Relationship among quality management practices, innovation and competitive advantage in manufacturing companies certified with ISO 9001 in Brazil

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Abstract

The objective of this study was to investigate the relationship among quality management practices, product and process innovation and competitive advantage in manufacturing companies certified with ISO 9001 in Brazil, using the model proposed by Kafetzopoulos, Gotzamani, and Gkana (2015). The study can be classified as descriptive, with data collection carried out by survey and quantitative approach with structural equation modelling. The results showed the model adopted has quality to measure the proposed relations, in addition to support the hypothesis previously defined. The conclusion of the study indicates the results contribution to the studies on the theme, the quality management practices have a positive and significant relationship with both types of innovation investigated, and the respective constructs of innovation have positive and significant relationships with competitive advantage.

Keywords: Competitiveness; Total quality management; ISO 9001; Process Innovation; Product Innovation; TQM.

1. Introduction

One of the main objectives of companies is the excellence in performing their activities. It is an important element for the success of them in order to obtain competitive advantage compared to their competitors. There are several aspects related to organizational performance, an extensive area of interest to managers and researchers to detect, explain and develop ways to achieve such requirements. Quality and innovation are among the several aspects.

The two areas of research are in a wide range of interpretations and perceptions in conceptual and practical terms. This fact makes them theme of the most varied studies and discussions, which advance the knowledge extent and depth of analysis. Several studies about the two themes contributed to a great accumulation of academic papers investigating the relations in terms of organizational performance, as well as the influences both can have between themselves, as the works of Flynn (1994), Prajogo and Sohal (2003), Martínez-Costa and Martínez-Lorente (2008), Kafetzopoulos, Gotzamani, and Gkana (2015), and others.

The literature shows there is not consensus on the existence of relations between the practices attributed to quality management related to innovation. There are different results from studies with this objective, also the criticism regarding the methodological elements adopted and the real possibility of inferences provided by the results of studies. This reflects the lack of studies available and can negatively affect or become opportunities for future research (Segarra-Ciprés, Escrig-Tena, & García-Juan, 2017).

For a long time, quality had an important role in the search for competitive advantage. One of the ways to achieve competitive advantage through quality involved the creation of a culture of quality management, based on principles for all the organization, as total quality management (TQM). To formalize the pursuit for quality development in organizations, certifications, as ISO 9001, has emerged. They can be seen as a way to create an organizational culture to pursue quality (Mangiorotti & Riilo, 2014).

However, a better performance in quality became increasingly common among organizations, they begin to give more attention to innovation as a driving force toward achieving competitive advantage (Flynn, 1994). The study of Kafetzopoulos, Gotzamani, and Gkana (2015) tried to identify the relationship among five quality management practices associated with TQM (leadership and support from senior management, training and involvement of employees, information and learning, management of processes, and focus on the client), product innovation, process innovation and competitive advantage. The study has been tested and validated in Greece, proving all the assumptions established previously.

The main justifications for this study are the few studies investigating relationships between quality management practices and innovation in Brazil, lack of studies on this theme also investigating the relationship between innovation and competitive advantage, and low replicability of existing models in literature in different contexts. Thus, the objective of this study was to investigate the relationship between quality management practices, innovation and competitive advantage in manufacturing companies certified with ISO 9001 in Brazil, using the model proposed by Kafetzopoulos, Gotzamani, and Gkana (2015).

2. Literature Review

Historically, the management of quality have developed through several practical policies, tools and methodologies. This shows the effort to pursue quality in an objective and organized way. Other names as principles, elements, constructs and techniques also compose this long list of classifications names related to quality management. They may even be considered synonymous in many cases.

The so-called quality tools are already well known and disseminated, one of the leading names of their popularization is Kaoru Ishikawa. This famous specialist in quality area, proposed seven tools closely related to the statistical control of quality and resolution of problems. They are check sheet, chart for trend analysis, histogram, Pareto chart, cause-and-effect diagram, scatter diagram, and control chart (Neyestani, 2017).

Other designations of quality tools are also present in the literature as affinity diagram, diagram of arrow, array of data analysis, relationship diagram, brainstorming, sampling, and others. The techniques of quality management, for example, are benchmarking, analysis of departmental purpose, design of experiments, Failure Mode and Effects Analysis (FMEA), fault tree analysis, poka yoke, troubleshooting methodology, quality cost, Quality Function Deployment (QFD), times of improvement of quality, Statistical Process Control (SPC), and others (Singh, Khan, & Grover, 2012).

Kafetzopoulos, Gotzamani, and Gkana (2015) present as quality management practices the leadership and support from senior management, training and involvement of employees, information and learning, processes management and customer focus, which are commonly associated with TQM. The leadership and support from senior management go beyond the simple authority to take decisions in organizations. It is a practice associated with managers ability to guide and help to create an environment capable of motivating people to reach goals (Flynn, 1994; Kafetzopoulos, Gotzamani, & Gkana, 2015).

Training is associated with development of employees capacity in organizations, enabling them to acquire the knowledge and skills to better execute its functions (Kim, Kumar, & Kumar, 2012; Saraph et al., 1989). For a better development of quality culture within organizations, employees should be trained in the use of quality tools, as principles of TQM and processes. It is also necessary to involve them in decisions and strategies of the organization, in order to best use their creativity and maintain an environment in which they are motivated (Bon & Mustafa, 2014).

The effective use of information and learning are elements associated with organizations ability to acquire, develop and better use the information to achieve their goals, which can be shared both internally and externally (Calantone, Cavusgil, & Zhao, 2002; Kafetzopoulos, Gotzamani, & Gkana, 2015).

The management of processes involves orientation and direction of efforts in a coordinated way within the framework of the processes. This implies a greater integration between tasks and activities of the most varied functions of organizations (Kafetzopoulos, Gotzamani, & Gkana, 2015; Psomas, Fotopoulos, & Kafetzopoulos, 2011). The management of processes is related to the management of the routine activities of the organization, and those that generate the products and services offered (Gutierrez Gutierrez, Tamayo Towers, & Garcia Morales, 2010).

The focus on the customer is the core of the total quality management, a perspective that tries to first identify the needs of customers to serve them (Carvalho, 2012; Kafetzopoulos, Gotzamani, & Gkana, 2015). An organization following the principles of TQM has the customer in the centre of its decisions (Ross, 1999).

Innovation can be understood as the creation of something new or with significant improvements (OECD, 2004). This and other definitions are associated with different classifications. Some classifications can be grouped by type (product innovations, process, organizational or marketing), degree of novelty (new innovations for the company, the market or the world), and impact (radical or disruptive). Other classifications of innovation are incremental innovation (Tether, 2003; Constant, 1987), open innovation (Barczak, 2012; West et al., 2014), and social innovation (Barczak, 2012).

Kafetzopoulos, Gotzamani, and Gkana (2015) present a model to product and process innovations. The product innovation can be understood as an entirely new product or service, or a product or service with significant improvements in functional aspects (OECD, 2004). Tether (2003) and Saviotti, and Metcalfe (1984) say a product involves the output of a process, subsequently delivered to a particular customer, specified in relation to what it is (technical characteristics) and what it does (service features). The authors complement affirming the characteristics of service are the most perceived by customers, and the changes or recombination of technical features and services determine the emergence of a new product.

The process innovation can be understood as a new or significantly improved way to produce or deliver products and services, new or not. Innovation in processes involves technological aspects (process technology) and non-technological aspects (methods and techniques of production and distribution) (OECD, 2004). A process can be specified by what it does (product) and how it does (steps of manufacturing). Different from what happens with a product, the identification of a process innovation is not clear, because it usually involves small changes to its improvement over time, the "continuous improvement". However, if the change is on a large scale and involve substitutions or significative improvements in technologies and techniques used, then the innovation process becomes more evident (Tether, 2003).

The concept of the competitive advantage is intimately connected to the value an organization creates and delivers to its customers, value not generated by another competitor (Porter, 1985; Barney, 1991). Another aspect raised by Porter (1985) and Barney (1991) involves more than obtain a competitive advantage: its sustainability. Gain a competitive advantage is not a great benefit for an organization if it cannot continue for a specified period of time (Porter, 1985). It should also involve something difficult to replicate (Barney, 1991).

Prajog and Sohal (2003) emphasize the quality would no longer be a criterion for winning order, because strategies would be widely adopted in organizations, making the performance in quality only for qualifying order. Innovation would be assuming this role to represent a criterion for winning order for organizations, replacing quality, which would make innovation a more effective aspect to pursue competitive advantage.

Martínez-Costa and Martínez-Lorente (2008) emphasize innovation is a critical success factor for organizations, an important strategic component allowing them to react better to quick environmental changes by the exploration of new markets launching new products. In this way, innovation is becoming not only a competitive advantage for organizations, but also a necessity in times of great competition, rapid technological change and shortage of resources.

Trivellas and Santouridis (2009) argue the total quality is still an important strategic factor for organizations, the effective application of TQM principles impacts directly the organizational performance in such a way they are still able to increase competitiveness. However, organizations rely increasingly on knowledge management, and innovation will be the main point for achieving sustainable competitive advantage.

Kafetzopoulos, Gotzamani, and Gkana (2015) argue innovation is a competitive advantage, it is not enough to an organization create something new, it has to penetrates in its culture, such a concept. The internal and external pressures of an organization force it to pursue creative solutions, and it can configure a fertile environment to test the capacity of an organization in terms of innovations generation.

3. Development of Hypotheses

An organization experienced at the use of quality management practices has a solid basis for innovation (Flynn, 1994). Considering change a basic element for innovation (Tether, 2003), this can happen due to the adoption of quality management practices reflecting a desire and a need for change in organizations, as the case of companies pursuing certification ISO 9001 (Segarra-Ciprés, Escrig-Tena, & García-Juan, 2017).

In addition, Perdomo-Ortiz, González-Benito, and Galende (2006) argue the adoption of quality management practices can also contribute to accumulation and better use of knowledge, important elements for decision-making concerning changes in organizations, which is important for the development of innovation. Many empirical studies found positive and significant relationships between quality management practices and innovation, and a few empirical studies found negative relationships. Researches about the product and process innovations are more common (Segarra-Ciprés, Escrig-Tena, & García-Juan, 2017).

The quality management practices adopted in the model of Kafetzopoulos, Gotzamani, and Gkana (2015) are found in other works on the same theme, most often associated with TQM (Bourke & Roper, 2017; Kim, Kumar, & Kumar, 2012). The authors designated them leadership and support from senior management, training and involvement of employees, information and learning, processes management, and customer focus. In terms of innovation, the roles of leadership can be assist in building a culture of innovation (Ooi et al., 2012), align the innovation strategies with the overall strategy of the organization (Dervitsiotis, 2010), making decisions about the design of products and processes (Flynn, 1994), and others.

The development of new knowledge and skills provided by training is more than the mere performance of basic tasks. It also qualifies the employees to develop new ideas, operate new systems more easily, as well as to accept and better promote changes in organizations (Martínez Lorente, Dewhurst, & Mitchell, 1999). Combined to training, the involvement of employees in the decisions and in providing innovative ideas allows companies to leverage their innovative capabilities, this would not exist without employees participation (Kafetzopoulos, Gotzamani, & Gkana, 2015; Perdomo-Ortiz, González-Benito, & Galende, 2006).

The intelligent and effective use of information gives employees of an organization more understanding of its processes and products, assisting the identification of elements that add value or not, and reduce the time necessary for the introduction of new products on the market, and the improvement of processes (Kim, Kumar, & Kumar, 2012).

Manage processes can reduce the response time of the organization by increasing efficiency, which also helps to reduce the time to launch new products (Honarpour, Jusoh, & Md Nor, 2017). In addition, continuous improvement is a critical element for the innovation process (Tether, 2003), and it is also provided by the effective management of processes (Kafetzopoulos, Gotzamani, & Gkana, 2015; Honarpour, Jusoh, & Md Nor, 2017).

The focus on the customer, as a pursue to identificate the needs of customers, allows organizations to obtain important information about desirable requirements for new products to be developed (Kim, Kumar, & Kumar, 2012), improvements in existing products (Honarpour, Jusoh, & Md Nor, 2017) and also the production processes and delivery of these products (Kafetzopoulos, Gotzamani, & Gkana, 2015). Based on these arguments, and following the work of Kafetzopoulos, Gotzamani, and Gkana (2015), the following assumptions are made:

H1 – Quality management practices have a positive and significant relationship with product innovation.

H2 – Quality management practices have a positive and significant relationship with process innovation.

In terms of innovation, Flynn (1994) says aspects as fast deliveries and high quality were becoming increasingly common among organizations, which would no longer be ensuring competitive advantage for them. Instead, a source of competitive advantage would be the differentiation provided by launching new products on the market. In addition, some elements to be observed in the external diagnosis of competitive forces, such as markets stagnation, non-explored emerging markets, lower transaction costs, and reduction of trade barriers, are important drivers of innovation in organizations, in terms of products and processes, to obtain sustainable competitive advantages (Volberda et al., 2013; Kafetzopoulos, Gotzamani, & Gkana, 2015). Based on this, and following the work of Kafetzopoulos, Gotzamani, and Gkana (2015), the following hypotheses are presented:

H3 – Product innovation has a positive and significant relationship with competitive advantage.
H4 – Process innovation has a positive and significant relationship with competitive advantage.

With the proposition of hypotheses, the theoretical model used in this study can be presented. It has been extracted and adapted from the article of Kafetzopoulos, Gotzamani, and Gkana (2015), and is illustrated in figure 1. The model establishes the relationship between quality management practices as a single construct, to investigate the relationships between them and the innovations in product and process, as well as the relations between the two types of innovation and competitive advantage.

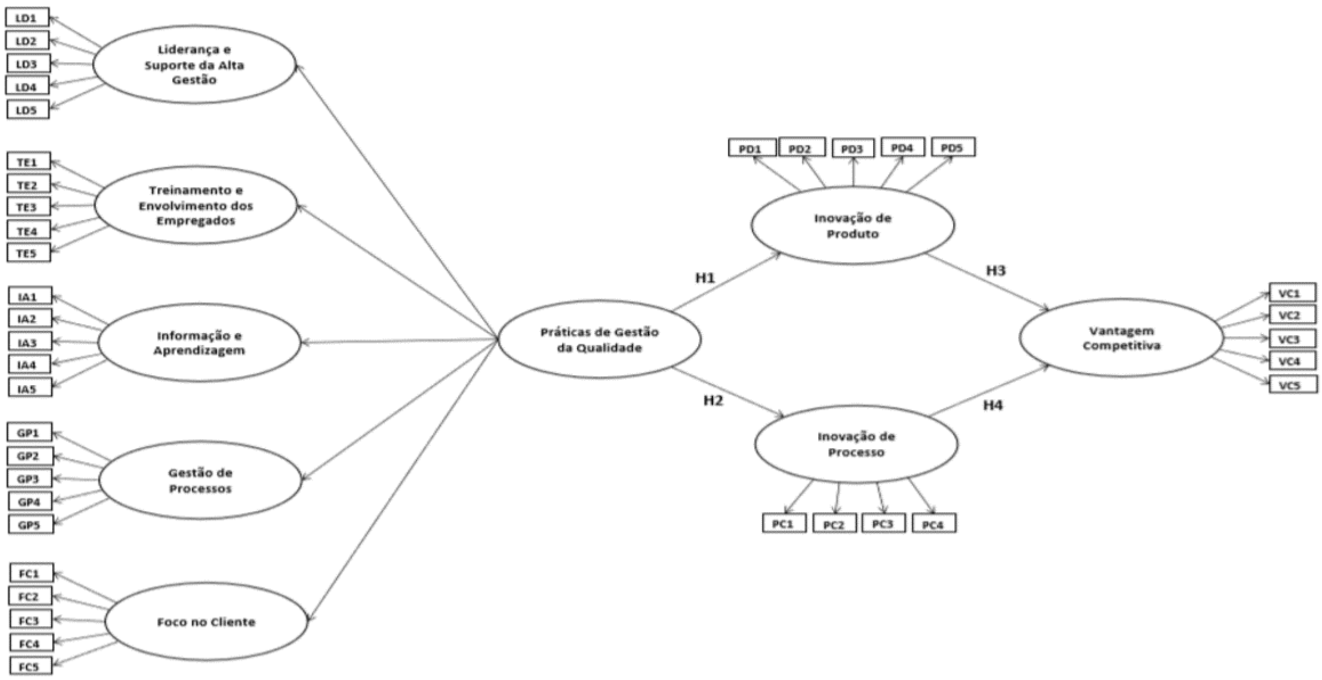

Figure 1. Theoretical Model of research.
Adapted from Kafetzopoulos, Gotzamani, and Gkana (2015).

4. Method

This research can be characterized as descriptive, because it aims to describe the relationships between quality management practices, product and process innovation, and competitive advantage in manufacturing companies certified with ISO 9001 in Brazil. Furthermore, it is also a quantitative research, because it uses numerical data obtained from responses to a closed questionnaire submitted to statistical tests, both from the point of view of descriptive and inferential statistics. The softwares used for the analysis of the data were: Microsoft Excel® 16.0, IBM SPSS® 25, G*Power 3.1, and SmartPLS© 2.0.

The instrument for data collection adopted in this study was a questionnaire extracted and adapted from Kafetzopoulos, Gotzamani, and Gkana (2015) translated by the researcher. The original questionnaire has 39 questions, they have been translated, some of them were adapted by the researcher. In addition, other 4 questions relating to general information of the company and of the respondents were added.

The 39 questions of the original instrument are related to constructs of quality management practices, product and process innovation, and competitive advantage. Each construct comprises 5 questions, except the construct of process innovation, with 4 questions. The Likert scale of seven points was adopted, ranging from 1 (very low) to 7 (very high). The 4 questions about general information of companies and of the respondents were open and had the following themes: branch of the company, company size, state in which the company is located, and sector in which the respondent work in the company. The questionnaires were addressed to employees of different areas and hierarchical levels of companies.

A list with 7670 manufacturing companies, certified with ISO 9001 in Brazil, was obtained from the site Certifiq, of the Instituto Nacional de Metrologia, Qualidade e Tecnologia (National Institute of Metrology, Quality and Technology - Inmetro, 2018). After eliminate double records (722), companies the researcher could not contact or could not find the site (1263), companies not identified as industries (113), organizations not identified as companies (5), and companies identified but not contacted in time (106), the questionnaire were sent by email to que remaining 5461 companies.

131 questionnaires were answered. This number, for the purposes of multivariate analysis with the techniques of structural equation modelling by partial least squares (SEM - PLS), can be considered sufficient, since it is an approach that can produce consistent results with small samples (Ringle, Silva, & Bido, 2014).

To identify a minimum sample of reference a priori and an estimate of the post hoc statistical power, based on statistical criteria, software G*Power (Ringle, Silva, & Bido, 2014) were used. The results revealed a value of 68 respondents as minimum sample, fixing a median effect size ($f^2 = 0.15$), a power of 0.80 and a maximum number of two predictors pointing to a latent variable (construct "competitive advantage").

To calculate the power of post hoc test, it was used as input the size of the sample obtained in the present study, number of two predictors and median effect size ($f^2 = 0{,}15$). The results showed that, for a sample of 131 respondents, the power of the test is 0.98, in other words, there is 98% chance of correctly rejecting a null hypothesis when it is false (Hair Jr et al., 2009).

The analysis of the sample found, with respect to the branch of activity, that most of the companies of the sample act in metallurgy (14 companies - 10.69%). About the size of the company, the majority consists in midsize businesses (68 companies - 51.91%). In regard to localization, most companies are in the state of São Paulo (53 companies - 40.46%). With respect to the sectors in which the respondents work in their respective companies, most of them are in the sector of Quality (75 respondents - 57.25%).

This research used the multivariate statistics, more specifically the structural equations modelling by partial least squares (PLS - SEM). The steps followed for data analysis consisted in the preparation of data (analysis of lost data, atypical observations and test of normality), quality evaluation of measurement model adjustment, quality evaluation of structural model adjustment, and testing of hypotheses.

The analysis of atypical observations was performed by boxplot graphs and normality was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. They test the hypothesis of normality for each variable observed, considering not normal data presenting value of less than 5% significance (Hair Jr et al., 2009).

The quality evaluation of measurement model adjustment considered the validity (convergent and discriminant) and the reliability of latent variables. To analyse the convergent validity, the average variance extracted (AVE) of each latent construct were observed. In the case of the discriminant validity, two criteria were adopted: the criterion of Chin and the criterion of Fornell and Larker. About reliability, Cronbach's alpha (CA) and composite reliability (CR) (Ringle, Silva, & Bido, 2014) were analysed.

The quality evaluation of model structural adjustment involved the observation of the Pearson coefficient of determination (R^2), t-Student test (t), predictive validity or indicator of Stone Geisser (Q^2), the size of the effect or Cohen indicator (f^2), and path coefficients (Γ). Table 1 presents a summary of the indices used to evaluate the quality of adjustment of measurement and structural models. For this study, the index of adequacy of the model (Goodness of Fit - GoF) was not used, because its power to distinguish valid and not valid models is controversial (Ringle, Silva, & Bido, 2014).

Table 1. Indices of adjustment of measurement and structural models.

INDEX / PROCEDURE	PURPOSE	REFERENCE VALUES / CRITERIA
Average Variance Extracted (AVE)	Convergent validity	AVE > 0.50
Cross-loads	Discriminant validity	Values of loads in the originals VLs higher than in others
Criterion of Fornell and Larker	Discriminant validity	The square roots of AVE values of each construct are compared to correlations (Pearson) between the constructs (or latent variables). The square roots of AVEs must be larger than the correlations of the constructs
Cronbach's alpha and composite reliability	Reliability of the model	CA > 0.70 CR > 0.70
T-Student Test	Evaluation of the significances of the correlations and regression	$t \geq 1.96$
Evaluation of Pearson coefficients of determination (R^2)	Evaluates the portion of the variance of the endogenous variables, which is explained by structural model.	For social and behavioural sciences, R^2 = 2% is small effect, R^2 = 13% is average effect and R^2 = 26% is large effect.
Size of the effect (f^2) or indicator of Cohen	Evaluates whether each construct is "useful" for the adjustment of the model	Values of 0.02, 0.15 and 0.35 are considered small, medium and large.
Valid Predictive (Q^2) or indicator of Stone-Geisser	Evaluates the accuracy of the adjusted model	$Q^2 > 0$

Index of adequacy of the model (GoF)	It is a score of the overall quality of the adjusted model	GoF > 0.36
Coefficient of path (γ)	Evaluation of the causal relations	Interpretation of the values based on the theory.

Source: Adapted by the authors from Ringle, Silva, and Bido (2014).

The test of hypotheses was performed through the analysis of statistical significance, strength, and signal of causal relations established in the structural model. The statistical significance was analysed based on the values of t-Student test, values above 1.96 were considered significant. The strength and the signal of relations are associated with the path coefficients (Γ), which indicate relationships stronger or weaker depending on how far the values are from 0, as well as if they are positive or negative based on signal (Ringle, Silva, & Bido, 2014).

5. Results

This section presents the results of the research, demonstrating the preparation of the data, performing the quality analysis of measurement model adjustment, the quality analysis of structural model adjustment and test of hypotheses.

5.1 Preparation of data

With respect to lost data, there were no omissions of response of participants to the 39 questions about the performance of companies in the implementation of quality management, innovation and competitive advantage practices. Even so, as regards the answers to the descriptive questions (branch of activity, company size, location and working sector of the respondent), it was impossible to identify some of the replies, the only cases of omission of data in the present study.

Analysing the atypical data, by a box-plot graphs it was identified that 17 variables presented outliers. According Hair Jr et al. (2009), occurrences like this are common, there is no need expressed for the disposal or processing the data when the researcher feels it is important to keep them. Thus, the choice was to maintain the variables without changing the original data set, because the original configuration is important to elucidate the reality.

To analyse whether or not the variables have a normal distribution, the tests Shapiro-Wilk and Kolmogorov-Smirnov were performed. They test the hypothesis of normality in the data through the observation of the values of significance for each variable observed. Very low values of significance reject the null hypothesis, in other words, they show the data do not have a normal distribution (Hair Jr et al., 2009). The results of the tests of normality showed significance levels below 1% for all variables, which rejects the hypothesis of normality in all of them.

With this, it is possible to say the variables does not meet the assumption of normality, and it is not advised to follow with structural equation modelling based on covariance (CB - SEM). In cases in which it does not have a set of data meeting the assumption of normality, it is possible to use the approach known as structural equations modelling by partial least squares (SEM - PLS) (Ringle, Silva, & Bido, 2014).

5.2 Quality analysis of measurement model adjustment

In the case of the quality analysis of the measurement model adjustment, the first index to be analysed was AVE to certify how the observed variables converge to their respective latent variables, in other words, the convergent validity. AVE values higher than 0.5 indicate a satisfactory level of convergent validity (Ringle, Silva, & Bido, 2014). Analysing the AVE results of each latent variable, all the constructs are higher than 0.5, and the second-order construct "quality management practices" presents the lowest value (a little more than 0.5). Table 2 shows the initial values of AVE for each latent variable model of measurement.

Table 2. Indicators of initial measurement model adjustment

LATENT VARIABLES	AVE	CR	CA
Focus on Customer	0.781288	0.946882	0.929506
Processes Management	0.557981	0.861806	0.798331
Information and Learning	0.76806	0.942993	0.92424
Process Innovation	0.88392	0.968195	0.956025
Product Innovation	0.777767	0.945893	0.928321
Leadership and Support from Senior Management	0.670588	0.910079	0.875238
Quality Management Practices	0.500131	0.960818	0.956822
Training and Involvement of Employees	0.601102	0.882584	0.833412
Competitive Advantage	0.558573	0.862856	0.814645

Source: Prepared by the authors (2019).

The second step consists on evaluate the discriminant validity, and can be done by the observation of cross loadings of observed variables (OV) (criterion of Chin) (Ringle, Silva, & Bido, 2014), and the comparison of the square roots of AVEs with Pearson correlations between the latent variables of the first order (criterion of Fornell and Larcker) (Wetzels, Odekerken-Schröder, & Oppen, 2009; Oliveira et al., 2016). The analysis of cross-loads table shows the results conform the criterion of Chin, because the factorial load of each item are higher in its respective constructs than in others, as can be seen in bold in Table 3.

Table 3. Cross-loads of observed variables

OV	Focus on the Customer	Processes Management	Inform and Learning	Process Innovation	Product Innovation	Leader. and sup. of Senior Management	Train. and Invol. of Employees	Competitive Advantage
FC1	**0.83246**	0.508657	0.675277	0.398804	0.428496	0.626523	0.550805	0.648295
FC2	**0.92915**	0.474076	0.695004	0.389591	0.373498	0.687312	0.608612	0.689497
FC3	**0.89317**	0.362972	0.578835	0.375768	0.290292	0.597871	0.568625	0.652632
FC4	**0.91801**	0.465442	0.677185	0.437308	0.434248	0.648298	0.619029	0.714941
FC5	**0.84241**	0.400856	0.535806	0.3333	0.329612	0.555515	0.457033	0.642894
GP1	0.242869	**0.70925**	0.40958	0.448071	0.435745	0.439495	0.400346	0.435685
GP2	0.202785	**0.7496**	0.390488	0.440665	0.365944	0.433437	0.394178	0.395217
GP3	0.496034	**0.84243**	0.579841	0.420648	0.328938	0.575453	0.576541	0.524147
GP4	0.424364	**0.6068**	0.474098	0.330224	0.321409	0.392474	0.481271	0.382234

GP5	0.447267	**0.80441**	0.433224	0.280376	0.258607	0.462713	0.506572	0.450812
IA1	0.544983	0.524417	**0.84502**	0.440593	0.507382	0.664241	0.593258	0.476009
IA2	0.610662	0.53628	**0.89094**	0.559334	0.599702	0.662838	0.560539	0.572742
IA3	0.667563	0.538124	**0.90906**	0.538493	0.578212	0.752963	0.618974	0.588373
IA4	0.645651	0.559248	**0.89206**	0.564869	0.594109	0.749643	0.676441	0.630634
IA5	0.676596	0.564589	**0.8428**	0.392801	0.43748	0.732441	0.590921	0.577691
PC1	0.403071	0.458705	0.546215	**0.91541**	0.66741	0.500292	0.407584	0.605429
PC2	0.416523	0.501694	0.517604	**0.96024**	0.674115	0.5386	0.470045	0.666892
PC3	0.391284	0.528518	0.528568	**0.96453**	0.686043	0.555665	0.511378	0.63482
PC4	0.441342	0.426113	0.554921	**0.91941**	0.674216	0.507605	0.430906	0.665816
PD1	0.414824	0.389133	0.560019	0.651298	**0.91567**	0.556296	0.476146	0.614937
PD2	0.38097	0.409585	0.587676	0.738552	**0.88469**	0.549899	0.440783	0.576925
PD3	0.399661	0.419278	0.533059	0.626187	**0.85187**	0.429821	0.450978	0.633798
PD4	0.379951	0.370004	0.576054	0.570864	**0.90658**	0.549359	0.41256	0.587238
PD5	0.27593	0.400199	0.473472	0.575829	**0.84861**	0.399253	0.380805	0.566122
LD1	0.532123	0.448049	0.666821	0.476594	0.451697	**0.83699**	0.517277	0.603037
LD2	0.565206	0.479891	0.751142	0.471549	0.499644	**0.88161**	0.566876	0.542292
LD3	0.526781	0.539456	0.609065	0.493153	0.45313	**0.79426**	0.605475	0.522417
LD4	0.664547	0.554799	0.737119	0.472157	0.49787	**0.86206**	0.62849	0.606583
LD5	0.600094	0.532105	0.553323	0.372415	0.405597	**0.70792**	0.604546	0.566291
Nt1	0.474276	0.5576	0.520614	0.331646	0.317158	0.5015	**0.70058**	0.367148
Nt2	0.591946	0.55982	0.517643	0.424153	0.416007	0.617481	**0.80614**	0.560891
Nt3	0.359632	0.478799	0.450972	0.404057	0.455813	0.522191	**0.78328**	0.498852
Nt4	0.426446	0.453307	0.565212	0.36897	0.360128	0.539448	**0.79108**	0.480184
Nt5	0.590514	0.437575	0.626477	0.349062	0.360179	0.577542	**0.79087**	0.495982
VC1	0.603383	0.50423	0.549078	0.44566	0.535864	0.487759	0.485993	**0.72116**
VC2	0.507761	0.576407	0.49149	0.433896	0.313805	0.590244	0.468073	**0.70209**
VC3	0.675901	0.409868	0.354908	0.290524	0.181948	0.446189	0.443294	**0.67989**
VC4	0.786413	0.460889	0.572107	0.465116	0.41616	0.639117	0.590233	**0.81667**
VC5	0.436472	0.355596	0.459891	0.720141	0.765812	0.481554	0.406679	**0.80664**

Source: Prepared by the authors (2019).

As regards the criterion of Fornell and Larcker, the value of the square root of AVE of "competitive advantage" (0.747377) is a little smaller than its correlation with "Customer Focus" (0.758512), demonstrating "competitive advantage" does not meet the criterion established for the discriminant validity. Table 4 presents the correlation matrix of the latent variables with their respective values of square roots of AVEs in the main diagonal cells (in yellow), with red highlights for "competitive advantage" and "focus on the customer".

Table 4. Pearson Correlation Matrix

Latent variables	Focus on the Customer	Processes Management	Inform. and learning	Process Innovation	Product Innovation	Lead. and sup. of Senior Management	Train. and Invol. of Employees	Competitive Advantage
Focus on the Customer	**0.883905**							
Processes Management	0.502852	**0.74698**						

Information and Learning	0.7195	0.62164	**0.87639**					
Process Innovation	0.439503	0.509461	0.570719	**0.94017**				
Product Innovation	0.422401	0.450698	0.620621	0.718445	**0.88191**			
Leader. and sup. of Senior Management	0.707622	0.62437	0.814456	0.559314	0.56563	**0.81889**		
Train. and Involv. of Employees	0.637918	0.641738	0.694885	0.484599	0.491638	0.71455	**0.77531**	
Competitive Advantage	**0.758512**	0.591755	0.651252	0.684801	0.676372	0.694159	0.622435	**0.747377**

Source: Prepared by the authors (2019).

To comply with the criterion of Fornell and Larker, it was observed in table 3, the differences between the cross-loads of items related to the variables "Customer Focus" and "Competitive Advantage" in the table of cross-loads (Ringle, Silva, & Bido, 2014). The smallest difference found was for the item VC3 (0.675901 - 0.679891 = 0.00399). The removal of this item contributed to increase the value of the square root of AVE on the construct "Competitive Advantage" (0.763053), above the new value of correlation with "Customer Focus" (0.729475).

Table 5 shows the new values in the matrix of correlations, illustrating the compliance with the criterion of Fornell and Larker for the assessment of discriminant validity. As the withdrawal of VC3 also influenced the indices of convergent validity and reliability of the measurement model, these indices were updated in Table 6.

Table 5. New matrix of correlations after the withdrawal of VC3

Latent variables	Focus on the Customer	Processes Manageme nt	Inform. and learning	Process Innovation	Product Innovation	Lead. and sup. of Senior Managemen t	Train. and Invol. of Employees	Competitive Advantage
Focus on the Customer	**0.8839**							
Processes Management	0.502852	**0.74698**						
Information and Learning	0.7195	0.62164	**0.87639**					
Process Innovation	0.439516	0.509426	0.570802	**0.94017**				
Production Innovation	0.421971	0.450718	0.620429	0.71839	**0.88193**			
Leader. and sup. of Senior Management	0.707622	0.62437	0.814456	0.559292	0.565419	**0.81889**		
Train. and Involv. of Employees	0.637918	0.641738	0.694885	0.484533	0.491408	0.714549	**0.77531**	
Competitive Advantage	0.729475	0.586553	0.660349	0.707161	0.7148	0.693226	0.615315	**0.763053**

Source: Prepared by the authors (2019).

The third step involves the indexes of reliability and internal consistency: CA and CR. These two indices assess whether the variables, on the whole, are reliable to measure the proposition. Values higher than 0.7, both CA and CR, indicate good reliability and internal consistency of the latent variables (Ringle, Silva, & Bido, 2014). According to the results, all the latent variables showed values higher than 0.7 for both CA and CR, indicating the measurement model is reliable. The values of CA and CR can be seen in Table 6.

Table 6. Indicators of measurement model adjustment after VC3 removal

LATENT VARIABLES	AVE	CR	CA
Focus on the Customer	0.781288	0.946882	0.929506
Processes Management	0.557981	0.861806	0.798331
Information and Learning	0.76806	0.942993	0.92424
Process Innovation	0.883923	0.968196	0.956025
Product Innovation	0.777808	0.945906	0.928321
Leadership and Support from Senior Management	0.670588	0.910079	0.875238
Quality Management Practices	0.500131	0.960818	0.956822
Training and Involvement of Employees	0.601102	0.882584	0.833412
Competitive Advantage	0.58225	0.847265	0.768667

Source: Prepared by the authors (2019).

5.3 Quality analysis of structural model adjustment

Regarding the quality analysis of structural model adjustment, the results of coefficient R^2 showed values higher than 26%, which indicates large effects (R^2 of the construct "quality management practices", apparently is not only predictor, there is no arrow pointing it in the structural model). In the case of the indicator Q^2, it is possible to see all variables presented values higher than zero, which indicates the predictive validity of the structural model. The evaluation of the values f^2 confirms almost all constructs have large size effects (above 0.35), with a construct (competitive advantage) with effect between medium and large. Table 7 shows the values R^2, Q^2 and f^2 for the structural model.

Table 7. Indicators of structural model adjustment

LATENT VARIABLES	Q^2	F^2	R^2
Focus on the Customer	0.53235	0.649407	0.716446
Processes Management	0.315795	0.363839	0.578568
Information and Learning	0.637216	0.642627	0.834999
Process Innovation	0.311838	0.780322	0.358035
Product Innovation	0.269972	0.65774	0.360874
Leadership and Support from Senior Management	0.549361	0.502092	0.825255
Quality Management Practices	0.45254	0.45254	-
Training and involvement of employees	0.421113	0.396322	0.719766
Competitive Advantage	0.296583	0.31166	0.588437

Source: Prepared by the authors (2019).

The *t*-Student test aims to evaluate the significance of relations in the structural model, considering significant relations in which t-values are larger than 1.96 (p-value $\leqslant$ 0.05) (Ringle, Silva, & Bido, 2014).

Thus, the relations present in the structural model analysed can be considered significant, since they all have t-values greater than 1.96. Figure 2 presents the values of *t*-Student test.

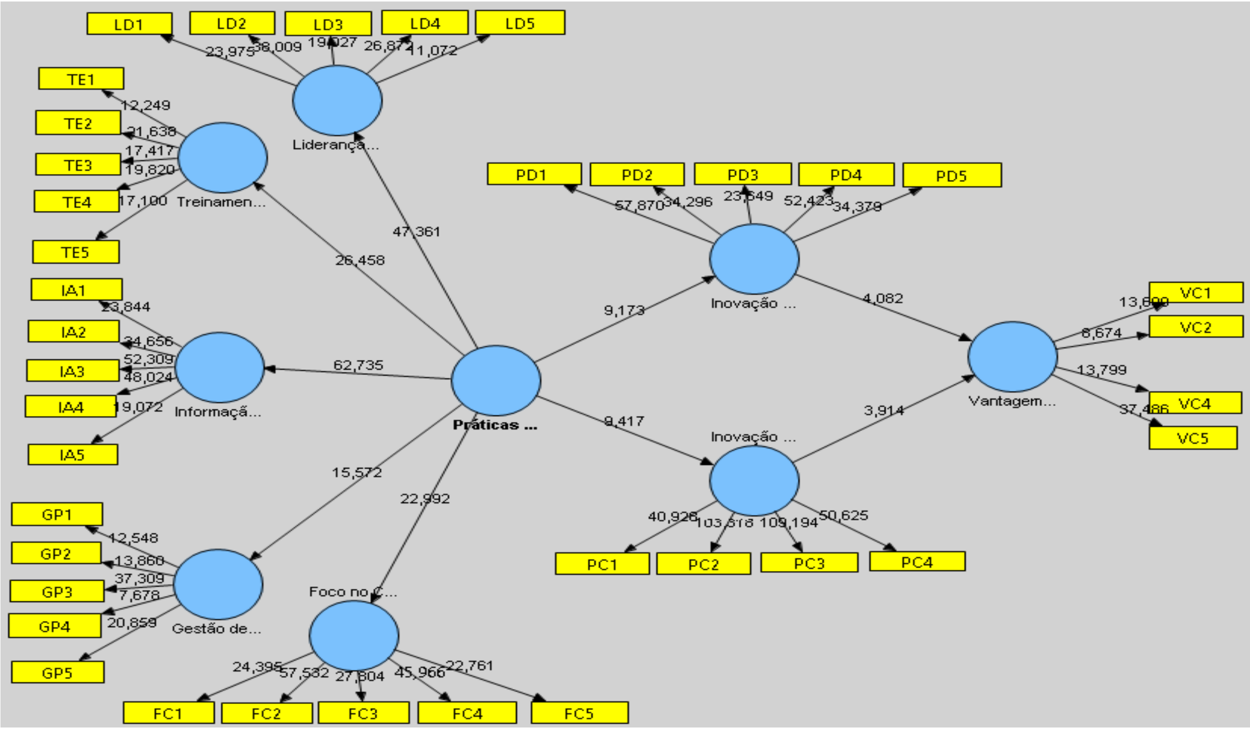

Figure 2. Values of *t* -Student test.

The path coefficients (Γ) values are similar to the values β in regression equations, ranging from -1 to +1. The more distant from 0 is the value, stronger is the relationship between two variables (Ringle, Silva, & Bido, 2014). The results of Γ coefficients for the structural model of this study were all positives and distant to 0, indicating a positive and strong relationship. Figure 3 illustrates the coefficients Γ (the values are represented by the arrows in the paths diagram).

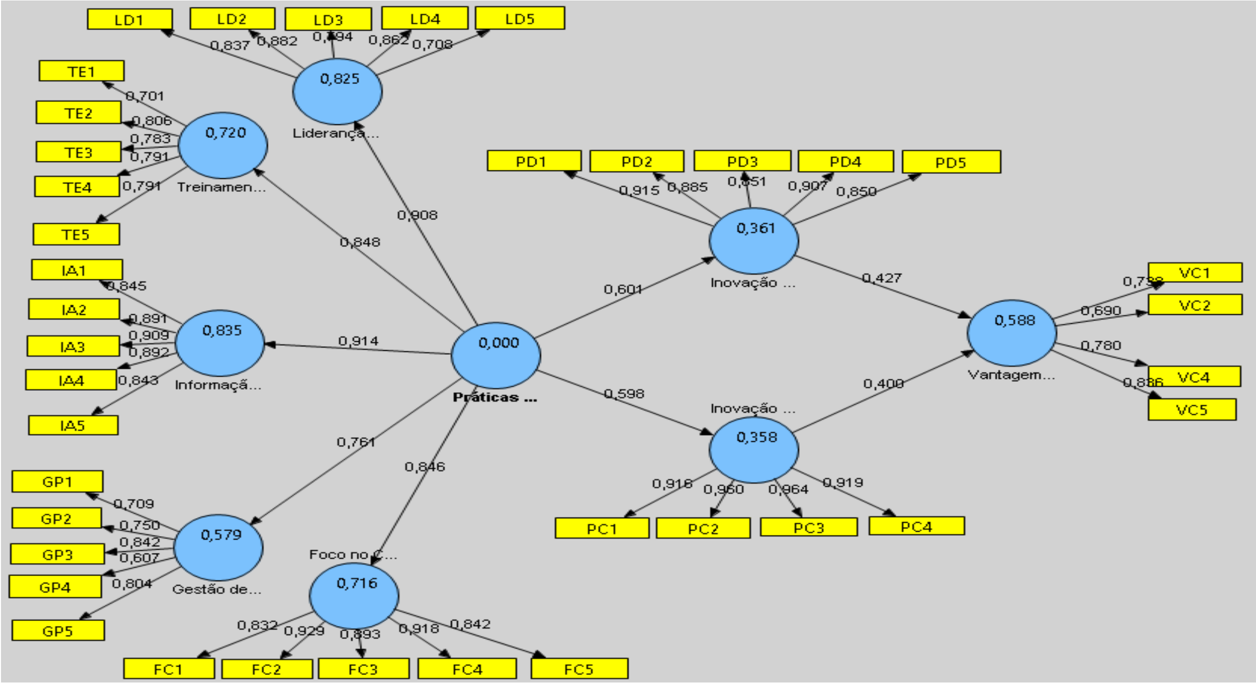

Figure 3. Values of Γ coefficients

5.4 Quality analysis of structural model adjustment

To find out if the assumptions presented in this study are real, the values of path coefficients (Γ) and Student's *t*-test were analysed for the relations established between the exogenous latent variable "quality management practices" with the endogenous variables "product innovation" and "process innovation" (H1 and H2), and between the endogenous variables "product innovation" and "process innovation" with other endogenous variable "competitive advantage" (H3 and H4).

Observing the values of the coefficients Γ in the paths diagram, it is possible to see they are all positive, and distant from zero, also indicating strong relations. Analysing the paths diagram with *t*-values for each causal relation established by the hypotheses of the study, it is possible to see all of them have *t*-values greater than 1.96, indicating significant relations. Thus, the null hypothesis is rejected for the four alternative hypotheses of this research. Table 8 presents a summary of *t*-values and Γ coefficients, demonstrating the confirmation of alternative hypotheses based on the results achieved.

Table 8. Summary of the testing of hypotheses

CAUSAL RELATIONS	Γ coefficients	T-values	Hypotheses	Result
Quality Management Practices → Product Innovation	0.601	9.173	H1	Confirmed
Quality Management Practices → Process Innovation	0.598	9.417	H2	Confirmed
Product Innovation → Competitive Advantage	0.427	4.082	H3	Confirmed
Process Innovation → Competitive Advantage	0.400	3.914	H4	Confirmed

Source: Prepared by the authors (2019).

6. Discussion

This chapter discuss the results of the present study in order to better reflect about them, comparing them with results of other studies on the same topic. Also infer about the possible impacts quality management practices can have on innovation performance in manufacturing companies certified with ISO 9001, as well as the possible effects of innovation on competitive advantage.

To Prajogo and Sohal (2003), the result found by them indicates a positive relationship between quality management practices and product innovation can be an indirect result of the adoption of the practices of TQM, since the aim, in essence, is the improvement of quality in organizations. Furthermore, the authors believe the contribution of TQM for product innovation tends to be more incremental than radical, which may be related to the philosophy of continuous improvement (change) from TQM.

Prajogo and Sohal (2003) and Dedy et al. (2016) offer to discussion of the results obtained in their research, the argument of positive and significant relationship between the practices of TQM and process innovation is more consistent, understanding the focus on continuous improvement promoted by TQM adds a series of incremental innovations of process, aiming to improve the performance of production and the quality of products.

Advancing, Prajogo, and Sohal (2003) also argue a large and continuous number of incremental innovations in a process can generate radical innovations, depending on the degree of overall change in the process. Furthermore, the authors also suggest that the pursue for quality, understood as an important criterion for the achievement of organizational goals, can contribute to facilitate the adoption of process innovation with this purpose, as the introduction of new technologies, for example.

According to the analysis of the results of the study of Kafetzopoulos, Gotzamani, and Gkana (2015), the authors affirm quality management and innovation are important strategic components for improving the competitive performance of organizations. Furthermore, according to the authors, the quality management practices influence directly on the innovative performance of organizations, and innovative organizations tend to gain greater competitive advantage than non-innovative companies.

To Kafetzopoulos, Gotzamani, and Gkana (2015), the innovation process is usually introduced in an organization, precisely in order to improve its overall performance, because it promotes more profitable ways to produce with fewer losses and delivers quality products to customers. This highlights the strategic character of the innovation process, because it allows organizations to be more competitive both in cost and in quality.

Comparing the results of the study of Kafetzopoulos, Gotzamani, and Gkana (2015) with the present study, it is possible to see a greater effect of quality management practices in innovation performance of enterprises. This can be associated with a greater internalization of quality management in Greek companies compared to the Brazilian, and can make the desire and the acceptance of change at the companies analysed easier. Additionally, the managers of quality, having greater knowledge about the quality management in companies, may observe a greater correspondence between the quality management practices and innovation than employees in lower hierarchical levels.

Another detail this comparison can highlight is the lowest strength of relationship between the innovation process and the competitive advantage in the results of Kafetzopoulos, Gotzamani, and Gkana

(2015), in relation to the one obtained in this study. Considering the innovation process as an aspect of performance closely associated with the improvement of companies quality of the products (Prajogo & Sohal, 2003; Dedy et al., 2016), the results may point to a perception that quality is a criterion qualifier in Greek companies, while in Brazil could be still seen as a criterion to win orders.

7. Conclusion

The objective of this study was to investigate the relationship between quality management practices, innovation and competitive advantage in manufacturing companies certified with ISO 9001 in Brazil, using the model proposed by Kafetzopoulos, Gotzamani, and Gkana (2015). For this reason, a survey was carried out by closed questionnaires sent by e-mail, addressed to companies classified as processing industry (manufacturing), certified with ISO 9001, which are in the database of the site Certifiq of Inmetro.

According to the results, the theoretical model of Kafetzopoulos, Gotzamani, and Gkana (2015), when replicated in the context of companies certified with ISO 9001 in Brazil, presented good adjustment quality of measurement and structural models. However, it was necessary the exclusion of the item VC3, the latent variable "competitive advantage", to meet the criteria of discriminant validity. By statistical evidence, a change in quality management practices causes a similar amendment in both product innovation and process innovation, as well as the product innovation contribute a little more to competitive advantage of the innovation process.

This research contributes to the theory revealing the existence of a positive and significant relationship between quality management practices and innovation in organizations, specifically the product and process innovations. This corroborates the results of most of the jobs about the theme. It also contributes to the production of knowledge specific to Brazil, in addition to be a way to disclose even more this topic of research, aiming to attract more Brazilian researchers to do similar studies. Furthermore, the replication of models contributes to the achievement of broader research as meta-analysis, using the results of empirical studies as its input data to analyse the consistency of results of research or even testing the same hypotheses (Card, 2012).

When a large number of studies presents results in one direction regarding the investigation of causal relations, it is possible to say the evidence of the existence of this type of relationship becomes stronger. In this way, taking as a premise, for example, the quality management practices influence positively on the innovative performance of organizations, as well as assuming that a company more innovative has competitive advantage face its competitors, the greater the number of results pointing in these directions, the larger will be the possibilities of practical implications.

This study was characterized as quantitative, which usually assumes the analysis of a greater volume of data, pursuing results in greater amplitude, as a way to describe or explain what is being investigated. Even so, this type of research has the limitation of not pay attention to specific details about each component of a sample, for example, leaving out important details that can differentiate each element. In this way, to capture these particular characteristics, it is possible to perform qualitative research to assess, with more details, cases of companies adopting quality management practices and how they can influence on innovation and competitive advantage.

The arguments used in this study tried to confirm certain types of quality management practices, together, can influence both types of innovation (product and process), and process may influence the competitive advantage. Even so, it is known that other aspects can affect innovation and competitive advantage that can be inserted in the theoretical model as latent constructs, as the performance in quality of products, aspects of the development process of innovation, other types of innovation, organizational culture, and others.

About the theoretical model used, different arrangements can be carried out based on several arguments found in literature. Among them, the quality management practices would be better represented by more than one dimension, as the closest practices to the prescriptive management tools used by the organizations (hard quality management) and those more associated with human and social factors (soft quality management) (Zeng, Anh Phan, & Matsui, 2015; Zeng et al., 2017). With this, future research could pursue a new configuration for the model, dividing the practice in hard and soft dimensions of quality management, instead of a single construct.

As the context and the composition of the sample to perform the study can influence its results, it is also suggested to perform local studies instead of national studies. In this way, it is possible to find different results to the relations established in the model, also allowing a comparison between regions. About the composition of the sample, future research could explore specific industry sectors (such as only the metallurgical industry or information technology, for example), highlighting their differences to other sectors.

8. Acknowledgement

We are grateful for the financial support from Capes to contract a translation service for scientific articles, related to the term of granting of financial aid AUXPE-CAPES / FAPITEC No. 2079/2017, process no. 88881.159569 / 2017-01, 11/2016 - Program to stimulate increased effectiveness of Postgraduate Programs in Sergipe.

9. References

[1] Barczak, G. (2012). The future of NPD/innovation research. *Journal of Product Innovation Management*, *29*(3), 355–357. https://doi.org/10.1111/j.1540-5885.2012.00907.x

[2] Barney, J. B. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*. https://doi.org/10.1177/014920639101700108

[3] Bon, A. T., & Mustafa, E. M. A. (2014). Impact of total quality management-based people management practices on administrative innovation in service smes. *Middle - East Journal of Scientific Research*, *19*(9), 1162–1168. https://doi.org/10.5829/idosi.mejsr.2014.19.9.11873

[4] Bourke, J., & Roper, S. (2017). Innovation, quality management and learning: Short-term and longer-term effects. *Research Policy*, *46*(8), 1505–1518. https://doi.org/10.1016/j.respol.2017.07.005

[5] Calantone, R.J., Cavusgil, S.T., & Zhao, Y. (2002). Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management*, *31*(6), pp. 515-524.

[6] Card, N. A. (2012). *Applied meta-analysis for Social Science research*. New York: Guilford Press.

[7] Carvalho, M. M. (2012). Histórico da Gestão da Qualidade. In: Carvalho, M. M.; Paladini, E. P. (Coord.) *Gestão da Qualidade*: Teoria e Casos. 2 ed. Rio de Janeiro: Elsevier/ABEPRO.

[8] Constant, E. (1987). The Social Locus of Technological Practice: Community, System or Organisation. In: Bijker, W.; Hughes, T.; Pinch, T. (eds.) *The Social Construction of Technological Systems*: New Directions in the Sociology and History of Technology. Cambridge: MIT Press.

[9] Dedy, A. N., Zakuan, N., Omain, S. Z., Rahim, K. A., Ariff, M. S. M., Sulaiman, Z., & Saman, M. Z. M. (2016). An Analysis of the Impact of Total Quality Management on Employee Performance with mediating role of Process Innovation. In *IOP Conference Series: Materials Science and Engineering* (Vol. 131). https://doi.org/10.1088/1757-899X/131/1/012017

[10] Dervitsiotis, K. (2010). A framework for the assessment of an organization's innovation excellence. *Total Quality Management*, *21*(9), pp. 903-918.

[11] Flynn, B. B. (1994). The Relationship between Quality Management Practices, Infrastructure and Fast Product Innovation. *Benchmarking for Quality Management & Technology*, *1*(1), 48–64. https://doi.org/10.1108/14635779410056886

[12] Gutierrez Gutierrez, L., Tamayo Torres, J., & Garcia Morales, V. J. (2010). An empirical study of current quality management initiatives on the organizational innovation and flexibility. *Revista Espanola De Financiacion Y Contabilidad-Spanish Journal of Finance and Accounting*, *39*(148), 677–709.

[13] Hair Jr. J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2009). *Análise multivariada de dados*. 6 ed. Porto Alegre: Bookman.

[14] Honarpour, A., Jusoh, A., & Md Nor, K. (2017). Total quality management, knowledge management, and innovation: an empirical study in R&D units. *Total Quality Management and Business Excellence*, *29*(7–8), 798–816. https://doi.org/10.1080/14783363.2016.1238760

[15] Instituto Nacional de Metrologia, Qualidade e Tecnologia (Certifiq/Inmetro). Consulta às empresas certificadas. Disponível em: https://certifiq.inmetro.gov.br/Consulta/ConsultaEmpresas. Acesso em: setembro de 2018.

[16] Kafetzopoulos, D., Gotzamani, K., & Gkana, V. (2015). Relationship between quality management, innovation and competitiveness. Evidence from Greek companies. *Journal of Manufacturing Technology Management*, *26*(8), 1177–1200. https://doi.org/10.1108/JMTM-02-2015-0007

[17] Kim, D.-Y., Kumar, V., & Kumar, U. (2012). Relationship between quality management practices and

innovation. *Journal of Operations Management*, *30*(4), 295–315. https://doi.org/10.1016/j.jom.2012.02.003

[18] Mangiarotti, G., & Riillo, C. A. F. (2014). Standards and innovation in manufacturing and services: the case of ISO 9000. *International Journal of Quality & Reliability Management*, *31*(4), pp. 435-454.

[19] Martínez-Costa, M., & Martínez-Lorente, A. R. (2008). Does quality management foster or hinder innovation? An empirical study of Spanish companies. *Total Quality Management and Business Excellence*, *19*(3), 209–221. https://doi.org/10.1080/14783360701600639

[20] Martínez Lorente, A. R., Dewhurst, F., & Dale, B. G. (1999). TQM and business innovation. *European Journal of Innovation Management*, *2*(1), 12–19. https://doi.org/10.1108/14601069910248847

[21] Neyestani, B. (2017). Seven Basic Tools of Quality Control : The Appropriate Techniques for Solving Quality Problems in the Organizations Seven Basic Tools of Quality Control : The Appropriate Techniques for Solving Quality Problems in the Organizations, (March), 0–10. https://doi.org/10.5281/zenodo.400832

[22] OCDE. (2004). *Manual de Oslo*: diretrizes para a coleta e interpretação de dados sobre inovação. 3 ed. OCDE/Eurostat/FINEP.

[23] Oliveira, A. S., Gandia, R. M., Silva, D., & Vilas Boas, L. H. B. (2016). Modelando a percepção do consumidor de café em cápsula com base na cadeias meios-fim. In: SEMINÁRIOS EM ADMINISTRAÇÃO FEA/USP – SEMEAD XIX, 19, 2016, São Paulo. *Anais...* São Paulo: FEA/USP.

[24] Ooi, K.-B., Lin, B., Teh, P.-L., & Chong, A. Y.-L. (2012). Does TQM support innovation performance in Malaysia's manufacturing industry? *Journal of Business Economics and Management*, *13*(2), 366–393. https://doi.org/10.3846/16111699.2011.620155

[25] Perdomo-Ortiz, J., González-Benito, J., & Galende, J. (2006). Total quality management as a forerunner of business innovation capability. *Technovation*, *26*(10), 1170–1185. https://doi.org/10.1016/j.technovation.2005.09.008

[26] Porter, M. E. (1985). Competitive Advantage - Creating and Sustaining Superior Performance. *New York: FreePress*. https://doi.org/10.1182/blood-2005-11-4354

[27] Prajogo, D. I., & Sohal, A. S. (2003).The relationship between TQM practices, quality performance, and innovation performance: An empirical examination. *International Journal of Quality & Reliability Management*, *20*(8), pp. 901 – 918.

[28] Psomas, E., Fotopoulos, C. and Kafetzopoulos, D. (2011). Core process management practices, quality tools and quality improvement. *Business Process Management Journal*, *17*(3), pp. 437-460.

[29] Ringle, C. M., Silva, D., & Bido, D. (2014). Modelagem de equações estruturais com utilização do SmartPLS. *Revista Brasileira de Marketing*, edição especial, *13*(2).

[30] Ross, J. E. (1999). *Total Quality Management*: text, cases and readings. 3 ed. Boca Raton: CRC Press.

[31] Saraph, J. B., Benson, P. G., & Schroeder, R. G. (1989). An instrument for measuring the critical factors of quality management. *Decision Sciences*, *20*(4), pp. 810-829.

[32] Saviotti, P. P., & Metcalfe, J. S. (1984). A Theoretical Approach to the Construction of Technological Output Indicators. *Research Policy*, *13*, pp. 141-151.

[33] Segarra-Ciprés, M., Escrig-Tena, A. B., & García-Juan, B. (2017). The link between quality management and innovation performance: a content analysis of survey-based research. *Total Quality Management & Business Excellence*, *3363*(November), 1–22. https://doi.org/10.1080/14783363.2017.1401460

[34] Singh, M., Khan, I. A., & Grover, S. (2012). Tools and Techniques for Quality Management in Manufacturing Industries. *Proceedings of National Conference on Trends and Advances in Mechanical Engineering, YMCA University of Science & TEchnology, Faridabad, Haryana, Oct 19-20, 2012*, (1995), 853–859.

[35] Tether, B. S. (2003). What is innovation? : approaches to distinguishing new products and processes for existing products and processes. *CRIC Working Paper ; No. 12*, 41.

[36] Trivellas, P., & Santouridis, I. (2009). TQM and innovation performance in manufacturing SMEs: The mediating effect of job satisfaction. In *IEEM 2009 - IEEE International Conference on Industrial Engineering and Engineering Management* (pp. 458–462). https://doi.org/10.1109/IEEM.2009.5373306

[37] Volberda, H., Frans, A.J., Van Den Bosch, F.A.J., & Heij, C. (2013). Management innovation: management as fertile ground for innovation. *European Management Review*, *10*(1), pp. 1-15.

[38] West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy*, *43*(5), 805–811. https://doi.org/10.1016/j.respol.2014.03.001

[39] Wetzels, M., Odekerken-Schröder, G., & Oppen, C.V. (2009) Using PLS path modeling for assessing hierarchical construct models: guidelines and empirical illustration. MIS Quarterly, *33*(1), 177-195.

[40] Zeng, J., Anh Phan, C., & Matsui, Y. (2015). The impact of hard and soft quality management on quality and innovation performance: An empirical study. *International Journal of Production Economics*, *162*, 216–226. https://doi.org/10.1016/j.ijpe.2014.07.006

[41] Zeng, J., Zhang, W., Matsui, Y., & Zhao, X. (2017). The impact of organizational context on hard and soft quality management and innovation performance. *International Journal of Production Economics*, *185*, 240–251. https://doi.org/10.1016/j.ijpe.2016.12.031