



**REASONS FOR TECHNOLOGY-BASED COMPANIES
CONTEMPLATED BY THE FIRST COMPANY PROGRAM TO SEEK
ISO 9001:2008 CERTIFICATION**

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ABSTRACT

The search for implementation of Quality Management Systems aims to continuously improve their results. Thus, for the services and/or products offered to convey trust and credibility, they must be designed within appropriate norms and standards. However, It was observed that companies have different challenges regarding the certification. Furthermore, the reasons for the implementation of ISO 9001 could be different between them. In this sense, this study seeks to assess the reasons that induce incubated technology-based companies to seek adequacy of their quality management system to the NBR ISO 9001:2008 standard. Through an exploratory survey in twenty-six incubated technology-based companies, a twelve-question questionnaire proposed by Bhuiyan and Alam (2005) was applied. After analyzing the data, it is concluded that the reasons for adequacy of QMS to the NBR ISO 9001:2008 standard are: competitive advantage over competitors; consultant's approach for implementation; improvement in product quality; and government



funding for ISO 9001 certification. It is found that the consultant's approach stands out as a strong reason for seeking the adequacy of QMS to the NBR ISO 9001 standard.

Keywords: ISO 9001; Certification; Project; PRIME.

1. INTRODUCTION

A growing literature discusses and evaluates the capacity of financial support policies to increase private investment in R&D through two main instruments: tax incentives (indirect support) and direct subsidies (direct support) (MONTMARTIN; HERRERA, 2015). Furthermore, the same authors assert that this topic is especially important in a context of public budget pressure that requires all public expenditure to be justified and effective. In this context, we can describe the Brazilian government actions.

The Brazilian government has developed several actions to reduce technological dependence and promote local and regional development (e.g. technology parks, business incubators, research incentive laws). This study addresses one of these incentives, the PRIME program developed by FINEP, which allocated investments of R\$ 230,000,000.00 in technology-based companies (TBC).

In Brazil, two thousand technology-based companies obtained R\$ 120.000,00 to invest in market and management advisory services. The undertakings funded by FINEP started their projects in November 2009. Some companies, among the consulting firms hired, opted for certifying their Quality Management System in accordance with ISO 9001:2008, either by requirements of the market or their own initiative (SALGADO et al., 2014a).

To coordinate the PRIME program, 12 coordination centers were selected, one of them located in the South of Minas Gerais State with 66 companies covered by this program. The decision to adopt a quality management system (QMS) is a strategic decision, especially for small technology-based companies, because the QMS helps the company to obtain other certifications. Specifically for the companies' object of this study, some markets and customers require specific certifications: Software development companies (e.g. CMMI, MPS-BR; ISO/IEC 15504); manufacturing companies (e.g. automotive industry ISO TS 16949).



Several research teams have sought to identify the reasons that motivate companies to implement ISO 9001 (PSOMAS; FOTOPOULOS, 2009; MAGD, 2008; TIAN; TAM, 2007; POKSINSKA; EKLUND; DAHLGAARD, 2006; BHUIYAN; ALAM, 2005; YAHYA; GOH, 2001). Those studies focused on large companies from several countries. Differently, Rouber et al (2014) have identified and analyzed the effects of the ISO 9001:2000 implementation process in a small Brazilian company in the printer supplies business. In this way, this study has the same focus, having as object of study incubated technology-based companies.

Based on the above, the following questions served as motivation for this research: what are the reasons for a Technology-Based company implement a QMS based on ISO 9001? The research method is the same used by studies similar to the exploratory survey (e.g. SALGADO, et al. 2014a; FERREIRA, et al. 2015). It has as hypothesis:

- H1: the reasons for implementing QMS based on the NBR ISO 9001: 2008 standard identified by the work of Bhuiyan and Alam (2005) are the same as those of technology-based companies in the South of Minas Gerais contemplated by the PRIME program that allocated resources in certification projects;
- H2: the age of the company is related to the implementation reasons;
- H3: the implementation percentage of the project is related to the implementation reasons.

This paper aims to identify the reasons that TBC had to implement their Quality Management System in accordance with ISO 9001:2008. The study was conducted in three stages. The first consisted of a literature review on the TBC and the quality management system - ISO 9001. This stage has been proved as of great importance to the implementation of a QMS, as well as the importance of the TBC in the national economy.

In the second stage, a survey was carried out on technology-based companies in the South of Minas Gerais contemplated by the PRIME program that allocated resources in certification projects, which could participate in the field-research. Besides that, the questionnaire of Bhuiyan and Alam (2004) was chosen to perform



the data collection. In the third stage, the compilation and analysis of data was performed.

2. LITERATURE REVIEW

2.1. ISO 9001

The interest in ISO 9001 certification is growing. It is no longer a privilege of multinational and large companies, but increasingly, micro, small and medium companies have achieved certification (ALDOWAISAN; YOUSSEF, 2006). Much of this search for certification is due to client demands, making it a mandatory requirement for many companies to become a supplier (GÓMEZ, et al, 2009). In addition, Gómez et al (2009) state that ISO 9001 is, among the models of the QMS, the most influential and most implemented standard. The adoption of a QMS should be a strategic decision (MELLO; SALGADO; SILVA, 2005; PISKAR; DOLINSEK, 2006; HERAS; CILLERUELO; IRADI, 2008).

With the growth of ISO 9001, several researchers approached the subject as object of study. The topics are diverse, such as: reasons, benefits, obstacles, partnerships, leaderships, concerns, tools, techniques, fears, difficulties, implementation systematic, obligations in the implementation of a QMS, financial performance in various sectors of activity such as: Staines (2000), Pascal, Chalochet and Damour (2002), Bhuiyan and Alam (2004), Bhuiyan and Alam (2005), van der Heuvel, Koning, Bogers, Berg, van Dijen (2005), Poksinska, Eklund, Dahlgaard (2006), Aggelogiannopoulos, Drosinos and Athanasopoulos (2007), Fotopoulos and Psomas (2008), Jovanovic and Jovanovic (2008), Benner and Veloso (2008), Sampaio, Saraiva and Rodrigues (2009), Kirsch, Vogg, Hosten and Fleba (2009).

This study is based on Bhuiyan and Alan's article (2005) which provided its research protocol, identifying the reasons for certification of a quality management system as described in Table 1.

Storey and Tether (1998) on researching articles from different countries, say that each country defines technology-based company differently. According to Dahlstrand (2007), defining technology-based company is a complex task because the parameters for such classification are relative, since the measurement of a technology does not admit single answers. To that end, they seek to identify



technology conceptions of "traditional" and "advanced", "breakthrough" or "emerging" bases.

Table 1 - Qualitative research versus quantitative research

Reasons to seek ISO 9001 certification

- 1 - Customer requirements/expectations
 - 2 - Competitive pressure from competitors
 - 3- Competitive advantage over competitors
 - 4 - Aid to export-related activities
 - 5 - Potential access to export market
 - 6 – Consultants' approach for implementation
 - 7 - Government procurement policy (item required in biddings)
 - 8 – Improvement in product quality;
 - 9 - Improvement in quality management practices
 - 10 - Culture / discipline the organization
 - 11 - Government funding for ISO 9001 certification
 - 12- Meet all necessary legislation for the marketing of products (e.g. ANVISA)
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2.2. Technology-Based Company

Technology-Based Company is focus of many researches such as Lindelöf and Löfsten (2003), Ng (2006) as Salgado et al. (2014b). In this paper, the term Technology-Based Company is based on the definition proposed by The National Association of Entities Promoting Innovative Enterprises (HENCE; ANPROTEC, 2002).

Hence and Anprotec (2002) defines technology-based company as one that has a process or product that results from scientific research and whose added value comes from advanced technology areas such as: information technology, biotechnology, fine chemicals, precision mechanics, new materials etc., and can even be characterized by the application of scientific knowledge, the mastery of complex techniques and the high technical qualification work.

Countries considered of global economy recognize the loss of advantages in traditional industries and have shifted their focus, including policy and support to emerging industries. These industries have their basis in knowledge and innovation activities, developing products and services that generate high levels of aggregated and social outcomes (MOHANNAK, 2007).

According to Ng (2006), technology-based enterprises as a matter of study object is justified, since they explore technologies with a continuous development focusing on profits due to launching of new products, services and solutions with a



high aggregated-value to the final client. This whole process just mentioned does not happen in the same way for traditional industries. On the same line, Lindelöf and Löfsten (2003) claim that technology-based enterprises' role is to accelerate the technology propagation and to enhance the enterprise competitiveness.

3. RESEARCH METHOD

The survey research, according to Fink and Kosecoff (1998) and Forza (2002), is a method of collecting information directly from people about their ideas, feelings, health, plans, beliefs and, social, educational and financial background, or about the unit, company or organization they operate. According to Pinsonneault and Kraemer (1993), the Survey research can be classified as to their purpose in explanatory, exploratory or descriptive. Based on the classification proposed by Pinsonneault & Kraemer (1993), as to the purpose, this research is exploratory due to its goal. This research used steps proposed by Pinsonneault and Kraemer (1993), Fink (1995) and Forza (2002):

- Defining the purpose of the research
- Population and Sample: Incubators of the Mineira Innovation Network
- Implementation Method
- Preparation of the instrument
- Validation of the instrument
- Data Collection
- Preliminary analysis of the data

The questionnaire was prepared in accordance with factors, processes, variables and scales to identify the reasons for implementing ISO 9001. We used the questionnaire elaborated by Bhuiyan and Alan (2005); see Table 1, which is based on a Likert scale. The respondents assigned a single response to each reason, with five options to choose from, varying the intensity from very much (5) to none (1). The opinions were collected from partners of the companies, which were the ones in charge for the allocation of PRIME resources into advisory projects. A question regarding the company's business segment was added to the questionnaire: 1 - manufacturing; 2 - hospital doctor; 3 - Software; 4 - services.

The survey on Technology-Based Companies was conducted for 20 days in November 2010, and the contact was established through electronic mail (e-mail),



interviews and phone calls. The first step was to validate the questionnaire used, so that the information obtained from respondents corresponded to reality, even though it was their personal opinions.

To assess whether a questionnaire has reliable variables, an internal validation can be used, which refers to how well the instrument measures what it is proposed to measure; and an external validation to infer a possible situation in the population, and if the results are generalizable, according to Giuffre (1997a, 1997b).

The sample for this study was defined as all the companies covered by the PRIME program in the southern region of Minas Gerais, which have developed adequacy projects of their Quality Management System to the standard ISO 9001: 2008. A total of 34 companies (51%) allocated PRIME resources aiming adequacy of their QMS with focus on ISO 9001, of which 26 (76%) completed the questionnaire. It is worth noting that all companies started the project at the same time due to requirements.

To determine the reliability of the questionnaire, the degree of homogeneity of the set of responses was calculated using Cronbach's alpha, since it provides internal consistency values, enabling the evaluation of the scale used (HAIR JR. et al., 2005).

Internal validity indicates the instrument's application conditions, in this case the questionnaire. While there is no absolute standard, Cronbach's alpha values equal to or above 0.70 reflect an acceptable reliability (NUNNALLY; BERNSTEIN, 1994; HAIR JR.; et al. 2005).

However, Malhotra (2006) recommends, as a decision criterion for "Cronbach's alpha to be considered acceptable, indices above 0.6; and the closer to 1, greater the reliability". In this work, Cronbach's alpha was calculated using the software Minitab 15®. The lowest value found was 0.9498, which can be considered acceptable.

In this paper, we used the "Partial Least Squares" regression method or PLS that applies when there are: multiple dependent variables, highly correlated predictors, and more predictors than observations, according to Yacoub and MacGregor (2003), Helland (1988). The PLS method reduces the number of predictors to a set of principal components. Therefore, PLS is a method that seeks to



form components that capture the maximum information of the variables X and that is useful for predicting Y_i , while reducing the dimensionality of the regression problem by using a smaller number of components than original variables.

The correlation analysis using PLS, calculated through the software Minitab 15[®], uses the algorithm NIPALS (Nonlinear Iterative Partial Least Squares). The NIPALS is an extension of PLS used for multivariate data analysis. As in PLS, the NIPALS is used in cases where all dependent variables are provided simultaneously, according to Sena and Poppi (2004).

The PLS model and a waste analysis were performed to verify their normality. In case of abnormality of the waste, you eliminate its generating element and recalculate the model. The process is repeated until normality of the wastes is obtained and only then the analysis of the PLS results is performed. Data normality was obtained in the waste analysis.

One major issue that arises in the Principal Component Analysis is the criterion for choosing the number of components to retain. Kim and Mueller (1978) report that the most popular methods are: Kaiser, which proposes to consider only the eigenvalues greater than one, demonstrating that these values would be statistically significant.

But this condition is not sufficient. Not all eigenvalues greater than one correspond to components with apparent significance; and the Eigenvalues Diagram: which consists of observing the diagram of eigenvalues and retaining the ones situated above the breakpoint of the fall of the curve of the function that relates the order and the eigenvalues.

Thus, if two factors are associated with almost equal eigenvalues, they represent the same proportion of variability and there is no reason, a priori, to keep one and not the other. However, a strong decrease between two successive eigenvalues follows in conserving the predecessor factors in the interpretation.

According to Babbie (2005), one deemed adequate response rate is 50%, a rate of 60% is considered good, and a rate of 70% or more is considered very good. The author believes that these rates have no statistical basis and that honesty in the answers have a much greater importance than a high response rate.



As we obtained 76% of responses, by the managing partners, the questionnaire was applied in person and 100% of the questionnaires were validated, the external validity is considered appropriate. After data collection, statistical analyzes were performed on the number of employees and in relation to the time to get certified. For both data (time to obtain and number of employees), it was performed waste analyzes, number of principal components, variance analysis, determination of factors and alpha Cronbach.

4. RESULTS AND DISCUSSIONS

Data box plot was carried out (Figure 1 and 2), and the outliers kept in subsequent analyzes. In addition, Figure 3 presents the Market Segment of the companies that participated in the Survey

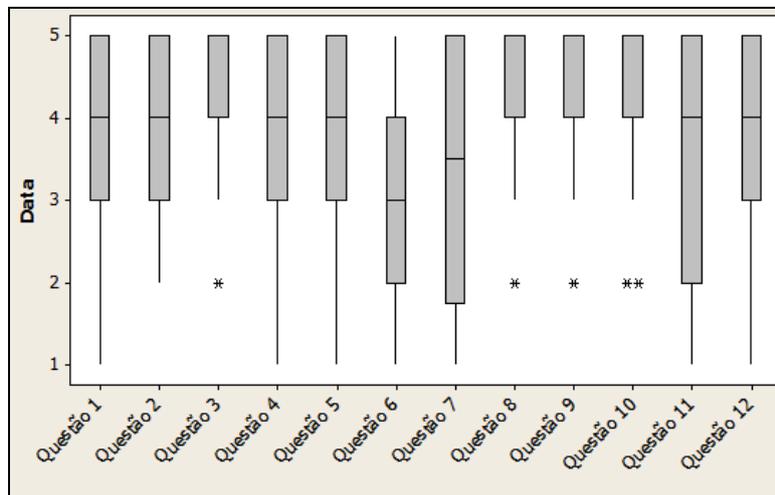


FIGURE 1: Box Plot of the opinions on reasons for implementation.

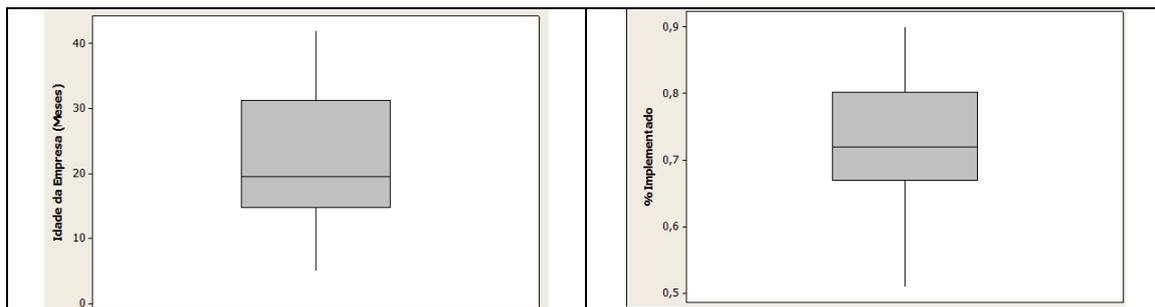


FIGURE 2: Box Plot of the company's age and the % of implementation of the QMS adequacy project to NBR ISO 9001: 2008.



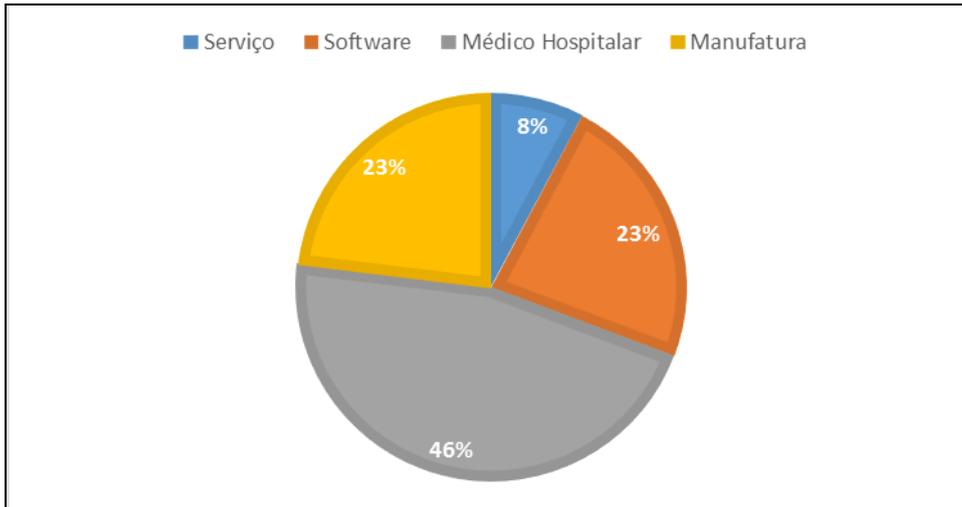


Figure 3: Market Segment of the companies that participated in the Survey.

There is great dispersion in the implementation reasons (Figure 1). In Figure 2, the median age of the companies is 19.5 months, the minimum 5 months and the maximum 42 months. For the percentage implemented, the median is 72%, the maximum 90% and the minimum 51%; it turns out that none of the companies completed the project within the deadline established by PRIME (12 months). Subsequently, the T test (Table 2) in the Minitab15 ® software for the perception of difficulties in the implementation of the section, considering a statistical difference of 5% (p-value lower or equal to 0.05). The statistically significant reasons (H1) are described in Table 3.

Table 2: T Test reasons to implement NBR ISO 9001: 2008

Variable	N	Mean	StDev	SE Mean	95% CI	T	P
Question 1	26	3,769	1,366	0,268	(3,218; 4,321)	-0,86	0,397
Question 2	26	3,769	0,992	0,195	(3,368; 4,170)	-1,19	0,247
Question 3	26	4,577	0,758	0,149	(4,271; 4,883)	3,88	0,001
Question 4	26	3,808	1,327	0,260	(3,272; 4,344)	-0,74	0,467
Question 5	26	3,615	1,203	0,236	(3,130; 4,101)	-1,63	0,115
Question 6	26	2,846	1,255	0,246	(2,339; 3,353)	-4,69	0,000
Question 7	26	3,308	1,543	0,303	(2,684; 3,931)	-2,29	0,031
Question 8	26	4,500	0,762	0,149	(4,192; 4,808)	3,35	0,003
Question 9	26	4,462	0,811	0,159	(4,134; 4,789)	2,90	0,008
Question 10	26	4,385	0,983	0,193	(3,988; 4,782)	2,00	0,057
Question 11	26	3,385	1,444	0,283	(2,801; 3,968)	-2,17	0,040
Question 12	26	3,385	1,211	0,237	(3,396; 4,374)	-0,49	0,631



Table 3: Statistically Significant ISO 9001 Implementation Reasons - (T Test)

Bhuiyan and Alam (2005)	Technology-based companies in the South of Minas Gerais contemplated by PRIME that allocated resources in a certification projects	Comments
1 - Customer requirements/ expectations	6 - Consultants' approach for implementation	The technology-based companies are mostly incubated (88%), still in the development phase of their products, so there are no customer requirements. In addition to being influenced by the consultants.
3- Competitive advantage over competitors	3- Competitive advantage over competitors	Coincident between the surveys, prevailing an external perspective (market)
8 – Improvement in product quality	8 – Improvement in product quality	Coincident between the surveys, prevailing an external perspective (market)
9 - Improvement in quality management practices	11 - Government funding	The motivation for hiring assistance to conform the QMS to the NBR ISO 9001:2008 standard was the resources allocated by the PRIME project. As most technology-based companies are in their product development phase and just beginning the production process, there are few needs of improvements in quality practices.
10 - Culture / discipline the organization		The technology-based companies are young, on average 19.5 months old, still in the development phase of their products and creation of their culture.

The comments were obtained from the managing partners of the companies through semi-structured interviews.

Subsequently, It was used the method of regression "Partial Least Squares" or PLS that applies when there are: multiple dependent variables, highly correlated predictors; more predictors than observations (YACOUB; MACGREGOR, 2004; HELLAND, 1988).

The PLS method reduces the number of predictors to a set of major components. Therefore, PLS is a method which seeks to form components that capture the maximum information from the variables X and that is useful for predicting Yi, while reducing the dimensionality of the regression problem by using a smaller number of components than original variables (SILVA, 2009).

In this research, there are 12 reasons for implementing NBR ISO 9001:2008 (X), and it was identified that they are correlated, besides the existence of more predictors than observations (20 variable X questions against 2 Yi: company age and percentage of the certification project developed).



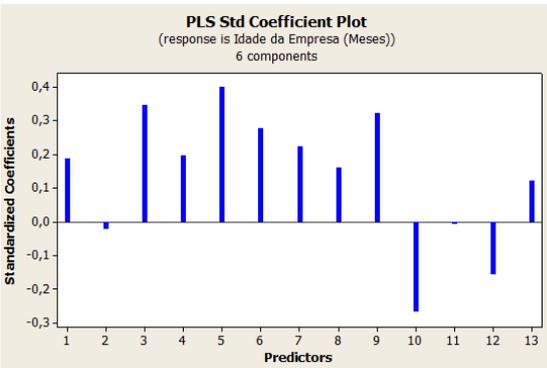
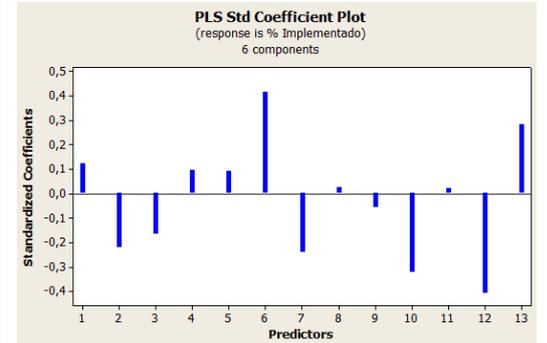
	<p>Reasons present in companies with greater age of existence (Hypothesis H2):</p> <ul style="list-style-type: none"> 5 - Potential access to export market 3- Competitive advantage over competitors 9 - Improvement in quality practices management 6 - Consultants´ approach for implementation 7 - Government procurement policy (item required in biddings) 4 - Aid to export-related activities 1 - Customer requirements/ expectations 8 – Improvement in product quality 13 - Market Segment
	<p>Reasons independent of age (hypothesis H2):</p> <ul style="list-style-type: none"> 2 - Competitive pressure from competitors 11 - Government funding for ISO 9001 certification
	<p>Reasons present in companies with lesser time of incubation (Hypothesis H2):</p> <ul style="list-style-type: none"> 12- Meet the necessary legislation for the marketing of products (e.g. ANVISA) 10 - Culture / discipline the organization
	<p>Reasons present in companies with greater implementation percentage (Hypothesis H2):</p> <ul style="list-style-type: none"> 6 - Consultants´ approach for implementation 13 - Market Segment 1 - Customer requirements/ expectations 4 - Aid to export-related activities 5 - Potential access to export market
	<p>Reasons that are independent of the implementation percentage (hypothesis H2):</p> <ul style="list-style-type: none"> 8 – Improvement in product quality 11 - Government funding for ISO 9001 certification 9 - Improvement in quality practices management
	<p>Reasons present in companies with lesser implementation percentage (Hypothesis H2):</p> <ul style="list-style-type: none"> 12- Meet the necessary legislation for the marketing of products (e.g. ANVISA) 10 - Culture / discipline the organization 7 - Government procurement policy (item required in biddings) 2 - Competitive pressure from competitors 3- Competitive advantage over competitors

Figure 4: Reasons to implement a QMS according to the NBR ISO 9001:2008 standard and the value of their respective PLS coefficient for the results analyzed.

The correlation analysis uses the PLS, calculated through the software Minitab 15 ®, that according to Silva (2009), uses the algorithm NIPALS (Nonlinear Iterative Partial Least Squares). All the results showed relation with the age of the company and the percentage of the certification project implemented for a confidence interval of 95% (Pvalue <0.05), obtaining for both values of PValue: 0,000. The waste analysis resulted in the normality of the data.



One major issue that arises in the Major Component Analysis is the criterion for choosing the number of components to retain. It was based on the eigenvalues diagram considering the ones situated above the breakpoint of the curve fall of the function that lists the order and the eigenvalues (KIM; MUELLER, 1978). Six major components were considered for both results.

Reasons to implement QMS according to the NBR ISO 2008:5 standard and the value of their respective PLS coefficient for the results analyzed (Figure 4).

Analyzing Figure 4, we identified that the reasons present in companies with greater age and percentage of implementation of the NBR ISO 9001:2008 project are: 6 - Consultants' approach for implementation; 13 - Market Segment; 1 - Customer requirements/ expectations; 4 - Aid to export-related activities; 5 - Potential access to export market.

Meanwhile, the reasons for companies with lesser age and a lower percentage of project implementation are: 12 - Meet the necessary legislation for the marketing of products (e.g. ANVISA) and 10 - Culture / discipline the organization Note that reason 12 - Government funding for ISO 9001 certification is a reason that is independent of the company's age and the percentage of the QMS adequacy project implemented.

The following comments were obtained when presenting the results to some managing partners participating in the research:

"... incubated companies that have been around for some time are starting the commercialization of their products, they are closer to the market and therefore more engaged in the implementation of the QMS. It was expected the reasons to be common: market segment; customer requirements/expectations; aid to export-related activities; and potential access to export market."

"... the influence of the consultant in selling us advice was for sure a major reason for us to buy their services. "

"... many companies have not progressed in the implementation of their QMS. The main cause was that the company's efforts were focused on product development; first comes the product that is the generator of revenues."

"... we had to spend the resources provided by PRIME"



A cluster analysis (Figure 5), performed in the Minitab 15® software, allows you to identify that the questions 4 (aid to export-related activities) and 5 (potential access to export markets) can be grouped together because they have a similarity level of 92.25%.

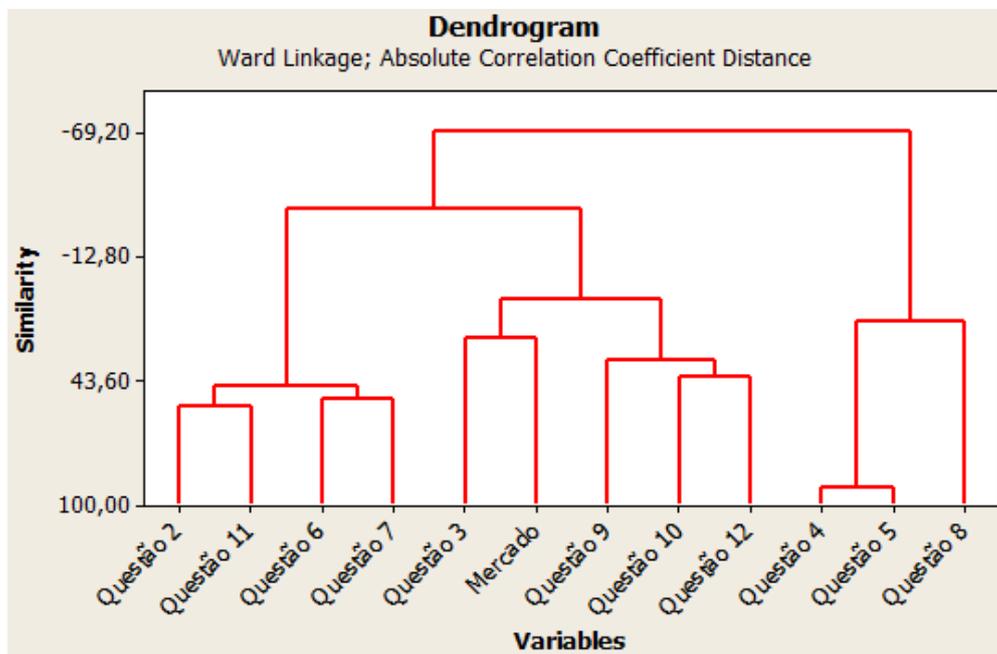


Figure 5: Dendrogram of the reasons that lead companies to seek adequacy of their QMS to the NBR ISO 9001: 2008 standard.

5. CONCLUSIONS

The reasons for technology-based companies in the South of Minas Gerais contemplated by the PRIME program have allocated resources in a certification project their QMS to the NBR ISO 9001: 2008 standard are: 3 - Competitive advantage over competitors; 6 - Consultants' approach for implementation; 8 - Improvement in product quality; and 11 - Government funding for ISO 9001 certification. It is found that among these reasons, three are of external origin and only one internal.

Regardless of the age of the company or the implementation percentage of the QMS adequacy project, the consultant stands out as a strong reason for searching adequacy of their QMS. In this sense, the criteria for selecting consulting firms, as well as guidelines provided by funding bodies proved to be object of special attention.

The market segment in which the company operates has influence in the search for adequacy to the NBR ISO 9001:2008 standard.



5.1. Managerial Implications

The results here stated provide managers, practitioners and researchers new information's to support their decision to implement a ISO 9001 taking into account the better understanding about the reasons for certification. Moreover, this research has identified the main reasons for Technology-Based Companies implement the ISO 9001. In addition, these results can support certification bodies and consultancy firms to demonstrate for the customers the point of view for the specialist.

5.2. Future Research

It has become apparent during this paper that many studies have been carried out with focus on identify the reasons, benefits and difficulties to implement ISO 9001. However, it is possible to suggest future research:

- First, increasing the number of companies participating in the PRIME project, so that the companies can be analyzed in a stratified way for the market segment.
- Also, considering that the Technology-Based companies certificated were not part of the scope of this research, a survey including them would be interesting.
- Finally, due to the ISO 9001 standard revision, the current research should be performed in the future in order to analyze the impact of the revision process in the reason, difficulties and benefits.

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