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Innovation and Quality: impacts of innovation outputs on TQM principles adopted[1]

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Abstract

Innovation and total quality management (TQM) are regarded as key competitive factors and the impact of TQM on innovation has been studied by several authors. Many of them suggest that the impact of TQM on innovation depends both on the TQM dimensions considered and on the type of innovation. The existence of common elements to TQM and innovation raises the idea that the organization's commitment to innovation can have some impact on the establishment and development of TQM. In this context, it becomes relevant to investigate whether or not the systematic and sustained development of innovative activities fosters the adoption and implementation of TQM principles. The main objective of this paper is to explore the impact of innovation`s outputs on TQM. The conceptual model proposed considers 6 innovation`s outputs (research, development and technological innovation; product innovation; process innovation; organizational innovation; management innovation; marketing innovation) as factors that can have impact on 8 TQM`s variables (leadership; customer focus; involvement and development of people; management by processes; continuous improvement; relations with suppliers; measuring results; product design). This study is based on empirical data collected through a questionnaire answered by 218 ISO 9001:2008 certified organizations. Findings suggest that different innovation types have dissimilar impacts on TQM dimensions.

Keywords: innovation; quality; TQM.

1 Introduction

The importance of total quality management (TQM) as a determinant factor in the innovative performance of the organizations has been addressed in the research studies of many authors (Prajogo and Sohal, 2001, 2003, 2004 a,b; Sá and Abrunhosa, 2007; Abrunhosa and Sá, 2008; Martínez-Costa and Martínez-Lorente, 2008; Prajogo and Hong, 2008; Perdomo-Ortiz et al., 2009 a,b). Different elements of the TQM will, however, have different impacts on innovation. The influence of TQM in innovation depends on the TQM principles, as well as on the type of innovation (Perdomo-Ortiz et al., 2009 a,b; Prajogo and Sohal, 2001, 2004 a,b). The existence of common key elements of innovation and TQM, suggested by Prajogo and Sohal (2003, 2004 a,b), raises the idea that emphasis on innovation may translate the organization's TQM interest. This study is focused within this context and the following research question can be identified: What type of impact does each innovation output have on the adoption of TQM principles?

The main objective of this paper is to study the impact of innovation outputs in the adoption of TQM principles. Data was collected through a questionnaire answered by 218 ISO 9001:2008 certified organizations.

Besides this first introductory section, the paper is composed by four chapters. In chapter 2 there is a brief literature review, where a reflection concerning the impact of innovation in the TQM is made and where a conceptual model is proposed. Chapter 3 presents the methodological approach of this study. Chapter 4 contemplates data analysis, results and discussion. Chapter 5 presents conclusions and future work.

2 Literature Review

The literature review shows that innovation has a substantial impact on the organizational performance, but there are many research gaps. This study contemplates the Oslo Manual (OECD, 2005) that typifies innovation in 4 different ways: product innovation; process innovation; marketing innovation; organizational innovation.

Alongside, TQM is considered a management philosophy that contemplates the application and integration of 8 quality management principles within the organization (Dale et al., 2009). It refers to a management approach that aims towards organizational excellence (Han et al., 2007) having in consideration all the interactions between the elements of the organization and focusing on efficiency improvement and the capacity to attend customer needs (Fernandes et al., 2010).

Next, several theoretical bases which support the hypotheses are presented. Although the literature review presents a substantial of innovation on TQM, there are evidences showing that the impact of a certain type of innovation in the quality management principles is far from being answered.

2.1 Innovation as a determinant of TQM

Innovation and quality are basic elements to the functioning of organizations and simultaneously focusing on both dimensions can be an enormous advantage for both. Quality can stimulate the innovation in the sense that it supplies adequate tools that become more efficient and guided towards customer satisfaction. Innovation is assumed as a vital process of success and organization improvement, there is no point in facing quality without an important part of innovation (Saraiva and Orey, 1999). The continuous improvement, the participation in the decision process, the support of top management, team work and "the open" culture of the organization, are common components of innovation and TQM (Prajogo and Sohal, 2003, 2004 a,b). Organizations focus on the systematic and sustainable development of innovative activities which can promote the adoption of TQM principles that have been efficient in the reply of organizations to the great and permanent challenge called innovation.

It is known that the performance of organizations is associated to its innovative capacity. Innovative organizations can be twice more cost effective than non innovative organizations (Akgun et al., 2007; Gilmore, 2009). Mossey et al. (2002) point out two conditions organizations should necessarily consider, without which, focus on innovation may become totally efficient: efficient communication to all the organization of decision taking; development of long run strategic plans. These two aspects suggest that focusing on innovation implies the involvement of top management as a driving and dynamic factor of the innovation process.

The capacity of the organization to access certain markets and attract customers can be strengthened by innovation. Discovering new ways to execute tasks makes collaborators more productive and involved in their activities (Lafley and Charan, 2008) and, innovative companies when compared to less innovative companies, show greater rates of productivity (Rogers, 1998). This suggests that the results of innovation will be able to exert some impact on management practices of the organization which lead to the possibility that focusing on innovation can stimulate TQM. In accordance to Lafley and Charan (2008), although the development of products is the most common type of innovation, there are other typologies that can show great importance for the organization: innovation in process organization; innovation in logistic activities; marketing innovation; innovation of the business model. Due to the multidimensional nature of innovation, it is important to think about the concepts associated to innovation outputs and the concepts associated to TQM.

Satish e Srinivasan (2010) measured the innovative activity of the organization through 5 concepts: R&D and technological innovation; product innovation; process innovation; organizational innovation; management innovation. This study, additionally considers marketing innovation (OECD, 2005). "Innovation outputs" are seen as demonstrations of innovative activities, carried out by the organizations, in the context of the innovation typologies proposed in the Oslo Manual (OECD, 2005). A summary description of the 6 concepts is presented in table 1.

Table 1: Concepts associated to the Innovation outputs

Research and development (R&D) and technological innovation	Associated to the creation and existence of an inquiry department and technological development
Product Innovation	Associated to the introduction of a new service or good or which hás been significantly improved
Process Innovation	Associated to the implementation of a new or significantly improved production method or product delivery
Organizational Innovation	Associated to the implementation of a new organizational method
Management Innovation	Associated to the implementation of a new management method
Marketing Innovation	Associated to the implementation of a new marketing method

Han et al. (2007), Pine (2007), Hung et al. (2010) and Satish and Srinivasan (2009, 2010) associate TQM to several concepts that incorporate the principles of quality management identified by norm ISO 9000. Of those concepts used by the authors and associated to TQM, 8 are considered in this study and summarily described in table 2.

Table 2: Concepts associates to TQM

Leadership	Associated to the commitment of top management with the culture of management through quality
Customer Focus	Associated to the way the organization determines the requirements, the needs, the expectations and the preferences of the customers
Involvement and Development of the People	Associated to the way the organization involves its collaborators and it foments its participation and persistence in the activities of the organization
Process Management	Associated to the way the organization identifies, generates and develops its processes
Continuous Improvement	Associated to the revision of the organization processes having as main aim their continuous improvement
Suppliers Relationship	Associated to the way the organization relates with its suppliers
Result Analysis	Associated to the way the organization selects, collects and analyses given data related to quality management
Product Design	Associated to the use of tools and quality techniques in the conception and development of products

2.2 Research hypotheses and proposal of the conceptual model

Robinson and Stubberud (2011) carried out a survey concerning the effect of innovation in 3233 Norwegian companies showing 9 important effects: Increased range of goods and services; Improved quality in goods or services; Entered new markets or increased market share; Improved flexibility of production or service provision; Met regulation requirements; Increased capacity of production or service provision; Reduced labor costs per unit output; Reduced environmental impacts or improved health and safety; Reduced materials and energy per unit output. These effects of innovation can be easily incorporated in the effects companies want to reach with the TQM philosophy and suggest TQM as an organization's answer to the innovation focus.

The existence of an R&D department is very expensive for the organizations, in the sense that minimum resources are required and sometimes these organizations do not have them (Ramer et al., 2009). Financing these activities becomes particularly difficult due to the high risk associated to innovation activities. Due to these new limitations, organizations are not involved in research activities and development of new technologies, they do, however, invest in activities that are less expensive. They all place great emphasis in the management processes of innovation, exploring its innovative potential through the use of suitable management techniques where, for example, the use of external knowledge is included. In a study developed with Australian companies Gilmore (2009), showed that the external

contribution provides an increase of 70% of the innovation level. The constraints associated to research activities, development and technological innovation can stimulate the TQM approach that supports the organization in overcoming obstacles and achieving goals. Based on what was said above, the first hypothesis of this study is formulated:

H1: Focusing on innovation, at R&D and Technological Innovation level has impact in the adoption of TQM principles by the organization.

The installed competition world-wide compels to the development of new or significantly improved products. Quality techniques such as the Failure Mode and Effects Analysis (FMEA), the QFD – Quality Function Development, the Design of Experiences, the Taguchi methods, can be decisive in achieving innovative products. On the other hand, basic quality tools and Brainstorming can stimulate the creativity of the team and contribute towards product innovation. The application of Benchmarking techniques can play an excellent role in product innovation when allowing the comparison with better practices inside or outside the organization. The second hypothesis of this study is formulated by the above:

H2: Focusing on innovation, at the level of Product Innovation, has an impact on the adoption of TQM principles by the organization.

The introduction of new or significantly improved processes can basically create two types of effect: reduction of the unitary cost of production and increase of the productive quality process (Lafley and Charan, 2008). Managing a process implies the establishment of boundaries, attributing responsibilities and establishing performance indicators. Process innovation thus seems to foment management practices at the level of people's involvement, continuous improvement, processes management and customer focus. Face to the displayed, the third hypothesis of this study is formulated by the above:

H3: Focusing on innovation, at the level of Process Innovation, has impact on the adoption of TQM principles by the organization.

Innovation management encloses a wide set of tools and techniques and comprises all the activities related to the innovation process of the organization. The aim is to maximize the results and it includes enabling measures at the level of the internal processes and connections with the exterior (Ramer et al., 2009). Internally, the cooperation between departments can be improved and strengthened and methodologies that foment the creation of new ideas can be created. Externally, the existence of relations with customers, suppliers and organizations in general, is very important in identifying innovation inputs and sharing of knowledge, where the notion of open innovation (Chesbrough, 2003) has directed the attention of the organizations for connections with the exterior. Ramer et al. (2009) consider 4 areas of management innovation through which the organizations can improve their innovative performance: Human resource management - the increase of incentives can promote the participation in innovative activities; Team work - sharing knowledge and mutual trust can benefit innovation; Searching for external sources – identification of innovation inputs from customers, suppliers, competitors, university and other organizations; Co-operation - creation of partnerships and external sources of knowledge that allow the sharing of costs and risks associated to innovative activities. The fourth hypothesis of this study is formulated by the above:

H4: Focusing on innovation, at the level of Organizational Innovation, has impact on the adoption of TQM principles by the organization.

Besides the introduction of new organizational methods, the organization can implement new methods of management (administrative computerization; motivation systems; new departments) or introduce new systems of knowledge management. Similarly to what happens at the level of the organizational management, the fifth research hypothesis is suggested:

H5: Focusing on innovation, at the level of Management Innovation, has an impact on the adoption of TQM principles by the organization.

An example of marketing innovation is the increasing use of the Internet for expansion of marketing channels. This innovative aspect can facilitate the management of the organization focusing on TQM

philosophy where certain aspects such as customer focus, continuous improvement and mutually beneficial relations with suppliers seem to become strengthened. The sixth research hypothesis is thus suggested:

H6: Focusing on innovation, at the level of Marketing Innovation, has an impact on the adoption of TQM principles by the organization.

In figure 1 is presented the proposed conceptual model is which aims at evaluating the eventual facilitating or inhibiting effect that each concept associated to innovation outputs may have in the concepts associated to TQM.

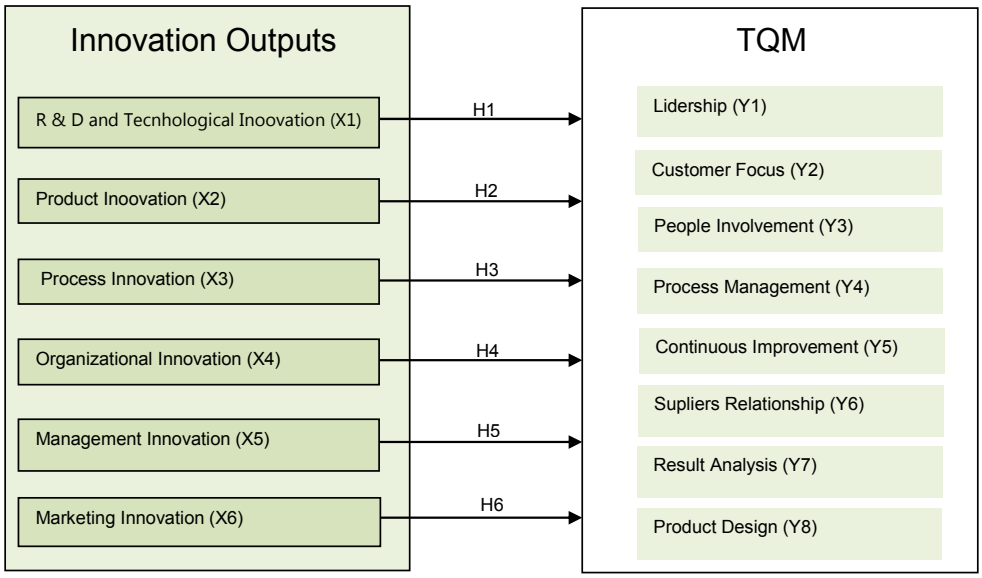

Figure 1: Proposed conceptual model

3 Methodology

3.1 Sample and data gathering

The study was developed from the information collected at 218 certified organizations. Certified organizations were considered to guarantee some organizational knowledge and interest on quality management as well as familiarity with the concepts used in the questionnaire sent to the organizations (Curry and Kadasah, 2002). The sample was constituted by organizations from several activity sectors and the invitation for participation in the research was made through an email sent to the general email address of organizations. In the body of the email there was a link to access an electronic questionnaire which was a basic instrument of information gathering. This methodological approach allows top management of the organization to answer the questionnaire and guaranties that there was internal validity in the study, in the sense that it allows an extensive knowledge of TQM and innovation in the entire organization (Taylor and Wright, 2003).

With the questionnaire it was possible to collect information concerning the perception of top management in each organization in what refers to different aspects related to adoption of TQM principles and innovation. Since it is a Likert type questionnaire, the respondent selected, for each item/indicator, his level of agreement with a statement, among 10 possible alternatives (of 1 – In total disagreement to 10 – In total agreement). The questionnaire was submitted to some top managers for a pre-test. This procedure allowed some improvements related to interpretation of statements.

3.2 Operationalization and validation of variavels

The literature review focuses on the possibility that innovation outputs have an important role in the adoption of TQM. In such a way that it explores the impact innovation outputs might have in the adoption

of TQM. As it was presented, previously in Figure 1, th 6 innovation outputs are represented through the independent variables (variables X1 to X6) and the 8 concepts associated to TQM represented through the dependent variables (variables Y1 to Y8).

The variables were submitted to reliability and validity tests. The reliability was measured through the Cronbach alpha, obtained with SPSS software. The lowest value obtained was 0.767, greater than the minimum value of reference, 0.70 (Hair et al., 2006), therefore considering it a reliable measuring instrument.

The validity makes it possible to measure whether the set of items/indicators represent, with precision, the associated variable (Hair et al., 2006). Some authors (González-Alvarez and Nieto-Antolín, 2007; Abrunhosa and Sá, 2008) recommend an analysis of the main factors in order to find out if the factors and the respective items/indicators are in compliance with the literature review and the assumptions considered in the elaboration of the questionnaire. The fulfilment of the reference value (minimum of 0.500) regarding the Kaiser-Meyer-Olkin test (KMO) (Hair et al., 2006) made it possible to consider factor analysis adequate for data treatment. Based on the factor analysis one concludes that only a factor should be considered for a set of items/indicators associated with each variable. In all cases, the Eigenvalue value (total variance explained by factor) obtained was superior to 1 (Hair et al., 2006). Additionally all the extracted factors represented more than 66% of the variance, this value was, in many cases, superior to 80%. The variance explained from the extracted factors must be at least equal to 60% (Hair et al., 2006). According to what has been presented, variables can be considered unidimensional. In what refers to factorial loadings, with exception to an indicator regarding the variable Involvement and Development of People, removed in the first iteration, all items/indicators were considered relevant for the respective factors, in the sense that they fulfil the reference value (higher than 0.70), suggested by Hair et al. (2006).

4 Analysis of data and discussion of results

4.1 Multiple linear regression in data analysis

In the multiple linear regression it is assumed that there is a linear relationship between a variable Y (the dependent variable) and at least one of k-1 independent variable. It is an adequate method of analysis when the objective is to determine the impact of two or more independent variables in a dependent variable (Hair et al., 2006). In the sense of determining the impact of 6 variables associated to innovation outputs in the 8 TQM variables, 8 multiple linear regression models were created in accordance to the following equation 1:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon \qquad (1)$$

However, before performing the regression analysis and obtaining the models it is necessary to verify the fulfillment of the assumptions. The first assumption is related with the independence of the observations which was guaranteed by the fact that the sample was comprised of 218 questionnaires and answered by 218 different organizations. The second assumption refers to the homoscedasticity of the residuals. The residuals must have a homogeneous variance around an average null value, where its value should remain constant in every range of observation. This assumption was verified through the observation of residual graphs, where, for the 8 models, a constant variance of residues was verified and therefore its homoscedasticity (Hair et al., 2006). The third assumption refers to the normal distribution of residuals. The observation of the normal probability plot made it possible to conclude, for the 8 models, that errors are normally distributed, in the sense that the values fall along the diagonal line without substantial or systematic deviations, indicating a normal error distribution (Hair et al., 2006). The fourth assumption is related to the existence of multicollinearity, which was evaluated through the Tolerance and of Variance Inflation Factor (VIF). Tolerance measures the amount of variance that is not explained by other independent variables. If others variables explain large part of the variance of a particular independent variable is a sign that there is multicollinearity. The reference value for tolerance is typically 0.10, where values inferior to 0.10 indicate multicollinearity problems. The VIF is the inverse of tolerance and has a

maximum acceptable value of 0.10 (Hair et al., 2006). The observed VIF values for independent variables are between the minimum value of 1.524 and maximum of 3.410, confirming the absence of multicollinearity.

Multiple linear regression analysis was performed through SPSS software using the stepwise method. Analysis estimates for the 8 regression models can be found in table 3.

Table 3: Estimates of the linear regression

Model	R	R^2	R^2 adjusted	Anova sig.
1	0.547	0.299	0.292	0.000
2	0.493	0.243	0.236	0.000
3	0.544	0.296	0.283	0.000
4	0.517	0.267	0.253	0.000
5	0.592	0.350	0.341	0.000
6	0.374	0.140	0.132	0.000
7	0.427	0.182	0.171	0.000
8	0.492	0.242	0.232	0.000

From the values of R^2adjusted, one concludes that the 8 models have reasonable adjustment to the data. Based on the values of ANOVA sig. it is possible to reject hypothesis, H0: β=0, for all models. Therefore it safe to state that there is a linear relationship between the dependent variable and, at least, one of the independent variables.

4.2 Discussion and Results

The coefficients of the 8 linear regression models and respective levels of significance are presented in Table 4. Only H3 is not sustained by the data. It was not statistically proved that focusing on innovation, at the level of new or significantly improved processes, has an impact on the adoption of TQM principles. Lafley and Charan (2008) suggest the reduction of the unitary cost of production and the increase of quality in the productive process are the two main effects of the innovation process. The results of this study are, partially, in accordance with this perspective, and support the idea that process innovation does not have an impact on the management philosophy of the organization. The H1, H2, H4, H5 and H6 are supported by the empirical data making it possible to state that R&D and technological innovation, product innovation, organizational innovation, management innovation and marketing innovation have significant impact on the adoption of TQM. These results are generically in accordance with the literature review. It is however, important to refer that similarly to what happens with the impact of TQM principles in innovation activities (Perdomo-Ortiz et al., 2009 b; Prajogo and Sohal, 2001, 2004 a,b), the impact of each innovation output in TQM depends on the variable of the considered TQM.

Table 4: Estimates of the multiple linear regression models

Model	Dependent Variable	Independent Variables	B Standard	Sig.
1	Leadership (Y1)	Organizational Innovation (X4)	0.348	0.000
		Management Innovation(X5)	0.252	0.001
2	Customer Focus (Y2)	Product Innovation (X2)	0.311	0.000
		Organizational Innovation (X4)	0.256	0.000
3	People Involvement (Y3)	R& D and Technological Innovation (X1)	-0.143	0.046
		Product Innovation (X2)	0.260	0.000
		Organizational Innovation (X4)	0.256	0.003
		Management Innovation(X5)	0.233	0.002
4	Process Management (Y4)	R& D and Technological Innovation (X1)	-0.177	0.016
		Product Innovation (X2)	0.314	0.000

		Organizational Innovation (X4)	0.275	0.002
		Management Innovation(X5)	0.138	0.076
5	Continuous Improvement (Y5)	Product Innovation (X2)	0.272	0.000
		Organizational Innovation (X4)	0.199	0.012
		Management Innovation(X5)	0.258	0.000
6	Suppliers Relationships (Y6)	Product Innovation (X2)	0.137	0.063
		Organizational Innovation (X4)	0.286	0.000
7	Results Analysis (Y7)	Product Innovation (X2)	0.185	0.011
		Organizational Innovation (X4)	0.157	0.078
		Management Innovation(X5)	0.184	0.025
8	Product Design (Y8)	Product Innovation (X2)	0.312	0.000
		Organizational Innovation (X4)	0.151	0.054
		Marketing Innovation (X6)	0.133	0.075

Table 5 symbolically presents, the positive (+) or negative (-) impact, of each innovation output in each TQM variable.

Table 5: impacts of innovation outputs in TQM variables

		GQT							
		Leadership	Customer Focus	People Involvement	Process Management	Continuous Improvement	Suppliers Relationships	Results Analysis	Product Design
Innovation Outputs	R & D and Technological Innovation			-	-				
	Product Innovation		+	+	+	+	+	+	+
	Organizational Innovation	+	+	+	+	+	+	+	+
	Management Innovation	+		+	+	+		+	
	Marketing Innovation								+

From analyzing table 5 we can verify a negative impact of R&D and technological innovation regarding the involvement and development of people in the management process. Positive results regarding the innovative activity seem to contribute to some disinvestment at the level of involvement and development of people and the process approach. This result is, in a way, in accordance with the literature since the organization managed to overcome the constraints associated to R&D activities, technological innovation and it does not feel so obliged to seek alternative ways of innovation. Thus, some lack of interest in adopting of TQM principles may be verified. The results support the initial idea that improving performance, at the level of product innovation, organizational innovation and management innovation, will promote the adoption of TQM principles. The results show that innovation outputs of marketing innovation promote the adoption of methodologies related to product design; suggesting that focusing on the organization, at the level of innovation in packing products, in communication techniques with the customer, in distribution methodologies and price policies, will have an impact on the level of product

design activities, such as the periodic revision of its characteristics considering the demands of clients and suppliers.

5 Conclusion and proposal of future work

The obtained results support the general literature suggestions. The most important difference of this study, when compared with other studies identified in the literature reviewed, is the simultaneous inclusion of innovation outputs along with TQM principles, assuming an integrative perspective either of the various demonstrations of innovative activities or the aspects of TQM. To the exception of the innovation process, all the other innovation outputs, considered in this research, have a positive impact in the adoption of TQM principles. In academic terms, this study represents an important contribution by bringing together innovation and TQM, more specifically by analyzing the impact of innovation outputs on the adoption of TQM principles. The purpose was to expand a little more the knowledge on these areas of the economic and social sciences and actively contribute to their development. On the other hand, in practical terms, by analyzing the impact of innovation outputs on the adoption of TQM principles, we seek to obtain information and knowledge useful for the organizations surveyed. As a result they may achieve profitable increases in organizational performance, with obvious benefits not only internally, at all levels, but also externally to all persons and institutions that relate to these organizations. The research presents some limitations. The empirical data refer to organizations of different activity sectors and for which, the generalization of the obtained results may not apply to certain activity sectors. Data gathering considers the perception of top managers that may not correspond completely to the feeling of the entire organization. Regarding future research, it could be interesting to divide the sample in different groups and analyze eventual impact differences in innovation outputs when adopting TQM principles. Dividing the sample could be made, for example, in accordance with the activity sector or with the dimension of the organization. Because there is a possibility of each innovation output being able to influence and be influenced by others outputs, and the same happens with variables associated to TQM, an evaluation of the cross impacts among variables associated with outputs of the innovation and variables associated with TQM is suggested.

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