is easily controlled with the local resources;
- **Level 2** Medium Scale (21 to 50 total victims and / or 4 to 10 serious casualties): the Emergency Room will need resource from other sectors of the Hospital, which will mobilize all sectors involved in the plan for quick resolution, so the institution can return to normal service flow;
- **Level 3** Large Scale (more than 50 total victims or more than 10 serious casualties): cause widespread damage reaching high number of victims. It requires support from all available resources: internal, external and even government.

Next, the Security Center must be notified about the outbreak of the disaster plan and what the set level, starting the preparation process of the infrastructure (internal and external signals, control inputs, guide security, etc.). They are directed to the ER for mounting the green area and assist in other contingencies identified by the LCC. At levels 2 and 3, the Central Crisis Management (CCM) will be mounted. The Security Center sends 3 independent radio pairs to provide the communication of the different areas of care (red, yellow and green) with the CCM in order to manage their needs receiving information compartmentalized. Internal and external communications are the key to effective disaster response (JCAHO, 2003).

Once triggered the Disaster Plan, support structures are assembled in order to facilitate care in the emergency room, setting destination fast to all victims. The gateway to victims will always be the emergency room.

The Triage area is set up outside the entrance of the Emergency Room (discharge of ambulances). The START method is used and the victims are distributed into four groups (BENSON, KOENING and SCHLTZ, 1996; MOSKOP and ISERSON, 2007):

- 1. Red (Immediate) patients whose injuries are critical and have good prognosis for survival.
- **2. Yellow** (delayed) patients whose injuries are serious but do not require immediate care to preserve life or limb.
- **3. Green** (minor) often called patients "walking wounded", who have minor injuries and can wait for treatment.
- 4. Black (expectant) patients that do not respond have no pulse and no breathing.

Only yellow and red victims will go to the Triage area. The green ones (walking victims) will be directed to an Auditorium outside of the emergency room, near to the Triage area.

This place will be isolated and green area will be organized in a large hall inside the Auditorium, which can receive lots of victims (more than 50 comfortably). It will be assembled by employees of the Emergency Room (4 nursing assistant and 2 administrative assistant) under the guidance of 2 nurses and 1 Orthopaedic and the Administrative Supervisor (local leader), who keeps the radio. This team is responsible for the care of this area. At this place the victims will be identified, assessed by the medical and nursing staff, made dressings, assets and medications. At the possible time, the victims will be forwarded to additional exams.

On the Triage area will be located:

- 2 nurses;
- 1 clinician;
- 1 administrative assistant.

On the Triage the victims will receive a standard numbered ID card (figure 3) with their classification and then forwarded to the target area (red or yellow).

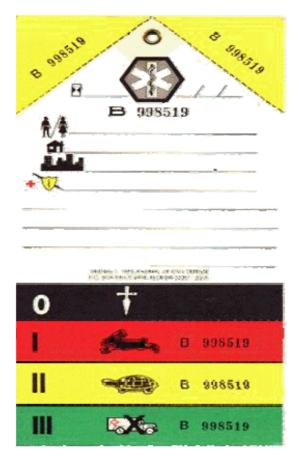


Figure 3 - Triage ID Card.

The care team of the red area is composed of three nurses, three nursing assistant, one physiotherapist and three physicians (one surgeon, one clinical and one cardiologist). The capacity of the red area is 12 red victims (serious casualties). The Medical Coordinator is the local leader (radio). The care team of the yellow area is composed of three nurses, five nursing assistant and 4 physicians (2 clinical and 2 pediatricians). The capacity of this area is 35 yellow victims. The Nurse Coordinator is the local leader (radio).

The black victims are directed to a room next to the emergency room entrance (Figure 4) where they will remain until his referral to the Legal Medical Institute (LMI) for the Necropsy.



Figure 4: Areas of Care (red yellow and green), Triage (orange) and Morgue (black)

Some observations need to be done:

- The minimum number of professionals present in any night shift from 12 to 7 a.m. (the lowest number of employees) were used to this distribution among the different areas;
- If the event occurs at a time of greater number of employees, they will be positioned as needed;
- If it is identified the need for more professionals, the CCM will forward other professionals to the ER;
- There is a contingency plan in case of impossibility of use of the emergency room.

As previously defined, in medium and large-scale disasters (levels 2 and 3), the Central Crisis Management (CCM) must be installed. Thus, when activated Security Center and informed of the outbreak of the Disaster Plan Level 2 or 3, the executive board of the Hospital needs to be informed and begin the installation of CCM in a pre-defined area: the Executive Committee Room (at the Administrative Center), on the Superintendence with access to images of the service outlets. There are some other options: Security Center (inside the Hospital) or other Hospital Unit (outside).

The CCM has consists of the following components:

- "Safety Officer" or, in his absence, the Administrative Supervisor;
- Director of Care Practice, Quality and Safety, or in his absence, the substitute;
- Director of Medical Practice or, in his absence, the substitute;
- General Director or, in his absence, a member of the Executive Committee;
- Superintendent of the Hospital or, in his absence, the Director of Medical Practice;
- Recorder frame elected in the crisis room;
- Consultant Crisis elected in the crisis room;
- Commercial and Marketing / Media Relations or in his absence, the substitute;
- Human Resources Director or, in his absence, the substitute;
- Director of Procurement and Logistics, or in his absence, the substitute;
- Director of Engineering and Maintenance, or in his absence, the substitute.

The CCM is the center of all the event information being reported by each of the areas regarding the number of victims, their names, diagnoses and needs. It is the sector responsible for providing the demands requested by each of the care areas (red, yellow or green) in order to provide resources (laboratory, radiological, haemotherapic) or even set professional offsets from other sectors. It is responsible for authorizing referrals (radiology, surgical ward, ICU, hospital units, etc.). The red, yellow and green areas may have independent communication with the Central Crisis Management (CCM).

When triggered Disaster Plan levels 2 or 3, after being forwarded to another unit, the victims never return to the place where they left, ie, the flow is unidirectional. Thus the care areas will be gradually emptied.

The CCM will organize a medical team to assess patients in the units and target services (radiology and laboratory) and direct them to inpatient units, Surgical Center, ICU or discharged.

There are professionals trained in the institution to support to the victims care and are defined in the Disaster Plan:

 Support Team for assistance to green victims (Auditorium): professionals with training for BLS (Basic Life Support) or support services that must remain in the units are directly to the green area when triggered by the Central Crisis Management (they may report to the leader of the green area):

- Inpatients Units (nursing and administrative);
- Nursery (doctors and nurses);
- Doctors registered;
- Internal transport;
- Offices (nurses, secretaries to support functions);
- Volunteers:
- Hospitality and Governance;
- Security;
- Social Service.
 - **Support Team for assistance to yellow and red victims** (Emergency Room): professionals available on the Hospital, with training for ACLS (Advanced Cardiac Life Support) and ATLS (Advanced Trauma Life Support), which will be called to assist in a place determined by CCM according to their professional training, otherwise must remain in their sector:
- ICU Professionals: go to the medical coordinator in the red area. Staff: 3 physicians, 3 nurses, 2 physiotherapists, 4 nursing assistant;
- Surgical-Clinic Professionals: go to the nursing coordinator of the yellow area. Personal and feature: 1 nurse, three nursing assistant, a resuscitation trolley;
- Anaesthesia (to be triggered by the Central Crisis Management): move to the emergency room (Red or Yellow area), Surgical Center (receiving victims) and / or Radiology (receiving victims);
- Blood Bank: providing blood supply 0 -;
- ICU and inpatient units: available beds;
- Surgical Center: suspend elective surgery and operating rooms available, keep beds in the postanesthesia care ready to receive ICU patients;
- Radiology and Laboratory: suspend elective exams, available resources.

The Central Crisis Management (CCM) is responsible for analyzing the situation based on the Local Command Center information (LCC) and take decision to suspend the Hospital Disaster Plan. At this time the CCM will announce to the involved and triggered areas the closure of actions and return to normal activities.

The meeting event of critical analysis will be scheduled and conducted by CCM and LCC with the contribution of all involved: Debriefing.

Experiences

This review, update, simulation and validation of the current Hospital Disaster Plan provided three very meaningful experiences for the institution: 2 Simulations and 1 Real Situation.

Simulations:

- October / 14: scenario: bus accident in the Hospital entrance: 34 victims (4 red, 8 yellow and 22 green) being triggered the Disaster Plan Level 2;
- May / 15: scenario: Rave Party explosion 5 minutes far from the Hospital: 36 victims (4 red, 4 yellow, 27 green and 1 black) being triggered the Disaster Plan Level 2.

• Real Situation:

- November / 15: elevator falled down from the 13th floor next to the Hospital: 17 victims (4 yellow and 13 green) being triggered the Disaster Plan Level 1.

Discussion

Considering the methodology, experiences and results, it was possible observe:

- Debriefing has identified the problem of communication between care areas and CCM with a single channel;
- The organization of the team and the response efficiency improve with repetition of Simulation;
- Isolating the green victims prevents confusion

Proposal

Carry out communication between the care areas (red, yellow and green) with the Central Crisis Management (CCM) with 3 pairs of radio with independent channels (3 different frequencies).

CONCLUSIONS

Based on these experiences, the communication between the areas of care (red, yellow and green) with the Central Crisis Management (CCM) may be done using 3 pairs of radio with independent channels, remaining each pair of radio communicating the leader of each area with a different person in the CCM. These persons may report the demands to the same one who guide the frame recorder and set the order of priorities. It may be an improvement opportunitty,

The practical implication of the Hospital Disaster Plan of the Hospital Israelita Albert Einstein is to minimize the damage and provide better results to the population directly or indirectly involved in such events, considering it is a plan of care for an emergency situation (MCE) and it is a need of hospitals in a big metropolis. Hospitals need to be prepared to handle such an unusual workload. This necessitates a well documented and tested disaster management plan (DMP) to be in place in every hospital (METHA, 2006).

The Plan can be disclosed efficiently though the e-learning; The isolation of the green victims, as well as the one-way flow facilitates care in red and yellow areas; the training of staff with Simulation and Debriefing at its end is an effective strategy in identifying problems and developing improvement actions for the team's performance.

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Reality Shock – Reducing the Risk

Campbell-Allen, N.M., Grigg, N. P. and Jayamaha, N. P.

Massey University, Palmerston North, New Zealand.

ABSTRACT

Purpose

It has been identified that one of the most difficult transitions a person may make is between education and full time employment. This can result in what has been described by Kramer (1974) as 'Reality Shock'. Ensuring students leave their organisations with the key competencies needed to succeed and thrive in the workplace is a key issue facing educators. It is vital that key stakeholder needs are adequately determined, that curriculum content reflects these 'real world' needs, and graduates leave with these requirements having been met. Once determined, appropriate learning activities can then be tailored to ensure theoretical and practical requirements can be incorporated to most effectively deliver the key competencies required

Design/Methodology

This paper discusses the unique New Zealand (NZ) context within which an international benchmarking study determining the 'leadership competencies' required of engineering graduates is being undertaken. The need for this study and how it will be conducted are considered.

Practical Implications

A number of practical applications are expected. These may include improvements to the design and delivery of Engineering Degrees at the participating Universities, and enabling new graduates to 'hit the ground running' as more active early workplace contributors Longer term, it is hoped there will be a reduced risk of new employees leaving industry early in their employment career due to 'reality shock'.

Originality/Value

The results of this study would be of value to both academics and practitioners who are involved in the design and delivery of engineering education.

Keywords:

Engineers, leadership competencies, reality shock, work readiness.

Paper Type:

Conceptual paper

Introduction

"It sometimes does us a power of good to remind ourselves that we live on two volcanic rocks, where two tectonic plates meet in a somewhat lonely stretch of windswept ocean just above the Roaring Forties. If you want drama you've come to the right place".

R.H. Sir Geoffrey Palmer

(cited Ministry of Civil Defence & Emergency Management, 2004)

Often called 'Aotearoa', 'The Land of the Long White Cloud' or 'Godzone', New Zealand (NZ) is an island nation in the South Western Pacific Ocean. NZ is approximately 1,500 kilometres (km) - 900 miles (ml) east of Australia, and 17,902 million km – 11,124 million ml from Europe as the 'crow flies'. The country is made up of two main landmasses - the North Island (or Te Ika-a-Māui, population 3,519,800), and the South Island (Te Waipounamu, population 1,076,300). The latter is frequently referred to as the 'mainland' (especially by its in habitants), because it is somewhat larger – comprising 56.2% of the landmass. There are also a number of smaller, inhabited islands - Stewart Island (or Rakiura, population 400) Chatham Island (Wharekauri, population 600), Great Barrier Island (Aotea, population 850), Waiheke and Matakana Islands (8,900 and 225 people respectively). In addition, there are a number of unpopulated islands.

New Zealand's Productivity:

Considered by many as a more remote part of the world, NZ was one of the last landmasses to be settled by humans. It is a nation of many cultures including Maori, Rarotongan, Fijian, Samoan, and Asian and European citizens from many nations. The current total population is 4.6 million (Statistics New Zealand 2016). Being a remote nation, NZ is heavily dependent on international trade – with dairy products, meat, logs and wood articles, fruit, crude oil, and wine being the principle exported commodities. The main export partners include China (20%), Australia (17.5%), The United States of America (9.3%), Japan (5.9%), with NZ\$34.33 billion of exports recorded in 2015. As an island nation, it is also very reliant on imports. The main imported commodities are petroleum (and petroleum related products), mechanical machinery, vehicles and parts, electrical machinery, and textiles. In 2015 imports accounted for \$35.34 billion. The countries main import partners are China (17%), Australia (12.3%), The United States pf America (11.7%), Japan (6.7%), Germany (4.8%), South Korea (4.5%), and Malaysia (4.3%).

The 'service sector' is the largest sector in the economy, contributing 69% of the total Gross Domestic Product (GDP) and 74% of the workforce. This is followed by 'industry' (e.g. agriculture, forestry, fishing, manufacturing, mining, construction, and tourism) at 26.8% of the GDP and 19%, of the workforce. The third main contributor is 'agriculture' (e.g. dairy products, sheep, beef, wine, seafood) at 4.1% of the GDP and 7% of the total workforce (Central Intelligence Agency 2016).

While GDP for New Zealand has grown over the years, despite being a developed nation the rate of GDP per capita (NZ\$30,179) continues to lag behind the OECD average (NZ\$37,181). This has been attributed to, among other things, weaknesses in international connections, reduced access to large markets and limited participation in global value chains (de Serres, 2014).

Economic Growth and Leadership Ability:

Leadership and management skills have been identified as vital to the success of NZ and NZ businesses. In a NZ Treasury Productivity Paper (entitled *Enterprise and Productivity: Harnessing Competitive Forces)*, skilled managers were identified as having a substantial impact on organisational performance and as being influential in creating an environment where innovation and skill development can flourish (New Zealand Treasury. 2008, pg. 13).

Research for the 2006 World Competitiveness Yearbook, by the International Institute for Management Development (IMD) asked business executives to rate the management quality in their countries. With a final ranking of 21 (out of 25 countries participating), NZ's perceived management skill levels were rated as lower than Australia, the United Kingdom and many other OECD countries (New Zealand Treasury. 2008, pg. 13)..

In a project commissioned by the Ministry of Economic Development as part of their upskilling initiatives for NZ managers, "Massey, Gawith, Ruth and Wilson (2005) concluded that a management capability problem exists and that the general consensus amongst experienced providers is that New Zealand lacks skilled managers" (New Zealand Treasury. 2008, pg. 13) and that "...on average, New Zealand suffers a dearth of high quality managers and entrepreneurs. This lack of managerial talent could be affecting both a firm's ability to internationalise and also the average firm's ability to identify new opportunities and grow" (New Zealand Treasury. 2008, pg. 13), and has led to appeals to take actions to enhance the leadership skills in NZ businesses.

The Need for Engineers with Leadership Ability:

NZ Engineers are employed in a variety of large and small organisations, providing services and products both nationally and internationally. In recent years, the range of outputs from these organisations has included such activities as crowd modelling for the 2012 London Olympic Games, project management services for the NZ Navy and various Middle East property developments, modelling of supply chain optimisation processes, and evacuation modelling for seismic events in city areas (Becca Corporate Holdings Limited 2016). As a result of this diversity of work, demand for graduates from all engineering fields exists

In 2008 and 2009 a consortium of representatives from industry, education, professional bodies and government, undertook a project to develop a coherent National Engineering Education Plan (NEEP). The aims of the plan being to:

"...produce the right number of the right types of engineering graduates to meet New Zealand's needs" (IPENZ 2010a); and

Address "...the long-term shortage of engineering skills in New Zealand, and the need to ensure that New Zealand's engineering education meets international best practice and can be delivered effectively by a nationally coordinated network of provision" (IPENZ 2010b).

The plan was a result of a Department of Labour Report entitled "Engineers in the NZ Labour Market". The report highlighted that employment forecasts "...indicate that demand growth will continue for engineering professionals. It is expected that an additional 1,200 to 1,300 engineering professionals will be required each year over the next five years" (Department of Labour 2008 pg 1). In two 2010 IPENZ reports these figures had increased to 2,000, if 'business as usual' existed, and to 2,750 should NZ focus on being an 'innovation led economy' (IPENZ 2010 a and b).

In the September 2012 national Budget, it was announced that \$42 million to assist in subsidising 1,000 additional engineering placements would be made available for 2013. In addition to this the Tertiary Education Commission (TEC) was adding a further \$8.3 million, with the potential for approximately 8,785 students to be studying Engineering at Universities and Polytechnics delivering engineering education. The Minister for Tertiary Education Skills and Employment, Steven Joyce commented in a press release in November 2012, "The reality is if we want faster economic growth for New Zealand then we need to invest in skills that will help grow the economy. Having more engineers will assist in building a more productive and competitive economy" (Joyce 2012).

Christchurch – A National Emergency and Major City Re-build:

To add fuel to this existing fire, on 4th September 2010 Christchurch, NZ's third most populated city, experienced a magnitude 7.1 earthquake - this was followed by thousands of aftershocks. On February 22nd 2011 what was considered an aftershock of 6.3 magnitude occurred that led to 185 deaths and \$40 Billion in estimated damages. The second quake caused widespread damage (especially in the central city and eastern suburbs). Damage this 2nd time around was considered tremendous as buildings and infrastructure had already been significantly weakened by the 2010 quake and its aftershocks. They estimate that in the eastern suburbs around 400,000 tonnes of silt due to liquefaction has been removed. Since September 2010 over 3000 inner city and residential properties have been partially or fully demolished (Stylianous 2013) – many of significant 'heritage' status or listing. 1000 of these demolitions have been in the central city alone, and have included public amenities such as the railway station, office buildings and hotel accommodation. Ongoing issues continue to arise including flooding resulting from underground/above ground waste water infrastructure issues.

In his 2013 Budget Speech, Finance Minister Bill English stated "The Treasury has recently increased its estimate of total rebuilding costs from \$30 billion to \$40 billion – the equivalent of almost 20% of New Zealand's annual GDP" (Treasury 2013). This funding will assist with "...redeveloping Christchurch hospitals, establishing a justice and emergency services precinct and supporting tertiary education institutes" (Treasury 2013), in addition to the rebuilding of roads, public amenities, and city support structures such as public transport facilities (railway and bus stations), a central library, sports complexes etc. In a speech to the National Party's South Island Regional Conference, 'post budget', Prime Minister John Key, highlighted that the Christchurch rebuild "...is the largest and most complex project in New Zealand's history. The scale of the rebuild is unprecedented" (National Business Review 2013).

As a result of the identified factors, the provision of advanced education in Engineering (and Food Technology) is vital to the future of NZ – for 'business as usual', to assist NZ being an 'innovation led economy', and for the future rebuild of Christchurch.

Massey University:

Massey University has grown from a small agricultural college (with 5 students in the first year), to become New Zealand's largest residential university with campuses in Auckland, Palmerston North (its Central Base), Wellington and Singapore. It has a student roll of over 35,000 internal and extramural students. The University's qualifications are recognised worldwide and many programmes have international accreditation including Engineering, Aviation and Veterinary Sciences. As a tertiary education provider, and centre for research the University has obligations to a number of key stakeholders and internal/external customers including its students, staff, the government, business, wider New Zealand Society, and international partners. The vision of the University is:

"To be New Zealand's defining university and a world leader in higher education and scholarship" (Massey University 2013 pg. 3).

The mission, involves defining the future of the country and taking the best of NZ to the world, through goals such as research-led teaching, the building of beneficial relationships with its many partners and stakeholders, and "...a teaching and learning environment that will enable (students) to be creative, innovative and connected contributors to society" (Massey University 2013 pg. 5).

The School of Engineering and Advanced Technology (SEAT):

Engineering and technology studies were first established at Massey over 40 years ago. Today courses are taught at the Palmerston North and Auckland campuses. The school employs 81 academic staff, 30 technical support staff, and has more than 700 undergraduate and 250 post graduate students. The focus is on producing graduates for the manufacturing and processing industries, in 6 main areas of study:

- 1. <u>Industrial Management and Innovation</u>: with courses available in product development, quality management, industrial management and supply chain management;
- 2. <u>Built Environment</u>: with focuses on green buildings, lighting technologies, construction contracts, cost engineering and value management, productivity of construction projects;
- 3. <u>Sustainable Processing</u>: with key areas of teaching including biotechnology, chemical and nanotechnology, environmental engineering, bioprocess and food engineering, and energy;
- 4. <u>Electronics and Computers:</u> including studies in image and signal processing, advanced sensor technology micro-electronics, telecommunications;
- 5. <u>Computer Science and Information Technology:</u> involving computer science, software engineering, human-computer interaction, e-learning, smart environments, health informatics; and
- 6. <u>Mechatronics:</u> with focuses that include artificial vision and intelligence.

Engineering programmes at Massey University are accredited by the Institute of Professional Engineers (IPENZ), who is a signatory to the Washington Accord (1988) – thus ensuring NZ engineering education is substantially equivalent with other Accord signatories internationally.

Key Issues in the Tertiary Sector:

Three key issues appear to be facing all those in the tertiary sector (1) ensuring graduating students complete their education with the skills and knowledge (key competencies) required to be successful in the workplace, (2) meeting the needs and expectations of key customers and stakeholders, and (3) ensuring ongoing funding for service provision. As service providers, it is imperative that the needs of actual and/or potential customers and key stakeholders are adequately determined and that graduates leave with these needs having been met. To ensure this the curriculum and its content must reflect the needs and expectations believed essential by these parties.

Educational institutions frequently compete for student enrolments. Student numbers attract funding from government and private sources, and this supports programme delivery at the highest level of quality possible. Gaps in service delivery - between what is expected and then delivered, can have the effect of pushing students to other providers, and lead to the loss of funding streams and concurrent alterations in organisational reputation.

Employability, and then the success of graduates once in employment are also themes that are receiving an increased focus within educational settings. Increasingly 'employability' and the ability of graduates to function quickly are becoming competitive advantages to educational providers, as employers develop 'mind sets' regarding the quality, employability and then usefulness to their organisation of certain educational institution's graduates. Many employers in fact seem to develop preferences for graduates from one educational institution over another.

Jollands, Jolly & Molyneaux (2012) note that for many years professional bodies have been questioning whether engineering graduates have the right attributes. Citing other studies (Grant and Dickson 2006, Nair et al. 2009, Spinks et al 2006), they conclude that although graduates have technical knowledge they are limited in their ability to apply it, with a significant concern being the graduates' capabilities in applying knowledge to industry problems. It is stated that graduates skills seem insufficient to meet the needs of increasingly complex and globalised workplaces, and that employers see gaps in areas such as communication, problem-solving skills, leadership, emotional intelligence and working with people of difference. Jollands et al (2012) comment "For educators, the question is how to present practice in such skills within the curriculum. A key outcome from these studies and reports is that graduate engineers should have skills beyond the narrowly technical, so that when they commence employment they are 'work-ready'".

Student expectations also continue to grow, and institutions must respond accordingly. Students seek the input of school career advisors, friends and colleagues and family members. Many now also consult 'leader tables' that provide an indication of top National and International University rankings - (such as the Times Higher Education World University Rankings (2015/16) - in their efforts to determine where best to study.

Reality Shock - The Transition Between the University and the Workplace:

It has also been identified that one of the most difficult transitions a person may make is between education and full time employment. This can result in what has been described by Kramer (1974) as 'Reality Shock'. In her milestone publication - Reality Shock: Why Nurses Leave Nursing - Kramer studied the reactions of newly Registered Nurses early in their careers. She described reality shock as "The conflict caused by the movement from the familiar school sub-culture of nursing to the strange and unfamiliar work sub-culture of practice".

Kramer researched the reaction of newly Registered Nurses early in their career. She described reality shock as "*The conflict caused by the movement from the familiar school sub-culture of nursing to the strange and unfamiliar work sub-culture of practice*". This 'shock' was identified as having four clear phases:

- 1. The 'honeymoon' phase the excitement of being a newly registered nurse;
- 2. Shock or rejection when the nurse realises that their working life is different to that of being a student, when they are faced with clinical situations they may not have come across during their training, and/or when they compared student life to a working life. Signs of stress and 'burnout' may develop;
- 3. Recovery as the nurse begins to view their situation with more objectivity; and
- 4. Resolution where symptoms of stress continue, a decision is made to leave the nursing role, or new ways of coping are learned.

This concept may hold true across other professions, such as engineering, as beginning practitioners adjust from their student studies to that of working professionals. In addition, the context within which businesses operate can have an impact on the requirement for graduates to be immediately effective workplace participants. In New Zealand these contextual factors include the countries geographical isolation and dependence on foreign trade, and in more recent times, significant earthquake events.

Developing Leadership Skills in Massey University Engineering Graduates:

Preparing students for the world of work beyond their university studies is especially important in the engineering sector as these industries consistently require graduates who can "hit the ground running" and contribute quickly and effectively to their employers bottom line. As educators we can facilitate this process by ensuring they are exposed to as 'true to life' knowledge, skills and scenarios as is possible, and that the content of courses is not purely what the lecturer or educator believes is required, but also reflects what students, future employers and other key stakeholders believe is essential.

As well as designing courses that take into account a student's development, in terms of meeting the professional competencies, lecturers also needed to be cognizant of the learning mechanisms that could ease their transition from the university to the workplace.

Pons (2015) states that the engineering "...profession depends on its practitioners developing management and leadership skills to achieve good client outcomes and robust, reliable products or services, delivered by profitable, ethically run engineering businesses. As educators we can facilitate this process by ensuring graduating students are exposed to as 'true to life' knowledge, skills and scenarios as is possible.

Jimenez, Palomera & Toledo (2002) suggest that by using research projects and exposing students to industry, students are able to bridge the gap between theory and practice while still within the tertiary structure. This co-operative approach between the university, industry and the student can "...complement traditional engineering education by allowing students to explore open problems in ways that are difficult to accomplish in a regular coursework", and "These projects offer students a way of bridging theory and practice..." (Jimenez et al, 2002), and of (hopefully) reducing the chances of reality shock.

Methodology

To most effectively design a curriculum that meets the ongoing needs of students and industry, it is necessary for educators to ask key customers and stakeholders what their wants, needs and expectations are. In this way, key competencies can be determined, learning outcomes developed and educational activities designed to develop the desired competences. As such, this study aims to measure the perceptions of key stakeholders to identify the leadership competencies required on new graduate engineers. Since universities and their employees should role-model and exemplify in their own practice that which is being taught to their students, this study includes the use of key Quality models to identify and then collect data from key stakeholders. In this section, we therefore review some widely used quality assessment frameworks, and discuss their respective roles in this study.

The Criteria for Performance Excellence:

A core business model used in NZ is the Criteria for Performance Excellence (CPE). Category 2.1 (Strategic Development Process) item b1(2) asks organisations "How do your strategic objectives consider and balance the needs of all key stakeholders?" (NZBEF 2013/14 pg.12). The context of strategic development from the criteria's perspective is about formal and informal approaches that organisations use in preparing for their future and to enable effective decision making and resource allocation. The criteria suggest that participation by key stakeholders, partners, and customers should be involved and their opinions sought.

Category 3 (Customer Focus) examines and asks questions as to how an organisation, such as the university, engages its customers for long-term marketplace success and "How your organisation listens to the voice of the customer ...and uses customer information to improve and identify opportunities for innovation..." (NZBEF 2013/14 pg.15). To effectively role model the use of this item of the criteria, it is necessary for educators to ask key customers (students, business leaders, other lecturing staff) their wants, needs and expectations of both the paper and the students, and to determine the competencies believed to be required of graduating students that would need to be included in the curriculum.

The CPE defines customers as those actual or potential users of an organisations products, programmes or services. This includes end users, purchasers and current and future customers. The CPE also clearly defines an organisations stakeholders as "All groups that are or might be affected by an organisation's actions and success" (New Zealand Business Excellence Foundation 2013/14, pg. 56). Stakeholders thus include not only customers, but also funders, policy makers, regulatory bodies and professional communities.

Stakeholders thus include not only customers, but also funders, policy makers, regulatory bodies and professional communities. As part of this study it is anticipated that the following stakeholder groups were asked for their input via a survey – (1) students in year 2 and 4 of their engineering degree, (2) business leaders who may potentially employ Engineering graduates in the future, (3) other lecturers within the school of Engineering who interact with both 1 and 2, (4) graduates in employment, and (5) representatives of professional engineering associations.

Service Delivery Gaps:

Gaps in service delivery - between what is 'expected' and then 'delivered', can have the effect of pushing students to other providers, and lead to the loss of funding streams and concurrent alterations in organisational reputation. Service quality gap models state that the key to service delivery is in identifying and then managing the gaps or discrepancies, from the customers' perspective, between what they have expected and what they perceive to have received. Parasuraman, Zeithaml and Berry (1985) identified 5 potential 'gaps' in the service delivery chain in which these can occur, Luk & Layton (2002), up to 7, and Shahin, A. & Samea, M., (2010), as many as 14. These gaps include those between the organizations perception of customer expectations & the design of the service specification, between the service design and the service delivered, and the customers' expectations of, & perception of, the service received.

Previous Research & International Benchmarking Opportunities

Previous research into the leadership competencies required of engineering graduates was undertaken by the writer between 2005 and 2015. During this 10 year period priorities for inclusion into the engineering curriculum were identified. This research involved identifying the priorities that new graduate leaders, potential employers, lecturers and other key stakeholders believe are essential for new leaders in industry.

The current study will extend and redevelop the work that has so far been undertaken in this area. An opportunity exists to undertake this research in a collaborative fashion with other countries where Engineering contributes to the development and sustainability of those Nations. It is intended that this will be an international benchmarking study with comparisons being made between New Zealand, Portugal (Minho University) and one Nordic (or other European) Nation. It is expected that such collaboration will lead to positive & applicable outcomes for all stakeholders, will allow data comparisons to be made, and facilitate potential improvements in the design and delivery of leadership competencies in the benchmarking partner programmes.

A consultative methodology will be used with data collection involving an extensive literature review, specific stakeholder surveys and structured interviews. The research aims to include the identification of:

- 1. The contextual factors that influence Engineering education amongst the benchmarking partners;
- 2. How the curriculum of Engineering programmes among the benchmarking partners are designed, delivered and assessed in particular, the leadership competencies;
- 3. Those core leadership competencies that are required by new graduate Engineers as identified by key stakeholders e.g. students, lecturers, businesses employing engineering graduates, past graduates, and professional associations responsible for engineering competencies and registration in the study countries;
- 4. How the desired leadership competencies are developed within the Engineering curriculum of participant universities, and if the current curriculum is developing the core leadership competencies identified as priorities by stakeholders.
- 5. Key stakeholders beliefs regarding if the development of the core leadership competencies is enabling new graduate Engineers to 'Hit the Ground Running' and be 'work ready'.
- 6. Opportunities that exist for curriculum improvement and/or further research.

The IPENZ:

As many of the students were obtaining engineering degrees, the competency standards of the IPENZ (as a key stakeholder) needed to be incorporated. The Institution of Professional Engineers New Zealand (IPENZ) is the professional body which represents professional engineers from all disciplines in New Zealand. The IPENZ is a significant stakeholder and driver of engineering studies, and is "...involved in many aspects of tertiary engineering study in New Zealand. It accredits engineering qualifications to internationally-benchmarked standards, provides support for individuals studying engineering, and guides the future direction of engineering education in New Zealand." (IPENZ 2014).

For someone who wishes to embark on a career in engineering and subsequently work towards becoming a Professional Engineer, IPENZ (2007) categorise the route they need to take as summarised in table 1.

Table 1 – Stages in the Route Towards Professional Engineer Status (IPENZ 2007)

Pre Stage One	Career Selection	
Stage One	Qualification	
Stage Two	Professional Competence	
	Part A: Initial competence development	
	Part B: Maintenance of competence	
Stage Three	Leadership	
Stage Four	Governance & Expertise	

To meet the minimum overall competence standard for Professional Engineers a person must demonstrate that she/he is able to perform each of the 12 elements the IPENZ have identified. The

following key elements from their competency standard were also taken into consideration as a stakeholder view:

Table 2 - Example - Key Elements Necessary to Meet the Competency Standard for Professional Engineers (IPENZ, 2016)

Element	<i>Criteria</i>				
6	Manage part or all of one or more <i>complex engineering activities</i> in accordance				
	with good engineering management practice				
10	Communicate clearly with other engineers and others that he or she is likely to				
	deal with in the course of his or her professional engineering activities				

It can take a graduate engineer anything from 4 years to build a portfolio of experience to support an application that they have met the competence standard for Professional Engineers. As the students are not yet at the stage in their careers where meeting this competence standard is achievable, for this course their experiences were assessed in the broadest possible viewpoint against the key elements. Some of the elements cannot be assessed against at this time in their career development as the competency of these elements only become apparent in an engineer's career after the first few years of graduation. Therefore, the IPENZ elements that are most relevant to the students, and will be discussed in the case study later in this paper, are elements 4, 6 and 10 (highlighted in table 2).

The students undertaking this course were nearing the completion of Stage One, where they would graduate with an IPENZ accredited engineering degree. Upon graduation they would embark on Stage Two where they, through on-the-job learning and additional professional development activities, progressively develop the core competencies expected of a competent engineering practitioner.

Industry and the Wider Community:

In addition, the New Zealand Qualifications Authority (NZQA), representing educational qualifications throughout NZ, has identified a number of Unit Standards, in consultation with businesses, that managers and leaders may become proficient in. The NZQA co-ordinates qualifications in secondary schools and in post-school education and training. There are two types of qualifications - National and Provider-developed (local). "On the National Qualifications Framework there are more than 18,000 national standards and 800 National Certificates and National Diplomas covering almost every area of work and learning" (New Zealand Qualifications Authority, 2010).

Trade and business qualifications such as the New Zealand Certificate in Engineering and New Zealand Diploma in Business are also administered by the NZQA. NZQA also approves all degrees offered outside the university sector (e.g. via polytechnics), and although, students undertaking the 'T&B' and 'TSO' papers do not obtain credits from the NZQA for their completion of these papers, they may choose at a later date, when undertaking other qualifications (e.g. provider-developed) to obtain cross credits and a 'Record of Achievement'. As such, industry, as a broad customer grouping, also needed to be considered, via the NZQA framework and relevant unit standards

needed to be reviewed for those key themes that may be applicable to the 'T&B' and 'TSO' papers. The following list contains a sample of the unit standards that were reviewed:

- Unit standard 8493: Provide leadership for a team in an organisation;
- Unit standard 11096: Analyse feedback contexts and apply constructive feedback techniques; and
- Unit standard 11096: Develop self to improve performance at work.

The Competing Values Framework (CVF):

The model used as the framework for determining the leadership competencies in this study is the CVF from Quinn, Faerman, Thompson, McGrath, St. Clair and Bright (2011 & 2015). "This text is built around a framework of leadership competency...that forces one to think about the competing tensions and demands that are placed on managers in new ways" (Quinn et al 2007 pg vii). The authors write "The framework offers managers an enduring foundation for analyzing what types of behaviours are most appropriate to achieve organisational goals in light of the existing environment", and "...that management is fundamentally paradoxical" (Quinn et al 2011, pg vi).

The CVF consists of 4 main management models (quadrants), associated leadership roles and competencies (as seen in table 3). The framework was developed after extensive consultation "With a group of experts, consisting of 11 nationally recognised scholars, and 11 prominent administrators and union representatives" (Quinn et al 2007 pg 20) whose role was to identify the most important competencies for leaders from an original list of 250. Based on their decisions the CVF was developed. The framework enables students to critically examine and understand what is required and expected of an individual in a position of leadership, and facilitates the individual in being able to make a decision as to what competency may be required in any given leadership situation, in a variety of organisational types and sizes. As such, it allows for the implementation of 'situational' leadership. In addition, its content meets the general knowledge requirements of management curriculum up to Masters level as identified and accredited by The Association to Advance Collegiate Schools of Business (AACSB International). This is an "...association of educational institutions, businesses, and other organizations devoted to the advancement of higher education in management education. It is also the premier accrediting agency of collegiate business schools and accounting programs worldwide (The Association to Advance Collegiate Schools of Business 2010).

Relevance and Contribution of the Proposed Study:

Curriculum Design:

Collecting data from key stakeholders in engineering education will lead to a greater understanding of needs and result in potential curriculum improvements. It is possible that a more robust curriculum and teaching methodologies will be able to be developed, that will suit all participants. The results will also encourage opportunities for discussion and learning about the 'real priorities' of 'the real world'.

By focusing on determining the needs of customers and stakeholders in the development of the curriculum, a broader review of the influences on potential key competencies that new graduate leaders need to know, understand and be conversant in/with can be obtained e.g. the IPENZ core competencies for professional engineers, a review of possible links to NZQA Unit Standards and

qualifications, previous research into key competencies of graduates by other authors and institutions, and the collection of ranked data from the key stakeholder and customer groups actually or potentially influenced by the content of these papers. As a result it is believed that the curriculum content could be developed to more accurately reflects the needs of all groups.

Students and Graduates:

The study will enable students to develop and strengthen their understanding of the key leadership competencies that are considered important priorities of new leaders in industry. Through this opportunity to examine and discuss the views of their potential employers, lecturers, professional organisations and previous graduates - why these may be similar or different, and what they may mean to their practice as new graduate employees – their understanding will be enhanced, and this may help facilitate their being able to 'hit the ground running' as new employees. Through the opportunity to develop these competencies whilst within the University education system, it is hoped that there will be improved 'leadership competency' development, increased 'early career' performance, a reduced risk of new employees leaving industry early in their employment career due to 'reality shock' from unrealistic expectations and poor preparation, and improved 'work readiness'. However, to accurately measure these outcomes a longer-term study would need to be completed of past graduates.

Employers:

Through their involvement in the study, actual or potential employers have a first-hand opportunity to influence the future of Engineering. Additionally, the mind set of potential employers regarding the 'employability' and 'work readiness' of graduates from the benchmark participant's may be enhanced by their own participation in the study and any curriculum changes that are made.

Organisations employing these new graduates may see advantages when these students enter the market place as their leadership skills and knowledge will be more developed. This should enable them to 'hit the ground running' when working in teams and/or when working on, or leading, workbased projects. The students gained by having the opportunity to develop the leadership skills and knowledge required by 'real life' organisations whilst still completing their tertiary education.

The Applicability of the CVF:

Finally, the overall usefulness of the CVF as a means of identifying and prioritising needed leadership competencies will be judged. For example:

- Does this framework provide a base from which competencies of beginning practitioners can be identified and then be scheduled within the curriculum?
- Can teaching and research infrastructures & initiatives be improved and/or strengthened by use of the CVF as a means of ensuring all customers and stakeholder perspectives are considered in the curriculums design?
- Can a greater synergy between educational & organizational needs be achieved through use of this model?

Conclusion

Traditional curriculum content often relies on the expertise of the lecturer to determine what is appropriate to include or to leave out. This international benchmarking study will enable the collection of key stakeholder and customer perspectives to facilitate 'real-life' views and content to be included to the benefit of the students, their future employers, the patriating universities, and the future development of their nations.

Table 3: The CVF Leadership Models & Associated Competencies.

The Competing Values Approach
Quinn, Faerman, Thompson, McGrath, St. Clair, & Bright (2011 & 2015)

Management Model	Action Imperative	No.	Competency	
Rational Goal (RGM)	<u>Compete</u> Improving Productivity & Increasing Profitability	2	Developing & communicating a vision	1. Think
		3	Setting goals & objectives	
		4	Motivating self & others	
		5	Designing & organising	
		6	Managing execution & driving for results	
Internal Process (IPM)	<u>Control</u> Establishing & Maintaining Stability & Continuity	7	Organising information flows	
		8	Working & managing across functions	
		9	Planning & coordinating projects	
		10	Measuring & monitoring performance & quality	
		11	Encouraging & enabling compliance	
Human Relations (HRM)	Collaborate Creating & Sustaining Commitment & Cohesion	12	Understanding self & others	Thinking Critically
		13	Communicating honestly & effectively	itically
		14	Mentoring & developing others	
		15	Managing groups & leading teams	
		16	Managing & encouraging constructive conflict	
Open Systems (OSM)	<u>Create</u> Promoting Change & Encouraging Adaptability	17	Using power ethically & effectively	
		18	Championing & selling ideas	
		19	Fuelling & fostering innovation	
		20	Negotiating agreement & commitment	
		21	Implementing & sustaining change	

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Implementation of six sigma methodology for the elimination of contamination in Fine Pitch connectors

Lopes, J.M.¹, Lopes, I. ², Roque, J.³ and Alves, A. L. ⁴)

1), 2) ALGORITMI research centre, University of Minho

3), 4) Bosch Car Multimedia Portugal

ABSTRACT

Quality drives companies to evolve, providing what customers need or even exceeding their expectations through products and services that play their functions properly during their lifetime. From this perspective, this study aims to solve a concrete defect that occurs during the assembly process of an electronic product for the automotive industry.

One of the new challenges in the electronics industry is the contamination issue in Printed Circuit Boards (PCB). Contamination can be defined as any type of particles (residues) that are deposited on PCB surface or within a component, causing unwanted behaviours in the electronic device.

In the present study, the investigated contamination is organic in nature and is originated by the solder flux. The solder flux is released during the welding process, being deposited inside the PCB Fine Pitch connectors. The DMAIC method was adopted as a Problem Solving tool. This method was selected to ensure the elimination of this type of defect. To support the investigation, the 5W2H and Is/Is Not quality tools were used.

The investigation was developed by a multidisciplinary team. After the root-cause identification, the connectors provider was involved to assist in the development of an effective and low cost solution.

The final solution resulted in the placement in the connectors of a protective cap. This solution, besides protecting the connectors, allowed a new collaborative relationship along the supply chain.

Keywords: Contamination, DMAIC, Electronics, Residues, Six Sigma.

Paper type: Case Study

INTRODUTION

The influence of external factors, such as the global competition and the growing of consumers demand, has generated a pressure on organizations over the years in order to continuously improve the quality level in their goods and services. This new orientation for continuous improvement led to the spread of new Quality Management methods, such as Six Sigma (Fursule, Bansod, & Fursule, 2012; Pešić, Milić, & Stanković, 2012; Sousa & Voss, 2002).

The development that is undertaken by organizations to allow their customers the access to intelligent and integrated devices, has created a new set of challenges, such as the production systems adaptation to handle with the decreasing of dimension of their raw materials (Khare & Maly, 1995). One of the new challenges in electronic industry is the contamination on PCB and their components, which potentiate the failures occurrence in the electronic devices (Steiner, Rendl, & Wirth, 2015).

The Bosch Group founded more than 100 years ago is an organization that, given its size, creates a strong competitiveness in the market. This company's continuous improvement mindset results in a daily ambition to achieve the excellence of their products and processes, as well as in to reduce the huge cost that the company incurs whenever a defect happens.

The opportunity to develop the investigation presented in this paper came from the challenge to analyze and eliminate a specific root-cause that resulted from the presence of a contamination inside of a specific navigation system product.

Therefore, this paper presents a case study that involved the application of the Six Sigma tool supported by the DMAIC method in a electronic components. The DMAIC method was adopted as a Problem Solving tool to support and guide the investigation. This methodology aims to increase the value of the organizations through scientific methods, according to a disciplined logic to improve and solve anomalies of their processes, products and services (Antony, 2014; Choo, Linderman, & Schroeder, 2007; Jacobs, Swink, & Linderman, 2015; Maneesh, Jiju, Jiju, & Madu, 2007; Parast, 2011).

The paper is organized in four sections: the Introduction where a first problem approach was made, the Literature Review to present the state of art about contamination problematic, DMAIC method and Six Sigma, then, the Case Study and, at the end, the Conclusion section where the conclusions are presented.

LITERATURE REVIEW

Contaminations

Contamination can be defined as any residue that can be deposited over PCB surface or inside a component, causing anomalous action in the products (Khare & Maly, 1995). According to ZVEI - German Electrical and Electronic Manufacturers (2014) residue is any particle composed by metal or any other material, such as polymer, minerals or salts.

The contamination thematic has becoming more relevant among electronic industry companies, once this type of defect can compromise the production, quality and reliability of their products (Bumiller, Douthit, & Pecht, 2002).

Duchi & Laügt (2014), Hildén et al. (2015) and Liu, Wu, & He (2014) have concluded that the contaminations are generally associated with some failure modes:

- Short circuits over PCB surface;
- Electrical contacts insulation;

- Electrical conductivity deviation from the expected value;
- Electrical circuits obstruction.

One of the strategies to deal with contamination without doing massive investments is can be through an effective products control. However, as Fernandes & Duarte (2014) emphasize in their, the contamination control is very complex to do, due the independent relation between the moment when the contamination occurs and the moment when its effects are identified (root-cause effect). Another constraint to develop an effective contamination control is related with the difficulty to identify her nature or origin, thus the contamination can occurs, theoretically, in every assembly process steps under a conductive (residues mainly composed by Iron and Zinc) or insulating (residues mainly composed by Oxygen and Carbon) type (Ambat et al., 2009; Smith, 1998).

Among the complexity to do an effective product control, another strategy to deal with contamination was proposed by Komagata (1995). He empathizes that the best way to deal with contaminations is through their sources reduction. The author suggests four steps to do it:

- 1. Understanding in which step of the process the contaminations may occur;
- 2. Verify every contamination sources inputs and outputs in that station;
- 3. Define all potential route causes;
- 4. Corrective measures implementation.

In summary, the development of the residues thematic is doing its first steps. This area can be very useful to better understand how this type of occurrence can be eliminated, taking into account the current productive systems.

DMAIC method

The DMAIC method is the strategy adopted to implement Six Sigma tool at the operational level, in order to reach the six sigma level. DMAIC is the acronym of "Define", "Measure", "Analyse", "Improve" and "Control" as observed in Figure 1 (Marçola & Politano, 2011).

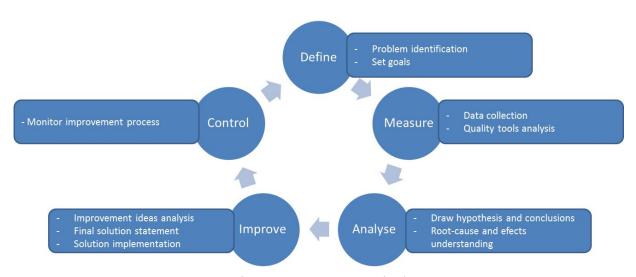


Figure 1 – DMAIC method

Each of these names is associated with each execution phase of the improvement process. A key advantage of DMAIC is the decomposition of complex problems in multiple problems with less complexity, following an

incremental improvement logic (Chowdhury, 2002). For this reason, DMAIC method is the most recognized approach in the literature to support Six Sigma projects (Narula & Grover, 2015).

The conclusions of this case study will be analyzed in the "Control" phase of DMAIC, by comparing the originally obtained data and the acquired data after the implementation of improvements in the process and in the product under review.

Six Sigma: Definition and Benefits

The Six Sigma tool appeared in 1987 by the initiative of an organization in the communication business, Motorola, which had the ambitious goal of decreasing the defects to a level that had never been achieved before. Motorola self-proposed to achieve a value of 3.4 defects per million units produced, increasing productivity and decreasing costs (Evans & Lindsay, 2002; Folaron, 2003; Mehrjerdi, 2011; Pande, Neuman, & Cavanagh, 2000).

The sigma term arises from the letter " σ ", present in the Greek alphabet and it is commonly used to represent the standard deviation (Desai, 2015). The term represents the inherent variability of products, services and production processes (Mahesh & Prabhuswamy, 2010). According to Liebermann (2011), the statistical measure of the ability of a process to meet specific requirements - process capability is expressed in terms of sigma quality level (SQL). SQL is the difference between average performance and the specification limit, divided by the standard deviation. A process operating at an SQL of 6 could be expected to have 3.4 defects per million opportunities (DPMO)".

Mehrabi (2012) defines Six Sigma as an approach of management oriented to projects for the implementation of improvements in processes, products and services, in order to continually increase the quality. Notwithstanding and Blakeslee (1999) defines Six Sigma according to an perspective of "Problem Solving". According to the author, Six Sigma can be regarded as a high performance approach, oriented to data, in order to research and find the root-cause, to solve it and prevent future occurrences.

One of the major factor for popularization of Six Sigma was the increasing amount of concrete evidences that large companies have reported in relation to their Six Sigma initiatives in last three decades (Shafer & Moeller, 2012). According to the existing literature on Six Sigma, the success of a project is directly related to the safeguard of some critical factors (Pande et al., 2000). Pande et al. (2000) lists the main critical factors presented in literature:

- Proactive attitude;
- Team work;
- Quality management based on scientific methods;
- Commitment of the organization, from the strategic to the operational level;
- Customer orientation.

Through the change of attitude and genuine application of the above mentioned factors, it is possible to state that there will be a positive change for all performance indicators affected by the Six Sigma projects (Hahn, Doganaksoy, & Hoerl, 2000).

STUDY CASE

The development of the case study took place at Bosch Car Multimedia Portugal S.A. which is one of the leading factories of Car Multimedia division.

The opportunity to develop this case study was born with the challenge to work directly with one of the most complex problems that the company is learning to deal: The contaminations problematic. The investigation main goal is:

The complete elimination of defects (non-conformities) with a root-cause associated to the presence of unknown residues inside display PCB fine pitch connectors, in a specific product produced in Braga facilities.

The case study will be presented following each phase of the DMAIC method.

Define

The analysis of the problem started with the define phase. In this first phase, the initial assumptions of the project are defined as well as the goals to be achieved (Patel & Shah, 2015; Vats & Sujata, 2015). The first process variables are collected and partially analysed in order to obtain the first orientations of what and where are the potential causes for the occurrence of variability not previously expected in affected processes or products.

For the development of the project, a multidisciplinary team has been formed and was composed by:

- Two Black Belts;
- A team leader;
- Quality complaints laboratory coordinator;
- A responsible for quality in production area;
- Customer assistant;
- Project sponsor (Responsible for Customer Assistance, and Process and Quality System sections).

The time frame established for this project was 12 months, oriented specifically to all complaints received by the company from January to December 2015.

Typically, the non-conformities (company claims) were manifested through a change not previously expected in the colour balance of the display in a specific product (Product A) that was produced in Braga plant, as observed in Figure 2.



Figure 2 – Example of display contamination

The adopted metric to check the impact of possible changes implemented by the team was:

Number of defective units due to contamination

Measure

In the measure stage, the non-conformities are validated and an intensive data acquisition was started in order to understand the current state and to obtain a first approach to understanding of the problem's root-cause (Barbosa, Carvalho, & Pereira de Souza, 2014; Vats & Sujata, 2015).

There is a big concern in the company to understand and eliminate this type of contamination due to the difficulty to achieve and maintain the quality standards that are set by the client during the contract definition.

To study and characterize in detail the occurrence of non-conformities, in absolute values, the team used some tools such as the 5W2H and Is / Is Not tools, in the time frame previously established, as shown in Table 1.

Table 1 – 5W2H and Is/Is Not analysis

	Problem:		Display: Color balan	ce alteration
(Collection of Facts	ON	IS	IS - NOT
What?	Object with defect (supplier, producer, customer, application)	1	Product A, Customer A	Product C, Customer B
W	Defect on the object (from analysis)	2	Connector Fine Pitch xxxx1 with isolator residue	Connector xxxx1 with no contact due to bent pin
			Germany plant (company plant) Braga Plant (company plant)	
Where?	in the process is the defect observed?	4	4 defects - United Kingdom plant 5 defects - Belgium plant	-
W	on the object is the defect? (from analysis)	5	Display Product A (Customer A)	Fascia Product C (Customer B)
	did object with defect occur for the first time?	6	17-02-2014	Beginning of Product A (Customer A) Production
When?	again (trend, rhythm of occurrence)?	7	Intermittent: 07-03-2014, 05-06-2014, 01-07- 2014, 21-08-2014, 13-09-2'014, 22-10-2014, 30- 10-2014. 17-12-2014	Constant
	in the life cycle of the object was the defect observed?	8	0Km and field	FOR
Who	discovered the defect?	9	Customer A Assembly line operator and final Customer;	Braga plant Quality Gates Operator
	How many objects show the defect?	10	9	-
How many?	How much of the object is affected?	11	In one contact pin of the connector	More than one pin
low n	How many defects are on the object ?	12	1	More than one
_	Trend	13	Constant or increase	Irregular

Through the use of these two tools, the team obtained some conclusions:

- The total number of non-conformities claimed by the customer during 2014 and 2015 was 9 Units;
- All claimed units were produced in 2014;

- All non-conformities happened due to the low electrical conductivity in a connector (fine-pitch type), responsible for establishing the connection between the display and the main printed circuit board (PCB);
- Defect occurrence is chaotic and no temporal pattern is observed;
- All defects were manifested in customer internal quality control (0km) and in final-customer (field).

Analyse

At this stage the team seeks to formally identify the causes that were leading and influencing the occurrence of certain problem (Patel & Shah, 2015; Sadraoui & Ghorbel, 2011).

With the support of technical documentations from the product and of the diagnostic tests performed by technicians at the quality complaints laboratory, it was understood that the problem's root-cause was related to the presence of a residue on the surface of the connector pins. This residue acts like a barrier that limits electrical conductivity between the PCB display connector and the main PCB, as observed on Figure 3.

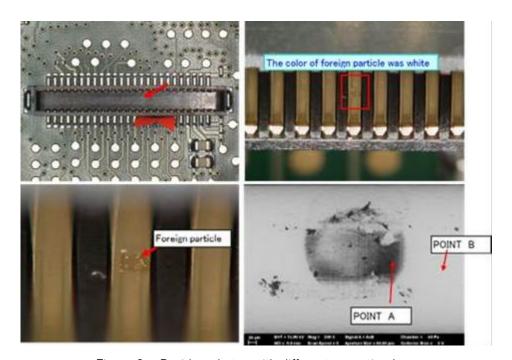


Figure 3 – Residue photos with different expantion lens

As observed on the photo from lower right corner (Figure 3) the residue has a drop shape. In all analysed products, this type of shape was observed, but the existence of a location pattern was not observed, once in each affected product, the residue was found in different connector pins.

Usually, when non-conformities are related with residues presence, laboratory technicians request two type of analysis in order to try to find their origin and composition:

- SEM analysis: Scanning electron microscope is a technique to analyse and examine microstructural characteristic of the specimen surface through the creation of a surface picture with a zoom between 1000 and 20000X (Fu, Croarkin, & Vorburger, 1994; Goldstein et al., 2012);
- EDS analysis: Energy-dispersive X-ray spectroscopy is a technique usually used to know the chemical composition and concentration of each element that constitutes the specimen (Amjad, 2013).

Given the results obtained from EDS analysis, it was concluded that the residue was mainly composed by organic elements as Oxygen (O) and Carbon (C).

Once the residue is of organic origin, the next requested technic to analyse was the FTIR analysis. FTIR or Fourier Transform Infrared Spectroscopy is a technic developed to characterize organic compounds (Wilson, Decius, & Cross, 2012).

In every FTIR performed to each claimed unit, the same characteristic curve was always obtained. From this result the team invited a company specialist in FTIR analysis to participate in a brainstorming session, where the guidance to research the solder used during PCP assembling process arose.

After comparing the FTIR characteristics curves of the residues found in each claimed unit with the FTIR of the solder used during the reflow process, a positive match was observed. In order to eliminate any possibility of error, the team picked up a sample of the solder during this process and requested a new FTIR analysis. Again, a positive match was obtained.

Given this positive match between the residue and the weld sample, it was understood that the root-cause from the change in colour balance of the display was originated during the reflow process with solder flux. After that conclusion, the team oriented the investigation to the reflow process of the PCB with the affected connector. The reflow process consists on the process of soldering the electronic components to the PCB. After the placement of solder paste on it, the PCB is controlled by video cameras to verify its correct distribution on the PCB's surface (Step A). Then the components are placed over the solder paste (Step B). When the step B is finished, the PCB enters in the oven with an atmosphere rich in nitrogen, which will gradually warm up until the reflow temperature. During this temperature gradient the solder paste turns to a viscous state, the solder flux evaporates and the gas is released to the oven atmosphere (Step C). In this point, the temperature gradient starts to decrease and the PCB leaves the oven, where a new quality control to evaluate the components solders happens (Step D).

During Step C, there is an interaction between different thermodynamic phenomena, including:

- 1. Temperature movements, firstly ascendants and then descendants, called temperature profile;
- 2. Different gases concentrations in oven atmosphere during the temperature profile.

Taking account these phenomena the team developed two hypotheses for contamination occurrence:

- 1. Ineffective or insufficient maintenance of the oven that can generate a high level of solder flux gas in oven atmosphere, due to the presence of solder flux debris inside oven retention grids;
- 2. Deposition of solder flux particles inside the connector due to temperature alteration.

Hypothesis 1 was not considered after its analysis. The team investigated the cycle of oven maintenance and the process of oven cleaning and concluded that there is not a direct influence between the production dates and oven maintenance. For this fact, the team started to investigate hypothesis 2.

In detail, hypothesis 2 extrapolates that, inside the connector, a deposition of solder flux particles in suspension on oven atmosphere occurs due to a thermal difference between the end of the heating and the beginning of the cooling process (interface zone), as schematized in Figure 4.

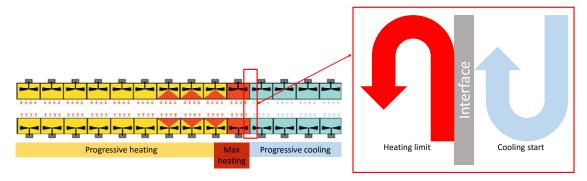


Figure 4 – Interface Heating-Cooling schema (Adapted from Juki Automation Systems (2015))

A team of experts in the maintenance area, conductive solders and thermodynamics was formed for a brainstorming session with the project team. In this session, it was empirically concluded that the solder flux (in the form of particles in suspension in oven atmosphere) is deposited on connector pins surface due to the occurrence of some events, such as:

- High density saturations of soldering flux at the bottom of the retention grids;
- Incomplete passage of solder flux to the gaseous state;
- Connector architecture.

Improve

At this stage, after the clearly identification of the root-causes, the team develops several ideas and propose solutions to eliminate the problem. At the same time, a study to know and prevent negative side effects was developed, derived from changes in the process or in the product (Júnior, 2007).

In this project development phase, the team identified three proposals to analyse and selected one to be implemented. The three proposals were:

- 1. Replacing the reflow oven by a new one with better technical characteristics;
- 2. Isolation of the connector with thermal tape;
- 3. Development of a specific connector cap.

Proposal 1 was discarded because it was an investment that would amount to several hundred thousand of euros. This investment would be only amortized after the end of product production.

Regarding proposals 2 and 3, the team analysed some aspects as economic impact, difficulty of implementation and result achievement.

In terms of economic impact, proposal 2 has an impact of 124.5 per 100 PCB lot, while proposal 3 causes an economic impact of 14 per batch of 100 PCB. To calculate the economic impact it was taken into account the raw material cost, labor cost and operational time cost.

About the difficulty of implementation, proposal 2 could be done inside Bosch plant, whereas proposal 3 needs to be implemented by the connector supplier. Another obstacle to the implementation of proposal 3 is the necessity to redefine the supply contract.

Finally, proposal 2 was not technically valid, because the thermal tape could only be applied on the connector after the reflow process. Therefore, proposal 3 is the only that ensures the permanent elimination of the non-conformities.

Therefore, the selected measure (corrective measure) was proposal 3.

This solution can be described as the colocation of a plastic cap, specifically designed for this connector type, as schematized in Figure 5.

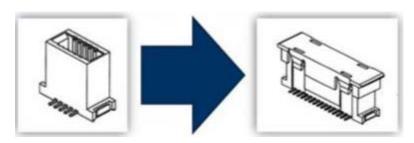


Figure 5 – Connector schema without and with the plastic cap

The cap is placed above the connector in Bosch supplier and removed during the assembly process, allowing a reduction of manpower cost and ensuring that the connector is protected during the whole reflow process and partially during the final product assembly.

A plus of this proposal was the integration of the supplier during the design process. This integration allowed an approximation of both companies to improve supply-chain quality.

Control

This is the last stage of DMAIC method. In this stage new processes are developed to ensure the maintenance of the performed improvements and, the changes in process or product are controlled in order to evaluate their effectiveness (Barbosa et al., 2014).

The corrective measure was implemented in September 2015. In order to ensure the control effectiveness, the team defined a time frame of six months, from September to February 2015, to verify the occurrence of other contamination.

After the end of the control period, no contamination was reported and, by this fact, the team was congratulated to have achieved the project main goal.

CONCLUSION

The investigation presented in this paper showed that Six Sigma tool is flexible and is able to adapt in order to solve problems, regardless of the process or product. This conclusion converges with the generic consensus found in the literature.

During the development of each DMAIC phase, this method allowed the decomposition of complex problems in multiple simple problems, in a disciplined order.

The use of the 5W2H and Is/Is Not tools allowed the achievement of a high degree of process understanding and non-conformity knowledge. The good understanding of the reflow process was a key factor that contributed to find the root-cause with low resources.

Additionally, regarding the tools used during the investigation, the Process Plan Sheet of residues inputs and outputs could have been used. It was not used because, in the process under analysis, the number of inputs and outputs was very small, taking into account the insulating nature of the particle.

The contamination sources identification proposed by Komagata (1995), during the Analysis phase of the DMAIC was used for the first time in the company. This approach guided the team for what and where should be investigated. In the past, according to the team experience, the residues investigation was made without the support of any disciplined approach. It was a trial and error process. For that reason, the company made another step to learn how to handle with the contaminations problematic.

Regarding the case study, despite the involved variables complexity, it was possible to reach the main goal of eliminating permanently the non-conformities, even without any scientific validation of the empirical conclusions and extrapolations that were made during the Analysis phase of the DMAIC method.

The adopted solution for permanent elimination and prevention of contaminations (regardless of their origin) inside connectors resulted in a lesson learned that will be taken into account for future products.

In the area of supply chain, an intensive investigation was made and another interesting conclusion was reached. A differentiating strategies consists in the creation of collaborative relationships between the stakeholders along the supply chain, in order to increase the products quality and operational efficiency.

ACKNOWLEDGEMENT

This work has been supported by FCT - Fundação para a Ciência e Tecnologia in the scope of the PEst-UID/CEC/00319/2013"

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Logistics Business: Kanban Implementation in an **Automotive Components Industry**

Ribeiro R.B.1, Araujo Jr A.H. F.2, Barros, J. G. M.3 and Sabbadini F. S.4

¹⁾Technology Faculty of São Paulo, Cruzeiro, São Paulo, Brazil

- ²⁾ State University of Rio de Janeiro, Brazil
- ³⁾State University of Rio de Janeiro, Brazil
- ⁴ State University of Rio de Janeiro, Brazil

ABSTRACT

The paper deals with a Kanban implementation in an automotive components industry located in the State of São Paulo, Brazil, by applying the concept of Kanban tool in the search for cost and time savings, decreasing order parts variability and improving the organization of local inventory racks and production modules. The implementation of the proposal occurred as a purpose to innovate and organize the local stock and supplies, due to anomalies, randomness occurred during the search process of finished products. We used the company ERP software to extract reports of monthly production schedules. The research's conclusion showed that in the adjustment process of racks these results were visible through an eight days parts calls economy, leading to significant cost savings with supply carriers and timing in the production line. With the new system and industrial scenario adopted it was possible to provide suitable places for storage of these items, linked to withdrawal orders by storing them first into the green markings and next into the yellow markings.

Keywords: Kanban implementation, logistics business, automotive components industry.

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1. INTRODUCTION

The logistics business makes use of several models and methods applied to supply chain management, among them the just-in-time system (JIT) which gives quality to industrial processes. In this context, the Kanban stands out as a signaling method that controls production flows and/or the transport in industries, impacting and reducing costs and inventories, and working to support the JIT philosophy.

Kanban is a scheduling system for lean manufacturing and just-in-time manufacturing consisting of an inventory-control system to control the supply chain as proposed by Taiichi Ohno, a japanese industrial engineer at Toyota to improve manufacturing efficiency.

This research had the locus on an automotive components company located in the Paraíba Valley region, State of São Paulo, Brazil, by applying the concept of Kanban tool in the search for cost and time savings, decreasing order parts variability and improving the organization of local inventory racks and production modules.

For this purpose, a comparative study of the previous system was carried out and implemented in the manufacturing process. Thus, it selected a test area, considered by management a strategic area in the supply and manufacturing chain.

The implementation of the proposal occurred as a purpose to innovate and organize the local stock and supplies, due to anomalies, randomness occurred during the search process of the finished products. Before systematizing the Kanban tool we observed a significant non-compliance rate in the production line with and incidence synchronized to parts inventory (lack of control between demand and production) which showed an excessive number of production orders (POs).

The motivation of this research was the partnership and closer relations between universities in Brazil and the national automotive industry in the development of a technological innovation project applied to cost reduction due to the use of the Kanban tool in the components industry.

2. THEORETICAL FOUNDATIONS OF THE RESEARCH

The work did not intend to give relevant theoretical contributions, but to demonstrate, in a practical way, the contribution of a quality tool in inventory management improvement and the reduction of production costs.

The logistics processes in companies involve the displacement and the related information of goods and services to customers and suppliers concerning aspects of cost, delivery time reduction, application synchronism, work methods and time standards. Above all, organizations have been implementing quality management tools to production operations, such as just-in-time and Kanban, to optimize their services and operational gains.

The JIT system is a tool, considered by many authors a philosophy, which according to Schlünzen (2003, p. 49), "means doing only what is needed, when needed and in the required amount, i.e. the production demand is made from which will be produced at each stage, so if you have the item at the exact time of its manufacture.

Oliveira (2002, p. 52) conceptualizes that

For companies to achieve the expected growth they must set out the main benefits of proper use and the just-in-time management: product manufacturing deadlines reduction; inventory continous minimization until it reaches a point that you no longer needs the reduction size of manufactured lots, seeking to generate conditions for working with the unit lot.

The JIT system stimulates productivity, eliminates idle inventory, improves product quality and reduces the consumer delivery time. The idea of the system is the total waste elimination, and all that does not add value either to the final product or to the costumer.

As the space of each item produced is limited only to items ordered as products are removed from stock, it establishes a real synchronous demand or in others words, according to Ohno (1997) "ideas on the Kanban was inspired by the US supermarket shelves that are replenished on an organized and synchronized manner.

Moura (1994, p.13) states that:

The Kanban tool consists of a material management technique and production in just-in-time moment. The Kanban system is a method to "pull" the needs of finished products and therefore is opposed to traditional production systems. It is a simple system of self-control on the factory level, regardless of parallel administrations and computer controls.

The main aspect of the Kanban tool is the visualization and mobility of the components through the production process in which the material has its own site, designed to house a precise and preferably small amount. This system provides the quantities only when made necessary therefore with estimates that contribute to the inventory and in process material reduction.

In this same direction, Tubino (2006) and Storch et al (2013) teach that the Kanban tool has the intention to move and supply components to produce only the required quantity in the required timing, minimizing work in process material, production in small batches with visual control and in a decentralized way. Its basic applications, in brief, are linked to the control of just-in-time production, inventory control and continuous improvement tool.

Kanban system is essential to 'pull production systems' which control the flow of materials and information through handling and production cards. These cards replace production and production orders and are associated with standard containers representing the lot size to be produced according to the 'make-to-order production' (SILVA; SANTOS, 2014).

The Kanban method for single card follows the following logic (SILVA; SANTOS, 2014):

- When necessary, operators of a workstation remove a full container of its supplier supermarket and return it empty while posting the Kanban card panel attached to it.
- The cards posted on the Kanban panel trigger the production workstation, which produces to the supermarket limit, as defined by the number of Kanban (and hence standard containers).

According to Schulünzen (2006, p. 51) "the Kanban system has as its main objective signaling demand by converting the raw material into finished products, with waiting time equal to the processing time by eliminating all queue time of materials and idle inventory. In general terms, the purpose is to regulate the flow of materials in the production lines to reducing inventories.

Gaither and Fraizer (2001, p. 413) say that in the context of the JIT, Kanban system is the means to signal the previous workstation that the following one is prepared for the production of the next batch of parts. That is, when a station is empty Kanban demonstrates the Pull Production system must pull more products in order to have an synchrony in output. Still according to Gaither and Fraizer (2001), the Kanban system works based on the use of signs to enable the production and movement of items by the organization.

These signals are conventionally made based on Kanban cards and panels Kanban holder. The Kanban conventional cards are made of durable material to withstand the resulting handling of the constant circulation of customer inventories and the supplier item. Each company, in deploying its own Kanban

system, prepares its own cards according to its information needs.

The Kanban cards are classified by three zones or colors (ALVES et al, 2013):

- a) Green Zone: Sets the minimum lot size. Every time a purchase order is triggered, the supplier must deliver at least the amount set in in the green zone;
- b) Yellow Zone (Order Spot): include the number of parts to be consumed from the moment the order is placed to the supplier, ie from the time of production to the date of receipt of such goods;
- c) Red zone: It is set in a directly proportional manner to the risks that a company runs to occur a change in use of production parts or a delay in delivery by the supplier.

Besides the traditional Kanban system, there is the electronic Kanban; it has some advantages over the traditional, which are: it allows improvements in relationships with suppliers, in case the systems are used outside of the enterprise; it allows to evaluate the performance of suppliers instantly; it ensures accuracy in required and transmitted amounts; it can be used in whatever physical distances between production operations and it decreases the amount of paper handled at the factory (VILELLA E GODINHO FILHO, 2014).

It should be noted the importance of synchrony between the JIT system and the type Kanban tool in the productive process, as both depends on each other and both work together to reduce and organize stocks.

3. THE RESEARCH METHODOLOGY

The methodology began with the theoretical background definition on the issues applied to the research that provides subsidies for the observation of practice in its research locus and secondly on the practice and empirical application in solving the problems of the Racks Layout, Kanban use at Factory level (physical) as well the simulation with the virtual platform through the development of electronic spreadsheets. The delimitation of the study site was restricted to a large automotive international company, located in the São Paulo Paraiba Valley region.

3.1 THE NEED FOR THE KANBAN IMPLEMENTATION

The company has in its manufacturing structure a wheels and chassis division designed to trucks, buses, light trucks, agricultural wheels and auto parts. The chassis division was chosen as the study object due to the fact that this division adds greater value to its customers in the face of managerial and operational changes sought by the company. The physical and virtual materials handling of the company have been relocated for strategic reasons, to the responsibility of the logistics sector, and on the other hand the improvement in materials management was subject to the correct storage, ideal supply and elimination of production losses.

There was a wide variety of items in the "Materials Logistics Department", so at first the tests were done in a single part model to implement the Kanban system, and the chosen piece called "H", whose supplier is located in the state's southernmost country, has a distribution center (DC) in São Paulo state, in order to streamline and optimize the parts delivery.

For each request of parts, the transit time of the DC to the factory, located in the Paraíba River Valley is 24 hours; this data was essential for calculating the point of replenishment/ replacement and the maximum stock.

As this item is payroll, ie, the item does not belong to the company under investigation, that means the cost stands for the supplier, and the company studied has not established effective control of the part, as it is the case of the other items, which when leaving the stock its amount is automatically reported to the ERP system of the company, which displays the remaining amount and generates the need for stock replenishment.

In the case of the "H" part, which is the main object of the research, the stock withdrawal process occurs when the forklift operator requests the part to the stock controller, which sorts the pieces placing them in the "picking area" (exit spot of parts), or when the forklift operator itself enters in the stock area and acquires the number of parts required to supply.

It was identified at this point the main bottleneck of the operation, which arises due to the lack of control, since the parts damaged, makes it necessary the return the forklift operator into the inventory area to order new parts to replace the damaged parts, preventing or making it difficult in effective operation control.

Prior to the implementation of the Kanban tool, the part "H" was stored in racks, and its maximum height should be 4 racks per row. Figure 1 shows the form of storage of the parts prior to the system deployment (before) and Figure 2 shows the parts available in an improper way and at a fixed location and contain many racks spread around the stock area.



Figure 1 - Part Storage before deploying Kanban System

Credit of the photo: the authors.



Figure 2 - parts stored in different locations of the stock.

Credit of the photo: the authors.

In the pictures above, it can be seen that there was no well defined organization before the implementation of the Kanban tool, which is detrimental to the location of parts, especially visually.

4. RESULTS AND DISCUSSION

In this paper we discussed improvements and assessed solutions applied to the operating environment of an industry aiming the quickly and effectively reduction of its inventory situation.

In planning for the implementation of the Kanban tool it was necessary to define the amount of necessary parts, and the daily production parts consumption. We used the company ERP software to extract a report of monthly production schedules.

The extracted system programming report, allowed us to overview the need of parts supply for the coming months of the year, according to Table 1. The data of the "H" part estimate monthly the reference of parts calculation, and was based on the week days production in December; the schedule indicated only 15 days due to the inclusion of collective vacations adopted by the company studied totaling 101 days.

To determine the monthly outcome consumption, the working days were multiplied by the daily consumption of parts, and then the results of the days of the period were added.

It was computed 1756 parts (to be produced by December) which was divided by the number of days mentioned above, (1756 divided by 101) resulting in 17,4 parts of daily consumption, according to Table 1.

Table 1: Average daily consumption

Reference month	ago/14	set/14	out/14	nov/14	dez/14	Total
Working days	21	22	23	20	15	86
Dayly consumption (parts)	15	18	15	20	20	88
Monthly consumption (parts)	315	396	345	400	300	1756

Average dayly consumption (last 4 months):	17 4
Twerage dayly consumption (last 1 months).	17,1

Source: the authors

After obtaining the daily parts consumption, the next step was to determine the amount of Kanban parts, especially the inventory policy, defined by the company to be of 4 days, so the system indicated a total consumption of 80 parts, result obtained by multiplying the daily consumption by the inventory policy (20 times 4 days).

The item is stored in racks, that houses four pieces each, generating a need for 20 racks, which can be calculated, dividing the total number of required parts in stock by 4, which is the number of parts required for each package (80 divided by 4).

After collecting the information, the next step was to propose the Kanban layout and the chosen types, in this case the marking on the floor and the electronic Kanban.

The markings worked this way: two green markings (32 parts), meaning the stock controller does not need to make calls to purchasing new parts, that is, the stock is adequately supplied; two yellow

markings, (also 32 parts), representing a state of attention, ie one should check the parts call schedule for when it is scheduled.

And lastly, a red marking, which stands for parts in critical condition, meaning that the assembly line will stop by lack of supply, containing 16 parts in total.

Then we proceeded to the approval of the layout for the preparation of Kanban area, with painted and organized racks in their proper areas, as shown in Figure 3.

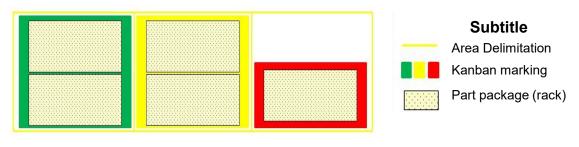


Figure 3 - Layout proposed and approved by the studied company.

Source: The authors

Figure 4 records the completed area with defined physical space and it is noticeable that the painting/marking on the floor was the most practical, rapid and inexpensive way to obtain results.

In this implementation phase, we initially analyzed the consumption average to be created after the electronic worksheets that helped in the calculation for the ideal standard to be followed as a model; it was set in 5 modules with four racks each. With the setting above mentioned, it was demarcated the Kanban area, by painting the floor with the colors: green, yellow and red.

And finally, Figure 4 shows the organization of the H part area where next, it was found the results of the implementation of Kanban tool. Note, first, the visual gains from the implementation of the system will subsequently reported the results and statistical gains of organizing the stock through the Kanban system. It may be noted initially the visual gains from the implementation of the system. The statistical gains that resulted from the organization of stocks through the Kanban system will be subsequently reported.



Figure 4 - completed study area

Credit of the photo: The authors

Table 2 describes how the parts manufacturing orders were performed before application of the Kanban system. Requests were made daily except on Fridays, due to the fact that no transporter partner works Saturdays and for this reason the Thursday requests are received and recorded on Friday. Another important factor before the introduction of the Kanban system, to be commented is that parts quantities were defined in accordance with the production schedule, and not through daily consumption.

According to the criterion that was used before the Kanban introduction, the most working days items were in a critical or emergency condition, which caused several problems, such as assembly line stoppages due to parts shortage. With the organization and use of the Kanban tool, the production scenario has changed significantly, as shown in Table 3.

Stock **Dayly** Receiving of **Tests** Demand Date Inventory Coverage Consumption **Parts** (days) Monday 1/set 51 18 0 16 12 First Tuesday 2/set 49 2 18 0 Week 2 12 Wednesday 3/set 31 18 0 25 Thursday 4/sept 1 14 12 0 Second Monday 8/set 17 12 12

Table 2 – Parts call prior to the Kanban introduction

Week	Tuesday	9/set	6	0	14	24	12
	Wednesday	10/set	4	0	14	28	24
	Thursday	11/set	13	1	14	0	28
	Monday	15/set	27	1	12	10	0
Third Week	Tuesday	16/set	15	1	16	20	10
	Wednesday	17/set	9	0	18	16	20
	Thursday	18/set	12	1	14	24	16
	Monday	22/set	13	1	18	24	24
Fourth Week	Tuesday	23/set	20	1	18	24	24
	Wednesday	24/set	26	1	18	24	24
	Thursday	25/set	32	2	18	12	24

Source: The authors.

Table 3 – Parts call after the Kanban introduction

	Dat	te	Inventory	Stock Coverage (days)	Dayly Consumption	Demand	Receiving of Parts
	Monday	29/set	80	4,0	12	0	0
First	Tuesday	30/set	68	3,4	15	0	0
Week	Wednesday	1/out	53	2,7	12	0	0
	Thursday	2/out	41	2,1	15	39	0
	Monday	6/out	41	2	15	39	0
Second	Tuesday	7/out	65	3	14	0	0
Week	Wednesday	8/out	66	3	11	0	32
	Thursday	9/out	55	3	16	0	0
	Monday	13/out	39	1,95	17	0	41
Third	Tuesday	14/out	63	3,15	10	17	0
Week	Wednesday	15/out	70	3,5	11	0	37
	Thursday	16/out	59	2,95	3	0	0
	Monday	22/set	59	3	11	21	0
Fourth	Tuesday	23/set	69	3	12	0	37
Week	Wednesday	24/set	57	3	12	0	0
	Thursday	25/set	45	2	12	35	0

Source: The authors.

The analysis of Table 3 showed that the introduction of the Kanban system with the stock supply being carried out in the proposed way would provide a decreased need for parts. It has been found also that in the previous scenario, ie. without Kanban, in 16 working days, there would be parts calls, in 13 of these working days. In contrast, after Kanban implantation the call of parts would occur in only 5 days in the same period.

Furthermore, it was observed that, after the implementation of Kanban the inventory would not reach the critical level (red) ie the risk of missing parts on the production line.

The analysis of Table 3 showed that with the stock being supplied thereby the parts requirements in relation to the scenario prior to the Kanban introduction, the parts need would decrease. We found that in 16 of the analysed working days, in 13 of them would occur parts call during the same time period. In contrast, with the implementation of the Kanban system, as shown in Table 3, calls of parts would occur in only 5 working days in the same time period. It was also observed that, after the Kanban system implementation, inventories would not reach the critical level (red level) that corresponds to missing parts on the production line.

5. CONCLUSIONS

It was shown in the adjustment process of racks that these results are visible through an eight-day parts calls economy, leading to significant cost savings with supply carriers and timing in the production line.

There was a shift in paradigm in relation to employees who were accustomed to acquire the parts without control, and particularly to store them anywhere in the inventory and available space. With the new system and industrial scenario adopted it was possible to provide suitable places for storage of these items, linked to withdrawal orders by storing them first into the green markings and next into the yellow markings.

From the study, we realized that the system generated effective results, and in a short time. The Kanban floor marking was chosen due its convenience and a fast deployment. The electronic Kanban besides being practical and safe would make possible to determine errors and delivery processes, shipping and manufacturing variables.

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Integrated Management Systems diffusion in South European countries

Cabecinhas, M. ²⁾, Domingues, J. P. T. ²⁾, Sampaio, P. ²⁾, Bernardo, M. ¹⁾, Franceschini, F.³⁾, Galetto, M. ³⁾, Gianni, M. ⁴⁾, Gotzamani, K. ⁴⁾, Mastrogiacomo, L. ³⁾ and Hernandez-Vivanco, A. ¹⁾

- Department of Business, Universitat de Barcelona, Barcelona, Spain
- ² Department of Production and Systems Engineering, University of Minho, Campus of Gualtar, Braga, Portugal
 - ³ DIGEP (Department of Management and Production Engineering) Politecnico di Torino, Torino, Italy
 - 4 Business Administration Department, University of Macedonia, Thessaloniki, Greece

ABSTRACT

Purpose – This paper dissects the diffusion of Integrated Management Systems (IMSs) encompassing the ISO 9001, ISO 14001 and OHSMS 18001 standards in the South European countries.

Design/methodology/approach – Data concerning the evolution of the amount of IMSs in Greece, Italy, Portugal and Spain were collected for the time period between 1999 and 2015. The behaviour of the evolution of the number of IMSs over the years was studied adopting both the Gompertz and the Logistic models. The results obtained with these two models were compared and analysed in order to provide a forecast for the next years.

Findings – The diffusion throughout the years of the number of IMSs follows an S- shaped behaviour. The evolution of the amount of IMSs in countries with a lower saturation level are better fitted by the Gompertz model while the Logistic model fits better when considering countries with a larger saturation level.

Research limitations/implications – For some of the analysed countries, the data related to early years are not available. In order to perform the analysis using both the Gompertz and the Logistic models, missing data have been extrapolated from the dataset provided by the annual ISO survey.

Practical implications – The obtained results provide a cross-section of the diffusion of IMSs certifications in the South European countries and enable a forecast for the trend in the next years.

Originality/value – This study aims, for the first time as we were able to find out, at the analysis of the diffusion of IMSs throughout the years.

Keywords: Certification standards, Integrated Management Systems (IMS), Diffusion model, Logistic model, Gompertz model.

Paper type: Research paper

1. INTRODUCTION

The concerns of the organizations related with new stakeholders have increased over the last few years. Hence, organizations seek to respond to various stakeholders through the adoption and implementation of different certification standards, which leads to the coexistence of several systems and the necessity of their integration, thus establishing a broad research field that has been explored extensively by management scholars.

International Organization for Standardization (ISO) publishes the ISO Survey of Certifications with data concerning to the number of certificates issued according to several management standards each year. However, data related to the number of Integrated Management Systems (IMS) are not available in this or any other relevant publication. Thus, this paper intends to report the first efforts of a work in progress that ultimately focus on the development of a forecasting model that may explain the diffusion of IMS in South European Countries. The present paper aims at answering important questions related to the diffusion of the Integrated Management Systems such as: (i) How has IMS diffusion evolved over time? (ii) How is it expected to evolve later on? So far, several authors have analyzed the individual diffusion of the most widely implemented and well known standards, i.e. the ISO 9001 and ISO 14001. This research enabled the development of forecasting models, highlighted the features that seem to promote a successful diffusion of certificates, outlined the path to sustainable certification and pointed out those countries where a saturation level apparently had been reached. Therefore, the development of similar work focusing IMS would bring some light on unexplored features disclosing the current path and the challenges yet to come. The results reported in this article have some shortcomings, since the simultaneous adoption of the ISO 9001, the ISO 14001 and the OHSMS 18001 standards is considered leaving out any information on the integration level of the respective Management Systems.

Besides this introduction, the remainder of the paper is structured as follows: Sect. 2 reports the analysis of the existing scientific literature about IMSs and the diffusion of certifications according to international standards for Management Systems; Sect. 3 describes the methodology of research adopted in the present work and Sect. 4 shows the obtained results, presents a discussion about the main findings of the research and proposes some elements for the future work.

2. LITERATURE REVIEW

2.1. Integrated Management Systems

Nowadays, the implementation of multiple Management Systems (MSs) is increasing, improving

effectiveness, efficiency and stakeholder assurance. Many organizations are implementing multiple MSs (Bernardo et al., 2011).

The recurring themes of the literature developed so far focusing IMSs are related with the limitations of non IMSs (Almeida et al., 2014; Domingues et al., 2014; Domingues, et al., 2012), identification of critical success factors (Almeida et al., 2014; Oliveira, 2013), guidelines and strategies for integration of MSs (Oliveira, 2013; Rebelo et al., 2014a), design of IMSs (Garengo and Biazzo, 2013; Manzanera et al., 2014; Rebelo et al., 2014b; Zeng et al., 2007), factors that influence the level of integration (Bernardo et al., 2011; Bernardo et al., 2012) and suggested integration levels or degrees (Jørgensen et al., 2006; Jørgensen, 2008; Sampaio et al., 2011b; Karanikas, 2014), and difficulties and benefits of implementing IMSs (Bernardo et al., 2015; Sampaio et al., 2012; Simon te al., 2012; Zeng et al., 2011).

More recent studies presented the development of a model to analyze the relationship between integration of MSs and innovation management performance or integration performance (Bernardo, 2014), relationship between adoption of MSs and business performance (Vílchez and Darnall, 2014), lessons learned from abandonment cases (Gianni and Gotzamani, 2015b), the role of the workflow-based electronic document management in an organizational integrated context (Pho and Tambo, 2014), how to design an IMS for building a socially responsible organization that contributes to sustainable development (Mežinska et al., 2015), and the relationships between IMSs and information MSs (Gianni and Gotzamani, 2015a).

2.2. Management systems diffusion

The growth and diffusion process was studied by several authors, focusing the patterns in terms of future trends or distribution functions in many areas, such as Biology, Innovation, Economy, etc (Carrillo and González, 2002; Meade and Islam, 2006). The study of the diffusion phenomenon of MSs is not new. Several authors have already

studied the diffusion of the ISO 9001, ISO 14001, ISO/TS 16949 and SA 8000 standards. Some relevant studies are presented in Table 1.

Table 1 – Selected articles about the diffusion of MSs certification.

Paper	Authors	Standard	Year
A new forecasting model for diffusion of ISO 9000 standard certifications in European countries	Fiorenzo Franceschini, Maurizio Galetto, Giovanni Gianni.	ISO 9001	2004
ISO 9000 and ISO 14000 standards: an international diffusion model	Frederic Marimon Viadiu, Martí Casadesùs Fa, Inaki Heras Saizarbitoria.	ISO 9001 ISO 14001	2006
Global Diffusion of ISO 9000 Certification Through Supply Chains	Charles J. Corbett .	ISO 9001	2006
A Spatiotemporal Analysis of the Global Diffusion of ISO 9000 and ISO 14000 Certification	Paulo Albuquerque, Bart J. Bronnenberg, Charles J. Corbett.	ISO 9001 ISO 14001	2007
ISO 14001 diffusion after the success of the ISO 9001 model	Martí Casadesús, Frederic Marimon, Iñaki Heras.	ISO 9001 ISO 14001	2008

The Diffusion of ISO9000 Certification in China: A Trend Analysis Based on Grey Verhulst Model	Yongqing Chen, Erli Liu.	ISO 9001	2009
ISO 9000 and ISO 14000 standards: A projection model for the decline phase	Frederic Marimon, Iñaki Heras, Martí Casadesús.	ISO 9001 ISO 14001	2009
Diffusion of ISO 14001 environmental management systems in China: rethinking on stakeholders' roles	G.Y. Qi, S.X. Zeng, C.M. Tam, H.T. Yin, J.F. Wu, Z.H. Dai.	ISO 14001	2011
ISO 9001 certification forecasting models	Paulo Sampaio, Pedro Saraiva, António Guimarães Rodrigues.	ISO 9001	2011
An institutional perspective on the diffusion of international management system standards: The case of the environmental management standard ISO 14001	M. A. Delmas, M. J. Montes-Sancho.	ISO 14001	2011
ISO/TS 16949: analysis of the diffusion and current trends	F. Franceschini, M. Galetto, D. A. Maisano, L. Mastrogiacomo,	ISO/TS 16949	2011
Diffusion of quality standards in the hospitality sector	María del Mar Alonso- Almeida, Frederic Marimon, Merce Bernardo,	ISO 9001 "Q" Standard	2013
Diffusion of ISO 14001 environmental management system: Global, regional and country-level analyses	W. M. To, P. K. C. Lee.	ISO 14001	2014
ISO 9001 certification in the American Continent: a statistical analysis and modelling	Eduardo Gomes Salgado, Luiz Alberto Beijo, Paulo Sampaio, Carlos Henrique Pereira Mello, Pedro Saraiva.	ISO 9001	2015
Social Accountability 8000 standard certification: analysis of worldwide diffusion	Josep Llach, Frederic Marimon, María del Mar Alonso- Almeida,	SA 8000	2015

Some scholars observed the path of the diffusion certification process and they had described this path with an S-shape, similarly to the behavior of the bio-population growth curve in limited resource habitat or to a diffusion process of technologies (Chen and Liu, 2009; Franceschini et al., 2004) .

Different forecasting models have been used in different areas with different degrees of success (Carrillo and González, 2002; Meade and Islam, 1995). More recently, the study of the evolution of the certification process wasn't an exception. It can be observed that several scholars studied the fitting of the logistic curve (Alonso-Almeida et al., 2013; F. Franceschini et al., 2011; Fiorenzo Franceschini et al., 2004; Llach et al., 2015; To & Lee, 2014; Viadiu et al., 2006), which is the most widely used growth curve in the case of management system diffusion.

3. MATERIALS AND METHODS

One of the critical assumptions in the growth curves for forecasting is whether the curve fitted is the correct one. (Martino, 1993) For that, the chosen growth curve must match with growth dynamics of the phenomenon observed. Thus, the behavior of the curve when extrapolated outside the range data will match the future behavior of the phenomenon (Martino, 1993).

There are many models used to fit S-shape behaviors, however, in this case we study only the logistic curve, already applied in the study of certification diffusion by many authors and the Gompertz model, which has been proposed in some studies in the area of biology and innovation showing a good performance when describing the path of the data analyzed (Meade and Islam, 1995; Zwietering et al., 1990). Other forecasting models have been presented in the scientific literature, for example, in studies of Carrillo and González (Carrillo and González, 2002), Meade and Towhidul (Meade and Islam, 1998) and Zwietering, Jongenburger, Rombouts and Riet (Zwietering et al., 1990).

Considering Gompertz and Logistic models, in both cases, the growth curve is divided in three phases:

- Lag phase: certification diffusion beginning, initial difficulties of the implementation;
- Exponential phase: faster growth, the initial difficulties of the implementation are overcomed;
- Stationary phase or saturation level: growth slowdown and achieve the maximum value (Buchanan et al., 1997; Franceschini et al., 2004; Martino, 1993).

None of the models applied consider an increasing or decreasing phase after the Stationary phase (Buchanan et al., 1997). Therefore, in both cases, the rate of growth is always positive, increasing until the point of inflection (the point in time where the rate of growth changes from increasing to decreasing) and then decreasing to zero when achieve the Stationary phase (Franses, 1994; Carrillo and González, 2002). It is possible observe the mathematical properties of both curves used in the study of Winsor (Winsor, 1932).

It is important to consider that:

- the model considers only the total number of certified enterprises, paying no attention to their specific dimension and to their commodity sector;
- we suppose there are not events or external interferences that can change the natural evolution of the number of QES (for example, international/national prescriptive changes, strong regulatory/legislation changes).

The Gompertz Curve is a model widely used in the scientific literature and it is described by an S-shape, asymmetric relatively to his inflection point. The value of a gives us the saturation value, the maximum number of certified companies possible to achieve, k is a mathematic parameter of

the model and t_c represents the time at the curve reaches to his inflection point (Mar-Molinero, 1980; Meade and Islam, 1995; Carrillo and González, 2002). The shape of the Gompertz curve is sketched in **Erro! A origem da referência não foi encontrada.** There equation is presented in (1)(Carrillo and González, 2002; Winsor, 1932; Zwietering et al., 1990)

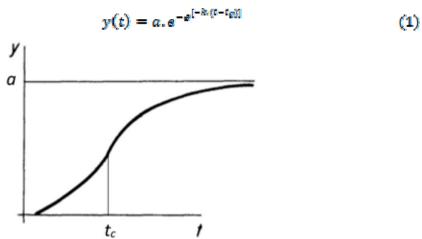


Figure 1 - Typical behavior of a Gompertz curve (Mar-Molinero, 1980)

The Simple Logistic Curve is one of the most used curves in the literature. This model differs from the Gompertz curve because it is symmetric relatively to the point of inflection, this means that happened when half of the saturation level is reached (Carrillo and González, 2002; Franses, 1994; Mar-Molinero, 1980; Meade and Islam, 1995). Like in the Gompertz curve, k is a mathematic parameter of the model and t_c represents the time at reached the inflexion point. The shape of the Logistic curve is observed in the **Erro! A origem da referência não foi encontrada.** There equation is presented in (2) (Carrillo and González, 2002; Winsor, 1932; Zwietering et al., 1990)

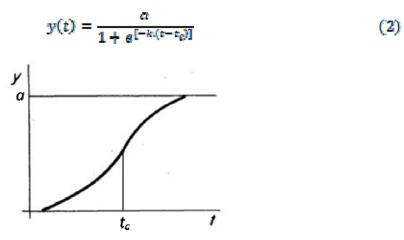


Figure 2 – Typical behavior of a Logistic curve (Mar-Molinero, 1980)

The most effective approach for fitting Gompertz or Logistic curves is the non-linear least squares regression (Seber and Wild, 1989; Martino, 1993; Meade and Islam, 1995; Zwietering et al., 1990). In the present work, we used the "Non-linear curve fits" function of the software Origin® 2016.

The performance of the fit is determined by the information present in the data used for the estimation. In particular, the result is affected by the number of collected observations and by the inclusion of the inflection point in the range of variation of the data (Meade and Islam, 1998).

4. RESULTS: ANALYSIS AND DISCUSSION

For data collection about IMS of Greece, Portugal and Spain, the local certification bodies were contacted in order to provide any information available, since there is lack of IMS information directly accessible, either public or private. In the Italian case, the required data have been obtained by the on-line database of Italian accreditation body ACCREDIA. Table 2 reports the source of the data, years and what they represent. The "number of certificates" represents the valid certificates annually issued in the studied period of time. This means that decertifications are also taken into account and, thus, data are regularly updated. The "number of companies" reflects the number of certified companies (not the number of certified sites, nor the number of certificates). There is a substantial difference between the "number of certificates" and the "number of companies", in fact a single company may hold more than one certificate. However, in our specific situation, this difference is negligible and does not influence the results of this analysis.

Table 2 - Synthesis of the extend of the collected data, what they represent and their source

Country	Years	Unit	Source
Greece	2013-2015	n.º certificates	Greek Certification bodies
<i>Italy</i>	1999-2014	n.° companies	ACCREDIA
Portugal	2007-2013	n.º certificates	Portuguese Certification bodies
Spain	2008-2014	n.° certificates with	Aenor
		standards implemented by	
		Aenor	

In this study, data refers to IMS simultaneously certified (QES, i.e. Quality, Environment and Safety) according to ISO 9001, ISO 14001 and OSHMS 18001 standards. However, it must be highlighted that the required data for the whole time interval from 1999 to 2015 were not available for some of the analyzed countries. Hence, in order to obtain, at least, an estimate of data from 1999 until 2013 for the considered countries, the missing values for Greece, Portugal and Spain were estimated by extrapolating them from the ISO survey (ISO, 2015). In the Greek case, due to the lack of data, it was extrapolated what happened during the previous seven years (2012 until 2006) in order to had points of the exponential phase and the saturation phase. The next section describes the procedure used for the extrapolation. The initial collected data are not showed.

4.1. Estimation of the missing data in the period from 1999 to 2013 for Portugal

In other to achieve the extension of data pretended, the linear relations were studied between the number of certificates QES and the number of certificates to each standard studied. Analyzing the relations obtained (not showed), it can be observed that a linear relationship can be substantiated between the number of certificates QES and the number of certificates to the standards ISO 14001 (R-squared coefficient = 0.9613) and OHSMS 18001 (R-squared coefficient

= 0,9713). This finding was used along with the ISO survey data on ISO 14001 (no OHSAS certification international data available) to estimate the relationship of the individual certifications with the number of QES.

Observing the percentage of ISO 14001 used in QES presented in the Figure 3, it can be observed that in the years studied, there is an increasing trend between 2007 and 2012, with a last-year decrease. Analyzing the figure 3 it is also possible to verify a moderate linear relation between the % QES/ISO14001 and the year analyzed. The resulting equation (see Fig.3) was used to calculate the % QES / ISO 14001 percentage and obtain QES data since 1999 until 2007.

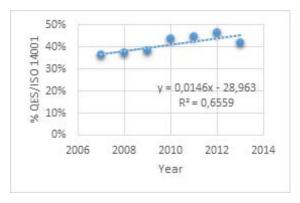


Figure 3 - Evolution of the %QES/ISO14001 from 2007 until 2013 from Portugal

The obtained QES data is presented in the Table 3. The data referring to the year 2008, it was not consider, since it was collected in August, and not in the end of the year, representing a point out of the path presented with the rest of the data collected.

4.2. Estimation of the missing data in the period from 1999 to 2014 for Spain

The starting point for the estimation of QES in Spain is the data provided by AENOR and the number of ISO certified companies (ISO, 2015).

In order to have an estimation of the QES population in Spain, the following parameters were considered for estimating the QES number.

The estimated yearly proportion of ISO 9001 certified companies with an integrated QES based on the AENOR data is calculated by the following equation (3).

$$p_t^*(QMS, QES) = \frac{QES_t}{QMS_t} \tag{3}$$

Consequently, considering the same yearly proportion of QES for the population of companies that have the ISO 9001 certification, the expected number of integrated MSs, when having ISO 9001, is written as follows in (4).

$$E^*(QMS, QES) = ISO9001_i * p_i^*(QMS, QES)$$
(4)

By using the same procedure, only now taking ISO14001 as reference, the expected number of integrated companies, when being ISO 14001 certified is calculated by (5):

$$E^*(EMS, QES) = ISO14001_t * p_t^*(EMS, QES)$$
(5)

Since both expected values take different references (ISO9001 and ISO14001), the average expected values of QES are used as estimations of the number of companies that have integrated MS at each level.

From years 1999 to 2008 the same proportions of ISO 9001 and ISO 14001 certifications relatively to QES are used, since the last available data provided by AENOR date back to 2008. The acquired data is presented in Table 3.

4.3. Estimation of the missing data in the period from 2006 to 2015 for Greece

In the Greek case, the data collected range only from 2013 to 2015. A data collection process similar to Portugal's was followed.

In this case, it was observed that QES number shows a linear relationship (R-squared coefficient greater than 0.8) with the number of companies certified to the ISO9001 and the OHSMS standards than to the number of companies certified to the ISO 14001 standard.

Due to the lack of less recent IMS (QES) data for Greece, a comparison was made with the evolution of the ISO 9001 certification percentage over the years for the Italian, Greek, Portuguese and Spanish cases. In the Figures 4, 5, 6 and 7 this evolution is presented for Italy, Greece, Portugal and Spain, respectively. These results are based on the data collected and not on extrapolated or estimated data.

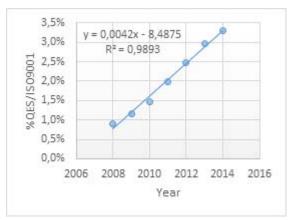


Figure 4 - Evolution of the %QES/ISO9001 from 2008 until 2014 from Italy

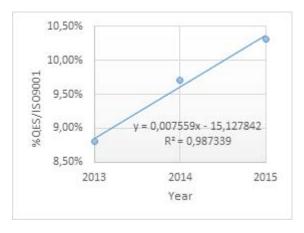


Figure 5 - Evolution of the %QES/ISO9001 from 2013 until 2015 from Greece

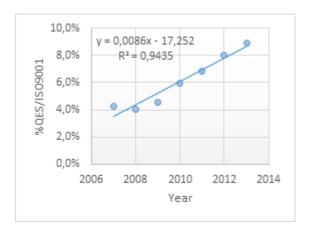


Figure 6 - Evolution of the %QES/ISO9001 from 2007 until 2013 from Portugal

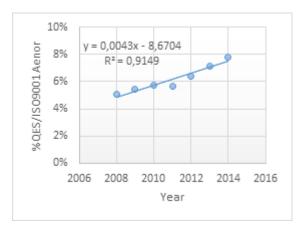


Figure 7 - Evolution of the %QES/ISO9001 from 2008 until 2014 from Spain

Comparing the different cases, it is possible conclude that the evolution of the %QES/ISO9001, in all cases, is crescent over the years, and has similar values, except for the Italian case. So, it was calculated the %QES/ISO9001 based on the data of ISO survey for the years back until 2006. Then, QES data was calculated for the time period ranging from 2006 until 2012. The data obtained is presented in Table 3.

Table 3 - Data used for constructing the forecasting models (note that **bold data** have been estimated)

Ano	Counter	Greece	Italy	Portugal	Spain
1999	1	-	3	7	240
2000	2	-	8	12	472
2001	3	-	32	25	519
2002	4	-	35	40	835
2003	5	-	53	77	968
2004	6	-	67	131	1252
2005	7	-	95	170	1486
2006	8	168	128	199	1825
2007	9	221	181	281	2105
2008	10	341	265	-	2280
2009	11	292	372	347	2198
2010	12	284	528	429	2419

2011	13	305	782	468	2120
2012	14	387	1060	577	2761
2013	15	353	1425	670	2316
2014	16	358	1759	-	2163
2015	17	308	-	-	-

Furthermore, the analysis of the Italian data seems to confirm proximity between the data collected and the estimation results. In fact the % QES/ISO9001 and the % QES/ISO14001 as a regular trend in the years after 2008 (see Figures 8 and 9). In Table 4 it is possible to verify that collected and extrapolated data for Italy are very close to each other.

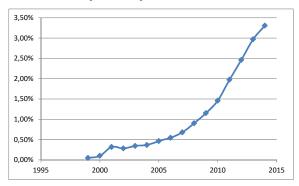


Figure 8 - Evolution of the % QES/ISO9001 from 1999 until 2014 in Italy

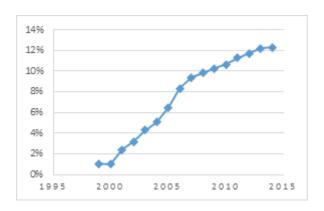


Figure 9 - Evolution of the % QES/ISO14001 from 1999 until 2014 in Italy

Table 4 - Comparison between collected and estimated data about QES certifications in Italy

Year	Collected	Estimated	Estimated
, , ,		<i>ISO9001</i>	<i>ISO14001</i>
1999	3	26	1
2000	8	33	3
2001	32	41	6
2002	35	51	11
2003	53	63	15
2004	67	75	24
2005	95	84	35
2006	128	96	49

2007	181	110	143
2008	265	245	243
2009	372	406	381
2010	528	608	563
2011	782	833	789
2012	1060	1088	1050
2013	1425	1416	1397
2014	1759	1795	1766

4.4. Logistic and Gompertz model regression

The models for forecasting and analyzing the actual state of QES have been constructed considering data in Table 3 and using the second column ("Counter") as independent variable.

The parameters of each model applied to different countries are reported in Tables 5 and 6. With this data and the graphics presented in Figures from 10 to 17, it is possible to observe that the studied countries reach different levels of the growth. For example, observing the curves obtained for Greece and Spain, it is possible to conclude that these countries have already achieved the saturation level. Studying the statistic parameters of this two countries both models present a good fitting of data, and the final values of the saturation level respectively obtained with this two models do not present any significant difference. Therefore, it is possible to conclude that, applying this two models to countries that already reach the saturation level, similar results for the value of the saturation level can be obtained. Observing the Residual Sum of Squares it is also possible to conclude that, in the Greek case, the Gompertz curve describe better the growth, and in the Spanish case, the Logistic describes better the current dynamic.

Analyzing the values for Portugal and Italy, we found that both countries are positioned in the exponential phase of the curve, and very dissimilar results are obtained when applying each model. For Italy, it is quite obvious which forecasting model is the best fit based on the currently available data, because the saturation level predicted by the Gompertz curve is unrealistic, this could happen, because the construction of the model consider that the data used do not reached to the inflexion point and it is far from that, in the case of Gompertz. Furthermore, observing the Residual Sum of Squares, it is possible to confirm that the Logistic model performs much better than the Gompertz one. With more data (future data) could be possible to obtain better results.

Looking at the Portuguese data, it seems that Gompertz curve provides better statistic results than the Logistic curve. This is further confirmed by the Residual Sum of Squares. Then, it is concluded that, the Gompertz curve describes better the dynamics of QES growth until now for Portugal.

If comparing Portugal and Italy, the selected models respectively predict that Italy will achieve the saturation model approximately in 2025, while Portugal is still in the growing phase, this was an expected result, since Portugal is having a slower growth if compared to Italy.

Observing the actual results, it seems that Gompertz curve describes better the dynamics the countries with lower saturation level, and the Logistic curve describes better the diffusion of the countries with larger saturation level.

These results will be improved when more information will be added throughout the years, since, as mentioned in the literature review, the performance of the model is determined by the

provided information, i.e. by the number of data and their positioning along the curve shape (Meade and Islam, 1998).

Table 5 - Parameters and statistics for the Gompertz fitting of Greece, Italy, Portugal and Spain

Gompertz Country Greece Italy Portugal Spain a 338,888 62748,162 1945,016 2524,022 *xc* 7,529 34,010 15,878 4,401 k 0,730 0,105 0,302 0,070 13 Degrees of Freedom 7 13 11 Residual Sum of Squares | 10430,931 7547,328 4605,993 425533,31 *R-Square* 0,660 0,998 0,993 0,956

Table 6 - Parameters and statistics for the Logistic fitting of Greece, Italy, Portugal and Spain

Country	Greece	Italy	Portugal	Spain
а	336,275	3709,132	996,990	2421,936
XC	8,016	16,213	12,908	5,646
k	0,927	0,413	0,296	0,475
Degrees of Freedom	7	13	11	13
Residual Sum of Squares	10547,777	2866,908	7368,164	339517,019
R-Square	0,656	0,999	0,988	0,965

Gompertz Curve

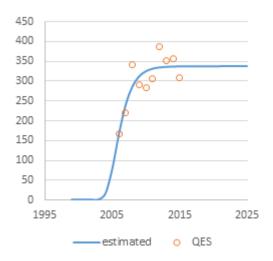


Figure 10 - Gompertz curve (Greece).

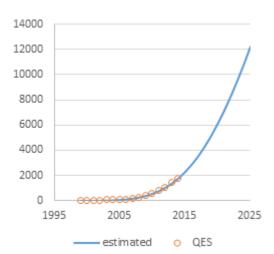


Figure 12 - Gompertz curve (Italy).

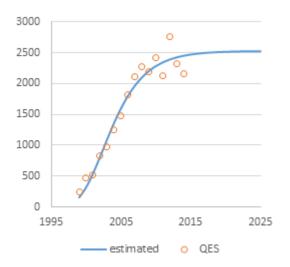


Figure 11 - Gompertz curve (Spain).

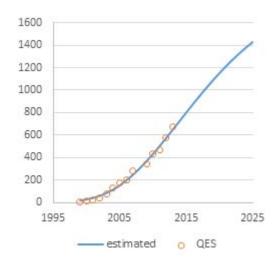
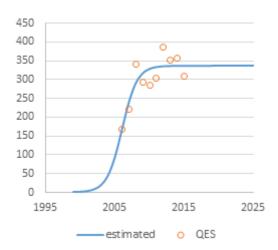


Figure 13 - Gompertz curve (Portugal).

Logistic Curve



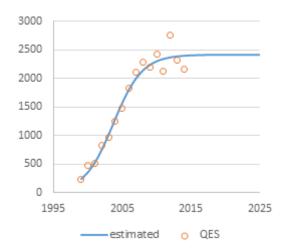
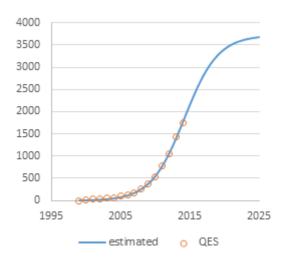


Figure 14 - Logistic curve (Greece).

Figure 15 - Logistic curve (Spain).



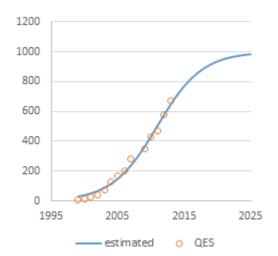


Figure 16 - Logistic curve (Italy).

Figure 17 - Logistic curve (Portugal).

5. CONCLUSIONS

Basing on the gathered information, it is possible to conclude that, despite the geographic proximity between the countries that participated in this research (all of them being South European) cross-country results show significant dissimilarities, with regard to QES evolution.

However, there is a similar growing trend in the percentage of ISO9001 used in the QES across the participating countries. In the case of Greece and Spain, this happens, due to their decrease of ISO9001 certification rates in the last years. In the case of Portugal and Italy, the implementation of ISO9001 has increased, and the %QES/ISO9001 has increased, as well, which means that, in the last few years, domestic companies decided to integrate more.

In relation to the considered forecasting models, Gompertz and Logistic, it was found that Greece and Spain have already reached the QES saturation level and the results of both models are similar in respect with the saturation level, yet Gompertz model describes better QES evolution in Greece, whereas Logistic describes better the Spanish case.

When both models are applied to the countries found in the exponential phase, i.e. Portugal and Italy, the results are very different. In order to define which one is the best fit model in this case, more research is needed to study the trends of the countries and the factors that affect the trend of diffusion within these countries, with respect to QES.

In general, it was concluded that a single model does not fit all the paths described for the countries studied, as in the countries that already achieved the saturation level, i.e. Greece and Spain that had all the necessary information for the construction of these models in their data yet leading to different conclusions (Gompertz better for Greece, Logistic better for Spain).

The lack of information relatively to the IMS are the main limitation of the present study. The only country where data extension was available was Italy since IMS data since 1999 until 2013 were provided. Data from Greece only refers to years since 2013 until 2015. In the case of Portugal, it was needed to extrapolate data from 1999 until 2007. In the Spanish case, data for the years since 2008 until 2014 were estimated based on the AENOR and ISO survey data, and it was needed to extrapolate data for the years before. These estimations and extrapolations introduced some uncertainty in the results.

Future research on Integrated Management Systems would further highlight whether the trend of the concurrent implementation of more than one standard is increasing, which will be the impact of the actualization of the standards in the present trends. Another interesting research topic is the impact of the OHSMS 18001 turning into an ISO standard on QES evolution. Furthermore, the study of IMS diffusion across more countries may lead to more robust conclusions, shedding light on possible causes for the different state and dynamics of growth.

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Integrating Lean Six Sigma with the new Management System Standards

Marques, P.A.¹⁾²⁾, Meyrelles, P.M.³⁾, Saraiva, P.M.⁴⁾ and Frazão-Guerreiro, F.J.⁵⁾

¹⁾ ISQ – Institute for Technology and Quality, Dpt. Strategy & Special Projects, pamarques@isq.pt

²⁾ Lusófona University of Humanities and Technologies, Faculty of Engineering

³ ISQ – Institute for Technology and Quality, Non-Destructive Testing Department

⁴ University of Coimbra, Faculty of Sciences & Technology, pas@eq.uc.pt

⁵ ISQ – Institute for Technology and Quality, Dpt. Strategy & Special Projects, figuerreiro@isq.pt

ABSTRACT

Purpose — This paper presents a model to integrate Lean Six Sigma with the new versions of the management system standards following the structure provided by Annex SL. The general model will be particularized for the requirements of the quality (ISO 9001) and environmental (ISO 14001) management system standards.

Design/methodology/approach – The model provides a framework that scopes the life cycle stages of a Lean and/or Six Sigma project, from its identification to the post-project phase, with the clauses inherent to the high level structure of the Annex SL. The general model can then be tailored for each specific management system standard, including ISO 9001 and ISO 14001.

Findings – In addition to providing an effective mean to facilitate the integration of multiple management system standards, Annex SL also provides a useful framework to link Lean and Six Sigma programs to the overall management system of an organization.

Research limitations/implications – The integration model herein proposed now needs to be tested in companies from different business sectors.

Originality/value – As far as the authors of this paper are aware, this is the first attempt to develop a framework to integrate Lean and Six Sigma with the 2015 versions of the ISO 9001 and ISO 14001 management system standards.

Keywords: Annex SL; Lean, Management System Standards, Six Sigma.

Paper type: Conceptual paper

INTRODUCTION

The publication of Annex SL in April 2012 brought a new and powerful framework towards the harmonization of management system standards, making it easier for companies to develop and implement integrated management systems. This document establishes a common high level structure for all management system standards published by the International Organization for Standardization (ISO), adopting identical names and sequences for the clauses titles, and making use of common terms and core definitions. Since then, all the revised ISO management system standards have been migrating to the new structure, including the recent 2015 versions of ISO 9001 and ISO 14001, which together, and according with the ISO Survey 2014 (ISO, 2015), correspond to about 90% of the total number of ISO certificates issued worldwide.

Many authors, such as Hahn (2005) and Salah et al. (2010), argue that the successful implementation of a Lean Six Sigma program largely depends on how effectively a company is able to articulate it with its management systems, including its quality management system (QMS). The integration of Lean and/or Six Sigma with QMS based on the ISO 9001 standard is a research topic that has been reasonably addressed by the literature; however, none of the integration models and guidelines that have been proposed so far involve the new version that was released in September 2015. In addition, the existing literature is scarce in terms of guidelines for making use of Lean or Six Sigma under the context of other types of management systems, including environmental and occupational health & safety systems.

This paper proposes and describes an integration model which aims to provide enterprises, regardless of their size and business, with a logical framework that will enable them to deploy a Lean Six Sigma program in conjunction with the regular activities of their overall management system, be it based in one or more of the new versions of the international management system standards, which now follow a common high structure provided by Annex SL. The illustration of the general model will be particularized for the case of the newest QMS standard (ISO 9001:2015) and environmental management system standard (ISO 14001:2015).

The paper is organized around five sections. Before presenting and describing the general integration model, the review of the literature is performed. This is followed by the illustration of how the model can used to integrate Lean Six Sigma with the ISO 9001:2015 and ISO 14001:2015 standards. The conclusions of the paper are discussed in the last section

LITERATURE REVIEW

Born from many of the TQM (Total Quality Management) principles, both Lean and Six Sigma philosophies have captured increasing interest over the years (Andersson et al., 2006) by both the scientific and business communities. Lean and Six Sigma have different focus, but they are complementary, so they are often used in conjunction in an approach usually known as Lean Six Sigma. Lean principles and tools focus on improving process flow/speed and in eliminating waste, while Six Sigma aims to minimize the occurrence of defects by reducing process variability. Both Lean and Six Sigma tools can be used throughout improvement projects following the well-known five-step DMAIC (Define-Measure-Analyze-Improve-Control) roadmap (Snee, 2010).

Due to the proliferation of ideas for enterprises' management according to quality principles that has been taking place, especially since the early 1980s, the family of ISO 9000 standards was created to induce organizations towards a structural model based on the logic of strategic quality management (Franceschini et al., 2006).

The ISO 9000 standards have resulted in a significant worldwide phenomenon, considering the impressive growth and diffusion of registrations according to the ISO 9001 standard in several countries and different kinds of organizations (Sampaio et al., 2009). Over the last decade, some researchers came up with models and guidelines to integrate the 2000 and 2008 versions of ISO 9001 with Six Sigma or Lean Six Sigma programs. Table 1 summarizes the most relevant integration proposals available in the literature. However, it

can be noticed that no model yet exists to assist managers in effectively combining Lean Six Sigma with the new ISO 9001:2015 standard.

Table 1 – Literature proposing models or guidelines to integrate Six Sigma with ISO 9001.

Authors	Year	Integration proposal
Dey	2000	Model where the Six Sigma DMAIC methodology works as an
		interface between the customer and the QMS
Warnack	2003	Framework containing a 7-step roadmap to achieve a proper integration
		between Six Sigma and an ISO 9001 QMS
Pfeifer et al.	2004	Model for a systematic articulation between the development of Six Sigma
		projects and a QMS based on the ISO 9001 standard
Lupan et al.	2005	Managerial point of view model where the DMAIC roadmap is integrated with
		each phase of the PDCA cycle to implement, develop, maintain, and improve
		the ISO 9001 QMS
Bewoor and	2010	Model containing a micro/operational level analysis that facilitates the
Pawar		implementation of the DMAIC roadmap phases as part of an organization's ISO
		9001 QMS
Karthi et al.	2011	Framework for integrating the DMAIC methodology and belt based training
		infrastructure with ISO 9001:2008 standard based QMS
Marques et al.	2013	Set of guidelines to combine and integrate the activities of a Six Sigma program
		with the clauses of the ISO 9001 standard

Dey (2002) was one of the first authors to reflect on the synergies between Six Sigma and the 2000 version of the ISO 9001 standard. He considers that Six Sigma offers a proven framework which satisfies ISO 9001:2000 requirements in the following issues:

- Demonstrating top management commitment to continually improving the effectiveness of the QMS (clause 5.1 of ISO 9001:2000).
- Competence, awareness and training in statistical techniques and quality management tools (clause 6.2.2).
- Continual improvement of the quality management system (requirement 8.1.c and clause 8.5.1).
- Monitoring and measurement of customer satisfaction (clause 8.2.1).
- Monitoring, measurement and improvement of processes (clause 8.2.3) and product (clause 8.2.4).
- Analysis of data (clause 8.4).

For Warnack (2003) Six Sigma DMAIC projects become one of the ways through which continual improvement takes place in an organization. To fully integrate Six Sigma improvement programs with the QMS based on the ISO 9001 standard, the author recommends a sequence of seven steps that is built on some critical success factors, including training in the Six Sigma tools, methodology and principles, as well as top management commitment. One of the interesting points in Warnack's model is his suggestion of including features related to the Six Sigma improvement program in the audit matrices and checklists.

The model developed by Pfeifer et al. (2004) expands the role of internal audits by considering that the auditing process can assist in the identification of improvement areas that might lead to the initiation of well-scoped Six Sigma projects. The authors also suggest the use of SIPOC (Supplier, Input, Process, Output, Customer) to map the key business processes identified in the QMS. Moreover, Pfeifer et al. (2004) consider that the procedures used to control documents and records within the QMS can be useful to document the Six Sigma project results.

The main purpose of the integration framework suggested by Lupan et al. (2005) is to increase the capability of managers to implement, develop, maintain, and improve their organization's ISO 9001 QMS based on the managing by facts principle. One of the most interesting guidelines contained in this model is the role of the management review process; in the opinion of the authors, management reviews can be used to assess the Six Sigma program itself and to define actions to continually improve its effectiveness.

More recently, and with the 2008 version of ISO 9001 already published, Bewoor and Pawar (2010) developed managerial and operational level frameworks for the integration of Six Sigma with QMS based on the ISO 9001 standard. The macro level (managerial) framework links Six Sigma with ISO 9001 by making use of the quality management principles. The micro level (operational) framework maps the clauses of the ISO 9001:2008 standard with each of the five stages comprising the DMAIC roadmap for Six Sigma, thus facilitating an effective adoption of this structured methodology during the continual improvement efforts of an enterprise.

Karthi et al. (2011) presented an integration framework, which they have called "L6QMS 2008", for integrating the DMAIC methodology and the typical belt-based training infrastructure of a Lean Six Sigma program with the QMS model inherent to the ISO 9001:2008 standard. In their research, the authors developed an alternative version of the standard by adding specific Lean Six Sigma requirements to the existing underlying structure; in addition, they proposed a variant of the process-based model of ISO 9001:2008 Lean Six Sigma, having called it "Lean Six Sigma QMS". This model was tested with success in a textile mill company (Karthi et al., 2013).

Marques et al. (2013) proposed a set of guidelines to articulate a Six Sigma program with QMS based on the ISO 9001:2008 standard in a systematic way. A total of 27 guidelines were organised around 6 main integration topics aligned with the high-level structure provided by the ISO Guide 72, an international document that was developed to improve the interface between the standards developing committees and the markets they serve. Each guideline was linked to the clauses of ISO 9001:2008. Marques et al. (2011) describe a practical application of this integration framework based on the ISO Guide 72 in a Portuguese enterprise that provides engineering services for energy infrastructures.

Some attempts to integrate Lean with ISO 9001 have also been proposed. Under this topic, the book *Lean ISO 9001*, authored by Micklewright (2010), assumes special relevance. The author discusses complementarity among the two approaches, stating that ISO 9001 does not contain explicit requirements for an organization to reduce waste; while, on the other hand, a QMS based on the requirements of ISO 9001 can be helpful to standardize work and to sustain improvements resulting from the completion of Kaizen events, from the application of the A3 problem-solving methodology, or from the structured employment of certain Lean tools. The author also studies the relationships between some of the ISO 9001:2008 clauses with Lean principles, concepts, and tools. Chiarini (2011) explores the specific role that Lean tools and principles can have under each clause of ISO 9001:2008; moreover, the author formulates integration guidelines for all those clauses.

The latest editions of the Certifications Survey published by the ISO reveal higher growth rates in the number of certificates issued for international management system standards other than ISO 9001. Because many organizations have been increasingly adopting different formal management system standards for certification purposes, in addition to ISO 9001, frameworks such as the Annex SL and the specification PAS 99 were published to make it easier for companies to deal with different management systems in an integrative way. These facts show the relevance of developing effective solutions to integrate Lean Six Sigma not only with quality management systems based on ISO 9001, but also with other relevant standards; however, the review of the literature shows that the availability of frameworks to integrate Lean and/or Six Sigma with other management system standards is still scarce.

There is a lack of published literature about the synergies between Lean Six Sigma and environmental management systems (EMS), including those based on the ISO 14001 standard. The U.S. Environmental

Protection Agency (EPA) published, in 2009, a guide to employ Lean and Six Sigma to drive environmental improvement and sustainability. However, this document never mentions ISO 14001, although the guidelines therein contained are still being useful in the context of EMS based on such a standard. According to EPA (2009), environmental impacts are embedded within the wastes that Lean targets; for instance, less overprocessing and more efficient transport results in lower emission levels, while less storage and inventory space results in reduced materials, land, and energy consumed. A literature review conducted by Garza-Reyes (2015a) reveals the increasing importance of the Green-Lean topic and identifies relevant literature on this issue. EPA (2009) also underlines the role of Six Sigma in reducing production defects and rework, thus resulting in lower scrap, residuals waste, and pollutant levels. Garza-Reyes (2015b) recognizes the limitations of the Green-Lean approach, and thus proposes the use of the Six Sigma DMAIC methodology to enhance the ability to promote continual improvement of an EMS. Calia et al. (2009) studied the impact of the development of Six Sigma projects over the Pollution Prevention program of a multinational corporation, having concluded that during a period of six years the environmental performance, in terms of pollution prevention, increased by 62%. A research survey conducted by Marsh and Perera (2012), which involved companies from over 20 industries in the UK, led to the conclusion that 60% of the surveyed companies achieved environmental benefits through the regular deployment of Lean Six Sigma projects; that being the case, the authors suggest the integration of improvement approaches such as Lean Six Sigma with the EMS based on the ISO 14001 requirements, but they do not propose any specific model for doing so.

The literature around the integration of Lean Six Sigma with occupational health and safety (OH&S) management systems is also very scarce. No literature is currently available in terms of providing models or guidelines on how a Lean Six Sigma program can be articulated with an OH&S management system based on the OHSAS 18001 standard. The existing literature usually focuses on how Lean Six Sigma projects can contribute to reduce safety and health risks, such as the minimization of accidents and injuries. There are some published practical applications of the DMAIC methodology to improve the performance in terms of OH&S; in this matter, the case studies presented by Ng et al. (2005), Williamsen (2005), Lok et al. (2008), Rehman and Rehman (2012), and Kubilius et al. (2015) should be highlighted. ReVelle (2004) explores several ways of using Six Sigma in a OH&S system and identifies a set of multinational corporations that develop Six Sigma projects to improve their OH&S performance.

PROPOSED INTEGRATION MODEL

In this section, a novel framework to integrate Lean Six Sigma with the new versions of the international management system standards (MSS) is proposed, in particular with regards to ISO 9001:2015 for QMS and ISO 14001 for EMS. The approach that is adopted to establish linkages between a Lean Six Sigma program and the international MSS published by ISO is illustrated in figure 1. It makes use of the high-level structure provided by Annex SL, which is summarized in table 2.



Figure 1 – Approach to integrate Lean Six Sigma with an international MSS.

A Lean Six Sigma program relies on a project-by-project approach. In this sense, Lean, Six Sigma, and Design for Six Sigma (DFSS) projects go through the following sequence of stages, which together comprise the overall phases of a project life cycle:

- 1. Project identification.
- 2. Project selection.
- 3. Planning, execution and completion of the project.
- 4. Post-project.

The reasoning behind the proposed model, depicted in figure 2, is that the activities inherent to the stages of a project life cycle can be linked to the clauses and sub-clauses mentioned in table 2. In the identical text proposals of Annex SL, "XXX" is an MSS discipline specific qualifier, such as "quality" (quality management system) and "environmental" (environmental management system), that needs to be inserted in the text of any specific MSS standard.

Table 2 – High-level structure provided by Annex SL

	Table 2 – High-level structure provided by Annex SL.				
Section /	Title of the section or clause				
Clause					
1	Scope				
2	Normative references				
3	Terms and definitions				
4	Context of the organization				
4.1	Understanding the organization and its context				
4.2	Understanding the needs and expectations of interested parties				
4.3	Determining the scope of the XXX management system				
4.4	XXX management system				
5	Leadership				
5.1	Understanding the organization and its context				
5.2	Policy				
5.3	Organization roles, responsibilities and authorities				
6	Planning				
6.1	Actions to address risks and opportunities				
6.2	XXX objectives and planning to achieve them				
7	Support				
7.1	Resources				
7.2	Competence				
7.3	Awareness				
7.4	Communication				
7.5	Documented information				
7.5.1	General				
7.5.2	Creating and updating				
7.5.3	Control of documented information				
8	Operation				
8.1	Operational planning and control				
9	Performance evaluation				
9.1	Monitoring, measurement, analysis and evaluation				
9.2	Internal audit				
9.3	Management review				
10	Improvement				
10.1	Nonconformity and corrective action				
10.2	Continual improvement				

The model will now be described for each particular stage of a project life cycle, and then particularized for the integration of Lean Six Sigma with the ISO 9001:2015 quality MSS, as well as with the ISO 14001:2015 environmental MSS.

Annex SL clauses applicable during the project identification and selection phases

Figure 3 details the reasoning behind the general integration model for the project identification and selection stages. Potential projects derive from opportunities for improvement and for innovation that are detected based on the periodic and systematic analysis of data with origin in several possible sources that can be grouped under the following categories:

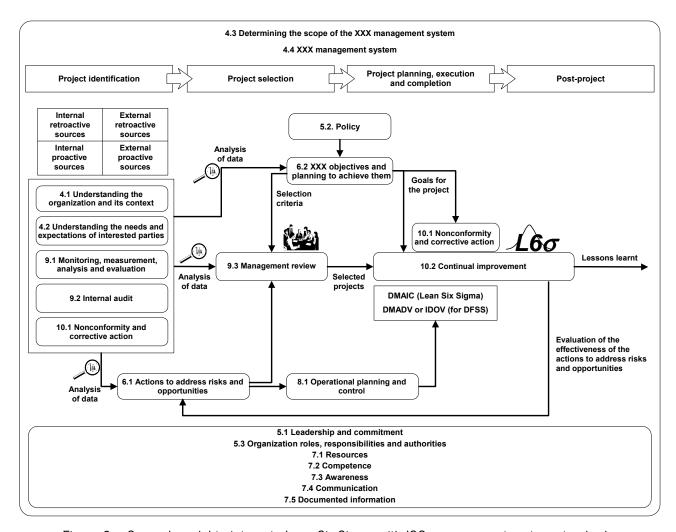


Figure 2 – General model to integrate Lean Six Sigma with ISO management system standards.

- Internal sources of data: Data generated internally in the organization.
- External sources of data: Data that comes from the outside of the organization.
- Retroactive sources of data: Existing documented or historical data.
- Proactive sources of data: Data usually not readily available, thus requiring proactive actions to be obtained.

These four categories of data sources can be organized around a four-quadrant matrix, whose structure is shown in table 3. This table contains a set of examples for possible sources of data that can be allocated to each quadrant.

Table 3 – Classification		مالاندين ماماند		مرم الحمران والممرم والممر
Table 5 - Classification	THAIRIX OF UALA	Sources with	examples for	each combination.

	Internal source of data	External sources of data		
Retroactive sources of data	 Key performance indicators (KPIs) results Available internal audit reports Existing technical and commercial reports Corrective/preventive action records Completed nonconformance reports Past safety and environmental occurrences 	 Results from previous customer satisfaction surveys Customer complaints and claims Available documentation (e.g. studies, reports) produced by external entities (e.g. regulation bodies, consumer associations, consulting companies) Historical product warranty data 		
Proactive sources of data	 Conduction of internal brainstorming sessions Improvement suggestions from employees Consultation and participation of the workers Conduction of <i>gemba</i> walks Product life cycle analysis/studies 	 Competitive benchmarking studies Conduction of interview sessions with customers Conduction of focus groups involving external stakeholders Conduction of external brainstorming sessions with external stakeholders 		

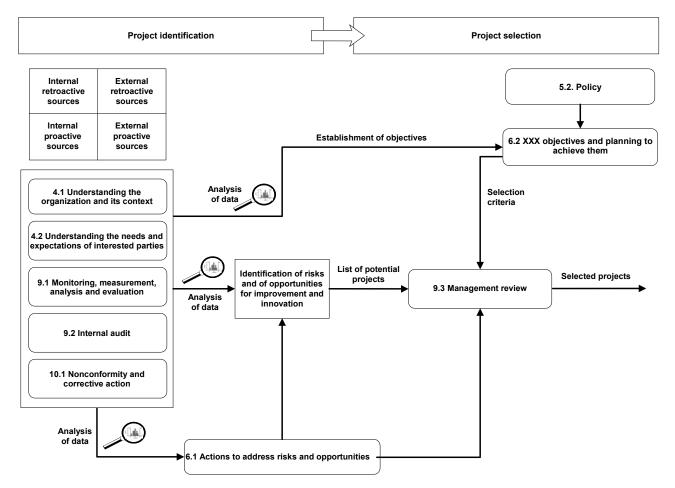


Figure 3 – Detail of the general integration model for the identification and selection of projects.

Data resulting from monitoring and measuring activities (clause 9.1) includes, among others, the values of the KPIs gathered over time to determine the performance of an organization's management system, including the efficiency and effectiveness of its processes. Potential Lean Six Sigma projects can for instance be identified based on gap analysis (comparison among the objectives set for the KPIs and the results actually

obtained), study of trends (comprehension of the evolution of those KPIs), or competitive analysis (comparison between the performance of the organization and of best-in-class competitors regarding a set of KPIs). Clause 9.1 also includes data regarding the continuous evaluation of suppliers as well as feedback information (e.g. complaints, suggestions, results from satisfaction surveys) from customers or other relevant stakeholders.

Many proactive sources of data, including that resulting from the application of Voice of the Customer tools (e.g. customer workshops, focus groups, Hall tests), are usually used to determine the needs and expectations of the interested parties (clause 4.2) in the management system. The understanding of such needs and expectations, including their evolution, is of course a core factor to identify and proper scope potential Lean, Six Sigma, or DFSS projects.

Results from first-party or internal audits (clause 9.2), but also from second-party (audits that are conducted by parties having interest on the organization, such as customers) and third-party audits (audits that are conducted by external and independent auditing bodies, such as certification bodies) provide other relevant sources of data and information. The results can be already available in auditing records, such as existing audit reports, or be proactively gathered by programming the realization of system and conformance audits.

Data which helps an organization to gain knowledge about the most frequent and concerning nonconformity situations (clause 10.1), including those related to the product or service, can of course lead to the identification of opportunities for improvement, and thus to the detection of potential Lean and/or Six Sigma projects. Historical documentation containing root cause analysis to determine the reasons for the existence of nonconforming products, the definition and implementation of corrective actions, and the assessment of their effectiveness can also be worthwhile to identify potential projects.

The requirements under clause 4.1 of Annex SL encourage organizations to determine and understand relevant internal and external context issues that are likely to affect their ability to achieve the intended outcomes of their management system. Among the intended outcomes are the needs and expectations of customers and other relevant stakeholders, including the applicable legal requirements, as well as the objectives (clause 6.2) that are set for the relevant functions and levels of the management system. Autoevaluation activities can assist organizations to assess their ability to achieve those desired outcomes, being also useful in generating data to unveil their strengths and areas for improvement, which in their own turn can lead to the identifications of potential projects as well. It is also important to realize that many internal context issues (corporate culture and values, organic structure, competence centers and knowledge, technology, among others) and external context factors (legal, economical, social, technological, political, and other environmental dimensions) are dynamic, so their evolution can have impact over an organization's business and ability to achieve the desired outcomes; it is thus important to systematically collect and analyze data to understand the main drivers of change, which can also uncover interesting opportunities for improvement.

Clauses 4.1, 4.2, 9.1, 9.2, and 10.1 thus provide factual data and evidences that once analyzed provide means for the identification of opportunities for improvement and innovation; in addition, they also enable the determination of risks (clause 6.1). Altogether, these opportunities and risks allow an organization to better identify and well-scope potential Lean, Six Sigma, and DFSS projects. A list of potential projects is thus created. The evaluation, prioritization and selection of projects can be periodically performed during the management review process (clause 9.3). The most promising project(s) should be selected attending to their relative merit in contributing to the achievement of the management system objectives (clause 6.2), which should be aligned with the management system policy (clause 5.2).

Annex SL clauses applicable in the project planning, execution & completion and post-project

Each selected project needs to be properly planned before starting its execution. Project planning decisions, in particular regarding project goals, should be aligned with the objectives for the management system of the organization (clause 6.2). To ensure that this is indeed the case, the goals defined for each Six Sigma project

should derive and be aligned with quality objectives. Another important planning activity concerns the anticipation, prevention and mitigation of risks (clause 6.2) for the integrity of the management system, as a result of the introduction of improvements that may lead to unintended changes or adverse side effects in the system as a whole (clause 8.1).

A certain selected improvement project is then executed according to the most suitable roadmap. Lean and/or Six Sigma projects are carried out according to the DMAIC methodology, while DFSS projects, which usually derive from opportunities for innovation, can be conducted according to the DMADV (Define-Measure-Analyze-Design-Verify) roadmap for product/service or process redesign efforts, or to the IDOV (Identify-Design-Optimize-Validate) sequence for new product, service or process design and development.

Especially for the case of DMAIC projects, corrective actions (clause 10.1) can be defined, implemented, and their effectiveness confirmed, in order to eliminate or minimize the causes of nonconformities detected during the Analyze phase.

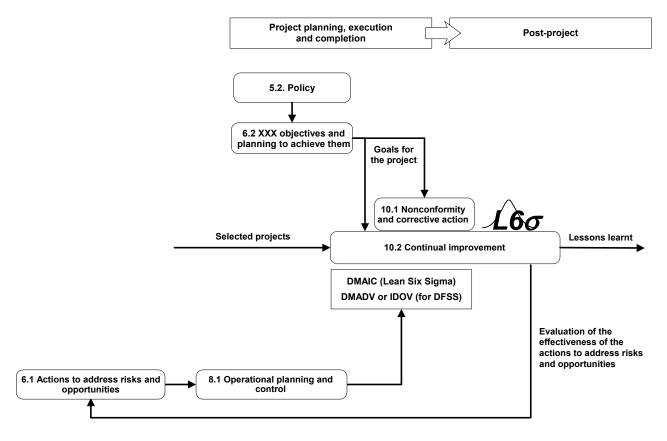


Figure 4 – Detail of the general integration model for the phase comprising planning, execution, and completion of the project, as well as post-project activities.

Regardless of the adopted methodological approach, the reasoning behind the PDCA (Plan-Do-Check-Act) cycle is followed, so that any Lean Six Sigma or DFSS project contributes to the continual improvement of the overall management system (clause 10.2).

When completed, the effectiveness of the project results should be assessed, hereby including actions undertaken to address risks and opportunities (clause 6.1) that led to the project identification. The lessons learnt, derived from all such projects, should contribute to increase the effectiveness of future projects, but also to the improvement of the management system.

Annex SL clauses applicable to all the project life cycle phases

Most of the clauses included in section 7 (Support) of Annex SL, as well as clauses 5.1 and 5.3 from section 5 (leadership), are related with all of the four life cycle stages of a Lean, Six Sigma, or DFSS project. The quality principle of improvement, embedded in clause 10.1, is also considered to be common to this set of four phases. Clauses 4.3 and 4.4 define the context and the borders of the management system, are also considered here.

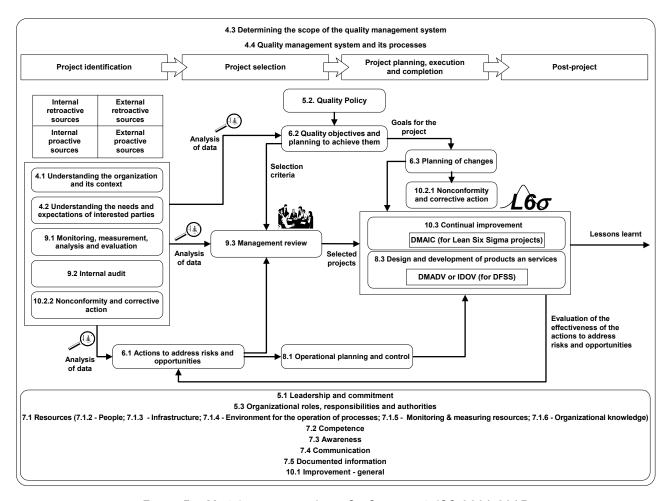


Figure 5 – Model to integrate Lean Six Sigma with ISO 9001:2015.

Utilization of the general model to integrate a Lean Six Sigma program with the new ISO 9001:2015 quality MSS and ISO 14001:2015 environmental MSS

The general model can now be used to integrate a Lean Six Sigma program with any MSS that follows the high-structure provided by Annex SL. Only slight adaptations need to be done for each particular situation.

ISO 9001 and ISO 14001 are the most relevant international management system standards and recently, in 2015, new versions of these two normative references were published, already in line with the structure and terms adopted by Annex SL.

Figure 5 depicts the specific model proposed to integrate Lean Six Sigma with a QMS based on the requirements of ISO 9001:2015. In this case, the standard contains a specific clause (8.3) for design and development projects, which are equivalent to DFSS projects.

In its own turn, the integration model for taking advantage of the synergies between an EMS based on ISO 14001:2015 and a Lean Six Sigma program is shown in figure 6.

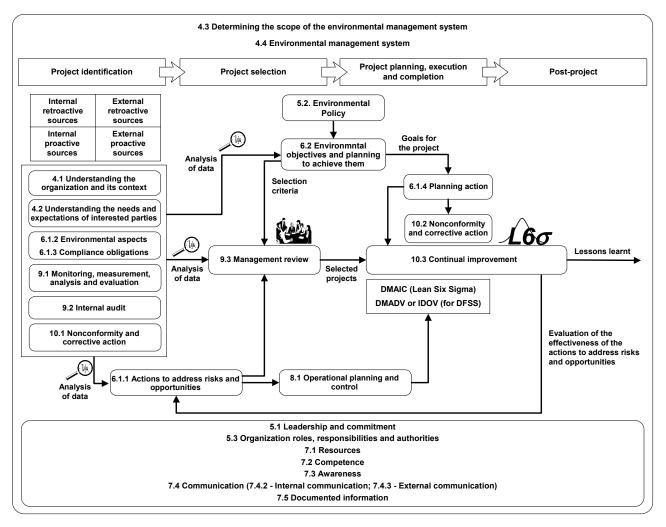


Figure 6 – Model to integrate Lean Six Sigma with ISO 14001:2015.

CONCLUSIONS

This paper presented a new model to integrate a Lean or Six Sigma program with the new versions of the management system standards, which already follow the terminology and high-level structure provided by Annex SL. The model is built around the framework provided by this Annex SL, where the different clauses and sub-clauses therein contained are arranged along the life cycle stages of an improvement project, which can be based on a Lean, Six Sigma, or DFSS approach. The general integration model, which can be used to integrate a Lean Six Sigma program with any type of management system standard published by ISO, was further detailed for the specific case of quality management system standards (ISO 9001:2015) and environmental management system standards (ISO 14001:2015). Two new avenues of future research are opened with this paper: the first one is to test the proposed model in companies from different business sectors; the second avenue is to particularize the general integration model to the scope of other management system standards.

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Employeeship

- the missing link between leadership and good results

Marita Bergendahl, Consultant, Sandholm Associates

Dr Lars Sörqvist, Associate Professor, Royal Institute of Technology

Stockholm, Sweden

ABSTRACT

Over time thousands of books has been written about leadership and management but very little about employeeship and how to act as a good and successful employee. Leadership is how to get people in an organization to do what they should do to reach goals in a highly motivated and committed way. But leadership has hard to work if there doesn't exist a relevant employeeship in the organization. Lack of good employeeship can make leadership hard or even impossible. A common and well-defined employeeship is an important quarnerstone for a good culture in the organization among the good leadership.

Most quality management and business excellence models address employee commitment, participation and competence heavily, but very little in this area are part of the quality methodology and toolbox. The understanding of the importance of building a quality culture is good but very little is written about how to do this and how to build a good employeeship. The key to success is creation of a strong and well-defined employeeship in the organization based on clear values, awareness and competence. There is also a need for tools related to development of people and their behaviors.

Employeeship is in many ways a reflection of leadership. Employees are in a way responsible for leading themselves, their relations and their own work. The foundation for good employeeship is responsibility for the own work and the result of this. Work should be done in a professional way with strong commitment. Loyalty and trust to the organization are another vital part of employeeship. Creative and curious questioning without judgement, rethinking and focus on improvements are central. Successful employeeship is based on a holistic view with strong focus on understanding of both customers and business processes. Co-operation within their own organization and cross-functional is natural. Respect is shown for other employees and their competence. Responsibility is taken for personal skills, learning, development and health.

This paper will discuss the need and meaning of good employeeship. Different important dimensions of employeeship will be introduced, a model developed by the authors for employeeship will be described and success factors for building good employeeship in an organization will be presented. The paper is based on many years of experiences working with leadership and employeeship from the authors, specific experiences from Scania, SKF, Volvo and the Swedish Armed Forces and results from focus groups interviews with Swedish quality managers.

Background

We have both been working with business development, continuous improvements, quality management and business excellence for decades as consultants, leaders and researchers. Very often we have meet situations organizations have a strong focus on structural development while cultural development is forgotten. The effect of this is lack of good results and unsuccessful initiatives. When working with concepts like Lean, Six Sigma, TQM etc. this happens very often. As a result of this the cultural aspects of quality are discussed more and more. Most of those discussions have to do with lack of good and committed leadership and how to lead change. Business excellence and quality management models include involvement of people and employee commitment but this is mostly expressed rather vague. It is known that this is very important but the knowledge about what to do is limited.

Our experiences from working with hundreds of different companies and organizations over the years, both as consultants and researchers, is that the employee side of change often is misunderstood. Finding the concept of employeeship (medarbetarskap in Swedish) within some successful Swedish companies gave us both a feeling of a possible solution of this problem. Since when, we have spent time understanding, exploring and develop this rather new subject area.

Employeeship has to do with responsibility, commitment and behaviors among employees. This is one of the missing links between leadership and good results. Without right culture and behavior among employees the possibilities to have a good leadership is small.

The purpose with this paper is to discuss the need for and meaning of good employeeship. Different important dimensions of employeeship will be introduced, a model developed by the authors for employeeship will be described and success factors for building good employeeship in an organization will be presented. This paper has the intention to describe a scoop and importance of a concept within very little research yet have been carried out.

Research methodology

Our research work started with doing a literature study within the area of employeeship. The first question we encountered was witch terms to use in English. In Sweden some research had been carried out at the University of Gothenburg and at Lund University. In this research the Swedish term "medarbetarskap" is used that in English publications often is translated to employeeship. Anyway it looks like most Swedish researchers are not really satisfied with this term as it not fully covers everything that is included in the Swedish term. Another term that sometimes is used is co-workership.

We found very few search hits outside Scandinavia and especially outside Sweden. When we found sources outside Scandinavia they are usually not very relevant as they refer to something rather different compared to what is meant by "medarbetarskap" in Swedish organizations. Our feeling more and more became that employeeship is something that have develop most in organizations in Scandinavia. Possible reasons for this will be discussed later in this paper.

Most information found about employeeship is written by consultants and organizations performing training of their employees. It seems like the development of employeeship mostly is driven by people practice this in organizations and that researchers on universities still have much to learn. Because of this we decided to focus more work on studying ongoing employeeship initiatives in Swedish companies. As a starting point we studied activities focusing on employeeship and cultural development among employees in organizations like Scania, SKF, Volvo and the Swedish Armed Forces. We have also had the opportunity to study company internal documents and training materials regarding employeeship from a number of other Swedish organizations. The result of this was a variety of different approaches and dimensions of employeeship.

Based of qualitative analysis through clustering of dimensions and comparison of different models we put up a test model for employeeship. To develop this model further we performed focus group interviews with totally 50 Swedish quality managers in groups of 5-7 persons. During those activities we let them discuss and question our test model. This resulted in a lot of new views and comments that we used to develop the model presented in this paper.

The next future phase in our research work will be to continue to test this model in focus groups and also perform pilots in companies and organizations. We will also explore the different dimensions pointed out in this first study much deeper through both literature studies and empirical research in companies and organizations that have successfully been working within those areas.

History of employeeship

Employeeship is a relatively new concept in the subject area of management. In Sweden the focus on employees and co-workers have a long tradition. More than one hundred years ago a stable situation was formed on the Swedish labor market. The strong socialistic government created a good relationship with strong worker unions in the early 1900s. A culture of consensus was created with focus on co-operation. What is good for employees are in many situations good for employers and vice versa became the Swedish way of thinking and acting.

The Swedish word "medarbetare" became popular in the 1980s and was more and more used instead of worlds like employee, worker or subordinate. The meaning of this Swedish word is difficult to translate. Co-worker is the direct translation, but the meaning of the Swedish term is much wider. This probably depends of the Swedish historical and cultural relationship between employees and employers mention above. In the 2000s, the concept of employeeship ("medarbetarskap" in Swedish) was introduced with the purpose to communicate what is expected of employees in a working situation. Again the translation is difficult. In this paper the authors have chosen to use the world employeeship even if it doesn't have exactly the same meaning as the Swedish word "medarbetarskap". An interesting reflection of this is that the automotive company Volvo Cars that work worldwide with employeeship in their plants have chosen to use the Swedish world "medarbetarskap" even in English documents.

Today most companies and organizations spend a lot of time and efforts to discuss and define what good leadership is, but the focus on what good employeeship means is still very unclear. Thousands of books and researchers have discussed leadership. There are leadership training providers easily available. About employeeship very little is written and very few training program exists, if none.

What is employeeship?

There is no common definition of employeeship. The concept of employeeship has to do with responsibility and commitment among employee in an organization. It is about co-operation among people and a mutual endeavor to deliver results. Employeeship also has to do with loyalty to the organization and respect for other employees. Development of skills and participation in continuous improvements of the organization is also central parts of the concept.

Our definition of good employeeship is the responsibility and commitment among employees, in co-operation with other employees, to strive to do what is of important to the organization and its customer and to continuously develop and improve this ability. To understand the concept of employeeship there are several dimensions like responsibility, commitment, loyalty, co-operation and development that are central and necessary and therefore are of importance. Those dimensions will be discussed later in this paper.

There are two ways of looking at employeeship. Either is employeeship the other side of leadership. Managers that apply leadership in his och her work lead someone. The person being led is an employee. This employee use employeeship to be able to be led in a good manner. Employeeship is in this perspective the way to become a god employee. The other way of looking at employeeship is as the employees approach to lead his or her own work. Employeeship could in this perspective be seen as leadership among employees. Every employee is a kind of leader that uses a personal leadership to carry out his och her work.

Effects and results of good and bad employeeship

Bad employeeship costs organizations a lot. Employees that lack commitment, motivation and loyalty can be extremely costly. People that don't take responsibility for quality, deliver in a professional way and/or have wrong attitudes can damage a lot for an organization. Dissatisfied employees that doesn't co-operate and respect each other's skills and competence could be a disaster.

Highly motivated and committed employees are on the other side an extremely valuable asset in an organization. People that take responsibility, works together in an effective teamwork and feel well provides the basis for good results. Good employeeship has to do with work satisfaction, proudness for the own organization and prosperous. Those are things that are of big importance for a successful organization. Things like this are also significant for the development of a culture that supports continuous improvements, creativity and rethinking.

A good employeeship in this way creates conditions for delivering fine results. Good employeeship is needed for getting more satisfied customers and more effective processes. It is the basis for both effectiveness ("doing the right things") and efficiency ("doing things right"). Together this affects both the income and the costs of a company and that way strongly effects profitability.

The employeeship model

As a part of our research work on employeeship we have developed a framework for employeeship based on a process including necessary requirements for good employeeship, how leadership and management interact with employeeship on a daily basis to "regulate", dimensions of good employeeship and effects and results of good employeeship. The model describes both the cultural and structural sides of this. The idea with this model is to visualize the concept of employeeship and by that make it more understandable. This model of employeeship is found in figure 1. One of the major reasons for putting up this model early in our research work is to create a framework for continuous development through tests. One other is to be able to communicate the meaning of employeeship.

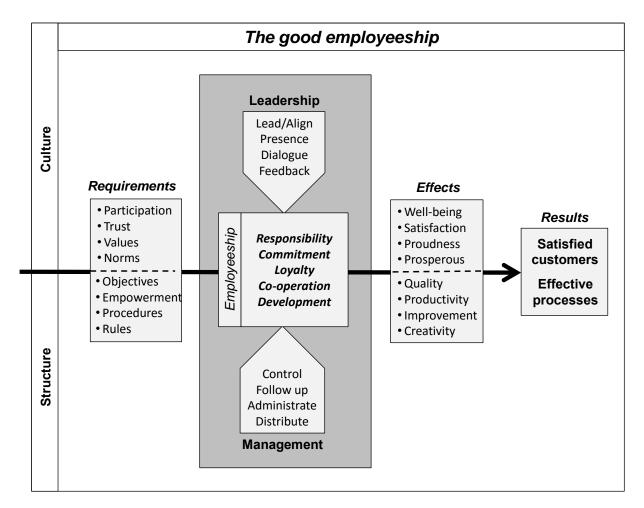


Figure 1. The employeeship model. The grey part in the model represents a daily commitment from both the employee and the leader, where the leader has to work on both the "culture side" with leadership and on the "structural side" with management.

Requirements for good employeeship

It is not easy to build a good employeeship and one of the more important things is to give the employees a platform to act from, to *give* a clear structural platform and *create* a safe cultural platform. We have found a number of important and mandatory requirements that have to be fulfilled if the establishment of employeeship should succeed. Besides those requirements even leadership and management plays a crucial role in a continual development of good employeeship.

Participation and involvement of employees is the basis for employeeship. Commitment arises through participation. Motivation depends on participation. *Trust* and safety are also of big importance by creating an "open" climate. To give people a feeling of trust continuity and a long term perspective is necessary. This puts great demands on leadership and management.

Clear values and norms that are aligned are significant. This creates a common understanding among employees about how to act and behave in different situations. It could also be wise to define the meaning and content of employeeship in the own organization. Important is as well to give responsibility, empower people and make the situation clear and easy to understand. Part of this is to establish common processes, procedures and rules. Measurable and understandable objectives that are broken down to individual level makes people aligned and help them focus on things that are important.

Training and development of people are likewise of importance. Activities to support well-being of employees, both physical and mental, are a part of creating a good employeeship. In those areas a lot can be done by the employer. Central is also to involve people in *continuous improvements* and to promote an improvement culture in the entire organization.

Dimensions of good employeeship

We have found five dimensions that describe good employeeship. To get there the requirement above has to be fulfilled. It's the organizations oblige to make/cerate that before it can demand a good employeeship. They dimensions are all rather complex and take time to understand and develop. Because of this establishment of a good employeeship should be seen as a cultural transformation for the entire organization. A never ending journey that will take years but at the same time gives interesting results all the time.

- A. Responsibility. Employeeship is based on responsibility. Employees should take and feel responsibility. That includes responsibility for doing a good work, for delivering nothing but quality all the time and for personal learning, development and responsibility for the own well-being. Awareness and understanding are important to be able to take responsibility.
- *B. Commitment.* Participation and involvement creates commitment. Motivation as well plays an important role in the development of commitment among people. Strongest is internal motivation that depends on an inner conviction. External motivation based on demands or rewards is weaker. Central is furthermore the ability among employees to dare and their will to take initiative.
- *C. Loyalty.* To be faithful, honest, solidary and trust worth is part of this dimension. Loyalty to the organization and to have correct attitude is important. Loyal employees often become ambassadors for the organization. Important to create loyalty among employees are trust, proudness and that people feel themselves valued. The strongest loyalty come from inside and is based on feelings and belief and are not just based on agreements, rules and employment.
- *D. Co-operation.* To co-operate locally on the workplace is important, but also to co-operate cross-functional over organizational borders. Respect for other people and their skills, fellowship and solidarity are basis for co-operation. A holistic view, clarity and involvement of people are other important factors. God communication between people is also a critical factor for co-operation.
- E. Development. Employeeship has a lot to do with development. Both personal development of skills and competence as well as development and improvement of the own work and affected processes. Central is participation in continuous improvements activities and contribution with good ideas and proposals for improvements.

And at last but not the least, it's important not to forget the importance to have fun in the workplace, as that empower all above...

Conclusions

Employeeship is a very important success factor for an organization and creates a link between good leadership and good business results. Good employeeship is needed as a necessary complement to good leadership. Good employeeship is about creating a culture based on responsibility, commitment, loyalty, co-operation and development. This is still an very unexplored area and this paper has the purpose to clarify the meaning of employeeship and present a model that describes the important dimensions and requirements of good employeeship. Based on this that we will continue to explore and develop the concept of Employeeship in further research.

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Biography of the authors

Marita Bergendahl is management consultant and specialist in business development, leadership and process management. She has a Master Science from the Royal Institute of Technology and an education in Organisational Development. Bergendahl has been working for many years in the Swedish Armed Forces with responsibility for management systems and security. She also has deep experience of management and business development from many other organizations.

Dr Lars Sorqvist is president and partner of Sandholm Associates. Over the years he had supported hundreds of organization in many different countries within the area of Quality Management. He has a doctorate in Quality Management since 1998 and is Associate Professor at the Royal Institute of Technology. Sorqvist has published seven books in Swedish and Mandarin (Chinese) and many articles. He is vice president of the International Academy for Quality (IAQ), chairman of the nomination committee of the Swedish Institute for Quality (SIQ) and board member of Business Excellence Sweden and Swedish Quality Management Academy. Sorqvist is also deeply involved in numerus projects within European Organization for Quality (EOQ) and American Association for Quality (ASQ).

Improving the quality of life through Six Sigma

lorga, D., PhD Eng.

Assistant Professor at FAIMA, University Politenica of Bucharest

Scafa, A., PhD

Assistant Professor at Bucharest "Medicina si Farmacie" University "Carol Davila"

Ionescu, S., Professor PhD. Eng.

Professor at FAIMA, University Politenica of Bucharest

Scarlat, C, Professor PhD. Eng.

Professor at FAIMA, University Politenica of Bucharest

ABSTRACT

Purpose - Because the relation between patient and medical personnel is often "very corporal", the implications of the quality of this relation are significantly high on the patient's satisfaction regarding the healthcare performance. This paper focuses on finding ways to develop a Quality Matrix that could help to control and improve the methods to manage the recovery process of the patient health who suffered a myocardial infarction.

Design/ Methodology - The current paper analyses a direct survey on a 500 persons' sample to identify the relation between different factors that affects the patients' QoL who received a hospital intervention for myocardial infarction.

The authors adapted Six Sigma methodology in order to create a Quality Matrix. In the analysis step the main tool was logistic regression.

Findings - A Quality Matrix was defined to help medical personnel to survey the correlation between factors (methods) and results in order to improve the patient health and satisfaction. Also, based on research the authors took into consideration the opportunity to design an IT online platform in order to improve the communication between the specialist and the patients.

Research implications - Continuous improvement methods in healthcare sector is a premier in Romania. However, because the research was limited to the one major emergency hospital, the paper conclusions should be inferred with caution. Therefore, the next step is to extend the analysis to the entire country.

Keywords - Quality of Life Management, Six Sigma, Logistic Regression, Quality Matrix

INTRODUCTION

The medical health care sector in Romania is evolving and many aspects of quality management became subjects of interest for medical professionals. One of the sensitive areas is myocardial infarction treatment that is influenced by the level of personnel skills, accuracy of the medical procedures and the effectiveness of the treatment.

This paper focuses on finding ways to develop a Quality Matrix that could help the medical personnel in charge to control and improve their methods to manage the recovery and maintenance process of the patient health who suffered a myocardial infarction. For this reason, the current paper presents and analyses a direct survey on a 500 persons' sample to identify the relation between different factors that affects the patients' quality of life who received a hospital intervention for myocardial infarction. The paper shows the impact regarding the time recovery and utilized methods on the patients' quality of life and emphasizes the importance of these results from economic and social perspectives.

For this research authors used the Lean Six Sigma methodology in order to conduct the research and also to analyze the results of the survey. From this perspective the research could be considered a premiere in Romania in terms of applying a continuous improvement method to identify the critical factors that influence the myocardial infarction patient recovery process.

RESEARCH METHODOLOGY

In order to achieve the purpose of this paper the authors decided to examine the possible ways to identify the proper methodology. Therefore, they have decided that from project management and research management perspective it could be an opportunity to use continuous improvement and redesign technics of the Lean Six Sigma methodology. Beside this approach, the authors reviewed the literature regarding the quality of life tools utilized by medical specialist to evaluate the recovery process of the patients and the confidence level of the patients during the process. Therefore, the authors took into consideration the Generic Quality of Life Instruments such as EQ 5D (Euro QoL), SF- 6D, HUI (Health Utility Index), SF-36 (Short Form 36) to develop a proper way to identify the main issues related to Quality of Life after Myocardial Infarction moment of the Romanian patients. These tools are classified as multi-attribute utility instruments (MAUI's) and the literature emphasize the "potential of the usefulness" (Brazier, 1993) of these tools in healthcare system. Therefore, in the next paragraphs the authors will present briefly the purpose and impact of the tools which helped in designing the questionnaire sent to Romanian patients (MI). Last decades many more countries decided that the healthcare system needs a different approach regarding the way the patients and health is generally assessed and for this reason the Quality of Life for patients who suffered a major medical intervention is consistently evaluated. One of the series of tools is the family of "short form" questionnaire designed to scale physical and mental components of patient health status. The initial SF 36 was designed to evaluate the physical and mental components of health on eight dimensions (Brazier, 1993). Physical component comprises physical function, role physical, bodily pain and general health. Mental component comprises mental health, role emotional, social function, vitality. The specialists use "short form" family of tools mainly to assess one treatment against an older treatment or an alternative one. Some specialist uses the SF 36 to identify predictors for the Quality of Life of the myocardial infarction patients during the recovery process after 6 months and 1 year (Beck et al, 2001), (Kristofferzon et al, 2005), (Erikson et al, 2013). The rest of the SF family of questionnaires, SF 12 and SF 6D, are even shorter

versions of the SF 36 that evaluate the physical and mental components. The reason for these simplified variants is to help the interviewed person to not be biased by complexity. However, even the main purpose is to evaluate different medical treatments, not always these assessments indicate significant differences between treatments but the age and psychosocial factors are the only important predictors (Beck et al, 2001). Some specialist conducted comparison research between these tools to identify which one is the most appropriate and how sensitive they are. (Cunillera et al, 2010). Based on this research the specialists identified that for their particular geographic area (e.g. Barcelona, Catalonia) the appropriate tools are EQ 5D and SF 12 (Cunillera et al, 2010). The EQ 5D was developed by EuroQOL group and the purpose was to develop an instrument for describing and evaluating health related quality of life (David et al, 2005), (Budaj, 2016). The tool is assessing 5 dimensions respectively mobility, self-care, usual activities, pain/discomfort, anxiety/depression. The EQ 5 D and SF 12 proved to be valuable tools to continually evaluate the health related status of the patient after a myocardial infarction. There are specialists who address the problem of the assessment process of the quality of life using direct recorded interviews based on experts' opinions and the questionnaires are not standardized (Roebuck et al, 2001), (Bagheri et al, 2007) and (Hildingh et al, 2006). Besides the consecrated tools used to evaluate the health related quality of life the specialists are using different other tools for different specific type of affection like Seattle Angina Questionnaire (Longmore et al. 2011). Based on these tools identified in the literature presentation, the authors decided that the guestionnaire that was created must cover the topics related to the physical and mental components but also other specific elements that have to be considered having in consideration the Romanian particularity of the healthcare system, for the example the physician cardiologist from hospital is more involved in offering psychologic support of the patient by direct counseling of the patient during recovery process than other countries (e.g. USA) where the nurses are the main pivot during this period of time. As the authors presented above the Lean Six Sigma DMAIC steps methodology was a very good approach in order to design a Quality Matrix able to emphasize the correlation between the input elements of the medical act and the level of physical and mental comfort perceived by the patients during the recovery process after myocardial infarction incident. The literature shows that health care system is already using Lean Six Sigma improvement tools to enhance the medical processes capability in coronary interventions or hip fractures length of stay time reduction (Kelly et al, 2010), (Niemeijer et al, 2013).

Consequently, the authors made a plan to develop their research based on Lean Six Sigma methodology and they have decided what are the actions and the results expected for each step of the DMAIC deployment. In order to implement or to use continuous improvement methods it is mandatory for the studied activity to generate repeatable and measurable results. Otherwise, the effectiveness of any improvement initiatives is futile. Therefore, the first step for this initiative was to identify the pillars of the process respectively: the inputs, the activities and the outputs.

Business processes vs. Medical processes

The process is defined as a set of activities that transform different tangible or intangible resources in necessary results that are expected by a beneficiary. In order to execute the activities, resources are needed and used.

Processes can be identified in every performed action. Some of them are generated for a precise and non-repeatable event, and others are documented, planned, monitored and maintained for longer periods of time (weeks, months or years).

In a business environment, performing processes represent an important element in order to obtain profit. Therefore, lately, many companies decided to pay attention to a systemic approach of enterprise organization, allocating time for developing resources, capable of using all the benefits resulted from process based management (Jeston and Nelis, 2008). Improvement systems for product quality or for creating new products that start with quality management like Kaizen, TQM and Lean Six Sigma or Design for Six Sigma represent powerful approaches in the entire business structure and in process based activity. Companies such as General Electric, Honeywell, Toyota, etc., have discovered that most of the problems appear in the modulation points of the processes, precisely at the limit of functional areas (Harry and Schroeder, 2000). They all understood that managers must get ready for a process based approach, where the final result is the most important and knowing the entire process ("end to end") by all involved employees is critical in order to perform. Some specialists define organization as: "people, processes, control, and structure mechanisms" (Madison, 2005). In an organization, the "people" dimension can be defined through role, responsibilities, skills, learning, motivation, capability, and work adjustment. The "processes" dimension is characterized by two major flows: work and information. At the informational level, it is important to mention the influence that the control of the informatics system has over the business processes and, also, over the design and redesign methods of the processes.

The General Model for the Process is figured below. In order to obtain a stable process, the people accountable for this process must understand and act to preserve and respect the established procedures.



Figure 1- Business Processes

In medical areas, processes are similar with business processes in terms of purpose. However, the main objective of health care processes is to save life and maintain the patients' quality of life. From this perspective, the healthcare management should take into the consideration that the medical personnel treat patients not diseases. Therefore, each patient is 'unique' and "non-repeatable" and the medical professionals should consider those actions with high risk to introduce harmful effects due to the inconsistent procedures that create variation in results and in consequence to design capable processes to deliver consistency to the patients. When these medical processes are not capable to assure a high level of satisfaction to patients, then the medical professionals must consider the continuous improvement methods such as Lean Six Sigma.

The Six Sigma concept was created in early 80' by Motorola with the purpose to solve the particular aspects of Motorola business processes. After the success obtained by several companies like Honeywell and General Electric based on the implementation of Six Sigma concepts, many other areas from United States decided to implement the Lean Six Sigma methodology by merging the Japanese concept of Lean with Six Sigma from Motorola (George, 2003).

For this paper the authors used the concept of Six Sigma by deploying the DMAIC steps in order to obtain the Quality Matrix for Romanian healthcare professionals. The DMAIC acronym stands from: Define, Measure, Analyze, Improve and Control (Breyfogle, 2003), (Pyzdek, and Keller, 2010). The authors considered to use only

the structure of the project approach which is typical for Six Sigma in spite of the fact that the hospital where this research was conducted is not having implemented the continuous improvement system Six Sigma at the organization level. This is only a limited initiative with the scope to demonstrate the efficiency and effectiveness of the Six Sigma methods in helping medical personnel and even researchers to achieve consistent results in their initiatives.

Six Sigma – Define step

Therefore, In the **Define** step the authors identified based on the professionals' knowledge and patients' feedback the problems and the objectives of this research. Also, in this step the authors collected relevant information from available literature regarding QoL evaluation as it was performed in other parts of the world. Based on these data collections, the authors designed a questionnaire customized to the situation of the moment that took into account the fact that patients were surveyed for the first time. The biggest unknown was their availability to respond. Therefore, the authors decided to create and send a questionnaire to the patients on condition that the patients will not behave as we hoped.

Define step - Questionnaire presentation (main output of this step)

The questionnaire objective was to collect data from patients who suffered a myocardial infarction accident regarding their period of recovery, quality of medical act and the patient health evolution after cardio vascular incident. All the patients selected in this study were from "Clinic Emergency Hospital Floreasca" records. The patients were hospitalized with the diagnostic of acute myocardial infarction and all of them made an emergency coronarography. The patients selected in the study had the time range, from the moment of the myocardial infarction incident versus the moment when the questionnaire letter was sent between 6 months minimum and 3.5 years' maximum. From the total number of contacted patients of 1400 persons, 497 people answered and 26 were dead at the moment of survey.

The questions from the questionnaire were designed to have a five or more gradual answers, based on severity, using an ordinal scale ranked based on evaluation of the medical specialist, the coauthor. One of the limitation of this scale is the lack of proportionality. Therefore, a 4 level rate is not two time more severe than a 2 level rate. However, the authors considered that for the actual stage and purpose of the paper it will be satisfactory. For example, for the question 4 presented in Table 1, the available answers on the questionnaire are from the lowest to the highest severity level as follows: rate 1 "No, I had no pain", rate 2 "Yes, mildly, I didn't need to go to the physician", rate 3 "Yes, I went to the physician, there were no problems", rate 4 "Yes, I needed to be hospitalized due to the pain", rate 5 "Yes, I have been hospitalized and the physician made a coronarography". Therefore, in the Table 1 the researchers presented the sequence order of the severity. The paper uses this scale in order to have a higher level of distinction between the patients answers for the medical purposes and a higher degree of segmentation from the social and economic perspective.

This study was done after the implementation of a new treatment in myocardial infarction, primary angioplasty (presentation of this treatment is not the purpose of this paper). Beside the patient recovery process, from medical perspective, very important in this study was the feedback regarding the level of the patients' satisfaction after the medical intervention and health care services. Also, the researchers intended through the questionnaire to understand and evaluate the patients' evolution from social, psychological and economical perspective.

Table 1 – Ouestionnaire presentation

	Table 1 – Questionnaire presentation					
No.	Customer impact	Detailed question	Answer – number of choices	Type of data – nonproportional scale		
1	Customer satisfaction	Are you satisfied of medical service level offered during the hospitalization for myocardial infarction?	· ·	Ordinal scale (discrete), decreasing severity order		
2	Customer satisfaction	How do you rate the quality of medical service that you received?	5 answers	Ordinal scale (discrete), decreasing severity order		
3	Patient initial health status	Was the chest pain perceived for the first time in your life at the moment of the myocardial inflation?		Binomial		
4	=			Ordinal scale, increasing severity order		
5	Patient post medical intervention health status	Have you been hospitalized after the myocardial infarction first medical intervention?	6 answers	Ordinal scale decreasing severity order		
6	Economical	How long did you stay in sick leave after the myocardial infarction?	6 answers	Ordinal scale increasing severity order		
7	Economical	Did you need sick leave periods after the first year from myocardial infarction medical intervention?		Ordinal scale decreasing severity order		
8	Economical and quality of life	What is your physical capacity of movement and action?	5 answers	Ordinal scale increasing severity order		
9	intervention health status	How many floors can you climb? What distance can you walk? (without exhaustion)	5 answers	Ordinal scale decreasing severity order		
10	Level of impact of myocardial infarction	Did you need a coronary revascularization procedure after the myocardial infarction?		Ordinal scale increasing severity order		

11		Have you been diagnosed with diabetes after the myocardial infarction?		Binomial
12	Risk prevention from health perspective (medical project management)		5 answers	Ordinal scale increasing severity order
13	education regarding	Have you been involved into a health recovery plan after the myocardial infarction		Ordinal scale increasing severity order
14	medical system capability	Have you been tested after the myocardial infarction for effort test or any other provoked ischemia heart disease?		Ordinal scale increasing severity order
15	Risk Prevention	Have you been blood tested?	4 answers	Ordinal scale increasing severity order
16	Customer relationship management	Do you think that an internet website where you can address questions to medical professionals would be valuable for your needs?		Binomial
17	Risk prevention	Who is your medical adviser in myocardial infarction recovery treatment		Ordinal logistic decreasing severity order
18	Economical	How much is the medication comparing with your month income?		Ordinal scale increasing severity order
19	Economical	How much is your family income	5 answers	Ordinal scale decreasing severity order
20	Risk prevention Patient behavior	Do you respect the prescribed treatment?	5 answers	Ordinal scale increasing severity order
21	Medication	What is your daily dose for you medication?	13 answers	Ordinal scale decreasing severity order
22	Economical	How long was the period for your reintegration in society after the myocardial		Ordinal scale increasing severity order

	infarction?	
23	How long was until you felt fully recovered?	Ordinal scale increasing severity order
24	Who were the people that helped you to overlap this difficult period?	Ordinal scale increasing severity order

Moreover, as the paper mentioned above the authors had inspired from a number of instruments (questionnaires) in order to capture also specific information regarding physical and mental health patients' status. Therefore, SF36/ SF12 and EQ 5D are mainly influencing the questionnaire presented, besides other sources, even there are not the main scope of the paper. In this aspect the paper will reveal in the following table the association between the questions created in the paper instrument and the classic instruments presented in the paper introduction.

Table 2 – Questionnaire association with classic instruments (SF36/EQ5D)

SF36 EQ5D	Physical functioning	Role physical	Bodily pain	General health	Vitality	Social functioning	Role emotional	Mental health
Mobility	Question 9	Question 23		Questions 12, 13				
Self-care		Question 7				Question 22		
Usual activities					Question 8			
Pain/ discomfort			Questions 3, 4	Questions 5, 6, 10				
Anxiety/ Depression							Questions 16, 24	Questions 1, 2

The questionnaire items 11, 13, 14, 15, 17, 18, 19, 20 and 21 are designed to assess the perception of the patients regarding their relation with the medical system from Romania.

The results of this questionnaire together with the interpretation done by authors based on medical and statistical knowledge revealed that some of the factors are correlated with the level of recovery after the myocardial infarction and shows opportunities to create a transfer matrix between quality of life indicators and effectiveness of recovery process and medical survey. Beside this questionnaire, the authors used the information recorded at the moment of hospital admission by the medical personnel such as information regarding medical history (diabetes issues, hypertension, bad behaviors and others). Therefore, the authors decided that the main objective of the research was to *design a tool named Quality Matrix* in order to find the dynamic relations between medical services/advises/communication and the level of satisfaction of the patients regarding their Quality of Life level.

Six Sigma – Measure step

The second step **Measure** was based on collecting the information from the patients which have send their feedback through the questionnaire. In this step the authors verified the answers and prepared the data to be analyzed.

Based on the information received from the patients we have obtained qualitative data which was interpreted as results of the medical act and the influence of the family and the social environment on the health process recovery of the patients.

Also, the authors decided that some attributes and factors should be considered as input elements for the future *Quality Matrix*. The problem identified related in the collected data was that the most of the information represent patient perception. Therefore, the accuracy of the data had a high level of relativity due to the length of the period in scope for each person and also due to the particular events they had lived near to the questionnaire completion. The people tend to change their minds if something have a higher impact close to the moment of the interview even that event is not related with the matter in question.

Therefore, the authors validated that the output of the Measure step is the following list of factors that should be analyzed in order to understand what is important for the patients to improve their quality of life after the myocardial infarction. Also the authors decided to verify the assumption made by the medical specialist that there might exist relations between the following list of factors.

Table 3 – Output vs. Input critical factors

Tuble 3 Output	vs. Iliput critical factors
Input factors (classification based on medical point of view)	Output factors (critical results)
Severity of patient health status at hospital admission (Kilip class). Measurable factor	General health status of the patient based on personal perception
	General health status based on post myocardial infarction hospital admissions and interventions
Treatment methodology and type of drug prescription. Controllable factor	Recovery time after medical interventions
Patient medical history such as diabetes, hypertension or other significant health problems that could influence the severity of risk. Measurable factor	activities
Personal behavior regarding negative enhancers such as smoking. Measurable factor	The economic impact of the cost of maintenance and treatment on the patient quality of life
General information regarding first symptoms of myocardial infarction. Measurable factor	The level of the confidence of the patient based on the perception of help received from the family and society in general
General perception of the patient regarding the	

medical act during the hospitalization. Measurable factor	
General perception of the patient regarding the medical act during the recovery period Measurable factor	
Level of cooperation of the patient during the recovery period. Measurable factor (the reaction could be influenced by communication)	
Medical system capability to have a positive influence on the patient trust during the recovery period. Controllable factor	
The patient level of understanding regarding the importance of rehabilitation programs post myocardial infarction. Measurable factor (the reaction could be influenced by communication)	
The level of acceptance of online communication with the medical specialists. Measurable factor (the reaction could be influenced by communication)	
Total income of the patient. Measurable factor	

Based on the data collected the authors carried on to the next Six Sigma step.

Six Sigma step - Analyze

The third step **Analyze** was the moment when based on the questionnaire answers the authors verified and interpreted from statistical and medical perspective all the information contained in the 497 questionnaires received from patients. In this step the authors draw conclusions in order to create the Quality Matrix. Therefore, based on the questionnaire results, the authors will present an example (questions 22 vs. 21, 15, 16 and questions 23 vs. 21,1) of how the data received from the questionnaire had been analyzed with the help of logistic regression in the following table:

Table 4 – Correlation/association analyses example

		Tubic 1 O	orrelation, association analyses example				
Output vs. Questions Impact		Impact	Correlation				
Input	number						
General health	22&23	46% of the	(22vs.21) The research (based on ordinal logistic regression)				
status of the		patients	identified a correlation between perception of the patients and				
patient based		declared that	the medication at admission, however this indicates that				
on personal		they became	clopidogrel is having a positive relation (odd ratio are almost				
perception		fully	double, p value for coefficient is < 0.05, and test for all slopes				
		operational in	indicate they are not equal 0, p < 0.05) with patient recovery				
		3 months or	time while the statine is having a negative relation. (22vs.15)				

more	The research indicated a moderate association between the frequency of blood testing and the duration of the reintegration in social life after the incident. Therefore, is 41% more likely to associate immediate integration if the frequency is higher (odd ratio is 1.41 and p value is 0.000 , test for all slopes indicate they are not equal 0 , $p = 0.000$). (22vs.16) The research indicated an association between interest of the patients and perception of integration (43% is more likely to integrate earlier the patient with the preference for online communication, odd ratio 1.43 , $p = 0.037$). Test for all slopes indicates they are note equal zero $p=0.03$
patients declared that they recovered within 1 month period and 65% in 6	(23 vs.21) the research identified (based on ordinal regression) an association between the absence of statina and sartan with the perception of the patient regarding the shorter time for recovery (odd ratio are almost double, p value for coefficient is < 0.05, and test for all slopes not equal 0, p < 0.05). (23vs.1) The research indicated a relation between patient perception of medical services and personal recovery. Therefore is 33% more likely to associate an immediate recovery if the medical act was perceived as good

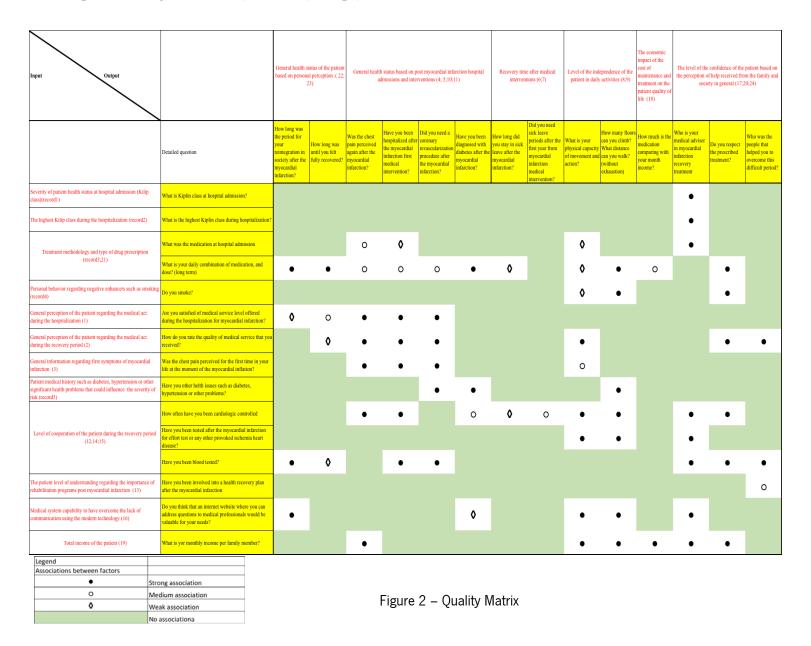
The results presented in above table shows that some of the factors are having a higher impact or are much more associated with the feeling of "wellness" of the patients than others. However, as the paper revealed earlier all these associations between factors should be taken in considerations under the condition that they are only and only part of the patient perspective and that are not showing the real health status based on clinical investigations done at the moment of questionnaire completion. The only data which are reliable are those recorded at the moment of the myocardial infarction and also the prescription medication done by physicians during the hospitalization. Therefore, in the future, the assumptions should be cross validated by combining the patient perception and clinical results at the moment of questionnaire completion. Consequently, all that will be assumed by this paper should be considered as an assumption made in the "information space of patient perception".

Six Sigma – Improvement/Design

The researchers pursued to create a healthcare Quality Matrix in order to survey and monitor the patients from medical point of view respectively: recurrence of symptoms, number of hospitalization after the first incident, necessity of revascularization, therapeutically compliance and medical counseling, treatment and medical services effectiveness. Also, the intention of the authors was to create a survey system to alert and prevent the extreme cases of death and to identify the impact of the social and economic factors. From the authors perspective that could be considered an important step in order to achieve a better recovery process of the patient. Therefore, based on continuous improvement philosophy the Quality Matrix creation should be considered a consistent improvement/solution compared with the moment before this initiative.

Matrix creation

Therefore, the authors decided the structure and the design of the tool named Quality Matrix in order to help the medical personnel to improve their response to patient needs. The main solution for the Quality Matrix was to implement the Transfer Function as a key element that should be embedded based on correlation, validated with the help of statistics. The design of the Quality Matrix was based on principles of the House of Quality, where two families of factors should be correlated, one of the family represents the critical factors from patient perspective and the other family is related to initial conditions/health status of the patients and the quality of the medical act based on patient direct rating. However, currently the paper revealed that the main constraints are related with the fact that most of this information, even majority of the predictor factors are based on patient perception. Nevertheless, at this stage the authors considered that the benefit of the Quality Matrix will be revealed especially by enhancing the effect of the "voice of the patient" regarding the quality of the medical act.



Interpretation of the Quality Matrix results

The QM shows that some of the input factors are having a significant influence to the output factors and that factors could be considered critical for the Quality of Life evaluation based on patient perception. Therefore, the daily medication (question 21) is having the most important association with the output factors of the patients. Beside question 21 there are another critical factors revealed by Quality Matrix such as "question2" (the medical services was satisfactory on long term), "question12" (the frequency of the cardiologic evaluation), "question15" (blood testing), "question19" (the level of the income per family member).

From the output perspective the most important factor is "question8" (capacity in movement and action). Beside question8 the other critical factors are "question17" (the medical adviser is....), "question4" (the chain pain repeated during recovery process), "question5" (the patient was hospitalized again), "question10" (a new coronary revascularization procedure was needed), "question9" (the patient has a high vitality, therefore he can walk and climb stairs without major problems), "question20" (the patient respect the medical prescriptions).

In the Quality Matrix figure the authors decided to symbolize with "•" strong association,

CONCLUSIONS

From the Six Sigma perspective the next step for the current research should be Implementation and Control step. These two steps are not part of the current paper, the research is still work in progress, because for implementation the authors need the implication of the authorities and hospital management. Currently one of the authors who is the main factor of this research works on these aspects. Nevertheless, in order to implement the Quality Matrix, the researchers consider to implement an IT online platform to enhance the effectiveness of the QM. However, at this stage the researchers consider that their findings revealed that the communication and the frequency of patient evaluation as being very important in the future endeavor for enhancing the Quality of Life of the patient. The results of the Quality Matrix association between factors shows that the patient perception when something is going well is always associated with the level of medical personnel implication. Also, an important factor revealed was the level of the income per family member and that indicates that in the future the researches should recalibrate their questionnaire in order to capture more many information from other dimensions of the social and economic life of the patients. As the researched observed during the results interpretation one of the most important thing in collecting data is the frequency of collection and also a good method in alternating the types of interviews, direct and questionnaires.

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Why Should We Hear Our Suppliers?

Dagnino, B.V.

Brazilian Quality Academy, ABQ

ABSTRACT

<u>Purpose:</u> this paper demonstrates the importance of a close relationship between the organizations and their suppliers, considered to be business partners, hearing them on their easiness or difficulties to comply with the requirements (technical and administrative) defined by the buyer.

<u>Design/methodology/approach</u>: initially a questionnaire was prepared, with open and closed questions, which was previously sent to the suppliers with a presentation letter of the superintendant; a survey was carried out formally through personal interviews of fifteen out of sixteen service suppliers of an Environmental Management area of a Brazilian utility, to gather information to improve the procurement process. In general guidelines of the International Standard ISO 10004 – Customer satisfaction – Monitoring and measuring, with due adaptations, were used.

<u>Findings</u>: qualitative remarks contributed to the improvement of the procurement activities of the utility and even extrapolated this objective, since even proposals to improve Brazilian legislation on energy conservation were received (for instance, increase of taxes for electric showers).

<u>Originality/value</u>: The measurement of customer satisfaction is a common practice, but hearing suppliers is not usual. The methodology can be broadened to encompass all stakeholders, for instance public offices. This would mean the extension of the traditional customer relationship management (CRM) to a stakeholder's satisfaction measurement (SRM).

Keywords: supplier's relationship management; supply chain

Classification: case study

1. Introduction

Why should we hear our suppliers? For many reasons: the first one is that they know better the product or service they sell to us than ourselves (if this was not the case, they most likely would have gone out of business).

This paper reports the experience acquired when surveying formally fifteen out of sixteen service suppliers of The Environmental Management Superintendence of one of the largest Brazilian utilities regarding their satisfaction with the utility as a buyer.

2. Survey Execution

The utility had a Superintendence of Environmental Management, with a Energy Conservation Advisory Group, which purchased a variety of services from about sixteen companies or professionals, such as:

- Energy conservation diagnosis
- Design, planning, production, organization and execution of public meetings on energy conservation, to make people aware of its importance (these included both events in theaters as well as large shows in open spaces)
- Entertainers and showmen/ showwomen (individuals and small companies)
- Development and printing of material to be used in energy conservation initiatives directed to different segments of society
- Catering as a support of events
- Design and execution of lighting systems for monuments and public buildings as a corporate responsibility action

In general guidelines of the International Standard ISO 10004 – Customer satisfaction – Monitoring and measuring, with due adaptations, were used. A cover letter from the Superintendent explained the reasons for the survey, asking the cooperation of the addressee to improve the procurement activities of the Group. Nearly all interviews were made personally in the states of Rio de Janeiro, Minas Gerais and São Paulo, in four cities, in the offices of the suppliers. One interview was made by telephone, to avoid travel costs for a more distant location (State of Rio Grande do Sul).

There was a need to present properly the reasons for it, to motivate them to contribute. So, a letter from a Director or Manager should emphasize its importance, thanking in advance the collaboration, and inform that they will be kept informed of the actions arising from the analysis of results.

A personal interview, or alternatively a telephone call, is the most efficient method, because it allows a larger range of information to be collected. Questionnaires sent by conventional mail or electronic are restrictive in this regard, and the answering rate can be very low; furthermore, you don't know who is answering: the director may forward it to the manager, who in turn send it to somebody else, and so one and so forth.

In any case, the questionnaires should not be too long, perhaps with a maximum of 12 closed questions with grades to be assigned from 1 to 10 (the best to increase the discrimination). Add a handful of open questions, the last one for comments, criticisms and suggestions. Once in a people's satisfaction survey a very direct question was included: "Do you think that we are

actually using the results of this survey for improvement actions"? But this of course would not be appropriate to asking for a supplier.

As people's own business, in particular the purchasing or other areas may have a connection or even developed some kind of friendship with the suppliers, it is desirable that the survey is carried out by someone independent from the purchasing process.

3. Results

In general the satisfaction level of the suppliers was between fair to average, and they were happy to provide services for an important corporation, one of the largest Brazilian companies in the electricity area.

Typical comments that originated changes in the procurement practice of the utility were:

- Increase the time lapse for the preparation of large events, since there was a need to hire artists, clowns etc., which required at least a couple of months to identify them and check if they were available as required by the programmed time schedule of the presentations
- Frustration of a competent professional when, for instance, he made a diagnosis of a school to reduce electric energy consumption, and there was no money available to implement the changes proposed; an arrangement to have a partner agreeing previously to support the project should be mandatory
- Contract specifications sometimes were not enough detailed to allow the supplier to know precisely what the utility needed; a review made by a specialist was included in the process to check the existence of gaps or to clarify dubious information
- Changes introduced in the contract at a very short notice; this includes both changes of dates, as well as of the specification of the service to be provided
- Lack of information to the bidders that did not win a contract
- Provide immediate feedback to suppliers on their performance
- Suppliers shall be informed of the utility budgetary limitations, to avoid the development of products and services not economically feasible
- Sponsor meetings with each supplier should be planned, in order the utility personnel to be updated on new techniques, products and services
- Plan also meetings with local suppliers countrywide, in order to expand the range of options and promote opportunities for small companies and, on the other hand, inform them about the utility needs and expectations
- Include in the contracts clauses regarding the supplier's responsibility on safety of attendees when applicable, and the obligation of the supplier to presenting a report after the conclusion of the service
- Changes in contractual conditions or additional clauses or services should be discussed in advance with suppliers, since they need time to adapt to new requirements

Some comments were made even outside the decision power of the area; for instance, tax reduction for electric showers (considered the villain of energy conservation) was criticized, since solar energy systems were not eligible for this reduction; a suggestion was made to the utility top management, to present a change in legislation to correct this distortion.

Other suggestion was the development of specific training material for rural areas, to demonstrate how a farm could reduce electric energy consumption. Another suggestion in the same line was to develop material useful to optimize energy use in offices. The installation of small exhibition halls on energy conservation countrywide with interactive models was also proposed.

Regarding social responsibility, the creation of Sound and Light shows and a list of public buildings and monuments to receive special illumination were presented by interviewees.

An engineer suggested encouraging the improvement of the quality of national lighting equipment, promoting the development of a Brazilian standard, elaborating more stringent specifications, standardizing lamps and fixtures, supporting the development of suppliers and facilitating access to testing laboratories. He also suggested the use of microprocessors in lighting projects, in order to enable the automation of lighting schedules, changing colors (including public holidays) and other special effects.

Also in the technical area, a suggestion was to offer a new product: support the installation of internal committees for energy conservation in any interested organization.

Several suggestions were presented by the suppliers in the communication and marketing area, in order to increase the knowledge of the Energy Conservation Advisory Group and its products by potential customers. These included the creation of a blog and the presentation of webcasts.

The need to identify partners, including other utilities, and sources of financial support was enhanced, in order to allow the provision of the services for additional public offices, schools, hospitals and small organizations. A suggestion to look for customers abroad, especially in Africa and South America was presented.

4. Conclusion

Suppliers are able to tell us whether we are buying in the right way or not. They can say, for example, if what we are specifying is updated or outdated. They can offer the best alternative, either because they are cheaper, simpler, more efficient and effective, and so on. So, suppliers can also tell us if our purchase order is comprehensive, that is, whether it provides enough information to understand exactly what we want, or is vague to the point of running the risk of receiving product or service very different from we had in mind. For instance: does it include package information, guarantee clauses, inspection or test methods, life expectancy, documentation to be provided, after-sales service, safety precautions etc. as applicable?

Their innovation and creativity are focused on what they sell, which should also be our case, which means that our efforts are geared to our specific area of expertise, not for theirs. If you are lucky, considering they know (or should) your manufacturing process, they can even suggest to your organization introducing new products using raw materials or parts they supply. This could be a good signal of a partnership relevant for both parties. Price agreements along the supply chain to foster competitiveness in the global market could also be a result of this close relationship. At a time when partnership is a keyword, having a happy supplier is very important. Among short-term gains and a fairly long-term relationship, both parties prefer the second.

Suppliers can also qualify our degree of openness or intransigence, if asked whether or not we accept new ideas, that is, whether or not we are flexible and open. They can also say if as an organization we are slow, bureaucratic, or agile. They can even say how is the relationship with our staff if they have any contact with our people, or if they as suppliers are satisfied with the payment terms we offer.

Especially in the case of products purchased under order or complex, where the supplier needs time to prepare its proposal and produce, we can ask him if the delivery time we asked for is satisfactory. This is even more critical when the supplier has to purchase products or services from third parties, thus also requiring time to order them.

The supplier can also provide indirectly information about our competitors, because it may also provide goods for them. With care, he can tell us something about them, which is important as inputs for our competitive intelligence analysis.

A supplier can also suggest potential customers for our products or services, or even give us suggestions on new products that fit within our business, since in this way he can also increase sales for our organization.

It is important to ask whether he knows enough our company and our current and future products. For our experience, listening suppliers of a large state enterprise, most of them would like to know more about it and its portfolio of products. Better still if we invite him to participate in our strategic planning, emphasizing integration, fairness, and transparency of relationships.

Thus, the same you do with your customers, you should do with your suppliers: we need to inform them on the improvement actions we decided to take, in order they are willing to respond to the next one. Nothing more discouraging to the supplier if it finds out that he has spent his time to cooperate with us, and nothing happened.

In a world where competitiveness is a matter of survival, the integration of the supply chain in terms of communication (including data interchange), business ethics (including transparency) and mutual trust is nowadays, with the emphasis on sustainability, a must.

So, in addition to listening to our customers, it is important to listening our suppliers: the concepts of Customer Relationship Management (CRM) can be easily translated to SRM – Supplier Relationship Management. Or, even better, it is worth listening all interested parties: besides customers and all types of partners, our employees, government agencies, opinion formers, community and society, in short everybody that can, directly or indirectly, influence the success of our business: than we have a Stakeholder Relationship Management (also SRM), a much encompassing practice to support our continual improvement efforts.

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A MODEL PROPOSAL FOR PRESERVATION PROCESS VALIDATION IN MICROBIAL BIOBANKS

Anabela Martins

CEB-Biological Engineering Centre, Universidade do Minho, Braga, Portugal

Nelson Lima

CEB- Biological Engineering Centre, Universidade do Minho, Braga, Portugal

(nelson@ie.uminho.pt)

Paulo Sampaio

Systems and Production Department, University of Minho, Braga, Portugal

ABSTRACT

Purpose

Microbial biobanks (mBb) are considered a key element in driving the growth of biotechnology. The Organisation for Economic Cooperation and Development (OECD) recommended mBb to ensure an effective and consistent preservation of microorganism biodiversity by validating its preservation process. As it does not exist any guidance for this endeavour, our goal is to develop a model for the preservation process validation and provide guidance on implementation.

Methodology

The model for the preservation process validation was developed based in the pharmaceutical process validation. Guidance on implementation was developed based in fungi cryopreservation procedures.

Findings

Current quality management in mBb follows a quality by testing approach which is not sufficient to ensure an effective microorganism preservation. Validation of tests and assays is not sufficient to ensure an effective microorganism preservation as well. At least theoretically, it is possible to embrace a process validation in mBb based on scientific approaches such as risk assessment, quality by design and formal experimental design.

Practical implications

The achievement of preservation process validation will enable mBb to consistently preserve the world microbial diversity making it available for further developments which are expected to drive major developments in biotechnology and foster bioeconomy.

Originality/value: Original paper

Keywords: validation, biobank, BRC, quality-by-design

Article Classification: Research paper

1 BIOBANKS QUALITY ASSURANCE

Biobanks, also known as Biological Resource Centres (BRCs), are considered a key element in driving the growth of biotechnology (MCT, 2002) (Lima, 2007) (OECD, 2007). They are asked to effectively preserve biodiversity (OECD, 2007).

Governments and industry are making large investments in recovering biological resources from nature. As emphasised by OECD (2001) these resources must not be lost and must be of guaranteed identity and quality OECD (2007). A set of Best Practice Guidelines (BPG) for BRC were developed and endorsed by the OECD's Committee on Scientific and Technological Policy OECD (2007) providing a basis to the ISO TC 276 develop a standard for biobanks (Furuta, 2015).

BPG targets are: (1) quality assurance, (2) process consistency, (3) the avoidance of biological material loss (OECD, 2001) by validation of methods and procedures used for preservation. This advice is consistent with current quality practice as validation is generally accepted as a regulatory requirement for the majority of the life science industries and products (PharmOut, 2016)

It is not usual for mBb to have their processes validated and there are no guidelines that specify exactly how process validation (PV) is to be done inside mBb.

For decades current practice in pharmaceutical industry requires that only validated processes are used for manufacturing. Guidelines for PV are provided for several organisations such as Food and Drug Administration (FDA) and the European Medicines Agency (EMEA).

2 THE PHARMACEUTICAL QUALITY SYSTEM

The *pharmaceutical quality system* (PhQS) supports the development and manufacture of pharmaceutical products including biological products. It is based on (1) ISO quality concepts and on (2) applicable regulations from Good Manufacturing Practices (GMP) (FDA, 2011) (EMA, 2014) (European Commission, 2015) which include PV guidance.

The implementation of the PhQS should result in the achievement of three main objectives: (1) products complying with the requirements; (2) product and process improvements to reduce variability, (3) an effective measuring and monitoring system to process control thereby providing assurance of continued suitability and capability [see 2.2] of the processes (ICH Q10, 2008).

2.1 PROCESS VALIDATION

2.2 GENERAL

Former PV provisions placed great emphasis on testing for conformity (Chatterjee & Wong, 2012). The underlying philosophy was the traditional quality by testing (QbT) [see 2.3.1] where the quality of the product is ensured by testing activities carried out through the process development.

Considering that quality must be *built into the product*, the current PV model (PVM) is based on the lifecycle concept (Figure 1) (Pluta, 2011). It links (1) product and process development, (2) process performance qualification, and (3) maintenance of the process and product in a state of control (FDA, 2011) (Pluta, 2011). It integrates various strategies and approaches serving as a model for all areas where validation and qualification are to implement (Pluta, 2011).

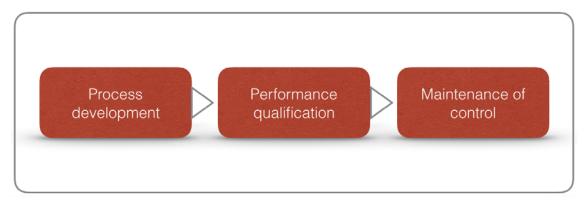


Figure 1 - Three stage approach to PV.

PV definitions include *consistency in complying with specifications* (ISO/TS, 2006), *quality assurance process* (Maropoulos & Ceglarek, 2010) and *effectiveness* (Patel, et al., 2015). Process *effectiveness* in linked to the *capability of a process to consistently deliver quality products* (FDA, 2011) (Parthasarathy & Krishna Priya, 2012) (Patel, et al., 2015).

PV enables to establish process capability which is a statistical measure of the inherent process variability for a given characteristic. Capability studies enable demonstration of the process reproducibility and consistency. Six sigma is the most widely accepted formula for process capability (Yu, 2008). Process capability index (*CpK*) is the value of the tolerance specified for a particular characteristic divided by the process variability (expressed as a standard deviation), which is defined as follows:

Process capability index (C_pK)

 $= \frac{\text{Upper limit of specification} - \text{lower limit of specification}}{6 \text{ standard deviation}}$

Equation 1 – Formula for process capability index calculation.

Accepted statistical guidelines indicate that processes with Cpk>1.33 are deemed capable; they

are performing well within statistical control and will statistically produce less than 63 defective units per million (Alsmeyer, 2015).

If the CpK<1.0, the process is incapable (Alsmeyer, 2015) and actions to reduce variability of the process are recommended (Yu, 2008).

2.3 STAGE 1 - PROCESS DESIGN

Process design is the first stage of the PV lifecycle. It includes activities relating to product and process research and development which can be performed using pilot batch studies and scale up activities (Patel, et al., 2015). The goal is to (1) develop and characterise product and process through building and capturing process knowledge and understanding and (2) establish a strategy for process control.

Enhanced product and process knowledge include (1) the identification of critical quality attributes (CQA)¹ and process parameters [see 2.3.4], and the extent to which their variation can impact on the quality of the final product, (2) knowledge of product performance over a wide range of raw material attributes, manufacturing process options and process parameters [see 2.3.4]. The achievement of a comprehensive understanding of the product and manufacturing process will provide the basis for the establishment of an expanded design space [see 2.3.5], a strategy for process control, continuous process verification, process improvement and PV (ICH Q8, 2009).

Current pharmaceutical development and process design comprises several activities including, at a minimum, the following:

- Defining the quality target product profile as it relates to quality, safety and efficacy;
- Identifying the potential CQA of the product with the aim of studying and controlling those that might have an impact on product quality;
- Determining the CQA of the drug substance and excipients;
- Selecting an appropriate manufacturing process;
- Defining a control strategy.

Each pharmaceutical unit operation has many input and output variables [see 2.3.4] as well as process parameters, so it is very difficult, if not impossible to experimentally study all of them. Investigators have to identify key input and output variables and process parameters to be investigated. Several approaches such as quality by design [see 2.3.1], design of experiments [see 2.3.4], risk assessment [see 2.3.3] and knowledge management [see 2.3.2] can be used, alone or in combination.

2.3.1 QUALITY BY DESIGN (vs Quality by Testing)

Quality-by-Design (QbD) is a systematic, scientific, risk-based, holistic and proactive approach which enables to plan, set and reach quality goals. It was first outlined by Juran (1992) who was guided by the belief that quality could be planned.

QbD is a tool for quality assurance by understanding and controlling product characteristics and

¹ CQA is "a physical, chemical, biological, or microbiological property or characteristic that should be within an appropriate limit, range, or distribution to ensure the desired product quality" (ICH Q8, 2009). CQA are typically those aspects affecting the pharmaceutical purity, dosage strength, drug release among others.

manufacturing variables. It has been increasingly used across industry in various applications (Peter J. Skrdla, 2009). In pharmaceutical industry it has been used with several purposes such as formula optimization (Girotra, et al., 2016), scale up activities (Agrawal & Pandey, 2015) and monitoring operations (Largoni, et al., 2015).

QbD has also been considered as a strategy for analytical method development in robustness domain (Boussès, et al., 2015) (Debrus, 2011) (Mallik, 2015) (Rozet, 2013).

The QbD approach begins by (pre)defining the project objectives, and continues by (2) seeking product and processes understanding through the efficient acquisition of data in a knowledge-driven manner exploring and maximise the understanding of operations (Verma, 2009) and (3) promoting process control (Yu, 2008) by performing a routine control of only those attributes that are critical (Skrdla, et al., 2009) to demonstrate that a given product has an acceptable and predictable quality profile over its shelf life.

A thorough understanding of the process is achieved by (1) identifying the raw materials (Yu, 2008) and critical process parameters (CPP)² that affect product and (2) understanding how those parameters affect the product CQA (Badawy, et al., 2012). As a result, the manufacturers are able to identify the control space as well as the design space (Yu, 2008). New information is continually provided by process measuring; as a result both product and manufacturing process can be updated in an ongoing basis to support new knowledge. A consistent quality is though assured (Zidan, et al., 2007). With this foundation of understanding, the process is well positioned to move into stage 2 (Chatterjee & Wong, 2012).

In sum, QbD paradigm includes the following activities: (Yu, 2008) (Badawy, et al., 2012):

- Definition of the target product quality profile;
- Design of both product and manufacturing process;
- Identification of the material attributes, process parameters, CQA, and sources of variability;
- Understanding of the impact of process parameters and raw materials on CQA;
- Control of critical sources of process variability;
- Continuous control of processes and process improvement.

Quality by testing (QbT) is a classic approach where product quality is assured by testing activities carried out through the manufacturing process. The quality of used raw materials, excipients or reagents is monitored by testing to verify if specifications are met. The process through which the product is build, transformed or processed is well established - the activities, parameters and product quality characteristics are stringently settled and tightly controlled as it is used to ensure process consistency (Yu, 2008). Finished product is tested for conformity with specifications before release, operation known as verification³ (Maropoulos & Ceglarek, 2010).

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² CPP are process inputs that have a direct and significant influence on CQA when they are varied within regular operating range (Yu, 2008).

³ Verification is a quality control procedure which is used to evaluate whether or not a product, service, or system complies with requirements imposed at the start of a development phase.

QbT is a reactive approach to management where quality is ensured by the combination of fixed (and thus inflexible) manufacturing steps and extensive testing (Yu, 2008). When a product testing fails to comply with specification the corresponding batch is discarded and the root cause of the failure is identified and corrected. If necessary, steps on the process are modified in order to obtain testing results within the predefined limits.

Some of the characteristics that can be found in QbT approach are (Yu, 2008):

- Root cause for failure are usually not well, understood, which can lead to re-occurrence;
- Production can be halted until root causes of failure are understood and addressed or acceptance criteria revised;
- Limited characterization of variability;
- Lack of process understanding to identify and quantify critical process parameters;
- Changes in the process will usually require more testing and additional controls.

QbD paradigm consistency comes from the design and control of the manufacturing process. Product quality is assured by controlling product formulation and manufacturing variables. Final product testing confirms the quality of the product and is not part of the manufacturing consistency or process control (Yu, 2008).

Under both paradigms the role that the product specification play is completely different. While under QbT each batch has to be tested to assure its quality and manufacturing consistency, under the QbD batches may not be actually tested as process understanding and control provide sufficient evidence that the product will meet specification if tested. Specification for product is solely used for the confirmation of product quality, not to assure manufacturing consistency and process control (Yu, 2008).

To facilitate understanding of differences between both approaches a diagram contrasting both activities is presented in Figure 2.

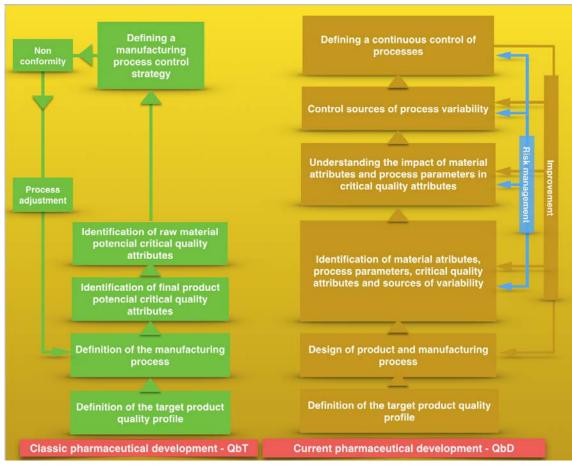


Figure 2 - Pharmaceutical Development approaches: QbT vs. QbD.

2.3.2 KNOWLEDGE MANAGEMENT

The so called "knowledge management" is a systematic approach aiming to acquire, analyse, store, and disseminate information related to final products, manufacturing processes, and raw materials (ICH Q10, 2008). This information comprises knowledge about the way manufacturing processes, and raw materials affect the CQA of the final product (Badawy, et al., 2012).

Sources of knowledge include, but are not limited to, documented knowledge (previously established), pharmaceutical development studies, technology transfer activities, PV studies over the product lifecycle, manufacturing experience, innovation experiments, results from continual improvement and management of change activities.

2.3.3 RISK ASSESSMENT

Risk assessment tools provide a proactive approach to identify and evaluate potential risks to quality [ICH Q10]. They are useful to (1) establish a suitable development program prioritising tasks (Pluta, 2011), (2) understand the sources of variation and control of variation commensurate with risk (Pluta, 2011), (3) identify and prioritise areas for continual improvement (ICH Q10, 2008), (4) establish the monitoring and control systems (for process performance and product quality) (ICH Q10, 2008).

Understanding the risks and the sources of variation provides (1) confidence to go into ongoing routine commercial production and (2) the basis to establish the key performance indicators (KPIs) necessary to create an ongoing monitoring program that will track and trend data for

continuous improvement (Long, et al., 2011).

2.3.4 FORMAL EXPERIMENTAL DESIGN

Widely performed in manufacturing industry, formal experimental design (also known as design of experiments) refers to the process of planning, designing and analysing an experiment enabling that valid and objective conclusions are efficiently drawn (Antony, 2014).

DOE has been applied to the bio-resources investigation (Hallenbeck-A, et al., 2015) in order to increase understanding and knowledge of processes behaviour by better estimating the amount of variability and its impact on processes.

A process is a transformation of inputs (factors or process variables such as people, materials, methods, environment, machines and procedures) in outputs (such as performance or quality characteristics of a product). In pharmaceutical processes, examples of inputs (or factors) are the raw material attributes (such as particle size and purity) and process parameter such as speed, temperature and time. Outputs are the final product CQA, such as tablet friability and hardness (Yu, 2008).

When performing a formal experimental design, changes will intentionally be made to the process inputs in order to observe corresponding changes in the process output (ICH Q8, 2009) allowing to evaluate multiple factors and their interactions while fully controlling the number of experiments (Hwan, 2011). The gained information can be used to undertake changes to the design parameters in order to find the optimum set of operating conditions and making the design performance insensitive to all sources of variation (Leon, et al., 1993).

In order to have a successful designed experiment it is necessary to have powerful statistical methods for data analysis, to choose a suitable design, sound planning and teamwork skills (Antony, 2014).

2.3.5 DESIGN SPACE AND CONTROL SPACE

Within the QbD paradigm, design space is defined as the multidimensional combination and interaction of process variables such as raw material attributes and process parameters that have been demonstrated to provide quality assurance. The ideal design space will be one in which the process parameters have no impact on the process stability and product quality.

The control space is defined as the upper and/or lower limits for the critical raw material attributes and process parameters between which the parameter and material are routinely controlled during production in order to assure reproducibility (Yu, 2008). The control space should be within the design space as it is a narrower portion of the design space that represents the recommended limits that will be allowed in the master batch record (Chatterjee & Wong, 2012). When the control space is much smaller than the design space, the process is considered robust i.e, it has the ability to tolerate the expected variability of materials, equipment, environmental conditions and human factors (Glodek, 2006).

2.4 STAGE 2 - PROCESS QUALIFICATION

The goal of process qualification is demonstration that the process is reproducible and will consistently deliver quality products during commercial manufacturing (Pluta, 2011).

This stage has two elements: (1) design of the facility and qualification of the equipment and

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⁴ Reproducibility expresses the precision between laboratories (Green, s.d.).

utilities and (2) process performance qualification (FDA, 2011).

Facility and utilities construction materials and performance characteristics should be evaluated for its fitness for purpose. They must be verified to:

- be built and/or installed properly and properly maintained and calibrated (when necessary);
- ensure they operate within the intended operating ranges and that they are qualified to operate in the ranges required in processing.

Each equipment must be qualified under production-level loads and for production-level durations. Performed testing should also include interventions, stoppage, and start-up as is expected during routine production (Pluta, 2011).

2.5 STAGE 3 - CONTINUOUS IMPROVEMENT

This is the continuous improvement phase of the PV's lifecycle and could simply be described as "maintaining the validated state". Any deviation should be identified and corrective actions or improvements prioritised. Risk to the patient and to the organization should be considered in prioritization (Pluta, 2011).

3 VALIDATION OF PRESERVATION PROCESSES IN mBIOBANKS

3.1 OBJECTIVE

This research was guided by the belief that only validation of the entire preservation process will enable mBb to consistently preserve the world microbial diversity fulfilling OECD and interested parties' expectations.

The aim of the study was to develop a model for mBb to design and undertake a preservation processes validation programme in order to ensure consistency in preserving microorganism with all its desired attributes.

3.2 METHOD

Identification of process factors was based on written descriptions of fungi cryopreservation used in *Micoteca da Universidade do Minho (MUM)*. The risk assessment and identification of the critical factors was based on individual judgment based on the previously referred descriptions. It is a theoretical study which goal is to propose a pathway to implement PV in mBb. The risk assessment was performed by (1) identifying the risks and critical points of the process that have impact on fungi authenticity if they fail or if they fall outside the control parameters (2) assessing the likelihood of occurrence for each identified risk and (3) the ability to detect risk. They were assessed according to the rates provided in Tables 1-3. The risk levels are presented in Table 4 and the risk level calculation formula is presented in equation 2.

 $\label{thm:condition} \mbox{Table 1 - Impact rate on authentication and shelf life for cryopreservation factors.}$

IMPA	ACT LEVE	L RATE	
ity)	1	Insignificant	Minor problem with no consequences to BM authentication
(I) henticity)	2	Minor	Some disruption possible (problem that interrupt an activity or process
Impact (e BM auth	3	Moderate	Significant lost of time and resources
육	4	Major	Problem having consequences on at least one of the authentication parameters
uo)	5	Catastrophic	Major problem whose consequences are loss a BM

Table 2 - Likelihood rates for problem occurrence.

LIKELIHOOD LEVEL RATE					
	1	Almost certain	> 90% chance		
d (L)	2	Likely	between 50% - 90% chance		
ihoo	3	Moderate	between 10% - 50% chance		
Likelih	4	Unlikely	between 3% - 10% chance		
	5	Rare	< 3% chance		

Table 3 - Ability for problem detection rate.

ABII	LITY TO DI	ETECT RAT	TE .
to (i	1	Impossible	Impossible to detect during routine
bility ect (4	2	Unlikely	Suspect sign can arise; possible to detected by non-routine mean
Ab	3	Possible	Easily detectable during routine

Table 4 - Risk levels for identified factors.

RISK LEVE	L CLASSIFI	CATION			
			Risk level (RL)		
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain					
Likely					
Moderate					
Unlikely					
Rare					
•					

RISK LEVEL CALCULATION (Risk level * Likelihood / Ability to detect) / 25 Where: 25 = 5*5*1 = worst situation (100% chance)

Equation 2 - Risk Level calculation formula.

3.3 QUALITY MANAGEMENT IN mBIOBANKS

The large majority of the certified mBb manage quality under the provisions of ISO 9001 standard which is mainly concerned with what to do to achieve customer satisfaction (Barradas&Sampaio 2011). A few mBb have ISO/EC 17025 (ISO/IEC, 2005) partially implemented. Other standards that can apply are the NF S 96-900 standard (AFNOR, 2007) and NIT-DICLA-061 (INMETRO, 2012) which were specifically developed for biobanks and are mainly based in ISO 9001 and ISO/IEC 17025 provisions respectively.

Process preservation in mBb include four main activities represented in Figure 3.

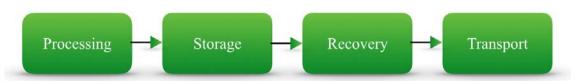


Figure 3 – Microorganism preservation process activities.

Current mBb preservation processes are based in QbT. As can be observed in Figure 4, microorganism authenticity is assessed before preservation. Added substances, such as cryoprotectants, can be tested for quality and during the microorganism processing stage (performed according to inflexible procedures) the process parameters (stringently settled) are measured and monitored. The microorganism quality is tested if any fail is detected. If the cell integrity has been compromised the microorganism is discarded. Similar situation can occur when quality checks are performed to stored microorganisms. If any failure occurs during preservation all microorganisms could be affected and lost. The authenticity of the supplied microorganism is assured by testing before release.

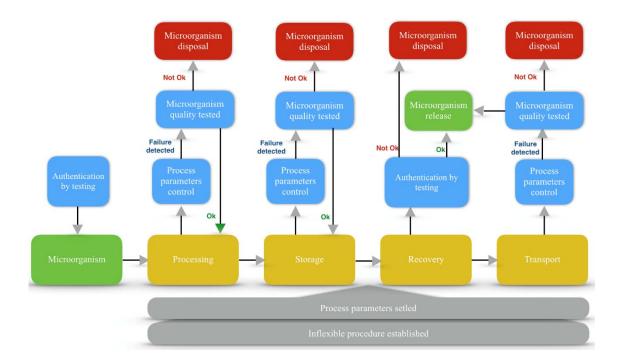


Figure 4 - Quality control diagram for microorganism preservation under the current QbT framework for mBb.

Blue box operations involve testing liable to be validated according to ISO/IEC 17025 standard. Grey boxes represent defined procedures and acceptance criteria for process control; variables such as operator competence, equipment, facility and utilities can be qualified, and added substances quality can be ensured by testing. Red boxes represent, microorganism loss arising from detected non-conformities. Material loss can arise from: (1) the processing stage failures, (2) during the storage stage – resulting from storage conditions failure or as a consequence of other previous undetected failure, (3) after recovery operation to ascertain microorganism authenticity. Yellow boxes represent though the operations lacking quality consistency. Together they encompass the entire preservation process. As can be observed preservation processes performed in mBb do not consistently preserve microorganisms with all its characteristics.

In sum, the following conclusions can be stated:

- 1. Testing can ensure that (1) authentic microorganisms are preserved and released from the process, (2) failures are detected throughout the preservation process;
- 2. Test validation (ISO/IEC 17025 implementation) does not ensure process effectiveness and a consistent microorganisms preservation.
- 3. Control systems in place (measuring and monitoring) can detect failure but are not effective in acting proactively preventing microorganism cells damage.
- 4. Quality is controlled but not assured.

3.4 PROCESS VALIDATION IN mBIOBANKS

This article outlines the general principles and approaches that could be appropriate elements for the microorganism preservation PV (PPV). PPV is based in a microorganism lifecycle⁵ approach (MCT, 2002) which can be applied to all preservation processes such as cryopreservation, lyophilisation, preservation in water (Castellani's method), in silica-gel and in mineral oil and associated procedures such as media preparation and sterilization. Different microorganisms can introduce substantial differences in process parameters and process variables thus requiring separate validation activities.

To validate its processes mBb are challenged to better:

- 1. Identify and understand the sources of variation along the microorganism preservation-lifecycle (preservation design microorganism preservation microorganism supply);
- 2. Detecting the presence and degree of variation that is transferred into the biological material from sources within process variables;
- 3. Understanding the impact of the detected variation on the preservation process and microorganism attributes;
- 4. Control the detected variation based upon (1) the understanding and knowledge of the sources of variation and the (2) risk it represents to the preservation process effectiveness and authenticity of the preserved microorganism.

These activities are described in Figure 5.

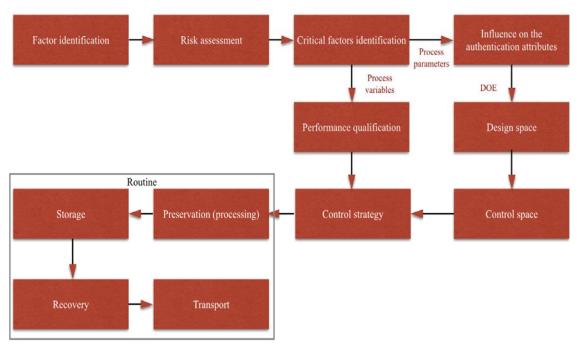


Figure 5 – Sequence of activities to PPV according to the quality by design approach.

Influence of factors on microorganism attributes has been studied and can be find in literature (Goos, et al., 1967) (Simon & Whang, 1967), (Hwang & Howells, 1968) (Lange & Boyd, 1968)

⁵ Microorganism lifecycle encloses several stages: microorganism culture, processing, transport, supply, use and discard.

(Yee, et al., 1972) (Cunningham, 1973).

3.5 MODEL FOR PRESERVATION PROCESSES VALIDATION

As previously referred the mBb PPV approach here proposed is based in pharmaceutical experience. There are three major differences between both models. The first is the absence of product design in mBb preservation as the microorganism attributes are its intrinsic characteristics to be maintained unchangeable during preservation. The second is the existence of a process output that is not a microorganism attribute: its shelf life. Although, shelf life is a process output that is liable to be designed. The third difference is the increased difficulty in establishing the links between process variables and microorganism attributes as it is a living organism enclosing though the well-known complexity of living systems.

The PVM for mBb is presented in Figure 6. It is a three stages approach (process design, performance qualification and continuous improvement).

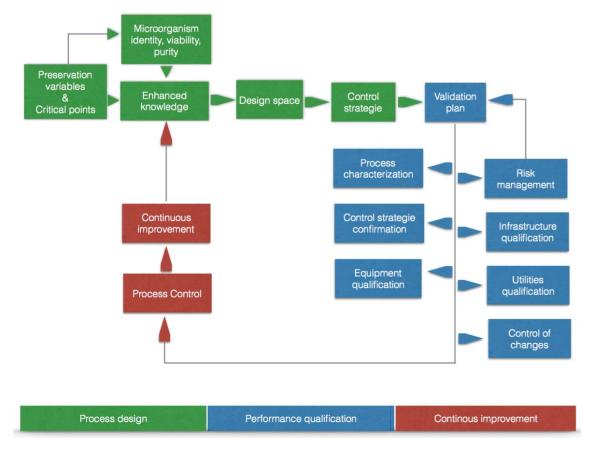


Figure 6 - Model for the PPV in mBb.

3.6 CRYOPRESERVATION DESIGN

Cryopreservation design is the initial stage of PV where an outline of the preservation process is drafted and all the process inputs and outputs are identified. Process inputs (factors) for fungi

cryopreservation were identified in Table 4. The preservation process outputs are the microorganism authentication attributes. Those have been a decades-old concern among mBb (Lessel, 1970) and include: identity, viability and purity (Becker, et al., 2015).

As all process variables may link to the to-preserve-microorganism authenticity directly or indirectly, a risk assessment must be performed in order to reduce the variables to be investigated identifying the potential critical factors to microorganism authenticity (

Table 5-9). It should be based on the mBb previous knowledge and experience, scientific process understanding and specific studies.

Further studies are conducted to evaluate the effects of variations of relevant process parameters and process variables on the identity, viability and purity of the preserved microorganism (Table 10). The purpose is to determine the critical process variables and the microorganism CQA and establish any possible relationships among them. Process variables that can potentially affect microorganism characteristics are identified. By understanding the tolerances of these critical points it is possible to establish limits for operation within which the integrity of cells is assured. A flexible and robust preservation process that can adapt and preserve microorganisms consistently over time can implemented.

In sum, the process knowledge and understanding build-up during this stage enables:

- Identification of sources of variation and their impact on the biological material attributes;
- Identification of process-parameter relationships with biological material authenticity attributes;
- An initial assessment of process capability.

⁶ I − Impact; L − Likelihood; **AB** − Ability to detect; **RL** − Risk level.

⁷ Critical process variables are process inputs that have a direct and significant influence on CQA when they are varied within regular operation range (Yu, 2008).

Table 4 – Identification of the factors for the fungi cryopreservation process.

FACTORS	PP	AA	RM	WEC	0	M	Е	U	P	Mth
Cryoprotectant temperature	✓									
Cryoprotectant components mass	✓									
Cryoprotectant suspension aliquots mass	✓									
Sterilisation temperature	✓									
Seterilisation time	✓									
Incubation temperature	✓									
Incubation time	✓									
Temperature decreasing rate in the freezing container	✓									
Time for freezing (freezing container)	✓									
Time for transfer	✓									
Transfer temperature conditions	✓									
Storage temperature	✓									
Temperature increasing rate	✓									
Cryoprotectant			✓							
Temperature				✓						
Humidity				✓						
Sterility				✓		✓				
Sanitation				✓		✓	✓	✓		
Microorganism authenticity		✓								
Microorganism purity		✓								
Microorganism viability		✓								
Calibration							✓			
Maintenance							✓	✓		
Fitness for purpose			✓				✓		✓	✓
Effectiveness					✓				✓	✓
Consistency					✓				✓	✓
Competence	✓				✓					
Specification			✓			✓		✓		

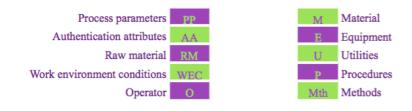


Table 5 - Risk assessment results for the fungi cryopreservation process (1).

Activity	Risk	I	L	AD	RL
Choice of the cryoprotectant	Cryoprotectant not adequate	5	5	3	33%
Preparation of the cryoprotectant suspension fluid	Cryoprotectant suspension components not complying with the specifications	3	1	2	6%
	Cryopreservation composition not complying with specifications	2	2	2	8%
	Cryoprotectant temperature not adequate	5	1	1	20%
	Chemical contamination of the suspension with poison substance	5	1	1	20%
	Operator lacking skills	5	1	3	7%
Suspension fluid distribution in aliquots in universal glass bottles	Container not adequate (e.g. contact material liberating poison substance)	2	1	3	3%
	Contamination of the suspension - contaminant afects microroganism authenticity	1	2	1	8%

Table 6 - Risk assessment results for the fungi cryopreservation process (2)

Activity	Risk			AD	RL
Glass bottles + cryoprotectant suspension sterilisation in autoclave	Failure in sterilisation leading to sample contamination and authentication failure	5	2	2	20%
Glass bottles tested for contamination by incubating at 25 -30°C a few drops in a petri dish	Failure in temperature	4	3	3	
	Operator lacking skills	5	1	3	7%
	Environement conditions not adequate (temperature, humidity,)	3	1	3	4%
Samples to preserve are grown in slants, for the necessary time	Inadequate growth time	5	1	3	7%
	Operator lacking skills	5	1	3	7%
$1-2\ \mathrm{mL}$ of the cold cryoprotectant suspension fluid is poured into the slant tubes with the grown and mature cultures	Insuficient growth, BM is not in a mature state	5	2	1	40%
	Inadequate cryoprotectant temperature	5	1	3	7%

Table 7 - Risk assessment results for the fungi cryopreservation process (3).

Activity	Risk	I	L	AD	RL
1-2 mL of the cold cryoprotectant suspension fluid is poured into the slant tubes with the grown and mature cultures	Inadequte quantity of the cryoprotectant suspension	4	1	3	5%
	Operator lacking skills	5	1	3	7%
A suspension of mycelia and spores is prepared (by scrapping with a sterile Pasteur pipette the surface of the cultures)	Sample contamination	5	3	3	20%
	Operator lacking skills	3	1	3	4%
	Absence of spores	5	2	2	20%
Cryovials labelling	Wrong labelling	5	2	2	20%
Suspension is distributed into the cryovials with the glass beads	Sample contamination	5	1	1	20%
Cryovials are distributed in a freezing container (Mr Frosty)	Distribution method not adequate	5	1	1	20%

Table 8 - Risk assessment results for the fungi cryopreservation process (4).

Activity	Risk	I	L	AD	RL
Mr Frosty is maintained at -80°C for at least 4 hours	Temperature decrease rate not adequate leading to cell damage	5	2	1	40%
	Stability in temperature not achieved	5	2	2	20%
	Failure in the time	5	1	2	10%
Cryovials transferred into the deep-freezer's cryovial boxes	Temperature decrease /thawing during transfer	5	3	3	20%
	Wrong results due to operator lackin skills	5	2	2	20%
Authenticity tested: purity, viability, identity	Equipment does not fit for purpose	5	2	2	20%
	Failure in equipment performance	5	2	2	20%
Choice of interval for viability checks	Late detection of problems	5	1	2	10%

Table 9 - Risk assessment results for the fungi cryopreservation process (5).

Activity	Risk	I	L	AD	RL
Storage at T < -80°C	Equipment failure (T>-80°C)		3	1	60%
	Failure not detected in time	5	2	2	20%
Recovery by thawing (temperature decrease rate)	Temperature increase rate not adequate leading to cell damage	5	3	1	60%
Transport	Transport conditions not adequate	3	2	1	24%

Table 10 – Critical factors and its influence on authentication attributes.

	OUTPUTS					
CRITICAL FACTORS	Indentity	Viability	Purity	Shelf life		
Cryoprotectant temperature						
Cryoprotectant components mass						
Cryoprotectant suspension aliquots mass				8		
Sterilisation temperature	10					
Sterilisation time				100		
Incubation temperature		00				
Incubation time		0				
Temperature decreasing rate in the freezing container				0		
Time for freezing (freezing container)		8				
Time for transfer				00		
Transfer temperature conditions						
Storage temperature						
Temperature increasing rate						
Cryoprotectant (fitness for purpose)				60		
Temperature				0		
Humidity				60		
Materials sterility				0		
Work environment sterility for operations						
Work environment sanitation				00		
Material sanitation				0		
Equipment sanitation				0		
Utilities sanitation						
Sanitation						
Microorganism authenticity						
Microorganism purity						
Microorganism viability				00		
Calibration				9		
Maintenance of equipment				100		
Maintenance of utilities				0		
Fitness for purpose						
Effectiveness						
Consistency				0		
Competence						
Specification				0		
Equipment fitness for purpose				0		
Procedure fitness for purpose				(3)		
Methods fitness for purpose				0		

The validation planning, known as Validation Master Plan (VMP), should be developed early in the validation activities as it will communicate the planned validation activities to the organisation. It should refer (1) the embraced validation approach, (2) the scope of validation, (3) the documented procedures to develop.

The following items should be detailed:

- Scope of application (processes to be validated and activities, utilities and equipment to be qualified);
- Responsibilities;
- Validation approach (validation protocols, control of changes, deviations, procedures, documentation, calibration, training);
- General acceptance criteria;
- Facility and process description;
- Documented information;
- Validation Schedule;
- Description of equipment and premises layout;

The knowledge gained from design and development studies studies enable to establish a control strategy for the parameters and attributes that affect the process consistency and microorganism authentication. Higher levels of control are implemented for parameters associated with higher risk (Pluta, 2011).

3.7 PROCESS QUALIFICATION

During the preservation process performance qualification (PPPQ) stage, the process design is evaluated to determine if it is capable of reproducible and effective routine preservation. The amount and usefulness of the information about biological material behaviour and process knowledge gained up to this point in the microorganism preservation-life-cycle will determine the approach a mBb takes with its PPPQ. The sequence of understanding, designing, qualifying and maintaining the validated state or qualification is applicable and desirable for all processes and methods performed in a mBb. Other processes and methods include cleaning, sterilising, packaging, bio-analytical testing, calibration, preventive maintenance. Further applying this sequence to other areas such as equipment, utilities and premises qualification and computer systems is also appropriate and desirable.

PPPQ procedure should include at least the following:

- Preservation process conditions and parameters, process limits, raw material specifications.
- How and what data should be collected and how should it be evaluated.
- Testing and acceptance criteria.
- Sampling plan (including sampling points and number of samples).
- Confidence level (based on risk analysis).
- Criteria for a rational conclusion of whether the process is acceptable.
- Statistical methods to use in data analysis.
- Method to address non-conformances.
- Design of facilities, qualification of equipment, utilities and facilities.
- Personnel training and method to assess competence (qualification).
- Material qualification (such as vials and closures, ampoules, petri dishes).

- Bio-analytical methods to validate.

Bio-analytical methods should yield results that enable a reliable evaluation of the microorganism attribute. Equipment used for these tests should be qualified as well as the measuring instruments used for the qualification. Qualification can include calibration.

The PPPQ can be considered completed when there is scientific evidence that (1) an appropriate level of assurance that the preservation system has been designed to consistently preserve microorganisms complying with requirements and (2) there is in place an effective measuring and monitoring system to control the preservation process.

3.8 CONTINUED PROCESS IMPROVEMENT (STAGE 3)

This stage comprises the ongoing preservation of microorganisms which is performed under the same or equivalent conditions as demonstrated in performance qualification.

The continuous process verification involves integration of the results obtained from the multiple measurement and monitoring systems. Tracking and trending of data leads to the detection of particular cause variability providing opportunities to improve process consistency by reduction of inherent common cause variability.

Determination on the state of control of the process in routine preservation should be calculated using appropriate statistics and derived from appropriate confidence levels. These confidence levels should be based on risk factors, experience, and attribute criticality.

4 CONCLUSION

mBiobanks are expected to preserve unchanged the microbial biodiversity. Under the current quality management paradigms mBb cannot assure its preservation processes are effective and consistent. Effectiveness and consistency can be achieved by process validation.

The proposed model for process validation in mBb is based in the GMP for the pharmaceutical industry and can be applied to preservation process and preservation-related procedures and methods such as sterilisation, packaging, equipment and facility qualification. The provided model can open the way on implementing a PPV in mBbs.

Examples of process analysis exercises are provided. Implementation in mBb must consider variation resulting from the use of different equipment, methods, operators, mBb dimension, and especially previous experience and gathered knowledge.

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Operational Excellence Programs influence on Organizational Culture Change: a conceptual model proposal

Carvalho, André M.1, Sampaio, Paulo2 and Rebentisch, Eric3

¹⁾ MIT Portugal Program; University of Minho, Braga, Portugal

²⁾ University of Minho, Braga, Portugal

3) Massachusetts Institute of Technology, Cambridge, MA, USA

ABSTRACT

Purpose - Operational Excellence Models are valid tools in the pursuit of improvement and competitive advantage. But as any other tools, they do not implement themselves, but rather are used by people in order to promote organizational changes. Thus, the understating of these models is highly impacted by the culture established in an organization. This relationship drove focus of research focus to an approach of single adaption for successful implementation, but left unanswered the question of how can organizations promote an enduring capacity to change.

Approach - After a first draft of the conceptual model was conceived based in a literature review identifying the elements, enablers and characteristics of the different concepts, this paper advances to its critical assessment and re-design, adding new perspectives and further inputs to the discussion, searching for a better fit to reality.

Findings - A new version of the conceptual model is conceived, supported in a broader literature review featuring the existing relationships between concepts and in the promotion of discussion over the model, allowing a more comprehensive, practical and structured view of the cultural change process and eliminating misleading hypothesis in the path towards the creation of an enduring capacity to change and meet the requirements of the unstable business environments.

Originality- Development of a conceptual model to cover for the lack of an enduring capacity to react to change, promoting understanding on how can adaptability be sought trough the implementation of an adaptable Culture of Excellence.

Keywords: Organization Culture, Organizational Agility, Operational Excellence, Excellence Models

Paper type: Conceptual Paper

INTRODUTION

Excellence models have become valid and powerful tools for achieving enhanced business results (Evans & Jack, 2003) and in providing guidance to help organizations promote competitive advantage, achieve superior performance and match their customers' demands (Boulder et al., 2013). Nevertheless, simply engaging in Excellence Programs has proven not to be sufficient to ensure long term and undisputed success. Continuously changing business settings demand constant evolution, as technological disruption reduces products' life cycles and globalization defies previously unchallenged markets. As costumers grow more and more exigent, even high-end technology organizations find themselves striving to live without a broader structure supporting its customer relations on flexible and adaptable market focus. Technical Industries are forced to adapt to these new circumstances: from mass volumes to customization, from production orientation to development, from technology focus to value creation and market awareness, change comes in different ways and organizations often find that it truly is the rule of "evolve or perish" that persists.

Answering to a changing environment where a growing variety of high quality products are requested in small quantities and short lead times demands a high capacity of adaptation. Changing, however, is not a simple task; agility is hard to achieve and will face resistance in most organizations, as people fear for their job stability or are unable to fit new strategies and actions in their perceived cultural framework.

This framework comes from the Organizational Culture which develops over time as organizations mature and set their unique features, behaviors and values. The cultural paradigm in an organization works fundamentally in orienting and influencing the way people work and relate with each other and with the surrounding environment, while reducing the perceived risk of failure and anxiety in face of critical situations (Schein, 1984). As such behaviors settle and values become taken for granted, they become unconscious and undisputable assumptions. As a result, people will become resistant to any changes that are incongruent with their current cultural beliefs and that clash against the emotional and operational stability that them provide (Schein, 1984) (Johnson, 1992).

In an attempt to successfully and sustainably manage change, companies integrate Operational Excellence programs and Organizational Culture. Such effort is driven by the understanding that Operational Excellence programs are not self-implemented solutions that run or manage change processes by themselves, but rather tools and models that are used by the people within an organization, and which will accordingly be highly impacted by the established organizational culture (Shingo, 2014). This strong and structural relationship consequently drove the main focus of research to an approach based on mutual adaption for guaranteeing successful implementation of Operational Excellence programs (Irani et al., 2004). But as change efforts are made in a perspective of alignment between the Organizational Culture and the guidelines and requirements of Excellence models, we are faced with a situation of single adaptation rather than a reaction to continuous business environment changes. In truth, although "change" is in fact happening in corporate culture and there is an improvement on business processes, the emphasis is in meeting a pre-defined set of criteria rather than becoming more adaptable. A single adaptation to such criteria will help to overcome several issues and even answer some of the demands the business environment might have in a certain and well defined time. However, it does not leave the company in a position where it can be considered agile, i.e., further reaction to change will be limited to the continuous engagement in Operational Excellence programs, and their capacity to perceive the correct opportunities and needs at a given moment. By not creating and promoting an enduring capacity to change, organizations are unable to react to the unstable business environment and its demand for a quickly adaptable manufacturing and organizational paradigm.

In face of this reality, the purpose of this research project is to bring the concept of organizational Agility into the current perspectives in the relationship between Organizational Culture and Operational Excellence programs, promoting an agile culture of excellence that should be capable to revise itself and change ever more quickly in order to meet market demands. Although being based on Operational Excellence programs, it should be able to evolve independently from engaging in them, thus avoiding the need of being continuously and bureaucratically assessed in order to evolve.

The aim of this paper is to serve as a follow-up to the evolution of the project, namely to the critical revision of the conceptual model that was outlined at an earlier stage of the project, and that relates the three different concepts (Operational Excellence, Organizational Culture, Organizational Agility). Being a first draft, before advancing and setting to practically test the model in industrial setting, a large critical assessment was promoted, with two different approaches being taken. In this sense, further literature review was carried out, assessing the relationship drawn in the model against the existing theory pairing the concepts. Whereas the model's first version was conceived based mainly on the literature in each concept independently - its characteristics, enablers and elements - this second review went deeper in the relationships between them, testing the links and influence between concepts. Although there is no literature engaging the three concepts – hence the novelty of this project - the literature existing in the dual relationship between Excellence and Culture, Quality and Agility or Culture and Agility allowed for a deep revision and great conclusions. At the same time, there was an effort to promote discussion over the model, also by presenting it at different professional meetings, international scientific conferences and trough the inputs of selected experts in the different fields considered in our proposed framework. The outcome of this process was a revised version of the model, which we consider to better fit the state of the art in Organizational Culture, Operational Excellence and Organizational Agility and to best depict the true nature of the practical correlations we wish to study.

The remainder of this paper starts off precisely with the above-mentioned literature review. Chapter 3 makes a small introduction to the research goals and presents the discussion over the model and its evolution, with the new revised version being outlined and supported. Further work and research agenda are finally presented on chapter 4.

LITERATURE REVIEW, BACKGROUND AND CONEPTS

Introduction to Excellence

The relation of Excellence Models with Quality is well documented. Different studies made worldwide back up the idea that there is a profound impact of quality thinking and engagement in companies that have followed the path of pursuing a "state of Excellence". Accordingly, although admitting that the full EFQM criteria is only scarcely to (at best) partially covered by ISO 9001, Fonseca and Lima (2015) showed that there is a positive correlation in Portuguese companies between the number of years passed since ISO 9001 implementation in a company and the highest achievements in the EFQM model valuation by that same subject. Similar findings resulted from another study in Cyprus, having the authors identified that the implementation of the ISO 9001 standard responsible for improvement practices in several areas and fields that traditionally fall under the excellence criteria assessment of EFQM (Gotzamani, Tsiotras, Nicolaou, Nicolaides and Hadjiadamou, 2007). Also Boulter and Bendell (2002) note a clear support of ISO 9000 series to Excellence in a study comprising around 1000 British companies. Companies engaging in Excellence initiatives show not only to have a strong background in the self-motivated move on the way to TQM, but further presented a common background in

the implementation of the ISO Certification – to a point of allowing it to be considered as the first step in the long road towards excellence (Araújo and Sampaio, 2014).

The cradle of Excellence is agreeably in the concept and frameworks of Total Quality Management (TQM) (Van der Wiele, Williams and Dale 2000) (Klefsjö, Bjarne and Rickard, 2008) (Adebanjo, 2001). In accordance, those that are now the main Excellence Models and associated prizes – the European Foundation for Quality Management Excellence Award (hereafter EFQM Excellence Award), The Malcolm Baldrige National Quality Award (MBNQA) or the Shingo Prize – have seen their Excellence criteria tested against TQM's core concepts with positive correlation (Curkovic, Melnyk, Calantone and Handfield, 2000)(Calvo-Mora et al., 2005), supporting the idea of the EFQM Model as a TQM framework on both a technical a social dimension (Bou-Llusar, Escrig-Tena, Roca-Puig, and Beltrán-Martín, 2008).

The name and branding move from TQM to Excellence happened as organizations began to look for new approaches in face of the repeated failure of TQM programs. Such failure was repeatedly blamed on the lack of adaptation of TQM tools to the culture and working practices of the organizations where they were being implemented, being considered as deeply prescriptive and mechanist tools with little search for context fit (Ashton, 1997)(Dommartin, 2000)(Dahlgaard- Park & Dahlgaard, 2007). In an attempt to bring focus to the structural importance of organizational cultures in the management of change, the main Quality management awards – such as the EFQM and MBNQA – have undergone restructuring and rebranding, featuring and highlighting the word "Excellence" while incorporating the philosophy of context-dependent approaches (Adebanjo, 2001) and definitely setting Organizational Culture as one of the keys for seeking sustainable success.

Organizational Culture and the importance of fitting the organizational context

It is this link with Excellence that led Organizational Culture to gain broader attention in the 1970's and 1980's, although since the 1950's there were mentions of the importance of dealing and managing cultural change within groups (Lewis, 1996). The galloping interest in the academic literature during these decades showed however an unusual and strong parallel in the business literature market, with a few books even climbing to top places in the Best Seller lists (Ouchi and Wilkins, 1985). Among these books, special impact is recognized to Ouchi's 1981 book "Theory Z: How American Business Can Meet the Japanese Challenge" and to a duo of 1982 books, Deal and Kennedy's "Corporate Cultures: The Rites and Rituals of Corporate Life", and Peters and Waterman's "In Search of Excellence: Lessons from America's Best Run Companies (Lewis, 1996) (Baker, 2002).

There are several well-known definitions of Organizational Culture. Some of the most popular include Williams, Dobson and Walters' statement "the way we do things around here" (1994, as cited in Maull, Brown and Cliffe, 2001) and Schein's (1984) definition of Organizational Culture as a "set of shared assumptions that have been developed by a group over time as a positive response to problems". According to the latter author, Organizational Culture works over the whole group not only in providing guidelines for tackling problems, but also in reducing anxiety in face of new, unknown challenges, and is so powerful that it is widely accepted and thought to new members as the correct way of acting.

Edgar H. Schein (1984) further explores Organizational Culture and dissects it by identifying three levels with different conscious awareness and visible presence. The most tangible level of culture – the one that is

observable or audible in clear day-to-day manifestation - is the level of Artifacts and Creations. These are the visible side of a culture, and include such things as architecture and office decoration, dress codes, visible behavior patterns or documentation. However, these Artefacts and Creations, although providing us with information that is very easy to obtain, are very difficult to understand. We are allowed to depict a certain pattern of behaviors, but we cannot reach an understanding on the reasons for them. The explanation lies in the lower levels of culture, such as the values and assumptions - and can only be reached through a deep and contextual study. Values stand in the middle level, and they support the behaviors and present a rationalized explanation for them. Although they are accessible to outsiders, though they are not easy to reach. They are not accessible trough a simple inquiry to any staff member or trough simple observation, and even in the cases where they are openly mentioned and discussed, a critical perspective is needed, as people will have a tendency to rationalize their behaviors into values which they believe to be more noble, but that might not accurately capture the full extension of the true supporting values. Finally, in the deepest level of a culture lie the assumptions, the least aware part and the most difficult to access and understand. Assumptions settle as time goes by and previously rational values become taken for granted and begin to be seen as undisputed truths. They become unconscious and are rationally unperceived by the great majority of people in an organization, and act almost as survival guidelines. Accordingly, this is the level that creates more resistance to change, and the one that is more difficult to openly discuss.

This characterization of Organizational Culture was vital to the development of the theory on the opportunities and limitations of managing and manipulating of organizational cultures in search for superior performance, competitive advantage, and overall excellence. For instance, the link between culture and strategy has been highly explored, with Barney (1996) arguing that if a culture is to be source of competitive advantage, it cannot be completely manageable since it alters the concept of being valuable, rare and imperfectly imitable. If one can manage a culture to a point of leading it, it will mean that the same efforts could be replicated somewhere else - thus making null the competitive advantage of the first culture. The debate around the need for a strong culture as a leverage to achieve superior performance is also well documented, with Peters and Waterman (1982) and Deal and Kennedy (1982) referring it as a cornerstone for success, while Schein (1989) supports a view that is aligned with Saffold (1988) in considering that it is more a matter of promoting cultural fit rather than a strong culture. Reeves and Bednar (1994) state that managing Organizational Culture is essential as it influences people's perceptions in all aspects of their work. It is precisely here that the importance of dealing with Organizational Culture is the scope of Excellence programs becomes clear: the Shingo Institute (2015) alerts to the fact that any Excellence frameworks must be seen as tool to be used by people within their organizations, thus being highly impacted by the prevailing culture; Araújo and Sampaio (2014) support the same idea, stating that Excellence is not made of standard tools but rather of organizational cultures, its values and its people, and that it cannot be sold as a standard approach. Excellence implementation is thus only possible when it is fully aligned with the daily practices and behaviors of the company.

Nevertheless, all this evolution in the literature addressing Organizational Culture and its relationship with Total Quality Management (TQM) and Excellence programs remained always centered on the need and ability to manage and change culture, embedding and fitting TQM principles to the established culture in it in order to successfully implement such programs (Lewis, 1996). Maul et al. (2001), for example, look into the need for a method for cultural analysis prior to the outlining of any improvement program. They give special attention to the fact that only when being fully conscious of its culture an organization is able to implement tools in a fit way. The authors also draw attention to the possible existence of different cultures inside one organization, and how it is essential to differentiate them in order to successfully manage and change Organizational Culture and its orientation with Quality and Excellence programs. In the same perspective, and while comparing the culture and performance between TQM and non TQM firms in Indonesia, also Aziz and Morita (2014) state that prior to such it is necessary to know the dominant culture and manage it to allow

integration of quality and excellence frameworks. This leaves us again with the idea that no "one size fits all" attitude is possible – and in order to achieve competitiveness trough the integration between such programs and Organizational Culture, adaptation becomes a demand. Change programs have to be tailored case-by-case, cultural fit is essential in order for improvement programs to work.

In this sense, although the positive results of integrating Quality and Excellence programs and Organizational Culture have been proved transversely in cases from all regions of the world, it became clear for us that there severe limitations in the study of cultural change, as it is remains glued to the perspective of adaptation between the two concepts, rather than in the one of managing change as a response to external inputs from business environments. One clear example of this tendency is observable in the work of Evans (2010), where the author aims to understand the learning capabilities of an organization in order to adapt its culture to the principles and requirements of Quality and Excellence Improvement Models. By assessing the documentation provided by an American company engaged in the Excellence program of the Malcom Baldrige National Quality Award - the most well-known American Excellence framework – the author identifies a clear evolution towards the principles of the Model is achieved, allowing the company to score better results and improve its Excellence recognition throughout the years. However, as the problematic of change is addressed solely from the point of view of adaptation, a huge gap is left in understanding how do these two concepts and their resultant change impact the ability of an organization to react to sudden and further change demands. In times of rapidly moving, turbulent markets, organizations need to be more flexible and faster to answer to the requirements of their stakeholders, making it urgent to understand how this management of Organizational Culture relates with the ability of being agile.

The need for Organizational Agility

The pursuit for Agility comes precisely as companies try to answer quickly and effectively to sudden and unexpected business environment alterations (Yusuf, Sarhadi and Gunasekaran, 1999). Factors for change could come from the marketplace, be promoted by a competitor or by new customer requirements; be a result of a new technology or the outcome of a series of social factors. As these changes become more common, agility gains importance as a survival kit for turbulent markets (Bottani, 2010). But Organizational Agility is more than a tool of resilience and subsistence in unpredictable environments. It is also a way of being more competitive; it is about cooperating and improving partners; about managing change and using people and information as a competitive leverage (Gunasekaran and Yusuf, 2002). Agility allows prospering by providing customers with low cost products with high quality levels within a short lead time and at varying volumes. It includes internal as well as external initiatives, focusing on re-engineering processes within the organization but also looking for customers and suppliers beyond their normal roles, improving performance throughout the supply chain (Fliedner and Vokurka, 1997).

As organizations begin to understand that cost orientation was no longer the key for competitive advantage and that they could no longer keep their production models of manufacturing large volumes for attain economies of scale and the lowest cost per product, new approaches became necessary. The manufacturing paradigm changed and mass production gave way to demands of quality, availability, reliability and, later, flexibility and customization. It is at this point that Organizational Agility comes to comprise all the different approaches: it includes all the characteristics of flexibility, but it goes beyond it by promoting preparation for unpredictable, sudden changes, while setting quality as the basis of its construction. Furthermore, it is context dependent, adapting to the specific differences, strengths and weaknesses of organizations in what regards their customers, competitors, markets and products (Vokurka and Fliedner, 1998).

Implementing and creating a true agile organization will demand large changes comprising organization, business and workforce relations. It is necessary not only to manipulate the structure and culture of the company but also to consider the impact on the ones of it partners and, consequently, on the market itself. Every company must thus be able to identify and manage its culture, business practices and technology in order to become agile (Gunasekaran, 1999). While having a deep impact on how any framework or approach is implemented, Organizational Culture plays a central role in this interdependence. Managing the existing culture is essential in order to build, contextualize and prepare a technical and emotional basis for Organizational Agility. Here, it is essential to remember the importance of Organizational Culture in providing emotional stability for the workforce of an organization. If Organizational Agility is to demand high flexibility and new working paradigms from the people that make an organization, then it is essential to manage the culture and fit the agile approach such that the levels of anxiety are controlled and the common sense security guaranteed. The same is valid for what concerns the outline of benefits. A clear view of the advantages of incurring in an agile approach must be clear in order to allow everyone in an organization to recognize the importance and value sustaining this change.

RESEARCH GOALS, MODEL DISCUSSION AND EVOLUTION

If Agility is to be seen as the current manufacturing paradigm in the pursue of competitiveness, managing change with the sole purpose of adapting a culture or parts of it to the requirements of Excellence models and frameworks will not provide a solution for facing the quickly changing and unpredictable markets. It is necessary to explore these modifications inside a company in a way that allows it to develop the ability of further reacting to change, not only in the scope of new or improved Operational Excellence programs but mainly in answering the demands of the complex business environments surrounding organizations.

Market trends change increasingly fast and show unseen behaviours. Organizations, especially firms operating in the highly technical and technological industries, face a strong demand to be both excellent and agile – showing superior quality and performance supported in a strong and stable basis, while being able to deliver a product that is highly competitive and follows clear requirements in terms of cost, quality, lead times and production volume.

With both Agility and Excellence sharing the same basic, structural principle – quality – and being extremely influenced by the organizational context and culture, it is for us a clear research opportunity to study how this relationship can be explored in such a way that allows us to discover and model (1) if the implementation of an operational excellence program is able to induce in an organization an enduring capacity to adapt to new business environments. Furthermore, we wish also to address other research issues that are both partial and structural in understanding this relation, namely: (2) Is the implementation of an operational excellence program able to induce in an organization an enduring operational excellence culture?, and (3) What features of an operational excellence culture contribute to inducing in an organization an enduring capacity to adapt to new business environments?

In order to answer these questions, the first step was to depict the possible relations between concepts and the enablers and elements that support and leverage each of them and their interactions. This first effort to model the relations of Operational Excellence, Organizational Culture, and Organizational Agility was mainly based in the independent literature supporting each of the concepts, as the main goal at this point was to understand them, and through that establish the structural basis for building the bridges between them. The model on figure 1 clearly depicts this strategy: whereas the links between concepts are already presented in a

clear way path towards adaptability, the main focus was on the cultural elements and on enablers that support Operational Excellence and Organizational Agility.

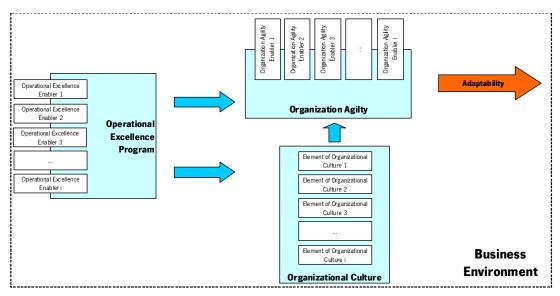


Figure 1- Conceptual Model initial version

However, the literature used in the building of the first draft of the model did not properly condense the state of the art in the research in these fields. In this sense, as the work proceeded, the effort changed to understanding how further these existing relations were explored and how accurate their depiction in the model was. Accordingly, and although the relationships between Operational Excellence and Organizational Culture and Organizational Agility were validated, as theory and discussion cumulated over the relationships depicted in the Model, doubts generated about the realistic perspective of proposing a direct link between Operational Excellence and Organizational Agility, bridging over Organizational Culture and leaving it behind. A series of questions popped up: can agility be achieved without its enablers being embedded in the culture of an organization? If by agility we mean an enduring capacity to adapt to new business environments, can such a characteristic exist without a strong support of a set of consequent values and beliefs? Could any excellence program help a company achieve a sustainable level of adaptability without cultural elements that are fit with a flexible and adaptable way of working?

Such doubts made us feel renitent to proceed to practical testing and validation in organizational setting with the current version of the model. In that sense, we turned once again to the literature and promoted further discussion with experts in the fields of Quality and Excellence, Organizational Culture, and Organizational Agility in search of clues that allowed us to clear the skies and advance without the dark clouds of worry and doubt hanging over us. Although we do not out rule that further evolution and modifications might be observed in the future (for science is an evolutionary process), this revision was felt to be essential in order to allow us to advance to the next step of the project without structural doubts haunting us. As we discussed and reviewed literature and learned concepts, we understood that both the Organizational Culture definition and its elements and the study of the relationship between Culture and Excellence were able to provide a set of data and crucial arguments for us to build and deduce concrete answers for our problem.

Let us start with Schein's (1990) definition of Organizational Culture, then, as a "pattern of basic assumptions (...) developed by a given group as it learns to cope with its problems of external adaptation and internal integration" and that has "worked well enough to be considered valid and, therefore is to be taught to new members as the correct way to perceive, think and feel in relation to those problems". In other words, culture

provides organizations with a way of setting against the challenges it has to face. In this sense, and if a continuously changing business environment is easily recognized as an organizational challenge, can the act of adapting and the characteristics of being agile and flexible not be considered as an essential part of an Organizational Culture? In the same scope, if we take Culture's most simplistic definition "the way we do things here", can we, in an organization that clearly works in the pursuit of agility, not deem the actions that lead and enable this pursuit as part of the established culture? By looking to the several agility enablers in Table 1, we find clear strategies and behaviors that can only be sustainable if consistent with strong sensed, fit cultural values.

Operational Excellence Enablers	 Leadership Top Management Commitment Systems Thinking Approach Organizational Culture Engagement Organization Strategy Alignment HR Skills and Competencies Processes Effectiveness and Efficiency Breakthrough Improvement Perspective
	- Stockholders' Needs and Expectations - Organization Communication Process - Learning Organization
Agility Enablers	Strategic Planning Product Design Process Virtual Enterprise Automation and Information Technology Supply Chain Integration Concurrent Engineering Knowledge management Learning Organization Organization Commitment and Employees Empowerment
Elements of Organizational Culture	ValuesNormsBehaviorsAssumptionsArtifacts

Table 1 - Elements and Enablers

Following this logic one can consider, for example, the case of a company with a deeply individualistic culture. Such organization would not be expected to implement a successful and lasting supply chain integration project. In the same sense, an organization whose culture shares as a belief that the behavior of its work force follows the pattern of Maslow's "Theory X" would never engage in employee empowerment and expect a deep commitment from them. Such actions simply are not fit with the established culture of each one, and would deeply clash with the ways of acting that are perceived as correct. In in such cases, when such actions are taken nevertheless, what companies find is strong resistance from their employees, who develop strategies to hold out the new culture (Ogbonna and Wilkinson, 2003). Same is the case of Excellence Programs. By exploring the existing relationship between Total Quality Management and Excellence and Organizational Culture, we find several cases where the need for adaptability is clear. Here, an idea of mutual adaptation is set as a critical success factor in the implementation of an Excellence Model: as the program is implemented, it will have to be adapted to the existing culture, understanding and respecting it (Maull et al., 2001). Failing to do so, and implementing any idea that goes against the current beliefs and values, will result in resistance to change, as people will not be able to recognize and absorb the new strategies and goals within their ways of working, not identifying the benefits and feeling anxious about changes that they might believe to be negative and fearing the impact of not being able to cope with them might bring upon themselves (Davy et al., 1988). The lack of adaptation of an approach of a Quality Program and the culture of an organization is often referred as one of the main causes for it to fail and, in fact, the less prescriptive and more adaptable approach of Excellence Models is one of the reasons why companies have moved from Total Quality Management to Excellence Programs (Adebanjo, 2001).

Indeed, if cultural fit is the key for successful implementation of excellence programs, how can it be withdrawn from the relation between Operational Excellence and an enduring capacity to respond to market changes? One example that might be given is the one of an Operational Excellence that does not produce perceived changes in a company. But if operational excellence does not produce changes it should be either because it failed to be implemented successfully due to cultural resistance or because its ambitions were purposely limited. If the program finds such a strong fit in the established culture that changes go by unperceived, its results were probably the outcome of a learning process within the pursuit of an excellence recognition award (no matter the level) than a search for improvement and flexibility.

Based on this perceptions, we are led to strongly believe that a path towards Organizational Agility where Organizational Culture is left outside does not realistic assess the true relationship of the concepts under study. Any Operational Excellence program resulting in the attainment of a greater capacity to be adaptable will always be dependent upon the established corporate culture and the fit between the actions and goals set in the Excellence program and the values and beliefs supporting that culture (figure 2).

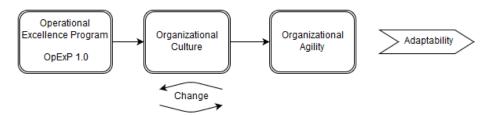


Figure 2- Revised Relationship flow for the Conceptual Model

It is precisely this fit or the lack of it that will determine the amount of effort and incremental cultural changes that will be necessary to attain a certain level of agility. Incremental changes will happen over time in the evolutionary path of "Cultures of Excellence" made under the influence of Operational Excellence programs (Figure 3). In order to achieve Organizational Agility, several culture changes might be necessary, creating step by step a more structured change and avoiding one single radical transformation that most probably would face resistance from the workforce (Johnson, 1992). This idea of incremental change gains even more importance as we define excellence not as a state to be achieved but as a continuous improvement and revision process.

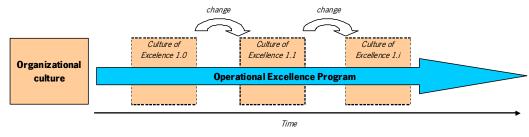


Figure 3 - Incremental cultural change process under the influence of an Operational Excellence Program

The first culture of excellence to be achieved is valid whether it is rather limited or promotes substantial change and improvement: in either case it means the most as the initial step on the long road to excellence.

The result of engaging in an excellence program will bring changes in the culture of an organization, and those changes might be enough to attain a certain level of agility, but many times the true consequences and resilience of this cultural change will only be proved if the strategic choices made by the organizations are in fact able to transmit the new culture in the form of excellence-bound decisions that promote a stable evolution and continuous improvement in the field. These strategic choices are the true drivers of a long-lasting commitment with Excellence, engaging in further OpEx Programs, delivering efforts in order to change and improve people, processes and products, and ultimately being responsible for achieving a higher level of agility and becoming more and more adaptable to the changing business environment. The importance of this evolutionary process led us to consider it as a structural piece of the Model, allowing a detailed view of the change process referred in the second stage of figure 2 e in figure 3. In this sense, we considered it in the new version of the model, expanding it as we present in Figure 4:

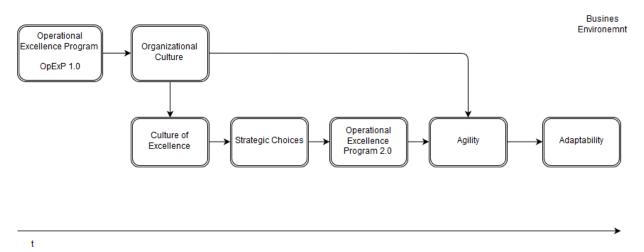


Figure 4 - Conceptual Model after revision

CONCLUSION AND FUTURE WORK

The design process of a conceptual model must follow a series of structural steps in order to be able to meet the true nature of the relationships it is trying to depict. Although the validity of the model can only be fully confirmed after its practical testing, it is important to have a critical view over it throughout the development phase. In this sense, the revision of first version of the model followed naturally. While the research supporting the first design addressed mainly the individual characteristics of each concept and promoted different interrelation hypothesis, this second version considers further inputs on these relations and is supported in the already developed work on the dual links between concepts, namely Operational Excellence and Organizational Culture and, in a more limited way, Organizational Cultural and Organizational Agility and Quality/ Excellence and Agility. This approach allowed us to confirm some of the relations, but, more importantly, to criticize, eliminate and redesign others. That was the case of the direct link between Operational Excellence and Organizational Agility - surpassing the cultural paradigm - and which we considered to be a wrongful representation of the process of organizational change towards adaptability.

Although conscious that further redesign of the conceptual model might be necessary, mainly as we reach the first case studies, as we reach this point it is our belief that it allows not only a more accurate perspective of the true relationship between Operational Excellence, Organizational Culture and Organizational Agility, but also an important close up view on the critical process of incremental change that occurs in most cases. By

considering all these aspects, we trust that the model is able to portrait reality and practically test the research questions of the project.

As for what considers our research agenda, the time has come to advance to the practical testing of the model. In that sense, the net step considers the preparation for the case studies, with the setting up of the research protocol, final selection and contractual agreements with the companies to undergo study, and the outline of our proposed schedule. Nevertheless, and at the same time, discussion over the project will be further instigated, in a scope of continuous and critical assessment and improvement – not so much fully centered in the model design but in the project as whole, its goals, methodologies and its approaches.

Acknowledgements: André M. Carvalho, corresponding author, gratefully acknowledges the financial support of "Fundação para a Ciência e Tecnologia" (FCT – Portugal) to this project, through the PhD Grant PD/BD/114149/2016.

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ANALYZING THE PROCESSES AT MISURATA AIRPORT USING THE SERVICE BLUEPRINT METHOD

Ramadan Abugeddida, Pat Donnellan and Enda Fallon

Mechanical Engineering, College of Engineering and Informatics, NUI Galway, Ireland.

ABSTRACT

The aim of this study was to identify points of failure and waiting times at Misurata Airport, Libya by analyzing key processes using the Service Blueprint Technique. The technique uses a schematic diagram that represents the details of a service from both the customer and the organization's perspective. It demonstrates how the various service components link with one another by identifying the different touch-points and options customers have to choose from and how the internal workings of the airport support those choices.

Before starting to use Service Blueprint, it is important to determine the main processes at the airport which are similar to a large extent to those at many airports around the world. In Misurata airport processes begin with car parking, followed by a security checkpoint, then the check-in desk, and finally passport control. After this stage there is a second security checkpoint after which the passenger proceeds to the appropriate flight gate.

The results of the application of the Service Blueprint Technique showed that there are some points of failure in several major processes. The most important of these was car-parking which is free, however the cars are not insured against theft. A failure was also found at the check-in desks due to the lack of experience and high turnover of staff. This results in the buildup of long queues in front of the desk as well as the narrow area allocated to passport control. A failure was also found due to the lack of a device to validate boarding passes. Allied to this, airport employees currently collect boarding passes which are then manually processed later.

Some failures were also found in the cargo cervices area. There were significant failures with respect to the permit procedures for cargo workers and trucks. There were also insufficient facilities to inspect the cargo received and a number of shipping companies did not have stores inside the airport.

Customs services were divided between two areas, one of which was located outside or away from the airport.

Keywords: Process Analysis, Service Blueprint, Airport Processes.

INTRODUCTION

Airports are a vital part of any country's infrastructure and provide services to many different customers. They generate significant income for the state. They have evolved greatly in the recent past and include many complex processes which require significant expertise to run them as intended.

The success of the airport at Misurata depends on the effectiveness of the operations management function which is similar in the case of larger airports around the world. It provides both goods and services at the same time and has evolved to include very large projects and investments. There are basic processes which must be followed to run the airport which are set by international aviations organizations. These include security checks, issuing of boarding cards and passport control and also many other supporting processes such as electronic systems and maintenance. Airport processes need qualified and trained technical staff in order to achieve successful operation of the airport and also to be able to compete in light of the strong competition in the airport sector of the aviation industry.

METHODOLOGY

The researcher used Service Blueprint as a tool to analyze the main airport processes. "Service Blueprint works within the Service Engineering process that enables the user to have a framework for viewing service improvement. Service Blueprinting alone does not lead to success; it is a visual tool designed to give valuable contributions to the service engineering process. What follows is a short description of the framework".(Maik Seyring, et, al., 2009).

There are five components of a typical service blueprint as follows: (Mary Jo Bitner, et, al., 2007):

- Customer Actions,
- Onstage/Visible Contact Employee Actions,
- Backstage/Invisible Contact Employee Actions,
- Support Processes, and
- Physical Evidence.

Researcher relied on data collection and analysis through observations, as well as interviews with staff at the airport, and then use Service Blueprint technique to draw all points of contact between the customer and the employee. A detailed analysis of the processes has enabled the researcher to figure out the points of failure, as well as waiting areas, which cause the creation of long lines.

The departments which were targeted to be studied security department, passports and nationality department, customs department, handling department, cargo department, as well as a number of companies operating at the airport, such as airlines, air cargo companies, customs clearance companies.

WHAT IS A BUSINESS PROCESS?

A business process is defined as, a collection of interrelated work tasks, initiated in response to an event that achieves a specific result for the customer of the process. (Victor Portugal, 2006). According to ISO 9000: 2015; A "Process" can be defined as a "set of interrelated or interacting activities, which transforms inputs into outputs".

THE AIRPORT BUSINESS PROCESSES

There is a great variation in the size of airports; some are small airports that operate a limited number of flights, and others are large airports that are like small cities offering a wide range of services. However, airports are complex systems because of the large number of sections and multiplicity of processes necessary to run them.

Airport Council International (ACI) has identified the six main processes required to run any airport. Those processes consist of: Access, Check-in, Passport/Personal ID control, Security, Finding your way, Airport facilities and Airport environment. A short description of each is given below:

Access: Ground transportation to / from airport, parking facilities.

Check-in: Check-in airlines desks

Passport/IID control: Passport / Personal ID inspection.

Security: Security staff, security equipment.

Finding your way: Signs and flight information screens.

Airport facilities: Staff, eating facilities, shopping, bank/ATM facilities, Wi-Fi, toilets.

Airport environment: Cleanliness of airport terminal, ambience of the airport.

MISURATA AIRPORT BUSINESS PROCESSES

Misurata airport provides two kinds of services: Passengers and air cargo. Both of these services were analyzed using the Service Blueprint tool in order to identify failures and waiting time points in their processes.

MISURATA AIRPORT DIAGRAM

The layout of landside and the terminal at Misurata Airport is shown in Figure (1).

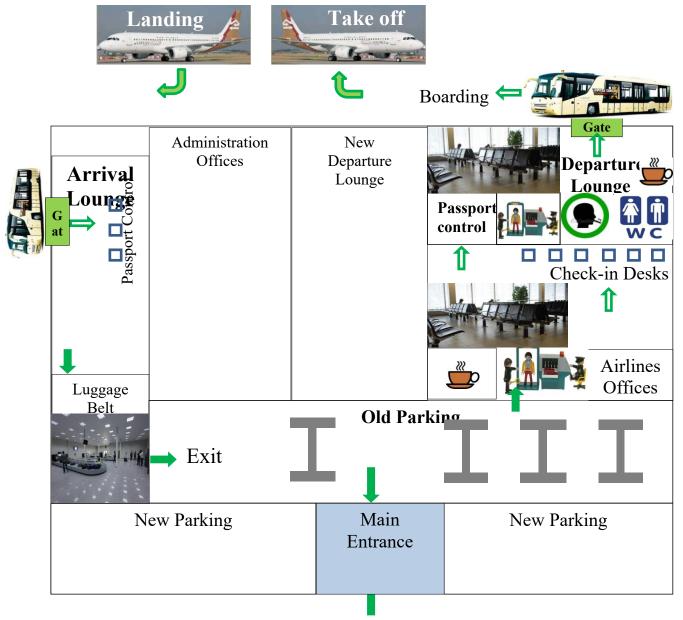


Figure 1 – Misurata Airport Layout – Landside the Terminal

THE MAIN PASSENGER PROCESSES

A number of service points can identified at both the point of departure and arrival.

1) Departure

- **The first security check point**: At this point, people and their luggage are checked by using two kinds of devices, a scanning machine and a metal detector. This process is carried out by security staff and customs' employees.
- **Check-in desk:** The employee ensures that the passenger has a reservation on the flight through checking his/her name in the reservation system, issues a boarding pass and weighs their luggage which is placed on the luggage belt.
- **Passport control:** At this point, the employee checks passports and enters passengers' details into the system and stamps the passport.
- **The second security check point:** At this point, people and their hand luggage are checked using a scanner and a detector. This process is carried out by security staff and customs' employees.

• **The last check point:** At this gate, passengers give their boarding pass to the airport employee standing at the gate who takes a part of it and checks their passport. Once this has been completed the passenger is allowed to transit through the gate onto a bus which brings them to the waiting aircraft.

2) Arrival

- Passport control: At this point, the airport employee checks the passenger's passport and the
 relevant visas required. Then he/she enters the passenger's information into the system and puts an
 entry stamp on their passport.
- **Security check point:** At this point, passengers and their hand luggage are checked by using a scanner and a metal detector. This process is carried out by security staff and customs' employees.

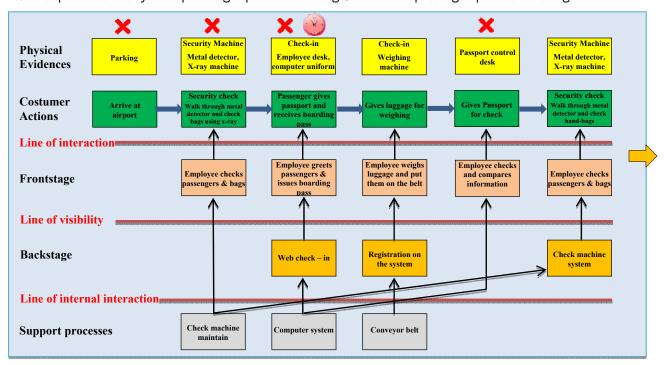
SERVICE BLUEPRINT

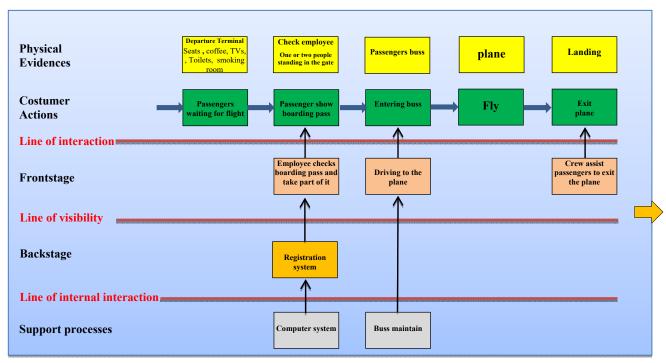
Service blueprint is a map or flowchart (called a process chart in manufacturing) of all transactions constituting the service delivery process (Shostack, 1984: 134; Fitzsimmons and Fitzsimmons, 2001). It is a flow chart that isolates potential fail points in a service process (Shostack, 1984: 134). Haksever *et al.* (2000) further explains that it is a visualization of the designer's concept of the product/process.

Service blueprint is a useful tool not only for the operations manager but for the marketing manager as well (Hoffman and Bateson, 1997). It enables the marketing manager to understand which parts of the operating system are visible to the consumer, and which the fundamental building blocks of consumer perceptions. The visible part of the operations process, with which the consumer interacts, must be supported by the invisible process (Hoffman and Nateson, 1997).

The use of Service blueprinting at Misurata airport

An example of the analysis of passenger processes using Service Blueprinting is presented in Figures 2 below.





🗶 - Failure 💮 - Waiting time

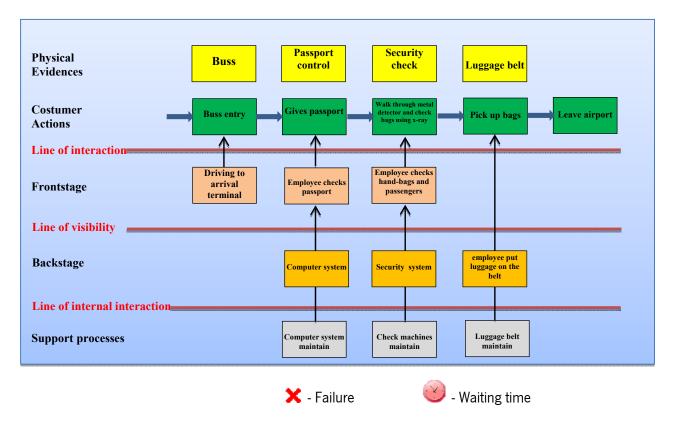


Figure 2 – A Service Blueprint Analysis of Passenger Processes

Following the application of the Service Blueprint approach at Misurata airport a number of potential failures and waiting points were identified. The data for the analysis was collected in consultation with the staff concerned. These are described below:

Parking: Parking is free, however there is no security for cars against theft, nor are environmental conditions suitable due to the fact that the car park is an open area.

Check-in: A large proportion of workers at the check-in desk are not qualified nor do they have enough experience dealing with reservation systems. Consequently long queues form. This problem is partially caused by the high turnover of staff.

Passport control: The area has been allocated to passport control is very small, resulting in a queue in front of passport control. The main reason for this is that here is insufficient space due to lack of investment.

Departure lounge: This lounge is very small. Problems occur appears especially when more than one flight arrives at a time. Also the seats in the lounge are very uncomfortable.

AIR CARGO

The Service Blueprint approach was also applied to the cargo processes. The results are presented below in Figure 3.

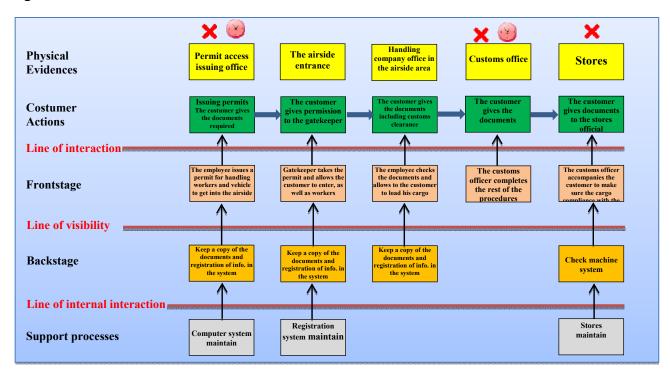


Figure 3 – A Services Blueprint Analysis of Cargo Processes

According to the Figure (3), there are potential failure points in cargo services as follows:

- Due to the change in handling workers when trucks enter the airport area the authorization procedures to enter the airside require further scrutiny. This causes a delay in granting permits to workers as well as the trucks.
- Customers need to move between more than one customs office; one is inside the airport and the other outside the airport. This causes confusion and difficulty and delays in customs transactions.
- The airport has a limited number of stores. Some cargo companies hire stores outside the airport and this causes confusion within cargo services. In addition the warehouse stores lack scanners, especially large ones, to ensure the safety of the cargo.

CONCLUSION

The results showed that some of the major processes at the airport, either for passengers or for air transport services included points of failure and waiting times. The most important reasons were lack of operations equipment, the weakness of means of communication, bad facilities and inadequate spaces.

In addition to these failures, most departments suffering low efficiency of workers and it is due to high labor turnover rate, as well as the impact of the low salaries.

The airport needs to develop sources of funding to be able to improve services and operations in all departments and achieve customer satisfaction and provide excellent services in the future.

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ISO 9001 and EFQM Model: a good approach for Higher Education Institutions?

Sá, P.S¹, Sampaio, P.² and Rosa, M.J.³

- ¹ Department of Production and Systems Engineering, School of Engineering, University of Minho, *Campus* de Azurém, 4810-058 Guimarães, Portugal. *e.paulass@gmail.com*
- ² Department of Production and Systems Engineering, School of Engineering, University of Minho, *Campus* Gualtar, 4710-055 Braga, Portugal. *paulosampaio@dps.uminho.pt*

³CIPES - Center for Research in Higher Education Policies and DEGEIT - Department of Economics Management, Industrial Engineering and Tourism, University of Aveiro, *Campus* Universitário de Santiago, 3810-193 Aveiro, Portugal. *m.joao@ua.pt*

ABSTRACT

The evaluation of higher education in Portugal, similarly to what happens in most European countries is not a new topic, deserving, however, particularly relevance with the implementation of the Bologna guidelines. The Agency for Assessment and Accreditation of Higher Education (A3ES) is the organization responsible for conducting the assessment of Portuguese higher education. Parallel with the evaluation and accreditation of study cycles, and to simplify this task, A3ES proposes the adoption and possible certification of Internal Quality Assurance Systems (IQAS) for the Higher Education Institutions (HEI). At a time where the assessment and accreditation of study cycles is at cruising speed and whose procedures have been appropriated by HEI, it is important to understand how these institutions are responding to the assessment and accreditation requirements of their study cycles and how they see the A3ES guidelines for the implementation of the IQAS.

With the implementation of these systems, the Agency, seeks that HEI integrate in their organizational culture, cyclical assessment practices that can trigger continuous improvement actions. Since, in essence, these systems share the principles that support the ISO 9001 standard and the EFQM Excellence Model, one can raise the question: *in what way the ISO 9001 standard and the EFQM Model can contribute for quality management and integration of the Internal Quality Assurance Systems in the organizational culture of the Higher Education Institutions*?

This study, involving representative institutions of Portuguese higher education, universities and polytechnic institutes, public and private, intends to list a set of practices of quality assessment developed and employed in Quality Management Models, such as ISO 9001 standard and EFQM Excellence Model that can contribute to an easiest implementation of IQAS.

Keywords: Higher Education, International Quality Assurance Systems, ISO 9001, EFQM.

INTRODUCTION

Much has been said and written about evaluation and accreditation of higher education in general, and in particular, about the Portuguese one. The pressure to which HEI are subject, due to both external or internal factors, has dictated the need for these institutions, in a higher or lesser degree, to implement a significant number of quality management practices. These practices are becoming, more and more demanding and need to be efficient in order for institutions not only meet the requirements imposed by external quality assurance mechanisms, but also strive to optimize of their performance, given the constraints to which they are exposed to.

In an attempt to simplify accreditation procedures of study cycles, but also to promote internal institutional culture of quality assurance through the adoption of quality management practices that can improve their processes and activities, A3ES proposes a model for certification of HEI IQAS, seeking to promote their development and continuous improvement. This study aims to understand how HEI see and feel about the implementation of these systems, and identify quality management practices, already implemented, that can contribute to an effective implementation of their IQAS. On another vein, the study also wants to understand how quality management practices associated to existing frameworks, such as the widely known ISO 9001standard or the EFQM Excellence Model, which has proven results in other sectors of activity, can help and support quality management in higher education.

This paper is divided into five parts. In the first part we discuss quality management in higher education with reference to the factors that justify its current concern, the emergence of the Portuguese Agency for Assessment and Accreditation of Higher Education and the certification model for IQAS suggested by the A3ES to HEI. The second part is dedicated to the ISO 9001 and the EFQM Excellence Model quality management frameworks, discussing on whether and how these systems could support quality management in HEI. In the third part the guiding objectives of the investigation are clarified and the population involved in the study is presented. In the fourth and fifth sections are presented, respectively, the results and the main conclusions of the study.

QUALITY MANAGEMENT IN HIGHER EDUCATION

The preoccupation with quality in higher education has been a constant since the appearance of the first universities, with more or less emphasis over time, following in some ways what has happened in other sectors. Especially in the industrial sector, the constant concern with the market and competition dictated a faster evolution. In fact, the quality movement grew more sharply in the 70s and 80s, under the competition to which big European companies were exposed, forcing the search for solutions allowing their survival through a quality orientation and a focus in customer satisfaction over quantity. A similar situation happened in the 90s, with higher education, where the following trends could be identified: i) the exponential appearance of new HEI, which contributed to increased competitiveness in terms of student recruitment; ii) the rising costs of higher education and its consequences in terms of the forms of financing; iii) changes in the higher education system regulation model, with the State assuming a supervisory role instead of a control one, increasing thus the autonomy of the institutions; iv) the training and skills required for the teaching staff, with an emphasis on scientific research and its results; and v) the increased number of stakeholders, since HEI are required to have an increasingly active role in the society. These trends are examples of factors that have led to a change in the paradigm of HEI view of quality. So, quality management plays, today, a leading role in defining HEI's strategy (Rosa and Amaral, 2007; Sitnikov, 2011).

European higher education has been, over time, target of change and reforms; nevertheless it is effectively in the 90s that the changes take contours never before seen and imagined. Parallel to the mentioned

factors, Sitnikov (2011), highlights as responsible for the changes, three key events: the Sorbonne and Bologna Declarations (1998 and 1999), whose main objective was to create a compatible European curriculum structure based in 3 cycles (bachelor-master-doctorate degrees), thus making the European higher education system compatible, and the Lisbon strategy (2000), which allowed strengthened the reforms of the still fragmented educational system of European countries, guiding them to a more robust and integrated knowledge base society.

Under the Bologna Declaration, signed in June of 1999, twenty-nine European ministers and their governments committed themselves to create a European Higher Education Area until 2010, which, together with the curriculum reform programs, given the structure of 3 cycles degree, has generated consensus on compatibility and led to the need to ensure quality, accreditation and even recognition, confirmed after by the Berlin Communiqué (2003). Quality assurance has become thus one of the most important lines of action in the context of Bologna, where the accreditation is the visible result of quality assurance, and can be seen as an important contribution to the creation of the European Higher Education Area (Hartley and Virkus, 2003; Sitnikov, 2011).

The Agency for Assessment and Accreditation of Higher Education, A3ES

Even before Bologna, a series of activities in higher education, such as evaluation and accreditation, had raised the need to create throughout Europe responsible bodies for th evaluation, monitoring and accreditation of study cycles and institutions. In December 1998, the Council for Cooperation in Higher Education Quality Assurance recommended that countries should establish their own quality assurance agencies, and created a European Network of Quality Assurance Agencies, aimed at the promotion of different initiatives to explore the context and the feasibility of accreditation, to clarify the key concepts and issues, as well as to discuss possible forms of accreditation at European level (Hartley and Virkus, 2003).

Given the need to respond to these guidelines, as well as the need to structure a quality assurance system internationally recognized, was published in 5th November of 2007, the Decree-Law no. 369/2007, which established the Portuguese Agency for Assessment and Accreditation of Higher Education, A3ES. The A3ES mission is to contribute to improving the quality of Portuguese higher education, through the assessment and accreditation of higher education institutions and their study programmes, and to ensure the integration of Portugal in the European quality assurance system of higher education (A3ES, 2016a).

The main objective of A3ES is to promote the improvement of the higher education institutions and their study programmes, and to guarantee the fulfilment of the basic requirements for their official recognition, through assessment and accreditation activities, promoting an internal quality assurance culture within higher education institutions (A3ES, 2016b).

Accreditation and the Internal Quality Assurance Systems

In any organization, an evaluation process aims at quality improvement, at least in theory. So accreditation can be considered as a way to validate the level of quality achieved by HEI, and ensure a minimum quality standard. In higher education systems, evaluation and accreditation by a body such as the A3ES, allow the comparison of institutions in the eyes of different actors, once published the results of the evaluation processes of study programs and institutions. It will certainly be a form of "labeling" the quality of teaching, research and university management. In this context, Serrano-Velard (2008) affirms that the evaluation and accreditation are powerful consumer protection instruments in an educational context increasingly competitive and international.

At the beginning, and in an attempt to standardize procedures and make a real evaluation of the study programs in operation, A3ES developed its activity focused on preliminary accreditation processes of study cycles in operation. After this first phase, th agency has focused its activity mainly in the evaluation and accreditation of study cycles in operation, and new ones, through accreditation processes. The process of evaluation and accreditation of a study cycle in operation requires the submission by the HEI, of a set of specific information, gathered in a self-evaluation report, to be submitted to the Agency for the evaluation by an External Evaluation Commission appointed by A3ES. A visit of this Commission to the institution complements the process. All these activities are, indeed, carried out with a great expense of time and resources. In order to be able to reduce some of the procedures and resources for the accreditation process, is part of the objectives and part of the A3ES activity plans, the possibility of certification of the HEI internal quality assurance systems. According to Santos (2011) the certification will be "[...] an essential tool for further simplification of procedures in the process of external evaluation and accreditation of institutions and study cycles."

The IQAS certification model, proposed by the A3ES, is based on a set of standards designed after a comparative study of European processes for internal evaluation and certification of quality assurance systems which, although considered by A3ES as not being absolute standards, are guidelines for the design, development and implementation of internal quality assurance systems within HEI (A3ES, 2016c). 10 standards are then proposed (Santos, 2011) for the implementation of internal quality assurance systems in Portuguese HEI, aligned with the ESG (*European Standards and Guidelines*, 2009). The standards are:

- 1. Definition of a quality policy and objectives
- 2. Definition and quality assurance of educational offer
- 3. Quality assurance of learning and of student support
- 4. Research and development / targeted research and high level professional development
- 5. External relations
- 6. Human resources
- 7. Material resources and services
- 8. Information systems
- 9. Public information
- 10. Internationalization

To ensure the response to each standard, institutions must develop a set of procedures and mechanisms for collecting and analyzing information, which allow them to make explicit to others their position in relation to each standard implementation. The standards are not meant to be prescriptive, being up to each HEI, in accordance with its mission, goals and institutional culture, to define the organization of its own internal quality assurance system. Santos (2011) also refers that these standards are intended to promote and encourage innovative approaches as regards to the promotion of an institutional culture of quality and continuous improvement, rather than just responding and complying with external references.

Implementing mechanisms for quality evaluation, assurance and management, in order to respond to the proposed standards, or to others, implies that HEI create a set of structures and indicators to support a dynamic evaluation culture. Evaluation culture that, even if only at the level of accreditation and maintenance of accreditation of study programs, begins only now, to take shape in a significant number of Portuguese HEI.

THE ISO 9001 STANDARD AND THE EFQM EXCELLENCE MODEL

The development and maturity of quality led this management area to no longer be confined only to the industrial domain, gaining importance in other sectors, particularly in the services sector and also in higher education. The term quality, though suffering over time, changes of paradigm and meanings, is currently one of the most used by managers and executives. According to Heras-Saizarbitoria *et al.* (2011), the reasons for that have to do with the success associated with the implementation and certification of quality management systems supported by the ISO 9000 standard and other models like the Excellence Model of EFOM, especially in a self-assessment component.

In the last three decades of the twentieth century, the quality of management reborn in organizational management, with an emphasis on excellence. Despite the doubts about the real contribution of quality to create value, due to some philosophies' confusion, models and techniques related to quality and risk management sometimes poorly understood, it is important to realize that quality in organizations is here to stay. Quality allows organizations to walk a clear path, improving their responses to change, leading them in the desired direction, and thus, constitutes itself as an organizational sustainability tool (Camisón and Pérez, 2010; Wiele *et al.*, 2011).

ISO 9001 Standard

The ISO 9000 family, known as quality management standards, is the result of an international consensus among experts on good quality management practices. Developed in order to support the implementation and operation of effective quality management systems, the ISO 9001 standard stands out as the member of the family that defines the requirements for the implementation of quality management systems in any organization, regardless of size or activity field. The application of this standard enables organizations to become more efficient and effective, improving customer satisfaction.

The standards provide guidance and tools for companies and organizations who want to ensure that their products and services consistently meet customer's requirements, and that quality is consistently improved. (ISO, 2016)

ISO 9000 standards do not refer to the fulfillment of a goal or to the reach of a certain result, that is, they do not measure the quality of the products or services of an organization, but establish the need to systematize and formalize the organization's processes and procedures. Applying the ISO 9001 standard on a voluntary basis in an organization means that the organization has implemented a quality management system based on documented and standardized procedures, allowing the systematization of tasks that support and lead to the production of products or provision of services, achieving compliance with the specifications established by the customer (Heras-Saizarbitoria *et al.*, 2011; Ollila, 2012).

ISO 9001 has proved to be dynamic, as is required to a quality framework that, necessarily, has to follow the contingencies of markets globalization and of increasingly consumers demand patterns. The current version, ISO 9001:2015, results from the revision of ISO 9001:2008 and has recently been published (22th September, 2015). Basically following the previous structure, this new version is structured to facilitate the integration of this standard with other management systems. Furthermore, it gives special emphasis to risk management, based on a "risk thinking" approach. Thus, quality results of a proper risk management that goes beyond the specific ambit of the product or service.

According to ISO (2016), an effective quality management system based on the assumptions of ISO 9001 can bring to the organization many benefits, namely: a higher commitment of the management bodies;

allows, in a more structured and adequate form, to deal with the risks and opportunities; allows the use of a simplified language and a common structure of terms, particularly useful for organizations using multiple management systems; and, addresses the supply chain management more effectively. It was based on the ISO 9001:2008 version, that the questionnaire, which supports data collection for this study was structured. The requirements of this version are stated in five main blocks: *Quality Management System – Management Responsibility – Resources Management – Realization of the Product/Service Delivery – Measurement, Analysis and Continuous Improvement*.

EFQM Excellence Model

The EFQM (*European Foundation for Quality Management*) Excellence Model was created in 1992, in order to assist European organizations, at the time, particularly large companies, to establish a management system able to continuously improve their performance. The model serves as the basis for the evaluation of the organizations aiming the attribution of the *European Quality Award*) (Dias e Melão, 2009).

Excellent Organizations achieve and sustain outstanding levels of performance that meet or exceed expectations of all their stakeholders. (EFQM, 2016a)

When created, the model aimed to stimulate European organizations to improve their activities towards excellence. The goal was to influence the results of the organizations, becoming a decisive factor and a competitive advantage in face of the globalization. More indirectly, but also associated with its genesis, this model also intended to establish a comparison between the best management practices identified in organizations, promoting the exchange of experiences. It is now used by many European organizations as a means to implement quality management systems. It is based on approaches that allow the evaluation and continuous improvement, ensuring that organizations focus on the effective development and implementation of a strategy resulting in a higher added value and greater perception of their position in the market. Each organization is assessed based on the same set of criteria to which a score is assigned.

This is a model that, similar to what happens with the ISO 9001, is dynamic, since it has undergone changes resulting in different versions, the last one in 2012. It is based on eight fundamental principles or concepts that allow an organization to achieve Sustainable Excellence, describing the attributes of an organizational excellence culture (EFQM, 2016a).

As the ISO 9001, this model can also be applied to any organization, regardless of size, sector or maturity. It is not prescriptive and ensures that all management practices used by an organization form a coherent whole that is continuously improved and provides the appropriate strategy for the organization. The EFQM Excellence Model is based on nine criteria. Five of them are "Means" – *Leadership – People – Strategy - Partnerships and Resources - Processes, Products and Services* – and four are "Results" – *People Results – Customer Results – Society Results – Key Results.* The "means" criteria cover what an organization does and how it does it. The criteria "results" cover what the organization achieves. The "results" are a result of the "means" and "means" are continuously improved for improving the "results" (EFQM, 2016b).

According to Martín-Castilla (2002), the EFQM Excellence Model is part of a humanistic approach that puts the consumer, in its multiple meanings, as the center of the organization's activity, with particular emphasis on his role as a responsible member of the community. The results oriented approach assumes that the organization should direct its activities to meet the needs and expectations of the stakeholders. One of the most recognized virtues of this model is its non-prescriptive nature since each criteria and subcriteria is defined and implemented through an open interpretation and adapted to each organization.

In a European environment of culture and organizational quality, the clear and firm position of the EFQM Excellence Model can easily be considered as a reference for organizations whose goal is excellence, offering them a comprehensive approach and integrating their most relevant dimensions. Can also be an objective, rigorous and structured tool for organizational diagnosis. The nature of this model, always dynamic and in constant change, in line with developments and trends of organizational management, is also an important element for the definition of coherence and general lines for continuous improvement to which the organization should be directed (Martín-Castilla, 2002).

ISO 9001 and EFQM Model: a good approach for Higher Education Institutions?

Given the competitive environment in which today's organizations are required to operate, the ISO 9001 and the EFQM Excellence Model are quality management tools with a special emphasis in the strategic decisions of the organization, improving its overall performance, with emphasis on increasing the satisfaction of consumers and employees and the acquisition of new customers and new market shares.

In Portugal, following the trend in most European countries, higher education institutions have been paying attention to quality issues. There are institutions where, clearly, evaluation and quality management practices are already part of their routine, some of them even having been certified by ISO 9001. The reflection which should and must be done, is then , on the one hand, the possibilities of increasingly applying these models in HEI and, on the other hand, the current need for HEI to define their internal quality assurance systems and the role these models can have in assisting these institutions in this arduous task.

Sitnikov (2011) states that these two models, along with others, are focused on the systematic development of the processes necessary to obtain measurable quality results that can be applied at the institutional level as a whole or a part, enabling a strategic approach to evaluation and quality management, as well as facilitating the identification of priorities for quality improvement. In a study presented by Sá *et al.* (2012), a comparative analysis was carried out between the ISO 9001 requirements, the criteria that support the EFQM Excellence Model and the standards proposed by the A3ES in the certification model of internal quality assurance systems, reaching the conclusion that a clear link exists between these three references. They are based on approaches that promote the evaluation and continuous improvement. The objectives and the information requested by each model to answer their requirements are similar. What may vary is the quality practices, mechanisms and tools that enable each institution to standardize their processes, gather information and work towards continuous improvement.

Sitnikov (2011) tells us that the management and continuous quality improvement must be worked in the HEI, using models based on frames of work internationally recognized, highlighting the ISO 9001 and the EFQM Excellence Model. The specificity of this sector and its institutions – higher education is not a business – makes, however, the adoption of these models more difficult. Nevertheless, the practices embedded in them could help HEI to perform an effective assessment of the needs of its stakeholders, optimize their processes and resources and enhance the appearance of external sources of financing. Thus the ISO 9001 standard and the EFQM Excellence Model can be important mechanisms for HEI quality assurance, with enormous influence in the future and on the sustainability of these institutions, in a time when the challenges are giants and funding to the sector tends to reduce. A reflection that Sitnikov (2011) makes about the new challenges of management and how higher education institutions must be managed, observes that today it is impossible to ignore the importance and need to anticipate scenarios and define future strategies. He also tells us that, although there are authors who differ on the strength that the quality function will be in the future in these organizations, they unanimously agree that their strategy should integrate the various fields of management, including knowledge management, change management, risk management, innovation management and total quality management as a cohesive element.

Rosa and Amaral (2007) argue that the HEI should look for quality assessment systems and models that enable them to secure and improve their quality, regardless of the presence of external systems of quality assessment. As centers of knowledge, whose raw materials are human beings, the HEI are very complex organizations, providing a "service" that is too complex and difficult to assess. According to these authors, the application of quality management models is not easy and when applied to these institutions may end up being a difficult process. However, this is one way that can be stepped by HEI in order to continuously improve the quality of the service that they provide; this option should, nevertheless, be a decision of the institution top management and not an imposition by external entities.

METHODOLOGY

Objectives

Admittedly, in higher education, quality, their assessment and management is an unavoidable fact of the reality of these institutions, which, with more or less difficulty, they have to respond in more or less sustained form. The adoption of IQAS by HEI has, at the moment, no mandatory character. More important than the adoption of a system like this, the A3ES demands that HEI interiorize, in her organizational culture, cyclical assessment practices that produce results, which after evaluating can trigger continuous improvement actions.

Data for this study was collected through a questionnaire sent to all Portuguese HEI, following a quantitative approach. The goal was to seek to realize if the existence of quality management models, such as the ISO 9001 or the EFQM Model of Excellence, widely known and used in other sectors of activity, can contribute to improve HEI's quality management, and simultaneously help the institutions implementing their IQAS, while integrating them in their organizational culture. We tried also to discuss if systematic quality management practices were already being implemented in these institutions, and if these practices are properly integrated into their organizational culture.

The design of the questionnaire had as a starting point, the exhaustive study of the requirements associated with the ISO 9001:2008, the criteria supporting the EFQM Excellence Model and the standards proposed by the A3ES for the certification of IQAS. It was considered appropriate to split the topics covered in the questionnaire in three main groups of questions:

- Quality and Quality Management The questions of this group helped explore and conclude on how quality and quality management are understood and defined in the context of Portuguese higher education;
- 2. Internal Quality Management Practices With this set of questions we intended to collect data that would allow to understand if relevant quality management practices for the implementation of IQAS exist at the moment in Portuguese HEI;
- 3. *ISO 9001and EFQM Excellence Model* Focused on the requirements of these two models, the questions that are part of this group allowed analyzing and concluding on the possibility of application of the ISO 9001 and the EFQM Excellence Model in HEI.

The questions were placed in the form of statements and answers were given using a concordance scale of 1 to 5, where 1 means "strongly disagree" and 5 "strongly agree". There was also the possibility to answer "do not know/not suitable".

Population

The Portuguese higher education system is binary, comprising both a university and a polytechnic subsystems. Furthermore, a public and a private sector coexist, comprising each one of them the two subsystems. The population to inquire has 82 institutions, 34 of them belonging to the public system and 48 to the private one. The institutions that are part of the public higher education system include 8 are dedicated to university higher education, 20 to polytechnic higher education and 6 institutions that integrate the two subsystems. In the private sector, there are 10 institutions offering university education, 29 offering polytechnic education and 9 institutions providing both educational subsystems, in a total of 48 institutions. Were excluded, from this study, the institutions of the military and police higher education, as well as the institutions in foreclosure process or in cessation processes of study programs. Given this reality and the technicality of the language used in the questionnaire, essentially focused on quality and quality management models, that require some previous knowledge about these matters, the methodological strategy has been to identify, in each of these 82 institutions, the responsible for quality and ask him to answer to the online questionnaire.

FINDINGS

From the 82 HEI who were asked to fill the questionnaire, 12 (35.29%) are public institutions and 39 (81.25%) are private institutions, in a total of 51that have answered the questionnaire leading to a response rate of 62.20%.

Since the study is still in progress, we present in this paper only some preliminary results based on the analysis of the collected answers. The results are grouped into 3 blocks (Tables 1, 2 and 3), corresponding to the questionnaire three groups of questions: *Quality and Quality Management, Internal Quality Management Practices* and *ISO 9001 and EFQM Excellence Model.* The information presented in the following tables is then complemented with a brief summary that highlights the main results and conclusions derived from its analysis.

Table 1 – *Quality and Quality Management*Main results (statistical characterisation of the HEI answers' distribution)

Topics	Median	Average (m)	Standard deviation (s)	Variation coefficient (c,=s/m)
Quality and Quality Management				
Increased institutional concern about quality and its management	5	4.53	0.81	0.18
Concerns about quality have been essentially motivated:				
. by internal reasons	4	3.86	0.99	0.26
. by external reasons	5	4.32	0.79	0.18
Concerns about quality and its management are evident at the level of: . teaching and learning processes . research and high-level professional development processes	5	4.51	0.67	0.15
. interinstitutional cooperation and with community processes . internationalization processes	4	3.80	1.02	0.27
. support (personnel management, information systems, support services) processes	4	3.94	0.93	0.23
	4	3.80	0.89	0.24
	5	4.36	0.72	0.17
In the institution:				
. is an adequate way of planning the implemented quality management practices	4	4.08	0.75	0.18
. are defined and communicated objectives and strategies	4	4.10	0.79	0.19

related to developed quality management practices				
. are mechanisms for monitoring and control of existing quality	4	4.22	0.79	0.19
management practices				
Concern about continuous improvement of quality and its processes		4.51	0.70	0.16
The implementation of quality management practices has led to visible				
results in quality of:				
. the institution as a whole	4	4.26	0.66	0.16
. the teaching/learning processes		4.34	0.72	0.17
. research and high-level professional development processes	4	3.56	0.93	0.26
. interinstitutional cooperation and with community processes				
. internationalization processes	4	3.78	0.93	0.25
. support (personnel management, information systems, support				
services) processes	3	3.58	0.95	0.27
	4	4.30	0.76	0.18
The existing quality management practices are aligned and integrated	4	4.28	0.76	0.18
into the organizational culture of the institution				
The quality management is, in this institution, considered part of the	4	3.78	0.65	0.15
overall management of the institution				

With a set of generic questions, this group intended to explore and conclude on how the quality and quality management are understood and defined in the Portuguese higher education context. It seems clear that there is a growing concern of HEI regarding quality and its management over the past years, driven firstly by external reasons, especially due to pressures exerted by external actors.

It is at the level of the teaching and learning process, followed by the support processes, that HEI have a greater concern with quality and where they highlight the visibility of the achieved results. Regarding the internationalization processes and the research and professional high-level development processes, HEI assume giving less priority to the implementation of quality management practices addressing them. Institutions also recognize that quality management results are less visible for these processes.

HEI highlight their concern with their own continuous quality improvement, referring the existence of mechanisms for monitoring and control of the existing quality management practices.

There appears to be convergence among HEI to assume that the existing quality management practices are integrated into their organizational culture. Slightly less optimism is demonstrated towards considering quality management as part of the institution overall management.

Table 2 – *Internal Quality Management Practices*Main results (statistical characterisation of the HEI answers' distribution)

Topics	Median	Average (m)	Standard deviation (s)	Variation coefficient (c,=s/m)
Internal Quality Management Practices				
Knowledge of the standards proposed by A3ES to implement IQAS	5	4.65	0.87	0.19
HEI benefit by implementing IQAS based in the standards proposed by A3ES	5	4.40	0.79	0.18
The implementation of an IQAS can induce HEI to separate quality management of the global institutional management system	2	2.64	1.31	0.49
Globally, the standards proposed by A3ES for the certification of IQAS are known:				
. by teachers	4	3.62	1.01	0.28
. by non-teaching staff	3	3.23	1.11	0.34
. by researchers	4	3.93	1.08	0.31

The institution defined strategic objectives for quality management	4	4.12	0.84	0.20
The strategic objectives are transformed into operational ones	4	4.00	0.86	0.21
The objectives defined for quality were communicated to the different				
stakeholders (teachers, non-teaching staff, students, external entities,	4	3.84	0.91	0.24
etc.)				
The actors involved in the existing quality management practices were	4	4.20	0.74	0.16
identified and their responsibilities were defined	4	4.32	0.74	0.16
There are documented procedures for quality management related to:				
. teaching and learning processes				
. research and high-level professional development processes	5	4.47	0.77	0.17
. interinstitutional cooperation and with community processes	4	3.67	1.09	0.30
. internationalization processes				
. support (personnel management, information systems, support	4	3.65	1.15	0.31
services) processes				
	4	3.69	1.12	0.30
	5	4.33	0.75	0.17
There are mechanisms for detecting quality problems	4	4.06	0.79	0.20
The identified quality problems, are analyzed and treated, seeking their	4	4.18	0.75	0.18
correction		1.10	3.75	3.10
There is a systematic and consistent articulation between quality	4	3.92	0.94	0.24
management practices and the strategic management of the institution		0.52	0.51	0.21
It is visible the support and commitment of the management bodies in	4	4.18	0.85	0.20
relation to developed and implemented quality management practices	•	1110		0.20
The information generated by implemented quality management				
practices is used to promote the continuous and systematic	4	4.06	0.68	0.17
improvement of the institution's quality				
There is an effective participation of the following stakeholders in the				
implementation of quality management practices:		0.04	1.00	0.05
. students	4	3.94	1.00	0.25
. teachers	4	4.22	0.76	0.18
. researchers	4	3.52	1.01	0.29
. non-teaching staff	4	3.96	0.88	0.22
. employers	3	3.17	0.97	0.31
. former students	3	3.00	1.01	0.34
. external partners	3	3.06	0.95	0.31
. society in general There are machining that allow to generate value at information to	3	2.67	0.95	0.36
There are mechanisms that allow to generate relevant information to: . teachers				
. non-teaching staff	4	4.33	0.71	0.16
. nor-teaching stan . researchers	4	4.33	0.71	0.18
. students	4	3.71	1.00	0.13
. Students	4	4.02	0.81	0.20
The information that is generated is properly transmitted to:		7.02	0.01	0.20
. teachers	4	4.37	0.65	0.15
. non-teaching staff	4	4.24	0.69	0.16
. nor-teaching stail . researchers	4	4.00	0.99	0.10
. students	4	4.24	0.77	0.18
In relation to its external stakeholders (employers, alumni, external		!	3.7.7	5.10
partners, etc.), the institution:				
. identifies their information needs	4	3.51	0.95	0.27
. provides information	4	3.76	0.81	0.22
. disseminates information	4	3.86	0.72	0.19
In a regular way, the institution has mechanisms to:	· · ·			
		4.25	0.80	0.19
, detect the need to define improvement actions	4	4.20		
. detect the need to define improvement actions . plan the implementation of improvement actions	4 4		0.80	0.20
. detect the need to define improvement actions . plan the implementation of improvement actions . document the improvement actions planned and implemented		4.04 4.08		0.20 0.21

. monitor the impact (effectiveness) of the improvement actions	4	4.12	0.74	0.18
implemented	4	4.04	0.80	0.20
Quality management practices currently implemented in the institution:				
. were properly defined				
. are properly documented	4	4.16	0.58	0.14
. are dynamics	4	3.96	0.81	0.20
. are effective, producing results at the institution quality level	4	4.12	0.75	0.18
. are consolidated and connected to each other, forming a whole	4	3.94	0.74	0.19
system				
•	4	3.58	0.76	0.21

The focus of this group of questions was to try to understand if there are already in HEI t relevant quality management practices for the implementation of IQAS. As a starting point, the first question asked to institutions was about their degree of knowledge regarding the certification model proposed by A3ES for IQAS implementation. Although there were institutions expressing their total ignorance about such a model, the overwhelming majority is aware of it and believes that implementing a IQAS based on the standards proposed in the certification model will benefit the institution. The results also tend to show that institutions consider that the implementation of an IQAS does not lead to a separation of quality management from the institution's overall management.

HEI highlighted the existence of documented procedures for quality management, especially with regard to the teaching and learning processes and to support processes.

Internal stakeholders, namely teaching staff, non-teaching staff, students and researchers (although the latter ones in a lesser extent) are the ones effectively participating in the implementation of quality management practices. A minor role is recognized for external stakeholders, in particular employers, alumni, external partners and society in general, in this respect.

It is mainly for the teaching staff that HEI generate relevant information, and it is also for them that the generated information transmitted.

HEI identify the existence of mechanisms to detect quality problems, highlighting that those allow detecting the need to define improvement actions. Less relevance is given to the existence of practices aimed at planning, implementing and monitoring these actions.

Globally, there is a tendency for institutions to consider that the implemented quality management practices are adequately defined and dynamic. There are more reserves of the institutions in considering them as being effectively a system.

Table 3 – *ISO 9001 and EFQM Excellence Model*Main results (statistical characterisation of the HEI answers' distribution)

Topics	Median	Average (m)	Standard deviation (s)	Variation coefficient (c,=s/m)
ISO 9001 and EFQM Excellence Model				
The institution developed its mission and its vision based on a strategy focused on its stakeholders (teachers, non-teaching staff, students, external entities, etc.)	5	4.32	0.87	0.20
Policies, plans, objectives and processes of the institution are developed and implemented based on the defined quality strategy	4	4.04	0.81	0.20
The government and management bodies of the institution are involved and committed with the implemented quality management practices, ensuring: . the identification and enforcement of the needs and expectations of stakeholders (teachers, non-teaching staff, students, external entities, etc.)	4	4.10	0.84	0.20

. the existence of internal communication mechanisms that	4	3.98	0.89	0.22
contribute to the effectiveness of these practices				
. the planning of the practices	4	3.94	0.89	0.23
. the review of the implemented practices	4	3.94	0.89	0.23
The government and management bodies have a vision and act based				
on values and ethics, anticipating the needs of the institution and	4	4.18	0.92	0.22
working for their continued success				
The institution has the adequate resources to implementation,				
maintenance and continuous improvement of the defined quality				
management practices, especially in terms of:				
. human resources	4	3.67	1.02	0.28
. infrastructures	4	3.96	0.94	0.24
. work environment	4	3.98	0.95	0.24
The institution manages its resources and partnerships based on a		0.50	0.50	0.21
defined strategy and policies, aimed at the operationalization of its	4	4.06	0.80	0.20
processes	4	4.00	0.00	0.20
•				
The institution values the people who work there, creating a beneficial	4	3.90	0.85	0.22
relationship between individual goals and the institutional ones				
The institution seeks to develop the skills of people working there, and to	4	4.06	0.97	0.24
promote justice and equity for all				
The institution promotes communication, reward and recognition of the				
people working there, motivating them and getting their commitment to	4	3.92	0.74	0.19
the organization				
The institution:				
. plans its processes (teaching, research,)	5	4.45	0.64	0.14
. identifies and reviews the requirements related to their different	4	4.22	0.81	0.19
processes				
. promotes the assessment and continuous improvement of its	4	4.27	0.72	0.17
different processes				
. ensures effective communication with all its stakeholders	4	3.98	0.79	0.20
(students, teachers, non-teaching staff, outside agencies, etc.)				
. ensures operations control, associated with the implementation				
of its different processes	4	4.04	0.75	0.19
. promotes the evaluation of its suppliers				
	4	3.64	1.15	0.32
The quality management practices are properly documented (quality	_	4.20	0.01	0.01
manual, procedures,)	5	4.30	0.91	0.21
Support documentation for quality management practices existent in the				
institution is adequately controlled (after prepared, the documents are	4	4.02	1.00	0.25
approved, coded, reviewed, and its different versions controlled)				
To demonstrate conformity of the processes and of the quality				
management practices implemented, the institution:				
. monitors the processes	4	4.06	0.93	0.23
, assesses student satisfaction	5	4.72	0.54	0.11
. assesses the satisfaction of teachers	5	4.39	0.86	0.20
. assesses the satisfaction of non-teaching staff	4	4.16	1.05	0.25
.assesses the satisfaction of external stakeholders (employers,	4	3.44	1.17	0.34
suppliers, etc.)	A	2 57	0.00	0.00
. evaluates the institution's image in society	4	3.57	0.93	0.26
. conducts internal audits (to determine whether the activities	4	3.77	1.19	0.32
and results relating to quality satisfy and allow achieving the pre-				
established goals)				
		4.00	0.76	0.18
. where appropriate, implement corrective actions (action to	4	4.20	0., 0	
	4	4.20	0.70	
. where appropriate, implement corrective actions (action to	4	4.20	0.70	
. where appropriate, implement corrective actions (action to eliminate the cause of a quality problem in order to prevent their	4	4.20	0.87	0.22

prevent their occurrence)				
. promotes continuous improvement	4	4.35	0.75	0.17

The third group of questions was constructed based on the requirements of these two models, the main goal being to be able to conclude on the possibility of applying them in HEI. HEI clearly assume that their missions and visions are developed based on a strategy focused on their stakeholders and, although with less conviction, they tend to believe that their policies, objectives and processes are developed and implemented based on the defined quality strategy.

At the level of the governing and management bodies, institutions tend to consider that these have a vision of the future, anticipating the needs of the institutions, working for their continuous success, which is also reflected in their involvement in the identification of, and answer to, their stakeholders needs and expectations.

In matters related to the resources required for implementing, maintaining and continuously improve their quality management practices, there is a tendency for institutions to give more importance to the resources associated with the work environment and infrastructure than to human resources.

Planning of the processes is of special importance in terms of the existing quality management practices, being followed by practices related to the evaluation and continuous improvement of the different processes. Supplier's evaluation was identified as the less relevant practice in the institutions' dynamics. Institutions tend to consider that the support documentation for their different quality activities exists and is adequate.

To demonstrate processes' conformity, institutions highlighted the evaluation activities regarding students and teaching staff's satisfaction, considering them as the most representative implemented practice. The assessment of external stakeholder's satisfaction is the practice to which institutions tend to give less prominence.

In the questionnaire, and specifically related to this third group of questions, three additional questions were posed to institutions, with the aim of understanding their positioning towards the implementation of the ISO 9001 Standard and/or the EFQM Excellence Model. Table 4 presents the results obtained for those questions, based on the analysis of all the collected answers.

Table 4 – Results obtained for to the questions on the implementation of the ISO 9001 and/or EFOM Excellence Model

Ouestion	Answers
Question	(%)
In some situation or moment, has the institution adopted the ISO 9001 or	
the EFQM Excellence Model?	
. yes, the ISO 9001	41.18
. yes, the EFQM Model	1.96
. yes, the two references	1.96
. No, none of these references	54.90
The practices associated to the ISO 9001 and to the EFQM Excellence Model	
can be adopted by HEI?	
. yes, the ISO 9001	27.45
. yes, the EFQM Model	3.92
. yes, the two models	39.22
. I do not know / not suitable	29.41
The practices associated to the ISO 9001 and to the EFQM Excellence Model	
can help HEI to respond to the standards proposed by A3ES for the	
certification of IQAS?	
. yes, the ISO 9001	25.50
. yes, the EFQM Model	5.88

. yes, the two models	37.25
. I do not know / not suitable	31.37

The analysis of this results shows that the vast majority of HEI never adopted any of the models under analysis. However, despite this result, it cannot be ignored the fact that 41.18% of the institutions that responded said that they have already used the ISO 9001 Standard.

When asked their opinion about the possible adoption of practices associated with these two models and if they could be helpful for institutions when implementing their IQAS, HEI tend to affirm that yes, particularly in the case of the practices associated with the ISO 9001 Standard.

CONCLUSIONS

Reinforcing that the study is still running at the moment, the results obtained so far allow us to conclude that definitely there is a significant concern with quality and its management in Portuguese HEI, mainly motivated by external reasons (and much probably due to the evaluation and accreditation procedures implemented by the A3ES, to which HEI have to answer in order to have their study programs accredited).

The results show that there are some quality management practices already implemented in Portuguese HEI and integrated into their organizational culture; however, institutions show more reserve regarding considering quality management as part of their overall management.

The promotion of an internal institutional culture of quality assurance is one of the main goals of A3ES. To this end, the Agency proposed HEI to implement IQAS, suggesting a certification model for them, which although not having a prescriptive character, indicates a set of standards that can support HEI regarding these systems' implementation. HEI know the model and the standards it is based on, and share the opinion that its implementation can bring benefits to them, improving their institutional quality. One may then conclude that HEI are aware that the development of institutional quality management practices and systems are very important for them and are to stay.

When asked about a possible application of the ISO 9001 Standard or of the EFQM Excellence Model, although the majority of HEI have not adopted any of these models, they strongly express the opinion that the practices associated with them are likely to be adopted by HEI and that they can contribute to support the implementation of IQAS. From the two models a special emphasis was given to the ISO 9001, most likely because, as already referred by Tavares *et al.* (2015), some polytechnic institutions have adopted this standard as a common practice in their journey towards quality improvement. Fact that is no stranger to the wide application of this standard in others types of organizations and services.

It is, generally, at the level of teaching and learning processes that the concern about quality and the existence of some practices already implemented in HEI is more evident. In a comparative study between the IQAS of HEI already certified by A3ES, Cardoso *et al.* (2015) conclude that these systems tend to focus, primarily, on teaching and learning processes, which is clearly evident in the importance that this processes have on quality assurance mechanisms and on support information systems, citing as the main reason the primacy that HEI give to these processes, directly link to their principal mission. It is at the level of the internationalization process that HEI recognize there is less concern about quality, fact also corroborated by Cardoso *et al.* (2015).

The concern with the promotion of continuous improvement has also followed the evolution of quality management in HEI, though, and essentially, by the existence of some evaluation mechanisms, and here again, with emphasis on the teaching and learning, where the satisfaction of students and teachers evaluation about the different aspects of the process are particularly relevant. Activities such as planning,

implementation and monitoring of actions that can contribute to the effective improvement of the system turn out to be less enhanced by IES.

Institutions consider that there are documented procedures and, in general, adequate supporting documentation for the different activities related to quality management. Given the nature of HEI and the fact that their activity is highly regulated *institutions will not be most preoccupied with the "form" than the "content"?* One of the conclusions associated with the analysis made by Cardoso *et al.* (2015) to the audit reports of IQAS certified by A3ES, pointed to the emphasis given by institutions to the documentary structure supporting the system, leading the authors to conclude that the existence of a multiplicity of documents could indicate the existence of excessively bureaucratic IQAS.

With regard to the stakeholders' participation in quality management practices, data, despite indicating a lack of unanimity in the answers given by the HEI, emphasizes mainly the participation of internal stakeholders, in particular the teaching staff. Certainly, this is an aspect to which HEI will have to pay more attention, a fact that in the study conducted by Tavares *et al.* (2015) is pointed out as a weakness of the IQAS already certified by A3ES.

In matters related to the resources required to support the quality management practices for implementation, maintenance and continuous improvement, institutions give greater importance to the resources associated with the work environment and to the infrastructures, and less to human resources. Since there was some dispersion in the responses, probably institutions have some discomfort with this issue. Tavares *et al.* (2015), claim that the human resources dimension (teaching and non-teaching staff), was referred as a weakness of the certified IQAS, either by internal and by external reports, which may indicate that this is indeed a sensitive issue within HEI.

Regarding quality management practices already existent and implemented in HEI, the following ones are highlighted:

- -The development of an institutional mission and vision, based on a strategy focused on stakeholders;
- The existence of documented procedures, although more visible in terms of teaching and learning processes;
- The definition of the different actors responsibilities in the existing quality management practices, focusing on the participation of students and teachers;
- The existence of support and commitment of the management bodies regarding quality management;
- The information generated by the quality practices is relevant and properly transmitted (especially for the teaching staff);
- Existence of mechanisms for detection of improvement actions needs;
- Existence of mechanisms of satisfaction evaluation to demonstrate the conformity of the processes, with particular emphasis on the participation of students and teaching staff.

Although one can conclude that there are a significant number of quality management practices implemented in HEI, it is not straightforward to assume that these practices are actually connected among them. In fact they seem to be insufficiently tied, which might point that institutions are implementing practices without a real strategy for quality management. Fact that can justify the difficulty that HEI have to recognize the quality management as part of the overall institutional management. This behavior may be caused by the need of these institutions to have reunited a set of information to respond to accreditation processes of their study programs and, in this case, the aforementioned practices are a way of doing this. But quality management is much more than just a collection of practices.

The A3ES has included in its activities' plan the IQAS certification in a clear intention to target HEI for improvement, transparency and simplification of individual study programs accreditation processes. For Cardoso *et al.* (2015), the autonomy of HEI gives them the possibility to design the characteristics of their IQAS and in this way it is expected that it contributes to their diversity among institutions. However, as HEI fear not having their IQAS certified unless they closely followed the A3ES audit model, there is the risk that institutions end up creating standardized IQAS.

The quality management models, such as the ISO 9001 and the EFQM Excellence Model, once focused on the systematic development of the processes necessary to obtain measurable quality results, will allow and force not only the coordination of the practices already implemented or to implement, as well as allow to structure a strategic approach for assessment and quality management, leaving the processes, mechanisms and quality instruments to the creativity of the institutions. As such, they may help the full development of IQAS respecting the organizational culture and the uniqueness of each institution, being this, probably, the wealth of quality management systems based on these models.

As already mentioned, this study is not yet completed. The data provides predominantly from higher education institutions of the private system. It will be relevant to check if trends remain with greater involvement of public institutions. It is also relevant to check whether the trends are, or not, convergent for the two Portuguese higher education subsystems, namely the university and polytechnic ones.

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Impact of Physicians on Patients Seeking Hospital Services: Information Asymmetry Combines with Shifts in Perceived Quality

Wasim I. M. Sultana and José Crispima

^aUniversity of Minho, School of Economics and Management, The campus of Gualtar, Braga. 4710-057, Portugal

ABSTRACT

Purpose: Physicians have been identified as a pressure group and should be considered to design and implement the system of healthcare provision. This study describes the unique characteristics of the hospital admission system in Palestine. Two situational roles of physicians may influence the patient perceptions of medical care quality: the gate-keeper role of the physician to control admission and the physician's communication practices to manage medical encounters.

Methodology: This study explores the hospitalization system and the driving forces of the healthcare system in Palestine. When compared to the theory and others' work, it is reasonable to hypothesize that the applied settings may make the opportunistic influences of the physicians possible, and impact medical care outcomes. Literature review, interviews, and self-administered questionnaire will be included to examine physicians' attitudes and behaviors.

Findings: The less cohesive system of hospitalization provision, and other geopolitical and socioeconomic factors may distance physicians from the patient best interests. Informal and unorganized health markets may allow physicians taking the advantage of uninformed patients.

Research limitation: The Palestinian context is unique, results may apply to some other developing countries, but cannot be generalized. Other relational behaviors are also important in delivering competent care as the nurses-patients and physicians-nurses communication tasks put forward more investigations.

Practical implications: The study captures the areas that merit more attention for improving the healthcare system and profession settings.

Originality: The physicians' attitudes towards effective communications have not been studied in Palestine.

Keywords – Care Provision. Perceived Quality. Professionalism. Palestine.

Paper classification: Conceptual paper.

INTRODUCTION

There is an increasing interest among healthcare providers and policy makers to implement the Patient-Centered Care (PCC) approach to improve health outcomes (Brunett et al. 2001). Patient centeredness has long been acknowledged as an appropriate attribute and essential aspiration of high-quality healthcare systems (Greene et al. 2016). The PCC addresses better understanding of patients' needs and enables self-management care within the complex healthcare environment. The Institute of Medicine included PCC as one of the six essential aims of healthcare systems (America 2001). The Agency for Healthcare Research and Quality (AHRQ) reported that around 45% to 62% of the patient encounters "always" used the PCC (Kelley et al. 2005). The slow implementation of patient-centered care is attributed to barrier factors as the resistance to change the traditional patterns of interactions, and the perceptions of increased time and cost among the providers (Robinson et al. 2008).

The advances in medical sciences improved health care outcomes but have inadvertently distanced physician from their patients (Barry & Edgman-Levitan 2012). Physician's attitudes are a complex combination of personal beliefs, values, motivation, experience, and behaviors, and are not in isolation from the social norms and the organizational settings in the workplace (Borkowski 2015). In hospitals, the resulting situational bed-side response of the physician is a reflection of his point view, his feelings, perceptions, and thoughts. Positive attitudes of the physicians to communicate effectively will facilitate the implementation of patient-centered care. Therefore, it is important to assess their attitudes first to decide the type, and level of training or education in this area, in addition, it is required to identify the target subgroup of practicing physicians to receive training.

The current geopolitical and economic environment in Palestine as being "Palestinian territory occupied by Israel" poses challenges to healthcare access and delivery (Shahawy & Diamond 2016). The Palestinian weak state of independence and weak Palestinian control on the ground create unique characteristics of the physicians' and patients' daily life (Mataria et al. 2009), which attribute to their attitudes and influence their situational behaviors. Despite the recent establishment of the Palestinian Medical Board institution and the existence of law for health care in Palestine. However, the medical profession is characterized by short experience and governed by physicians' own attitudes, rather than a common a charter as a means of the common sound of understanding of ethics. Our initiative is to shed light on how well the communication tasks are accomplished during physician-inpatient encounters. The physicians' attitudes towards effective communications have not been studied in Palestine.

This paper intends to explore, how proficiently the Palestinian physicians are managing the medical encounters with their inpatients in the hospital context. Based on this purpose, we investigate four interrelated aspects of physician-inpatient encounters from a PCC perspective. These are: (1) The effective communication elements (tasks) of patient-physician encounters? (2) The extent to which Palestinian physicians regard the effective communication elements as "excellent". (3) The perceived barriers in the hospitals to communicate effectively with inpatients. (4) The differences in attitudes across physician subgroups according to different background characteristics as experience and education background. Therefore, it is hoped that this research will provide assessment and a better understanding of the physicians' attitudes to promote patient-centered care principles in the complex context of the Palestinian hospitals. The expected results will help both the Palestinian healthcare and medical education policymakers to capture the areas that merit more attention for improving communication skills for both physicians in practice and in training.

As for the methodology, we use adapted questionnaire for the purpose of our study. The questionnaire statements build on the Four Habit Model as a framework (Frankel & Stein 1999), and most of the questions are adapted from the Communication Assessment Tool CAT of Makoul et al. (2007). Few specific statements are added to match our purpose and case of study. We use Likert scale with 1means "poor"; 2 means "fair"; 3 means "good"; 4 means "very good" and 5 means "excellent" to assess the attitudes. We apply hypotheses testing and proportions analysis to answer the research questions.

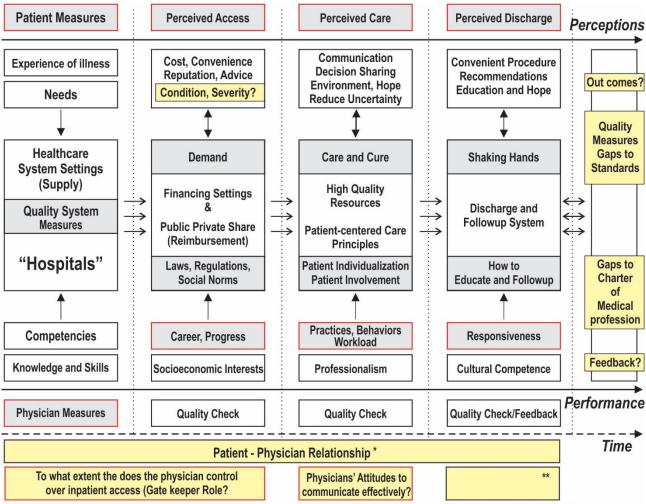
RESEARCH PROBLEM AND HYPOTHESES

Physicians respond differently to their inpatients' needs during medical encounters. They do so, according to different experiences, backgrounds and beliefs in mind towards the medical profession and towards the required competence to heal their patients. Other contextual factors may promote or impede their tendency to interact effectively with inpatient in the hospital. Supportive attitudes towards patient's individual needs (individualization) will promote their participation in care and improve health outcomes (Greene et al. 2016). Figure (1) shows a conceptual framework, the flow of the hospitalization process in Palestine.

Institutional weaknesses in the healthcare system in Palestine may make opportunistic behaviors by the system actors possible (Barigozzi & Levaggi 2008). In the first stage of the hospitalization system (admission), the physicians may act the role of gate-keeper and use their knowledgeable power to manage the available access alternatives to get possible beneficial effects. In the second stage of the system (inpatient treatment), the physicians are given a high level of autonomy to interact with inpatients. Given the case of absent charter for the medical profession and absent effective quality system, physicians are driven by their own medical ethics and doctors' altruism. The like hood of adverse events becomes highly physician behavior dependent.

We operationalize individualization during medical encounters as the bedside interaction of the physician with each inpatient's own story, his experience of illness, symptoms, educational needs, shared decision making and shared responsibility for treatment; diagnosis procedures, treatment alternatives, advice, education and side effects of the treatment in an environment characterized by empathy and compassion.

It is quite important to develop the supportive physicians' attitudes and behaviors as a means by which the PCC is put into action. Managers and policy makers cannot decide the type or level of training required and the targeted subgroup of physicians unless their attitudes are assessed. Fortunately, clinical communication skills can be learned, trained and practiced (Stein & Kwan 1998).



^{*} Other relational aspects as; between patients and patient-allied health staff, and the cooperation between all health staff members and administrative staff are also of great importance. But it is out of the scope of our study.** The discharge system is also out of our scope.

Figure 1- Conceptual framework: hospitalization process, the dynamics of inpatient perceptions.

To meet our inquiries, we test for the following alternative hypotheses:

- H1: Physicians perceive differently the importance of communication competency to enhance health outcomes.
- H2: The are differences in physicians' attitudes towards effective communication between government-employed and nongovernment-employed physicians.
- H3: The are differences in physicians' attitudes towards effective communication between male and female physicians
- H4: The are differences in physicians' attitudes towards effective communication between locally educated and out of the country educated physicians.

THE CASE OF PALESTINE

The recent partial recognition of Palestine by the United Nations did not make a real change in the daily life of the Palestinians. They do not control over sea, air and borders, Israel imposes restrictions on free movement for people and goods (Abuznaid 2014). The complex context of Palestine adds to the challenges of developing a country context to operate a competent healthcare system. In developing countries, the market environments of healthcare services and commodities are characterized by high level of informal and unregulated markets (Bloom et al. 2008). The Palestinian health care system is driven by unique forces due to the exceptional political situation. These forces are deteriorated economics, ambiguous political situation,

the pressure of international aiding agencies, unique social and cultural characteristics, geographical separation, and burden of health and health system problems (Hamdan & Defever 2002).

The unique context of Palestine impacts the Physicians attitudes and behaviors and the quality of hospital services. The eighty operating hospitals in Palestine comprise four ownership forms: public hospitals, the United Nations Relief and Works Agency (UNRWA), not-for-profit private hospitals (NGOs) and private for-profit hospitals. About 40% of the population are aged below 15 years (Health 2015). A clear policy for human resources is needed in healthcare, and the weakness of health institutions is severed (Mataria et al. 2009). Table (1) shows the hospital sector structure and a set of selected indicators of the national healthcare system.

Table 1- Selected Healthcare Indicators in Palestine 2014

	West	Bank	0	-
Indicator	Jerusalem	Others	Gaza	Total
Population	61	.1%	38.9%	4,682,467
Males				50.8%
Females				49.2%
Below 15 years old				39.7%
Over 65 years				2.9%
Hospitals	8	42	30	80
Hospital beds	658 (11.1 %)	2844 (47.9%)	2437(41%)	5939
Type of health care Services				
General beds	2554	(72.9%)	1784 (73%)	4338
Specialized beds	578 (16.8%)	519 (22%)	1106
Rehabilitation beds	112	(3.5%)	56 (2.3%)	178
Maternity beds	239	(6.8%)	78 (3.2%)	317
Ownership				
MOH (Ministry of Health)	15	579	1680	3259(54.4%)
UNRWA (UN, refugees agency)	6	53	-	63 (1.1%)
NGOs (not for profit)	13	348	619	1967(33.1%)
Private (for profit)	1	16		512 (8.6%)
PMMS (Military Medical Services)	-		138	138 (2.3%)
Practicing Physicians				
General physicians	45	65	2361	6926
Specialist physicians	16	668	1189	2857

Source: The annual statistical report 2014 published in August 2015 (Health 2015)

THE RELEVANT LITERATURE

The Patient-Centered Care (PCC)

The PCC approach recognizes the belief that healing involves knowing the patient as a person while accurately diagnosing his or her illness (Epstein 2000). It focuses on the individual's specific healthcare needs by addressing the patient needs effectively (Reynolds 2009). From a clinical practice perspective, the PCC supports patient involvement in the decision-making and considers a patient-provider relationship as one that integrates the patient viewpoint and preferences in the care process, to promote patient's participation in his own care (Oates et al. 2000). In order to implement the PCC approach, then the practices of effective communication, shared decision-making, and patient education are valued and promoted (Robinson et al. 2008). The patient involvement and individualization are imperative principles of PCC. Briefly saying: effective communication is a key element to achieving the aims of the PCC approach.

Studies reveal that patient-centered interactions promote adherence to suggested treatment and improve health outcomes (Robinson et al. 2008). This approach to healthcare has shown better patient's health and a higher rate of patient satisfaction (Reynolds 2009; Beck et al. 2002) Advocators of the approach have focused on the patient-physician or medical team relationship as an integral to other factors (Greene et

al. 2016). Patient surveys consistently show that patients want better communication from their doctors (Duffy et al. 2004). Information given to the patient by the physician has the much stronger relationship than internet health information (Laugesen et al. 2015). From the patient viewpoint, the relation builds on trust between him and the physician because of the state of uncertainty that characterize the provision of healthcare (Jones & George 1998). The proficient communication to manage patient encounters is as important as competent knowledge-based medical treatment to provide patients with best possible care.

Attitudes, professionalism and quality improvement

The Charter of Medical Profession is the best published general description of the profession related to the aims, qualities and conduct of medical profession (DeAngelis 2015). The charter lists the common global themes of the medical profession in the form of three fundamental commitments and ten professional responsibilities. The principles of primacy patient welfare, patient autonomy, and social justice are the fundamentals of the Charter. Despite the diverse cultures and national traditions across societies, all members of the medical profession share the role of healer. Physicians are challenged to keep on the nature and values of the medicine's commitment to patients, in the face of external forces; changes in technology, changes in market forces and variations in medical delivery and performs (Project 2002).

Professionalism and quality improvement are strongly related and embrace naturally to support each other (Mueller 2015). The foundations of the proposed framework of professionalism by Arnold and Stern (2006) are the clinical competence, effective communication skills and a sound of understanding of ethics (Arnold & Stern 2006). Professionalism is a belief system about how best to organize and deliver health care services and to carry for both the individuals and the organizations (Wynia et al. 2014). The tri-component model of attitudes includes feelings as an emotional dimension, beliefs and thoughts as a cognitive dimension and actions as a behavioral dimension (Borkowski 2015). They all point to the need for positive physicians' attitudes to communicate professionally with inpatients. Positive attitudes to communicate effectively facilitate the sharing of information with patients, reduce uncertainty levels and build trust between patients and physicians.

A limited number of studies examined the physicians' attitudes in the Palestinian context. A recent research examined the medical students' attitudes towards the free of movements between different hospitals and the barriers to doing their clinical courses (Shahawy & Diamond 2016). Hamdan (2013) measured the safety culture in the Palestinian neonatal intensive care units (Hamdan 2013). Attitudes among physicians and nurses to report medical errors have also been studied (Rashed & Hamdan 2015). They found that among the main barriers to reporting medical errors in Palestine, the lack of proper structure and the fear of physicians' competence to be questioned. Finally, attitudes towards hand hygiene knowledge and practices among physicians and nurses have been studied (Mu'taz et al. 2016). However, physicians' attitudes towards professionalism and effective communication are not studied in Palestine.

Technical competency versus personal competency:

The medical quality literature suggests two general approaches in evaluating medical professionals, including physicians; the technical competence and their interpersonal competence. The technical quality of care stands for the degree of conformance to professional standards and practices as specified on the basis of medical knowledge. It is operationalized at the provider level by Donabedian (1980) in terms of three constructs: structure, process, and outcome (Bopp 1990). In the medical profession, the physician's technical performance evaluates the functions directly related to treating various medical conditions to maintain patients' health (Ghosh et al. 2015). The curing perspective to evaluate performance is dominant over the caring perspective in this approach. In general, the medical professionals gave less attention to the environmental and interpersonal factors which they regarded as less important (Donabedian 1980; Bopp 1990).

The non-technical performance assesses the environmental factors and the role of personal interactions and behaviors of the staff and of the physicians to deliver medical care (Kelley et al. 2014). Interpersonal

competencies include all the caring and compassion factors that are accessible to be judged and verified by the patients, and constructs their quality perceptions. The author Bopp (1990) reviewed the literature to explore common factors that patients used to evaluate the quality of medical encounters. His findings categorized what he called expressive quality of staff and physicians in three main dimensions; expressive caring, expressive professionalism and expressive competence (Bopp 1990). A recent study applied a systematic review to quality dimensions as perceived by the patients has identified ten dimensions across the reviewed studies. The three most frequent dimensions are Communication, shared decision-making, and health care access. Further, communication is identified to be the most frequent one (Mohammed et al. 2016).

Physicians are required to demonstrate interpersonal skills and communication skills as core competence. Evidence-based studies show the benefits of this approach embedded in the effective involvement of patients in the treatment process (Makoul et al. 2007). The nature of patient-physician relation comprises both emotional and informational components (Barigozzi & Levaggi 2008, Kelley et al. 2014). Communication tasks center all the factors that attribute to fulfill patients' emotional and informational needs. Fear and hope in the patient side, knowledge, and competence in the physician side, a situation that recommends an alliance relation to dominate the bedside medical encounters.

Despite the lack of knowledge in the patient's side to judge the technical quality of medical care, the interdependency between patient's perceptions of quality and healthcare outcomes is frequently discussed in the theory of quality (Haddad et al. 2000). At the organizational level, quality audits should lead to a change in the clinical practice by encouraging a reflective culture of reviewing current practice, and by inducing changes which lead to better patient outcomes and satisfaction (Bowling 2014). The more satisfied patients are more likely to comply with the treatment requirements (Laugesen et al. 2015). Assessments of quality of care should include both patients evaluations and independent assessments of technical quality (Chang et al. 2006). A study to examine the role of patient's experience measures to evaluate health care quality finds that they are an appropriate complement to clinical quality measures (Price et al. 2014). Several authors have suggested that patient satisfaction or dissatisfaction as one dimension of health care quality (Hulka et al. 1970, Garvin 1984, Thom et al. 2004). A common understanding of the patient's situation through effective communication will help the physician to execute the right clinical plan , and to enhance patient satisfaction, subsequently, both will cooperate effectively and enhance medical care quality (Manary et al. 2013).

METHODOLOGY

Healthcare outcomes are driven by clinical accountability, however, clinicians must engage a process of collecting data to evaluate the effectiveness of what they do (Cornett 2006). Moreover, they need to communicate effectively from the very beginning. Hence, they share their patients the experience of illness and integrate patient needs and perspectives into the process of treatment. This will positively impact the patient adherence and enhance self-management. Our initiative is to shed light on how well the communication tasks are accomplished, rather than to specify how to accomplish communication tasks during physician-inpatient encounters. Therefore, our domain of investigation is the "communication tasks".

The hypothetical construct of an attitude is inaccessible to direct observation, therefore, it must be inferred from measurable responses (Borkowski 2015). Physicians can self-report the level of importance, favorableness, or agreement toward practice to express their attitude towards the object (patient's need, policy, setting) or they can score their concerns by a semantic differential scale of a set of bipolar adjective pairs, for example, good-bad, pleasant-unpleasant or harmful-beneficial (Ajzen 2005). However, this direct method has a drawback of weak reliability and low correlation between repeated observations.

Indirect multi-item measures provide opportunities for respondents to review different aspects of the investigated domain. The set of specific questions is then used to infer the attitudes of the physicians. This

method is common in the literature to explore physicians' attitudes towards different domains in the workplace such as; the attitudes of nurses and physicians to collaborate (Amsalu et al. 2014), and the physicians attitudes towards patient and family centered care (Nguyen et al. 2015). Studies applied to the developing country context also used questionnaires to analyze the influence of the Palestinian physicians' attitudes towards wife abuse (Haj-Yahia 2013). Another study explored the physicians' attitude towards knowledge transfer and sharing in the Sultanate of Oman (Jabr 2007).

Many assessment options are available in the literature to evaluate communication performance. Such as the framework for educating and assessing communication skills (Makoul 2001), the essential elements of communication in medical encounter "Kalamazoo Checklist" (Brunett et al. 2001), and other instruments used by the medical board institutions. Another framework to assess communication in cancer care defines six communication domains with patients (Epstein & Street JR 2007). Their framework is based on the core attributes of patient-centered communication. They show the complex interactions among these domains. The domains are: exchanging information, fostering healing relations, responding to emotions, managing uncertainty, making a decision and enabling patient self-management, and all contribute interdependently to healthcare outcomes. To achieve the particular purpose of our study, we use three main sources to construct a questionnaire to approach our endeavor:

- 1- The Four Habits Model developed by Richard Frankel and Terry Stein (1999) is a behavioral approach to the medical encounter (Frankel & Stein 1999). They refer to the term habit to denote the organized way of thinking and acting during the medical encounters. The four interdependent sequential habits are: invest in the beginning, elicit the patient's perspective, demonstrate empathy and invest in the end. Each habit concentrates on a group of tasks to be accomplished. The four habits model is the framework we use to explore the behavioral domain of our investigation.
- 2- The Communication Assessment Tool (CAT) developed and tested by Gregory Makoul et al. (2007). CAT is a reliable and validated assessment tool of physician performance in the area of interpersonal and communication skills. The (15) item instrument was tested in the field and successfully completed by both and the patients and physicians across clinical specialties. (Makoul et al. 2007). Two performance criteria of CAT tool are in conformance with our study; 1) CAT captures patient views soon after inpatient medical encounter, 2) The task approach of CAT to identify the key communication tasks.
- 3- Additional included items to capture the operational context of Palestine to explore the barriers to effective communication tasks. Two interviews with physicians will support us to capture the essence of reality in the questionnaire.

Our approach was structured around three components: 1) a literature review, discussed in the previous section, 2) two exploratory interviews with physicians, and 3) an online self-administered survey. The population of the study comprises all physicians working in any Palestinian hospital, they are general physicians, specialists, and residents. Since physicians in hospitals share common workplace environment.

CONCLUSIONS

The less cohesive the healthcare system the more chance for opportunistic behaviors of the functioning parties including physicians. The existence of unorganized and informal healthcare market settings is another ethical challenge to the profession of practicing medicine. We expect differences in physicians' attitudes among individuals and across different organizational settings. These findings highlight gaps on specific supportive attitudes, professional practices, and institutional settings. These gaps are relevant to medical care quality. Policy makers may build on these gaps to develop an improvement framework at the individual and organizational levels. Future interventions may target specific type and level of training to promote professionalism.

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Reduced time in the undercut beams building process in particular

Santos, F.B, Sabaddini, F.S, Barros, J.G.M. and Araújo Junior, A.H.

UERJ

ABSTRACT

Each year more companies use management tools in the search for better results and quality production. It is obvious that knowledge of the tools, when properly employed, generates results that contribute to the company to become, more efficient, leading to an increasingly competitive market. In this way, a small concrete company in the South of Rio de Janeiro has difficulty achieving the results of production and quality for not making use of these techniques and tools. However, even unaware of methods and tools of quality, can compete with your competitors and produce products with good acceptance by its customers. The case study developed in the production of this company showed points relevant to the improvement of production and, consequently, improve the quality of the product. The action plan proposed by the study has a high impact on the process. With 50% gain and without need for team work. Countermeasures of the plan of action are relatively simple and were proposed by their employees, as they were involved with the study. The case study was conducted in order to provide a better understanding of the work team. Great results were achieved with small financial increase. You can point out that the biggest gain was the understanding of quality tools for the production team of the company where the study was carried out. So the use of these tools has opened a new perspective of production and quality management as a whole.

INTRODUCTION

Every year more companies are used management tools in the search for better production results and quality. It is clear that knowledge of the tools, when properly employed generates results that contribute to the company become more efficient resulting in an increasingly competitive market.

In recent years, continuous improvement concept has been widely used by large companies, finding enough structured to be associated with the movement Total Quality. Because it is on a simple concept, easy to understand and low level of investment, continuous improvement has been enshrined as one of the most efficient ways to increase the competitiveness of a company (Bessant et al., 1994).

Understand and introduce continuous improvement techniques (TMC) is a way to improve the company making it more productive and profitable, paving the way for a more effective approach towards quality.

One of the issues noted in the organization under study is that despite following NBR 14859-1 ABNT (Brazilian Technical Standards Association), which sets out the requirements for the receipt and use of prefabricated slabs components do not use techniques and tools quality. However, even knowing the methods and tools of quality, can compete with its competitors and produce products with good acceptance by its customers.

The case study from the production of this company showed relevant for the improvement of production and, consequently, improved product quality.

This study aims to identify opportunities to reduce the time of use of metal molds in the process of manufacture of precast slabs beams. At issue involves answering the question;

- How to reduce metal molds usage time without compromising the structure of the beam? For this it is
- Map the process of manufacturing precast slabs joists, which are ribbed laminar structures, reinforced, formed by prefabricated concrete structural beams.
- Analyze the process mapped using the methodology of analysis of problems and quality tools.
- Propose an improvement in the current process.

The study was developed in a concrete artifacts of company Rio South. Where sectors were defined:

- Production which runs the job.
- Storage where newly produced beams are stored.
- Shipping product in condition to be shipped to the customer.

improvement project continues, focusing on reducing the production cost is important for all sorts of companies. As the cost of production is an important factor for the company, reducing it makes the company more competitive and can offer cheaper products or services, or even maximize profit.

Slack (1997) state that all transactions, no matter how well managed, are amenable to improvement. Sink & Tuttle (1993) state that before the performance of any process can be improved, it needs to be measured. The objectives of any process, according to Slack (1997), are: quality, speed, reliability, flexibility and cost. In addition to reducing the cost of Continuous Improvement Techniques of understanding contributes to increased knowledge and can trigger a process that transforms the organizational culture.

LITERATURE REVIEW

Continuous improvement

All processing operation of raw material in product or service made by a company because of which the cost is less than the sale price. Thus, the company makes a profit. Profit is one of the company's reasons exist. Logo improve the performance of their processes is important issue for all companies. But in recent years, the need for improvement has been greatly enhanced, due to technological advances and the much-discussed globalization (HARRINGTON et al, 1997).

Therefore, the search for continuous improvement of processes is critical to business survival. Which according Caffyn (1999), can be conceptualized as a broad process focused on incremental innovation, which involves the entire organization.

Thus, the continuous improvement idea is related to problem-solving ability (Bessant, Caffyn, GALLAGHER, 2001), through small steps, high frequency and short cycles of change (Bessant et al., 1994).

Continuous improvement, therefore, means the involvement of all people in the organization, to seek, constant and systematic way, the improvement of products and business processes. Continuous improvement requires minor changes as the organization of habit, for the great changes requires more planning.

Shiba, Graham, Walden (1997) classify the systematic improvement that is one caused by a scientific approach. It is a structured problem-solving process, which involves the identification of causes, choice, planning and standardization of the solution. In turn, there are three types of systematic improvement: process control, reactive and proactive improvement improvement.

According to (Silva Araujo, 2006), continuous improvement is part of various management practices (Kaizen, TQM, ISO 9001: 2000 and PCI array) and all can be identified the existence of performance indicators.

To be effective, continuous improvement needs to be managed as a strategic process with long-term focus (Bessant et al., 1994). The objectives need to be clearly understood in terms of its implications for the survival and success of the company and must be transcribed into organizational and individual performance factors (HARRINGTON, 1998).

PDCA

The PDCA cycle it is a well-known management tool in the administration. Broadly, it aims to control and improve processes and products in a continuous way, since it operates as a process that has no breaks or interruptions.

The concept of improvements method, known as PDCA cycle was originally developed in the 1930s at Bell Laboratories Labs - USA, the statistical Walter A. Shewhart, defined as a statistical cycle control of the processes that can be applied to any process or problem.

The PDCA is aimed at continuous improvement of the steps in a process, so it is bound to the fundamentals of philosophy Kaizen (Japanese culture and one of the quality management pillars). As the Kaizen philosophy, one of the PDCA cycle purposes are the speed and improvement of processes of a company by identifying the causes of their problems and implementing solutions to them. Second (CAMPOS, 1996) PDCA is a method of management processes or systems. It is the way to achieve the goals assigned to the products of enterprise systems.

This methodology has as its basic function the aid in the diagnosis, prognosis and analysis of organizational problems and are extremely useful for troubleshooting.

Process mapping and flow of activities

For Rother & Shook (1998 apud NAZARETH, 2009), the stream mapping is an essential tool, it helps to see more than just the individual progress. In this context, Hines & Taylor (2000 apud MENEGON, NAZARETH and RENTES 2003) state that, when we think about waste, it is common to be defined three different types of activities for their organization:

Value-adding activities: are activities that in the eyes of the final consumer, add value to the product or service. le activities for which the consumer would be happy to pay; unnecessary activities that do not add value: are activities that in the eyes of the final consumer, do not add value to the product or service and which are unnecessary in any case. These activities are clearly waste and must be disposed of in the short and medium term; necessary activities that do not add value: are activities that in the eyes of the final consumer, do not add value to the product or service, but they are necessary. It is difficult waste to be eliminated in the short term, and therefore require a more thorough treatment.

Hines & Taylor (2000 apud MENEGON; NAZARETH & RENTES, 2003) add that the manufacturing companies these three types of activities were found in the following proportion: 5% of value-adding activities; 60% of activities that do not add value; and 35% of activities that do not add value, but which are necessary therefore has a 95% of the universe of activities that can be improved.

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This methodology has as its basic function the aid in the diagnosis, prognosis and analysis of organizational problems and are extremely useful for troubleshooting.

METHODOLOGY

Scientific research depends on a "set of intellectual and technical procedures" (GIL, 1999) so that its objectives are achieved. The scientific method is the scientific discourse build path. It is the line of reasoning adopted in the research process. The methods that provide the rationale for research are: deductive, inductive, hypothetical-deductive, dialectic and phenomenological (GIL, 1999; LAKATOS; MARCONI, 1993).

As for the method adopted was the hypothetical-deductive due to the nature of the study is to gather information that will contribute to answer the questions posed in the introduction. Other relevant factors are the time and training, because once the hypothesis formulated to test it or falsify it would need these resources. Research as the approach was quantitative, in that best fit the context of the work, because it seeks the logical positivist thought, tends to emphasize deductive reasoning, the rules of logic and measurable attributes of the human experience.

According to Fonseca (2002):

Quantitative research focuses on objectivity. Influenced by positivism, believes that reality can only be understood based on the analysis of raw data collected with the help of standardized and neutral instruments. Quantitative research refers to the

mathematical language to describe the causes of a phenomenon, the relationships between variables, etc.

To develop a search, it is essential to select the search method to use. According to the survey characteristics may be chosen different methods of research, it is possible to combine the qualitative to the quantitative. However adopted the field of research that characterizes the investigation.

CASE STUDY

The industry whose case study was carried out, has been operating for 40 years in the cement artifacts segment, which is part of the non-metallic minerals industry. Making beams for slab, your product is in compliance with the NBR 14859 laying down the requirements for the receipt and use of according to the NBR 6118, NBR 7197 and NBR 9062. The lattice girder is an iron ribbed structure with a concrete armor shaped board. For its preparation manufactured using metal molds for trimming the concrete to allow drying and therefore hardening thereof. As the product is designated the construction of residential, commercial and industrial buildings, the request for making the beams is quite varied, for each calendar project has its own dimensions, making it difficult to manufacture a stock for due to wide variation in lengths of these beams. So what is generated an OS, service order, responsible for purchasing issues a lattice purchase order, which is a trapezoidal metal structure to your supplier. The trusses are made of 6 m and 12 m long, and cut the size according to the application, discriminated in the service order. This cut planning is done by the administrative assistant and attached the service order (OS), which is forwarded to the production department to produce.

The production manager receives the OS and starts the latticework cutting process that is executed by an operator using a machine with a cutting wheel abrasive material and binder material. Once the trusses are cut begins the preparation process of the panels, where the concrete will be poured. This preparation process is to clean the panels and grease them with a lubricant that enables a better undercut of the slab beams. It can be seen in Figure 2 there are five forms, and they are produced five slab beams each filling. This panel is made of sheet metalwith dimensions of $0.12 \times 12.00 \, \text{m}$. After cleaning and preparation of panels is poured concrete, which is a mixture of cement, sand and gravel in a predetermined proportion , prepared by two operators in a production mixer 400 liters. Figure 3 we can observe the molds with the concrete and trusses.

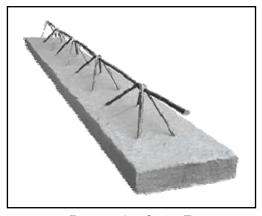


Figure – 1 – Girder Truss.



Figure 2 – Metallic mold.



Figure 3 - metal template with concrete and lattice.

When fully filled with concrete, the panels rest for 72 hours until desformados. After 72 hours the beams are removed from their shapes, carried by two operators and stored as shown in figure 4. The beams are stacked according to their size. At this point they are ready to be delivered to the customer.

Figure 5 describes the lay out of the factory and the flow of information and work. The numbers represent sectors respectively:



Figure 4 - beams storage Patio.

- 1. Office;
- 2. Cement tank;
- 3. Tavelas storage area;
- 4. Cutting area of trusses;
- 5. Storage area ready beams;
- 6. Sand and gravel storage area;
- 7. Mixers and storage of tools and molds;
- 8. Unwinding machine coil wire;
- 9. Production of trusses;
- 10. Storage pathy;

The red color flow of figure 10 represents the flow management information;

• 1-9: Issue OS and to manufacturing;

The flow whose representation is black in color, figure 5, corresponds to the workflow respectively.

- 9-4: separation of trellises for cutting (as OS);
- 2 7: separation of the amount of bags of cement for making concrete;
- 6-7: separation of the quantities of sand and gravel for making concrete;
- 7-9: preparation of concrete and transport to filling the metal panels;
- 9-5: After 72 hours undercut and transport to storage area;
- 5:03: Truck loading with the beams and tavelas.

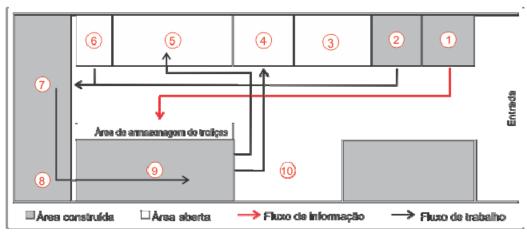


Figure 5 - Layout of the factory and information and work flow.

Production of trusses

In this department, work five people, with a production manager and four production assistants. The area of production is approximately 75 m^2 , which is twenty molds with five panels containing the dimension beams twelve meters each, totaling 1200 meters of beams, that is, $470 \text{ m}^2 \text{ slab}$ (beam and Tavela).

The time between the input in the total production and filling with concrete the mold is 6 hours curing time of 72 hour Table 1 describes the production of slab lattice beams for four weeks.

Table	1 -	Monthly	production	of trusses

Date	Morning	Afetrnoom	Activity	(m^2)
01/06/15	75% : 12:00	25%: 15:00	Production	420
02/06/15	-	-	Cure	
03/06/15	-	-	Cure	
04/06/15	25%: 12:00	75%: 17:00	Undercut and Production	410
05/06/15	-	-	Delivery	
Weekend				
08/06/15	25%: 12:00	75%: 16:00	Production	380
09/06/15	-	-	Cure	
10/06/15	-	-	Cure	
11/06/15	40%: 12:00	60%: 17:00	Undercut and Production	400
12/06/15			Delivery	
Weekend				

15/06/15 16/06/15	50% : 12:00 -	50% : 15:00 -	Production Cure	420
17/06/15	-	-	Cure	
18/06/15 19/06/15	40% : 12:00	60% : 17:00	Undercut and Production Delivery	400
Weekend			·	
22/06/15	55%: 12:00	45%: 15:30	Production	430
23/06/15	-	-	Cure	
2406/15	-	-	Cure	
25/06/15	40%: 12:00	60% :17:00	Undercut and Production	380
2606/15			Delivery	
Weekend				
29/06/15	50%: 12:00	50%: 17:00		400
30/06/15				

It can be seen in Table 2 that the total output during the 4 weeks is 3240 m^2 slab. The working time is 160 hours of which 64 hours were actually producing and 96 hours the beams remained on hold. So that 40 % of the time production is on hold and 60 %. Table 2 describes the way in which the company where the study was conducted operates. The mapping of production, allows use improvement tools in order to minimize the waiting time, allowing more efficient use of metal panels.

Table 2 - Order of production data

Period		Time			Undercut
	Production (m ²)	(h)	Production (h)	Standby (h)	(h)
Week 1	830	40	12	24	4
Week 2	780	40	12	24	4
Week 3	820	40	12	24	4
Week 4	810	40	12	24	4
Total	3240	160	48	96	16

PDCA

The Plan phase (plan) determines the goal, and the goal to be achieved. In this case, it is to reduce the time of use of metal molds in the process of making beams for slab. For this it is necessary to know the cause of the problem. He used the Ishikawa diagram to relate the problem and its nature. At a meeting with management decided to adopt Brainstorming as a tool to develop ideas. We used the GUT matrix as a decision making tool to treat the ideas generated in brainstorming.

Figure 7 is the result of the problems found in Ishikawa diagram. It is noted that the item belongs to the highest priority method. The second item belongs to machine, however occurrences (mixer maintenance and damaged panel) does not undermine the current production process, but can cause great loss in production if these items come to miss, that is, its action is more preventive. It was also noted that occurrences related methods are the lower costs to correct.

Occurrence	Origin	Urgency	Severity	Cost	Summation	Priority
damaged panel	Machine	3	2	5	10	2
Maintenance of concrete mixer	Machine	4	3	3	10	2
Floor unpaved	environment	1	2	5	8	3
open environment	environment	3	2	5	10	2
low light	environment	1	1	2	4	6
messing up machine	environment	4	2	1	7	4
Three days to unmold	Method	5	5	2	12	1
beam manual transport	Method	2	2	2	6	5
Unmold the beam manual	Method	2	2	2	6	5
remote storage site	Method	3	4	1	8	3

Figure 7 - Matrix GUT

Action plan

The events analyzed in the prioritization matrix are part of this action plan. The use of continuous improvement tools provided the production team a critical view of the production process. This view has generated ideas that are part of the countermeasures.

Note that the countermeasure (1) has a high impact on the process and the relatively low cost without the need for staff training. The cart design is more expensive, but has the possibility of substantial gain and improvement in storage area.

Countermeasur	Responsible	Term	Local	Rationale	Procedure
					Using additive.
(1)			Industry	To decrease	Compare the test of
Using cement additive	Production		production of	curing time and	time with additive
to accelerate the	manager	1 month	trusses.	consequently	over time the
healing process.				the use of	current process.
				molds.	
					Concrete floor rail
					installation where a
(2)					cart with 5 m long
Design changes and					apararia the beam
basket storage area.	Production	6 month	Production	To speed up the	after 24 hours of
	manager			process	curing

Figure 8 - Action Plan Template

CONCLUSION

The study was developed and will be helpful to the organization in the context that was planned. We obtained a good result, especially as the interest of the team involved and knowledge of the proposed methodology.

The project proposed by the working team has a great chance to succeed, as soon as implemented.

The study provided a new perspective of the business. As Campos (2004) mentions in several companies which advised that the difficulty in driving the process were caused by lack of study. "I think we do not like to read a lot".

This study contains information for future work on how to apply continuous improvement methodology in concrete artifacts sector companies.

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Organizational Culture of Brazilian Startups (BS): An Evaluation

Diógenes, J.R.F.¹, Queiroz, F.C.B.P.², Queiroz, J.V.², Lima, N.C.³ Silva, C.L.⁴, Queiroz, A.F.S²

¹Programa Doutoral em Engenharia & Gestão Industrial, Faculdade de Engenharia da Universidade do Porto - FEUP, Porto, Portugal (*E-mail: jamil.farkatt@fe.up.pt).

²Núcleo Aplicado à Gestão e Inovação, Departamento de Engenharia de Produção, Universidade Federal do Rio Grande do Norte, Natal/RN, Brazil.

³Programa de Pós-Graduação em Ciências Contábeis, Universidade Federal de Uberlândia, Minas Gerais/MG, Brazil.

⁴Programa de Pós-Graduação em Tecnologia, Universidade Federal Tecnológica do Paraná, Curitiba/PR, Brazil.

ABSTRACT: Lately, a large part of Brazilian entrepreneurial initiatives takes place in a Startup model. However, the life of these companies has expired early because of several issues. Therefore, looking for process of organizational improvement that allows the Brazilian Startups (BS) overcome these obstacles, this study aimed identify and classify the BS organizational culture (OC) profile, through the understanding that the OC possess influence in all working tasks. To achieve the objective was conducted a survey in 174 BS, based on the organizational cultural diagnostic tool developed by O'Reilly et al. (1991). The answers were statistically analyzed with a confirmatory factor analysis using structural equation modeling. The results show that OC predominantly focused on "orientation to results" and "teamwork", and the others cultural dimensions evaluated, "innovation" and "attention to detail", has low influence in the cultural body of these companies. Thus, the OC of the BS can be prepared to face all obstacles that promotes his premature end, if they not strictly guide their businesses through innovation?

Keywords: Organizational improvement; organizational culture; entrepreneurship; Brazilian startups (BS)

1. INTRODUCTION

Entrepreneurial initiatives have capacity to generate jobs and promote economic development (Schumpeter, 1934; Wilken, 1979). Therefore, emerging markets has been constantly increasing its share in the global generation of technological innovation through entrepreneurial activities (Khanna and Palepu, 2010).

In Brazil the entrepreneurial phenomenon has gained current expressiveness through Startups. In the country, there are more than 10.000 firms of this kind, moving in the economy, only in 2012, almost \$1.2 billion dollars (PEGN, 2014). This cash flow is result of millionaire's contributions from overseas investors who believe in the Brazilian entrepreneurial potential (ESP; Zuini, 2013).

The growth of Brazilian Startups (BS) is actually evidenced; however, there are still barriers to consolidate this success. Two of them are the different point of view between business partners (Kask and Linton, 2013) and, the relationship problems among employees and inability to adapt to the needs and market changes. Consequence of these problems 25% of BS close their operations before the first year and, half of them in less than four years (Arruda et al., 2014).

Looking for mitigate these two barriers highlighted, becomes interesting understand on what the BS Organizational Culture (OC) is based, since the OC leads the planning and execution of all working tasks (Green, 2012; Gimenez-Espin et al., 2013), this paper aims to evaluate and classify the BS OC in order to encourage OC changes that assist these firms overcome the high mortality observed in the local market.

Considering the presented arguments, this paper is structured in five sections. Besides this introduction, section 2 presents a brief literature review of OC, technological entrepreneurship and Startups. Section 3 accounts for the material and methods used and section 4 presents the results obtained. Finally, section 5 presents the conclusions.

2. LITERATURE REVIEW

2.1. Organizational culture (OC)

Schein (1992, p.373) OC is "a standard of basic assumptions shown, which are invented, discovered or developed by a certain group". Hofstede (1997) defines OC as "the collective programming of the mind, which distinguishes members of an organization of members of another."

The authors mentioned above give different emphasis in their conceptualizations of the OC. Schein (1992) says that the OC is the result of the dynamics of a particular organization. Hofstede (1997) considers the OC as the result of a greater cultural dynamics of society in which the organization operates.

It is understood that the OC is a system of behavior, standards and accepted social values and, shared by all members of an organization (Smircich, 1983; Kotter and Heskett, 1992; Hartmann, 2006; Fleury, 2007).

2.1.1. Types of organizational culture

Robbins (1998) classifies the OC as adaptive, conservative, strong and weak. According to the author, the adaptive are characterized by being malleable, flexible, susceptible to change, has emphasis on innovation, value ideas and opinions of their employees, and highly oriented to the

market. The conservative are resistant to change, keeping their ideas and holding their entrenched traditional values. For example, the strong cultures, which are those in which their values are shared intensely, influencing most of the behaviors and expectations of employees. On the other hand, weak cultures are those that are easily changed, typically refers to organizations early stage.

According to Cameron and Quinn (1999) OC qualifies in clan, adocratics, marketing and hierarchical. In the author's view, the clan culture is characterized in promoting flexibility in the process, by encouraging collaborative work, by entering the family values in the organizational context. The adhocratic culture is the one that promotes the dynamism, stimulating entrepreneurship, but does not share in effective collaborative work, leading differentiation among employees. The marketing culture, that is focused on results, with a focus on meeting the demands of the market, primarily by promoting competitiveness. Finally, hierarchical cultures are those that prioritize stability and control, standardizing its processes, producing bureaucratic work environment.

2.1.2. Cultural evaluation

Aiming to understand and classify the current culture in organizations is necessary to perform its evaluation. For this purpose, the scientific literature brings up several tools which make it possible to diagnose the cultural profile of the companies.

In order to better understand the tools, Ashkanasy et al. (2000) analyzed eighteen proposed cultural evaluation methods between the years 1975-1992, which are a representative sample of the population of these methods. As a result, they found that only two instruments have provided valid and reliable in their assessments, including one proposed by O'Reilly et al. (1991).

Regarding this tool, studies published by Cable and Judge (1997), Howard (1998) and Agle and Caldwell (1999), have confirmed this method as one of the most used by academics. The choice of this method is still in evidence, as shown in recent research carried out by Densten and Sarros (2012), Marchand et al. (2013), and O'Reilly III et al. (2014).

The highlighted instrument is called 'Organizational Culture Profile'. Its upgraded version has twenty-two items, grouped into six cultural dimensions, namely: (i) results orientation; (ii) attention to detail; (iii) stability; (iv) teamwork and respect for people; (v) innovation; (vi) aggressiveness.

The first dimension, 'results orientation', refers to how the organization establishes actions that lead to the achievement of goals, performance and competitiveness. The second dimension, 'attention to detail', is defined as how the organization promotes accuracy and reliability of the processes. The third dimension, 'stability', refers to the ability of the organization has to provide stability in the implementation of planning and permanence of the work team. The fourth dimension, 'teamwork and respect for people', is perceived as how the organization promotes the integration, equality and respect for employees. The fifth dimension, 'innovation', refers to how the organization is receptive and willing to implement changes. The sixth dimension, 'aggressiveness', refers to the organization stands up to conflict and controversial situations, these conditions can be or not aggressive and predictable (O'Reilly et al., 1991).

Fleury (1993) explains that organizations are resistant to solve management problems, especially when there is a need to change its culture. In addition, Ehlers (2009) points out that this change is a complex and lengthy process, which requires long-term efforts. For this purpose, Smith

(2010) states that the initial step should be taken by the organization's managers, since they have greater influence on the development of OC.

2.2. Technological entrepreneurship

Entrepreneurship is "a process of creating something different and with value by devoting the necessary time and effort, assuming financial, psychological and social risks correspondents, and receiving the resulting rewards of economic and personal satisfaction" (Hisrich and Peters, 2004, p.29).

In the business context, Bygrave (1997, p.2) defines entrepreneurship as "the process that involves all functions, activities, and actions associated with the perception of opportunities and creating organizations to pursue them."

In its technological aspects, entrepreneurship is guided by the creation of new businesses, with the support of development projects based on innovative discoveries (Zahra and Hayton, 2004). In this sense, Bailetti (2012) states that the main function of technological entrepreneurship is to establish a combination of skilled workforce and heterogeneous resources in order to generate value for the company.

However, the XXI century marks the beginning of the technological entrepreneur movement is evolving and driving the development of new business models. These models are based on modern means of how the organization creates, delivers and captures value. A current example of these new designs are startups, as will be described below.

2.3. Startups

The literature on Startups in an attempt to realize his concept uses three different criteria of definition, namely: (i) new, (ii) assets, (iii) independent.

The "new" is the creation of a new company which previously did not formally exist as an organization (Keeble, 1976). The "active" is the sense that the company is active, existing not only on paper (Hadden, 1997). The "independent" is related to creation of new business, from a parent company, but working in a new market niche and being holds its own operational and financial resources (Mason, 1983).

Therefore, considering these criteria, Luger and Koo (2003, p.19) defines the term Startup as a business entity "that never existed before for a certain period of time (new), which began its activities by hiring at least one employee in a certain period of time (active), and does not behave like a subsidiary ".

In summary, the Startup is an organization designed to generate a new service or product amid a uncertainty environment, with innovation (whether in process, product, or business model) as the center of their operations (Ries, 2011). In parallel, Meyer (2012) shows that startups are companies that start small but have big ambitions and a result of its significant capacity for innovation and indicate real chances of exponential growth in a short time.

Because of the beginner character, startups are usually small businesses, and is under development. During this period, they are supported by organizations such as incubators and accelerators. These organizations seek to support startups at the beginning of its activities, providing resources, improving its processes and products, and developing the skills of entrepreneurs (ANPROTEC; SEBRAE, 2002; FDC, 2014).

According to Copper et al. (2007) with the new world economy dominated by software technology, startups have focused on the generation of these intangible products. These are products that most Brazilian Startups (BS) guided their businesses, as will be shown below.

2.3.1. The Brazilian Startups (BS)

Despite the fiscal economic crisis experienced in the Brazilian economy from the first decade of this century, and the recent lowering of the investment rating of Brazil by Standard and Poor's (ESP, 2015), the Startups market in Brazil continues to grow. Currently, the data of the first semester of 2015 confirm that in the first six months of the year were invested \$74 million dollars in BS. This total amount it was managed by 43 investors (27 accelerator, 24 venture capitalists, and 15 groups of angel investors), these the principal amount is divided between 183 BS (Fundacity, 2015).

According to the database ABStartups (2015), the BS are mostly concentrated in the Southeast, 28% in the state of São Paulo, Minas Gerais 8%, and 8% in Rio de Janeiro. States like Rio Grande do Sul with 5%, Paraná and Santa Catarina with 4% each and Pernambuco with 3%, also stands out among the federal units that more headquarter Startups.

These BS, the majority 17% have a business model B2B (Business to Business), 12% B2C (Business to Consumer), 9% signatures, 6% marketplace, 6% advertising, 5 % Social 4% other, and 1% C2C (Consumer to Consumer). Among the active markets for BS 4% work in SaaS (Web App), 4% others, 3% on internet, 3% in education, 2% in communication and media, 2% retail, 2% in e-commerce, 2% entertainment, 1% in Mobile, 1% in events and tourism, 1% in telecom, 1% in finance, 1% in health, 1% in civil engineering, 1% in logistics, 1% in games, 1% fashion and beauty, 1% in agribusiness and environment (ABStartups, 2015).

Regarding the BS already consolidated in the market, the American Business Insider blog, one of the 25 best financial blogs in 2011 according to Time magazine lists the top 10 BS, namely: Peixe Urbano (group buying), LikeStore (purchases via Facebook), Sambatech (online videos), BuscaPé (price comparison), Baby (e-commerce items for children), OQVestir (e-commerce women's clothing), Clickon (group buying), Shoes4You (e-commerce clothing), ViajeNet (online travel agency), Vostu (games) (Geromel, 2011).

The BS have the incremental arrangement in business plurality, passing a good image in the international business world. However, many of these companies cannot reach the higher stages of development by not overcome certain barriers in its early years. On these barriers, the Fundação Dom Cabral (FDC) published in 2014 a report which describes the main causes of BS mortality, namely: (i) the number of partners involved; (ii) the amount of capital invested in the startup, before the start of their sales; (iii) the installation site of Startup.

The first cause is related to relationship problems between partners, which can lead to decreased ability to adapt to changes and market needs. The second cause is related to the amount invested, since applying a large amount of capital before invoicing, it can influence the demand for the actual demand. It is noteworthy that this demand has the power to shorten the path to sales, enabling the business to thrive with capital of their own customers. The last question relates to the fact that the Startup is protected, and constantly maturing, especially when this initially installed is shaped accelerator, incubator or technological park, enjoying all the operational and technological infrastructure that these partners can offer (FDC, 2014).

3. RESEARCH METODOLOGY

3.1. Type of research

The developed research is of applied nature, conducted in exploratory format and outlined by a quantitative approach. The study was based on technical procedures and bibliographical and documentary research, complemented by a survey, in order to achieve the proposed goals (Malhotra, 2011). The research type survey is characterized by the use of applied data collection instruments directly to research participants, aimed at mapping elements - economic, behavioral, etc. - Featuring given sample or population (Forza, 2002).

3.2. Sample size and data collection

The researched target population includes 1639 Startups associated by the end of 2014 as ABStartups (Brazilian Association of Startups). The survey took place by census form, however, after the end of data collection period it was evidenced the participation of 174 projects, representing a response rate of 10.55%.

3.3. Data collection technique

The data collection instrument used in the research was formatted by the authors being data collection divided into two parts. The first part corresponded to identify the socioeconomic profile of entrepreneurs and operating profile of Startups. The second part promoted the diagnosis of OC according to the methodology of identifying the Organizational Culture Profile (OCP), developed by O'Reilly et al. (1991). The structuring of the questions contained in the second part of the instrument was based on an interval Likert scale of 5 points ranging from 1 (very low) to 5 (very high).

The data collection took place in four stages. The first stage corresponded to the presentation of research (through social networks) to entrepreneurs coming from the ABStartups bases, highlighting the potential benefits for the organization, and consequently, identify your contact email for sending the questionnaires. The second stage was the adaptation of the questionnaire in the online platform Google Docs to start the systematic sending of questionnaires in the emails collected. The third stage corresponds to the sending of the questionnaires. The fourth and last stage corresponded to the monitoring and control of these requests, relaying the answers requests for those who previously had not responded to the questionnaire. The order of these requests (fourth time), took place in 6 rounds, each in 10-day intervals, accompanied by messages, which sought to highlight the importance of research for the organizational development of Startups participants and thus ratifying the manager's commitment to contribute to the study. At the end of six rounds (60 days of placement), ended up collecting data, confirming the participation of 174 Startups.

3.4. Analytical procedures

The data were processed and analyzed using Excel software, Statistical Package for Social Sciences v. 21 (SPSS) and SMART PLS v. 3.2.1. The Confirmatory Factor Analysis (CFA) second order without measurement of latent variable Culture was used to test and confirm a theory, since the OCP model did not contain variables to characterize the culture. It is a way to test how

well the measured variables are able to represent a smaller number of constructs, requiring the researcher to specify which variables are associated with each construct. The CFA uses Structural Equation Modeling (SEM) to model specification to be confirmed. The SEM is a family of statistical models that attempt to explain the relationships between multiple variables, describing all relationships between constructs involved in the analysis, then the analysis should be dictated by a strong theoretical basis (Hair et al., 2005).

4. RESULTS

4.1. Profile characterization of the respondents, and Startups.

The respondents were predominantly male (96%), aged less than 30 years (60.3%), with undergraduate (90.2%).

In relation to the Startups companies, almost all were created from 2010 (90.8%), while 68.4% have legal registration and 94.8% are service and trade sector. As shown in Table 1 most of the startups is located in the Southeast and South of Brazil, especially the states of São Paulo, Minas Gerais and Rio Grande do Sul.

Table 1 - Location of BS study participants.

State	Frequency	Percentage	Cumulative percentage
São Paulo	57	32,8	32,8
Minas Gerais	21	12,1	44,8
Rio Grande do Sul	14	8,0	52,9
Santa Catarina	13	7,5	60,3
Rio de Janeiro	10	5,7	66,1
Distrito Federal	8	4,6	70,7
Pernambuco	8	4,6	75,3
Paraná	7	4,0	79,3
Goiás	6	3,4	82,8
Ceará	5	2,9	85,6
Mato Grosso	4	2,3	87,9
Mato Grosso do Sul	4	2,3	90,2
Paraíba	4	2,3	92,5
Alagoas	3	1,7	94,3
Bahia	3	1,7	96,0
Amazonas	2	1,1	97,1
Espírito Santo	2	1,1	98,3
Piauí	1	,6	98,9
Rio Grande do Norte	1	,6	99,4
Rondônia	1	,6	100,0
Total	174	100,0	

Another finding is that one hundred and fifty companies (86.21%) are micro-enterprises with up to nine employees and with annual turnover less than or equal to R\$ 240,000, as reported in Table 2.

Table 2 - Billing and size of the BS in the study.

Billing Employees No.	Big > 500	Medium 100 a 499	Small 10 a 49	Micro ≤ 9	Total
Big Company (billing more than R\$ 50 million) Medium Company	0	1	0	0	1
(billing more than R\$ 2.4 to R\$ 6 million) Small Company	0	0	1	0	1
(billing more than R\$ 240 thousand to R\$ 2.4 million) Micro Company	0	0	4	14	18
(billing less than or equal to R\$ 240 thousand)	1	0	3	150	154
Total	1	1	8	164	174

The respondent companies used as the main source of funding for the opening of business just own resources (74.1%) and own resources together with other sources such as banks and angel investors (23.6%).

4.2. Model analysis

Initially all latent variables were linked to their constructs as the OCP instrument. After running the algorithm with the configuration Factor Weighting Scheme, the following factor loadings were found, as shown in Figure 1.

V10 0.862 0.886 0.888 0.700 0.904 **Stability** 0.408 0.604 **Details** 0.405 0.770 Estabilidade Detalhes 0.768 0.832 0.859 Results 0.798 Resultado V5 0.000 ٧6 0.000 Culture V24 0.972 V25 Aggressiveness Agressividade Cultura 0.000 0.000 V19 Innovation **Teamwork** 0.818 V20 0.601 0.670 0.702 -V21 0.756 0.751 0.816 0.595 0.782 0.832 0.833 0.840 0.773 V22 Inovação V23

Figure 1 - Conceptual Model

The variables that have lower factor loadings than 0.7 were eliminated from the analysis, as follow: from the construct Results the variable V1 was eliminated; from the construct Aggressiveness the variable V25 was eliminated; from the construct, Teamwork the variable V14 was removed; from the construct Innovation the variable V20 was removed. The construct Aggressiveness was excluded due to only a latent variable accepted.

It was held again the CFA and proceeded to the analysis of convergent validity to the theoretical model, seeking to understand when each variable converges to a factor, according to the parametric criteria: Average Variance Extracted (AVE) greater than 0.5; R2 greater than 0.3; Composed reliability greater than 0.7 and Cronbach's alpha greater than 0.6. Table 3, below, shows the results of the analysis of the convergence factors of the theoretical model:

Table 3 - Convergent validity indicators of the model latent variables

			Composite	Cronbachs
Variables/Indicators	AVE	R <i>Square</i>	Reliability	<i>Alpha</i>
Attention to detail	0,699	0,416	0,873	0,779
Stability	0,764	0,638	0,866	0,692
Innovation	0,607	0,804	0,860	0,783

Results orientation	0,656	0,764	0,905	0,869	
Teamwork	0,663	-	0,922	0,898	
Reference values	>0,5	>0,3	>0,7	>0,6	

All constructs meet the requirements of convergence, and thereby the discriminant validity was performed. Table 4 below shows the cross load between the factors and the factor of the intersection, the square root of AVE. As there is no greater cross load between the factors of the charge of their respective variables (yellow highlight), it can be said that the model assigns discriminant validity.

Table 4 - Matrix of cross-loads the model of latent variables

Variables/Correlation	Detail	Stability	Innovation	Results	Teamwork
Attention to detail	0,836				
Stability	0,542	0,874			
Innovation	0,488	0,422	0,779		
Results orientation	0,736	0,530	0,630	0,810	
Teamwork	0,548	0,455	0,666	0,663	0,814

It was conducted a bootstrapping to validate the multivariate model. Table 4 indicates that all the latent variables were significant, since p-value was below 0.05, indicating that there are correlations between the indicators (questions) and the latent variables (dimensions culture). Table 5 shows the standardized coefficients, Student's t and the p-value of the factors generated in the CFA.

Table 5 - Standardized coefficients

Table 6 Gtarradialed Coefficients						
	Original Sample (0)	T Statistics	P Values			
Culture ► Attention to detail	0,791	24,713	0,000			
Culture ► Stability	0,645	11,763	0,000			
Culture ► Innovation	0,799	16,373	0,000			
Culture ► Results orientation	0,897	61,386	0,000			
Culture ► Teamwork	0,874	27,224	0,000			

With the completion of the CFA and validation of the model, the end result is shown in Figure 2.

V10 VQ 0.888 0.700 0.861 0.887 0.904 **Stability Details** 0.624 0.413 V2 0.775 Estabilidade Detalhes ٧3 0.771 **Results** 0.836 ٧4 0.857 0.808 ۷5 Resultado 0.000 0.000 ۷6 0.000 Teamwork Culture 0.000 Trabalho Equipe 0.787 0.824 0.850 0.758 0.822 0.841 Cultura V15 V16 V12 0.000 **Innovation** Inovação 0.716 0.796 0.808 0.792 V19

Figure 2 - Cultural profile of BS

The results found indicates that the Orientation Results ($R^2 = 0.803$) is the most relevant construct for the Culture of Brazilian Startups followed by the construct Teamwork ($R^2 = 0.763$).

5. Conclusion

It was found that regardless of the crisis on the Brazilian economy, presented from the second half of 2014, the entrepreneurship of Startups, influenced mainly for its innovative culture has provided a great dynamism in entrepreneurial economy, implementing theoretical postulates that with the crisis and needs competitive wakes up innovations.

In relation to the objectives proposed in diagnosing and classifying the OC of BS, in order to support decision-making processes which, lead these organizations face assertively because mortality observed in the Brazilian market, and thus increase their chances of survival, the technique was undertaken of CFA second order, seeking to ascertain whether the measured variables (attention to detail, stability, innovation, results orientation and teamwork) behave properly.

The results showed that the CFA supports the latent structure through the five variables, as their parameterization prove the power of analysis, in other words, these variables are able to explain, diagnose and classify the organizational culture of Brazilian Startups.

Therefore, the CFA confirmed the model of latent structure among the five measured variables (factors). Regarding the factor model, it appears that the model showed no multicollinearity among the items on some factors. In other words, no covariation joint. This means that it was established that the dimensional structure gives explanatory power in predicting how the factors behave, being able to explain how such factors share covariance and have empirical and theoretical implications feasible.

The results of the research show that the Orientation to Results has a greater predilection to explanatory model proposed in the order of 80.3%, followed by the variable Teamwork of 76.3%, which are the most significant classification the OC of BS.

These results emphasize the importance of admitting that such factors demonstrated in this study are congruent and explanatory dimensional understanding of the OC in BS.

For the agenda of future studies, points out the need for model revalidation for more specific contexts and segments and refer to strictly innovative entrepreneurs, to be measured more focused parameters of validity to innovators, allowing for more unique validation, since in Startups gives priority to the new service or new product, as well as the use of this instrument in a wider range of locations to be allowed to capture grip impressions or convergence model.

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