A comparative analysis between certified and non-certified companies through the quality management system

Joaquín Texeira Quirós
University of Extremadura, Badajoz, Spain, and

Maria do Rosário Fernandes Justino
ISCAL-Polytechnic Institute of Lisbon, Lisbon, Portugal

Abstract

Purpose – The purpose of this study is to analyze a questionnaire answered by a sample of ISO 9000 certified companies and a control sample of companies which have not been certified, using a multivariate predictive model. With this approach, this paper assess which quality practices are associated to the likelihood of the firm being certified.

Design/methodology/approach – This paper implemented non-parametric decision trees, in order to see which variables influence more the fact that the company be certified or not, i.e. the motivations that lead companies to make sure.

Findings – The results show that only four questionnaire items are sufficient to predict if a firm is certified or not. It is shown that companies in which the respondent manifests greater concern with respect to customers relations; motivations of the employees and strategic planning have higher likelihood of being certified.

Research limitations/implications – The reader should note that this study is based on data from a single country and, of course, these results capture many idiosyncrasies if its economic and corporate environment. It would be of interest to understand if this type of analysis reveals some regularities across different countries.

Practical implications – Companies should look for a set of practices congruent with total quality management and ISO 9000 certified.

Originality/value – This study contributes to the literature on the internal motivation of companies to achieve certification under the ISO 9000 standard, by performing a comparative analysis of questionnaires answered by a sample of certified companies and a control sample of companies which have not been certified. In particular, this paper assess how the manager's perception on the intensity in which quality practices are deployed in their firms is associated to the likelihood of the firm being certified.

Keywords Quality, Decision trees, ISO 9000, Performance

Paper type General review

1. Introduction

Nowadays, quality is an element for competitiveness and possibly one of the variables that has been influencing the conduct of managers, which has contributed to meet the demands of the contexts in which organizations perform their activities. In this sense, quality management has been revealing itself over time as a competitive advantage for organizations that have opt for it. Competition has led companies to revise their forms of organization, since increased competition prevents the marketing of products and

services with no quality. The total quality philosophy has been evolving since its appearance in the early twentieth century as companies feel the need to increase their level of competitiveness within the market in order to secure their continuity. This has been driven by increasingly globalized markets which in turn bring greater competences into the entrepreneurial environment and an increasing number of customers demanding higher quality product (Texeira Quirós *et al.*, 2010b). However, to ensure quality, the organization must comply with various planned actions, which provide some confidence that a product or service meets the quality requirements. There are different systems to ensure quality, but the internationally recognized is the one which corresponds to ISO 9000, i.e. a rule that aims to certify the quality management system of a company.

The family of ISO 9000 standards are benchmarks for the implementation of quality management systems, which represent an international consensus on good management practices with the aim of ensuring the supply of products that meet customer requirements and with a focus on a continuous improvement. In this sense, standards are the basis for design, implementation, evaluation, specification and certification of quality systems, presenting a common international language. This also being a requirement for companies to remain in the market. Because of its growing widespread acceptance, ISO 9000 is becoming an important factor in international trade, almost an imperative for companies that export to the European Union (EU), where buyers often explicitly request ISO 9000 certification (Erel and Ghosh, 1997 *apud* Texeira Quirós *et al.*, 2010a).

In this sense, and according to the ISO Survey 2011, the total number of certificates issued worldwide in accordance with ISO 9001, was 1,111,698 in 178 countries, representing a decrease of over 6,812 certificates the previous year.

ISO Secretary-General, Rob Steele, comments:

> Certification to ISO 9001 for quality management decreased slightly by 1%. Experts put this down to the revision of the standards that will begin shortly, for planned publication in 2015, and also to continual improvement in verification of the survey data received from multiple sources.

Rob Steele continues:

> The survey is a pointer to the evolving global economy and of certification. A number of markets where certification took off in the early 1990s are showing signs of having reached maturity. For example, overall, this is the case of ISO 9001 certification in Europe, but the effect is not evenly spread for Italy is the country that experienced the highest growth in certificates. The East Asia and Pacific region has almost overtaken Europe for the regional share of ISO 9001 certificates.

There are several published works about the motivations of companies to be certified under the ISO 9000 standard. According to Tsiotras and Gotzamani (1996), there are essentially four main reasons that explain why companies implement a total quality management and cost system: improving the company's image and reputation abroad, meeting foreign demand and market pressures, facilitating and simplifying procedures and contracts between the company and its customers, and ultimately increasing productivity and the company's internal control and existing systems of quality management that the company may have implemented. For Jones *et al.* (1997), the companies get certified because they consider themselves obliged to do so, however,

companies which have a more developed concept of quality get more benefits. Heras *et al.* (2002) reveals a study conducted at 400 certified and non-certified companies, that only a minority of studies found that the cost or waste are reduced, suggesting that for most companies the quality has not improved as a result of quality certification. It is surprising that the only consistent benefit found is the increase in sales or market share. This benefit may be due to the benefits of marketing of the "badge of quality" to the detriment of customers and improvements in quality. In contrast, the few studies that used financial measures audited think that companies with quality certification have superior financial performance. Also per Jones *et al.* (1997), the companies make sure of how to improve their internal processes, reduce costs, and improve quality and customer focus. Other reasons are given by Abraham *et al.* (2000) for why companies are satisfied, i.e. the certification provides little guarantee of getting a great impact, unless it is accompanied by a change of leadership, communication and structure. On the other hand, Terziovski and Samson (1997) published one of the more rigorous studies, analysing this subject, whose objective was to test the relationship between ISO 9000 certification and organizational performance in the presence and absence of a total quality management (TQM) environment. The analysis was performed on a sample of 962 industrial companies in Australia and 379 from New Zealand and found that the ISO 9000 certification does not have a significantly positive organizational performance on its own. The authors say that the main motivation for companies to have a quality certification is the ability of certification to open doors to new customers that would be difficult to achieve without the quality certification. In this sense, Youngdahl and Kellogg (1997) examined the relationship between customer service, quality assurance, satisfaction and effort – all this in the perspective of the costs of quality – and found that the classification of costs to quality customer service and their relationship with both satisfaction and effort, provides important capabilities to the design and implementation of services. Thus, the cost of quality concept predicts that as quality increases the total cost of quality decreases (Hendricks and Singhal, 2001). The internal and managerial motivation to adopt ISO 9000 often has a positive effect on the likelihood of a certified organization achieving a better-performing effectiveness configuration (Boiral and Amara, 2009). Terziovski and Samson (1997) found that although ISO 9000 had little or no impact on company performance, it can contribute to organizational performance if a climate of change is created. However, leadership, management of people, and customer focus were the strongest significant predictors of performance (Samson and Terziosvki, 1999). Similarly, Sun (1999), found that TQM practices such as quality leadership, human resource development, and quality information contributed to an increase in customer satisfaction and business performance. It takes time for a company to reap the benefits from an ISO 9000 quality management system and it is most unlikely to cause a swift reversal in company's commercial or financial results. For Casadésus and Giménez (2000), there is no doubt that the process of certification according to ISO 9000, provides an evolution in how to manage a company, the organization, communication and quality system, in general are the key to success in business management. It took a cultural change, which affected the whole organization, where continuous improvement has become a basic tool to advance business competitiveness. Benner and Veloso (2008), studied the automotive companies in the USA, where they first explored how the expected performance benefits from the processes of

management practices, such as ISO 9000, can dilute while most companies in a given sector adopt them. Second, they explored the firm-specific conditions under which these practices might lead to sustainable performance advantages. The authors propose a possible explanation for the difference for those who adopt the standard before and those who adopt the rule later. The advantages on the financial performance of the pioneers tend to disappear as the late adopters implement similar improvements practices. The fact that this study has been carried out in the automobile industry, a sector which is constantly changing and where technology changes rapidly, has had an influence in this finding. If an organizational practice is firm-specific, valuable, and difficult to imitate, it may lead to a sustainable competitive advantage (Peteraf, 1993).

In the literature, the comparison of questionnaires answered by certified and non-certified companies is usually performed using conventional Student's *t*-test (Lima *et al.*, 2000; Gotzamani and Tsiotras, 2001; Martinez-Costa *et al.*, 2008). Here, we compare the answers provided by certified and non-certified companies using a multivariate predictive model. Conceptually, there is a subtle difference between comparing answers with *t*-tests and multivariate (or univariate) predictive models. The former should be used when we conjecture that certification conducts to different responses to the questionnaire; the latter should be employed when we believe that the perception of the respondents towards the questionnaire items conducts to certification. That is, rather than asking whether certified companies provide responses that are statistically different from those provided by non-certified companies, we try to understand if these responses predict, or are associated to the likelihood of the firm being certified.

Improving quality is one of the tools that companies have to improve or maintain their market position. However, despite the large number of papers published, a clear conclusion of the impact of ISO 9000 standards on business results has yet to be reached, given there are many conflicting opinions (Texeira Quirós and Justino, 2010). So, the aim of this paper is to analyse the responses of two groups of firms: a group of companies certified by ISO 9000 and another group of non-certified companies and attempt to establish a relationship between the responses of two groups of companies so as to see if the company is certified or not and what are the variables that influence whether the company is a certified or an uncertified one. This paper is organised as follows. The next section describes the data used in the empirical study. Section 3 shows the classification tree models. Finally, Section 4 concludes the paper.

2. Data

Our analysis uses data obtained by the Portuguese Institute of Accreditation (IPAC). Our universe and object of study in this paper is certified with a quality management system, accredited through NP EN ISO 9001, in a region of Portugal (Lisboa e Medio Tejo). Our total universe comprises 1,015 companies, we sent questionnaires to 666 Portuguese companies, and an attempt was made to obtain the maximum possible number of valid responses. As for data collection, our survey was sent by e-mail to all these companies, and this was followed up by a telephone contact, our total sample comprised of 172 certified companies and 172 non-certified companies. We use a structured questionnaire in order to address the relevant aspects of the object under study in a comprehensive manner. First, we made an initial telephone contact to explain

the nature of the research. We then sent an e-mail which contained an "introductory letter" to formalize the request and the actual questionnaire. This questionnaire was sent to the target companies and when necessary were followed up, i.e. a number of e-mails were re-sent and a new mailing was sent six months later. The design of questionnaire took into consideration: the objective of the research, the collection of data that could enable us to confirm whether the implementation of a total quality management system would increase the company's profitability, and a review of the literature and the relevance of the questions according to whether they are currently pertinent or not. The Likert scale was used to measure how the companies in our survey perceived the questionnaire. The outline we chose to use in our questionnaire can be summarized in an ordinal scale with five categories, according to the following scale: "1 – strongly disagree"; "2 – disagree"; "3 – neither agree nor disagree"; "4 – agree"; "5 – strongly agree".

The research design determined the inclusion in the questionnaire of 17 statements that measure the intensity of different quality practices. The questionnaire is shown in the Appendix. The statements aimed to ascertain the respondents' opinions about the impact of quality elements on the activity and economic environment of their firms. The 17 statements covered different elements of a quality management system: customers relations (statements 1-3); process management (statements 5 and 6); human resources management (statements 8 and 9); quality costs (statements 10-15); strategic planning (statements 16 and 17); and suppliers relations (statements 4 and 7).

The Likert scale was used to measure how the companies in the survey perceived the questionnaire statements. The level of agreement or disagreement with the statements was encoded in an ordinal scale with five categories: 1 – strongly disagree; 2 – disagree; 3 – neither agree nor disagree; 4 – agree; 5 – strongly agree.

3. Classification tree models
First, through the Cronbach's α scales we assessed the level of reliability in our study, since Cronbach's α determines the internal consistency or average correlation of items in a survey instrument to gauge its reliability. An acceptable Cronbach's α should be higher than 0.7 (Bland and Altman, 1997). In this sense, for all scales the reliability coefficient is above 0.77, which means that our measurement scales are reliable and valid.

Decision trees are non-parametric and non-linear predictive models in which the original data set is recursively partitioned into smaller mutually exclusive subsets using a greedy search algorithm (Breiman *et al.*, 1984; Quinlan, 1986). Therefore, it is interesting to understand the relationship between certification and questionnaire responses using a model that does not require a priori the choice of a functional form for the expected value of the nominal variable. This task may be accomplished with non-parametric models, in which the relationship between the variable of interest and explanatory variables is not predetermined by the researcher but is derived from information provided by the data. A popular non-parametric model for predicting nominal variables is the classification tree (Breiman *et al.*, 1984; Quinlan, 1986). In this approach, the original data set is recursively partitioned into smaller mutually exclusive subsets, and the models are represented by a sequence of logical if-then-else tests on the attributes of the observations. Suppose one has a set of observations (i.e. companies) described by a vector of attributes (i.e. questionnaire responses),

and that these observations belong to each of two classes (i.e. certified companies and non-certified companies). The goal of a classification tree is to separate as well as possible the observations that belong to one class from those that belong to the other through a sequence of binary splits on the data. The algorithm begins with a root node containing all observations. Then, the algorithm loops over all possible binary splits in order to find the attribute and corresponding cut-off value which gives the best separation into one side having mostly observations from one class and the other mostly observations from the other.

How are the optimal attribute and cut-off value defined? Denote by p the number of observations of one class and by n the number observations of the other class contained in a given node. The entropy $E(p; q)$ of that node is defined as:

$$E(p, q) = -\frac{P}{p+n} \log_2\left(\frac{p}{p+n}\right) - \frac{n}{p+n} \log_2\left(\frac{n}{p+n}\right)$$

Now, suppose that a given binary split of the data leaves p_1 and n_1 observations of each class in one daughter node, and p_2 and n_2 observations of each class in the other. The optimal splitting attribute and corresponding cut-off value are those that maximize the information gain, so:

$$gain = E(p, q) - \frac{p_1 + n_1}{p+n} E(p_1, q_1) - \frac{p_2 + n_2}{p+n} E(p_2, q_2)$$

Positive information gains result in reductions of entropy. Since the entropy characterizes the diversity of the population in a node, maximizing the information gain results in daughter nodes that are more homogeneous than the parent nodes.

This procedure is then repeated for the new daughter nodes until no further improvement in class separation is achieved or a stopping criterion is satisfied. Unsplit terminal nodes are referred by the figurative term of leaves, and are depicted by rectangles in the schemes representing decision trees (Figure 1). Starting from the
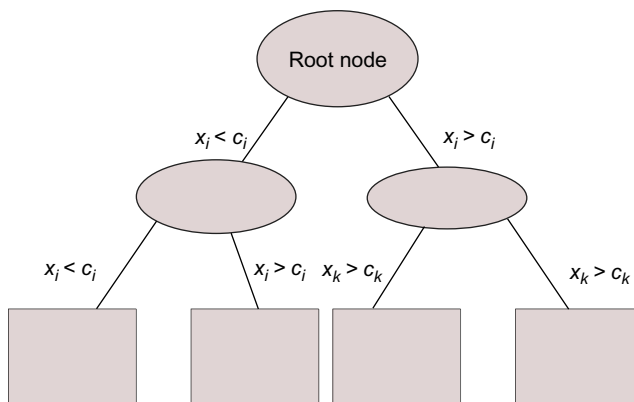
Notes: The model is represented by a sequence of logical if-then-else tests on the attributes of the observations; the terminal nodes, denoted by leaves, are depicted by rectangles

Figure 1.
Simple scheme of a
decision tree model

root node, all observations are routed down the tree according to the values of the attributes tested in successive nodes and, inevitably, terminate their path in a leaf. In the end, observations are classified according to the most prevalent class in the leaf where they terminated their path[1].

Figure 2 shows the classification tree model for the questionnaire responses and Figure 3 for the six dimensions. The interpretation of these models is intuitive and straightforward. First, statement 3 asks the respondents opinion about "Along with market globalization, there was an increase in competitiveness, which resulted in more demanding customers". This statement assesses the respondent's perception towards
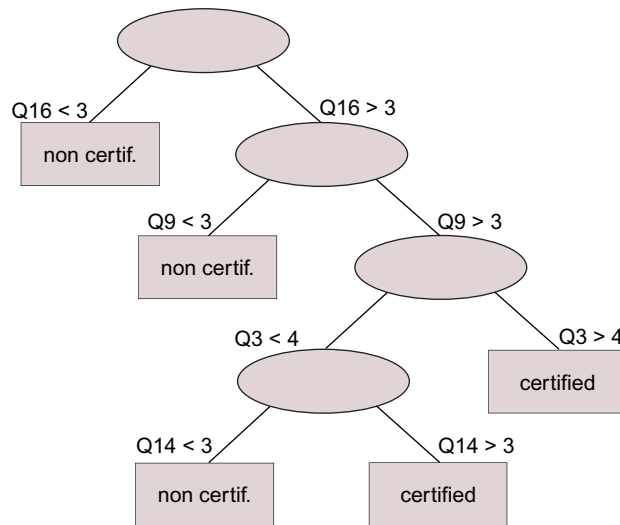

Figure 2.
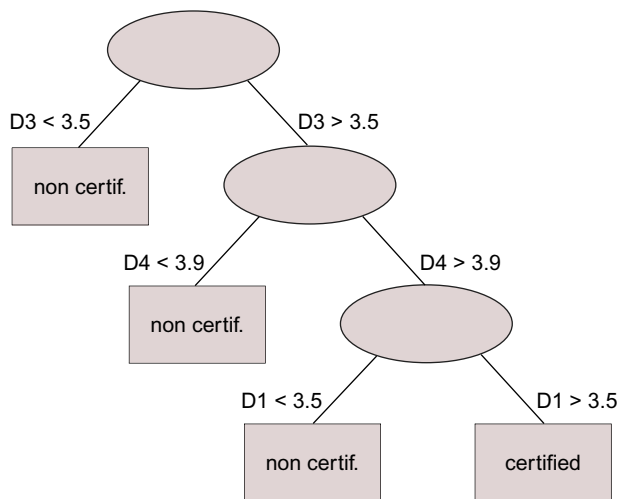Classification tree model
for questionnaire scales

Figure 3.
Classification tree model
for questionnaire
dimensions

the quality element "customers relations". The corresponding coefficient is positive, implying that higher values of the responses on the Likert scale are associated with certification. On the other hand, statement 9 ("Greater motivation of the employees provides an increase in commitment and individual responsibility towards the company.") measures the respondent's awareness with respect to human resources management. Statement 16 evaluates the opinion about "Strategic planning is a continuous process that generates the company's essential objectives. Those objectives should lead to a higher performance culture within the company". Then, at the root node the model inquiries about the response to statement 16. If the response to statement 16 on the Likert scale is smaller or equal to 3, then the model predicts that the company is not certified and the branch ends there. If the opposite occurs, the model then focuses on the response to statement 9. If the answer to this statement is smaller or equal to 3, the model again predicts that the company is not certified. If the contrary occurs, the model then inquiries about the response to statement 3. If the response to statement 3 is greater than 4, the model predicts that the company is certified. If the response to this statement is smaller or equal to 4, the model finally inquiries about the response to statement 14. If the response to this statement is smaller or equal to 3, the model predicts that the company is non-certified; otherwise it predicts that the company is certified.

The tree model found only questions 3, 9, 14 and 16 were significant to associate the probability of certification. Furthermore, the tree model suggests that higher values on the Likert scale of these answers to the questions are associated to certification. However, the tree model also suggests that higher values of answers to statement 14 are associated to certification. This question asks the respondent's opinion on "administrators actually know how much the company may lose by lack of quality", which evaluates the perception towards the element "quality costs". Although these relevant differences have arisen related with "administrators actually knowing how much the company may lose by lack of quality", in all other items (Q10, Q11, Q12, Q13, Q15) concerning the size "quality costs" there is no significant difference. We can say that although the analysis, measurement and adequate control of quality costs, contribute to prevent that making decisions are based on misinformation, which could lead to failure of the products or services in the market.

Although quality cost management is vitally important, we believe that often the administration is not aware of its economical incidence. If these costs were systematically measured, they could be systematically administered and that measurement provides a significant leadership of the quality's value, as well as of the growth of its profitability. This analysis is consistent with Sower and Quarles (2007), who prepared a study on 3,200 companies, members of the ASQ quality management division. Although it is crucially important to measure and control the costs of quality, there is little correlation between the data reported by the financial and quality departments, low participation of the finance departments in calculating the costs of quality and not understanding the impact of the cost on total spending. The authors also suggested that the reason companies do not control the costs of quality, is due to the lack of support from administration, the perception of lack of knowledge of the usefulness of these costs.

This tree structure allows us to draw the following conclusions. First, small values in response to statement 16 are associated to non-certified companies, since the branch Q16 < 3 leads to a "non-certified" leaf. For the same reason, small values in response to

question 9 are also associated to non-certified companies. Large (small) values in responses to statements 3 and 14 are associated to (non-)certified companies, since conditions Q3 > 4 and Q14 > 3, respectively, lead to "certified" leaves. The remaining questions are not relevant since they are not presented in the tree structure. Interestingly, all statements related to the quality elements suppliers relations, process management are not significant in explaining the likelihood of certification.

4. Conclusions

The aim of this article was to analyse the responses given to a questionnaire answered by ISO 9001 certified and non-certified companies, in order to assess if there are significant differences between the two groups. Conceptually, there is a subtle difference between comparing answers with t-tests and multivariate (or univariate) predictive models. The former should be used when we conjecture that certification conducts to different responses to the questionnaire; the latter should be employed when we believe that the perception of the respondents towards the questionnaire items conducts to certification. That is, rather than asking whether certified companies provide responses that are statistically different from those provided by non-certified companies, we try to understand if these responses predict, or are associated to the likelihood of the firm being certified.

The ISO 9000 family of standards are benchmarks for the implementation of systems of quality management, which represent an international consensus on good management practices with the aim of ensuring the supply of products that meet customer requirements and focus on continuous improvement. They are also a basis for the design, implementation, evaluation, specification and certification of quality systems, introducing a common language internationally. It is also now an essential requirement for a company to stay on the market.

The results show that variables such as, customers relations, human resource management, strategic quality planning, and even quality costs are most important than supplier relations and process management.

Thus, the main findings of this research are: by using non-parametric decision trees, and similarly to the previous point, there are differences in the items that comprise customer's relations; human resource management; strategic quality planning. However, we must highlight the item related to the costs of quality, although they are of utmost importance, administrations are often not aware of its economic impact. As the company implements a totally oriented quality management system, it affects all its employees from the very beginning; that is, to produce at the minimum possible cost products or services that meet customers needs and that motivate the company's employees. Calculating quality costs allows an assessment of the programs implemented in companies. The main conclusion of the analysis through decision trees, suggests that only four items on the questionnaire are sufficient to predict whether the company is certified or not.

4.1 Implications for research and practice

The reader should note that this study is based on data from a single country and, of course, these results capture many idiosyncrasies if its economic and corporate environment. It would be of interest to understand if this type of analysis reveals some regularities across different countries. Companies should look for a set of practices congruent with total quality management and ISO 9000 certified.

Note

1. A comprehensive description of tree algorithms is beyond the scope of this paper. The reader is referred to Witten and Frank (2005) for technical details of the algorithms employed here.

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Further reading

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About the authors

Joaquín Texeira Quirós is a Professor at the Faculty of Economics and Business of the University of Extremadura (Spain) and at the University Autonoma of Lisbon. He received his PhD degree from the University of Extremadura in Economics and Business Science.

Maria do Rosário Fernandes Justino is a Professor at ISCAL of the Polytechnical Institute of Lisbon. She received her PhD degree from the University of Extremadura (Spain) in Economics and Business Science. She is a Research Fellow at the SOCIUS, which is based at the School of Economics and Management of the Technical University of Lisbon. Maria do Rosário Fernandes Justino is the corresponding author and can be contacted at: mariarjustino@gmail.com

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Appendix
Mark your level of agreement or disagreement with the following statements.

	1	2	3	4	5
1. As a quality management system is implemented, it is perceived by its customers	1	2	3	4	5
2. It is easier to get your customers' loyalty by being a company with quality certification	1	2	3	4	5
3. Along with market globalization, there was an increase in competitiveness, which resulted in more demanding customers	1	2	3	4	5
4. The search for quality of your products frequently requires the search for new suppliers	1	2	3	4	5
5. There is the need to reduce the development period of new products or services	1	2	3	4	5
6. Increasing the internal link between activities improves the integration of different departments	1	2	3	4	5
7. Innovative products of higher quality should be introduced, relocating industrial products of intensive labor to countries where labor force is cheaper	1	2	3	4	5
8. The increase of individual qualification of the company's employees produces an impact on your products in terms of quality and cost	1	2	3	4	5
9. Greater motivation of the employees provides an increase in commitment and individual responsibility towards the company	1	2	3	4	5
10. The company's quality costs should be controlled and distinguished from other costs	1	2	3	4	5
11. The wrong idea that quality necessarily implies high cost is a relevant obstacle towards the establishment and consolidation of quality programs	1	2	3	4	5
12. Control and measure of quality costs should have a place in the company's management, under the responsibility of the management accounting	1	2	3	4	5
13. The quality costs for promotion of the company as an instrument of execution, planning and control should be measured	1	2	3	4	5
14. Administrators actually know how much the company may lose by lack of quality	1	2	3	4	5
15. There may be a failure in the control of quality costs, as they might be miscategorized	1	2	3	4	5
16. Strategic planning is a continuous process that generates the company's essential objectives. Those objectives should lead to a higher performance culture within the company	1	2	3	4	5
17. Performance assessment and stronger strategic alliances, developing new business areas in main competencies, should be improved	1	2	3	4	5

Notes: 1 – Strongly disagree; 2 – disagree; 3 – neither agree nor disagree; 4 – agree; 5 – strongly agree

Table AI.