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SUBJECT AREA: ORGANIZATIONAL STRATEGY AND BEHAVIOR

# Influence of Quality Management on the Innovative Performance

*Influência da Gestão da Qualidade no Desempenho Inovador*

*Influencia de la gestión de la calidad en el desempeño innovador*

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## ABSTRACT

The relationship between total quality management (TQM) and innovation has been studied in several investigations. However, there is some disagreement among the researchers. Many authors suggest that the impact of TQM on innovation depends both on the TQM dimensions considered and on the type of innovation. This paper aims at identifying elements of TQM as determinants of innovation *outputs* of organizations. The conceptual model proposed considers 8 TQM variables (leadership; customer focus; involvement and development of people; management by processes; continuous improvement; relations with suppliers; measuring results; product design) as factors that can have impact on 6

innovation *outputs* (research, development and technological innovation; product innovation; process innovation; organizational innovation; management innovation; marketing innovation). This study is based on empirical data collected through a questionnaire answered by 218 ISO 9001:2008 certified organizations. Generally, it is possible to conclude that the adoption of TQM principles plays a key role in innovation activities. The investigation has interesting practical implications practice. Therefore, the adoption of certain organizational principles can encourage the development of innovation.

**Key words:** Quality. Total quality management. Innovation performance.

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## RESUMO

Embora muitos trabalhos de investigação tenham estudado a relação entre a gestão pela qualidade total (GQT) e a inovação, as conclusões não são totalmente concordantes mantendo-se alguma controvérsia. Muitos autores sugerem que o impacto da GQT na inovação depende tanto das dimensões da GQT consideradas como do tipo de inovação. Este artigo visa identificar elementos da GQT como fatores determinantes do desempenho inovador das organizações. O modelo conceptual proposto considera 8 princípios da GQT (liderança; focalização no cliente; envolvimento e desenvolvimento de pessoas; gestão por processos; melhoria contínua; relações com fornecedores; resultados de medição; design de produtos) como fatores determinantes no desempenho inovador das organizações, medido através de 6 variáveis (I & D e inovação tecnológica; inovação do produto; inovação do processo; inovação organizacional; inovação na gestão; inovação de marketing). Foram usados dados recolhidos através de um questionário totalmente desenvolvido no âmbito deste trabalho e respondido por 218 organizações certificadas de acordo com a norma ISO 9001:2008. Para determinar o impacto da GQT no desempenho inovador da organização, foram construídos modelos de regressão linear múltipla. Concluiu-se com o estudo que a prática de revisão contínua dos processos da organização fomenta o desempenho inovador em formas de manifestação das atividades inovadoras realizadas pelas organizações. A investigação revela-se importante em termos práticos. A adoção de determinados princípios organizacionais pode encorajar o desenvolvimento de inovação.

**Palavras-chave:** Qualidade. Gestão pela qualidade total. Desempenho inovador.

## RESUMEN

Aunque muchas investigaciones han estudiado la relación entre gestión de calidad total (GCT) e innovación, las conclusiones no son plenamente concordantes manteniéndose cierta controversia. Muchos autores sugieren que el impacto de

la GCT en la innovación depende de las dimensiones de la GCT consideradas, bien como del tipo de innovación. Este artículo tiene como objetivo identificar los elementos fundamentales de la GCT como factores determinantes para el desempeño innovador de las organizaciones. El modelo conceptual propuesto considera ocho principios de la GCT (liderazgo, orientación al cliente, participación y desarrollo de las personas, gestión de procesos, mejora continua, relaciones con los proveedores, resultados de la medición, diseño de productos) como factores sustanciales para determinar el desempeño innovador de las organizaciones, medido por seis variables (I + D e innovación tecnológica, innovación del producto, innovación del proceso, innovación organizacional, gestión de la innovación, innovación de marketing). Hemos utilizado los datos recogidos a través de un cuestionario original, completamente elaborado en el ámbito del presente trabajo y al cual respondieron 218 organizaciones certificadas según la norma ISO 9001:2008. Los resultados cimientan las indicaciones de la literatura mostrando que los diferentes principios de GCT tienen también diferente impacto en el desempeño innovador. La investigación resulta importante en términos prácticos al mostrar que la adopción de ciertos principios de organización puede fomentar el desarrollo de la innovación.

**Palabras clave:** Calidad. Gestión de la calidad total. Desempeño innovador.

## I INTRODUCTION

The current context of social, political, economic and technological changes has led organizations to face the ongoing challenge of adapting to a global market characterized, among other aspects, by a growing consumer demand. Faced with this challenge, organizations have developed competitive strategies where Innovation and Total Quality Management (TQM) play an important role. Innovation is considered an important factor of economic competitiveness

(POHLMANN, 2005) and its concept is associated with the organization's tendency to, sooner than competing organizations, support new ideas and creative processes, implement changes and seize new opportunities (COVIN; MILES, 1999).

The increase of risk and uncertainty (LIAO; CHANG; WU, 2010), market changes, short life cycle of products (HUNG, 2007) and organizational attitude of customer orientation (TALIB; RAHMAN, 2010) are decisive factors of organizations' bet on TQM in response to customer requirements (HAN; CHEN; EBRAHIMPOUR, 2007) and gaining competitive advantage (PRAJOGO; SOHAL, 2001; SATISH; SRINIVASAN, 2010). The main concern of TQM is to respond to the needs and expectations of customers, integrating all functions and processes of the organization in order to reach a continuous improvement of the quality of goods and services (FUENTES; MONTES; FERNANDEZ, 2006; HAN; CHEN; EBRAHIMPOUR, 2007; LENKA; SUAR, 2008). It is a strategy based on global engagement of all employees that are encouraged to be more flexible, interactive and participatory in organizational activities (FERNANDES; LOURENÇO; SILVA, 2011).

Although the relationship between the adoption of TQM principles and the innovation is studied in several research papers, there are no consistent results on the influence of TQM in organization's innovative activities. While for some researchers (ZAIRI, 1994; PRAJOGO; SOHAL, 2003, 2004a, 2004b; ABRUNHOSA; SÁ, 2008; VIJANDE; GONZÁLEZ, 2008; PRAJOGO; HONG, 2008) certain principles of TQM drive innovation activities, for others (SINGH; SMITH, 2004; PINHO, 2008) the adoption of such principles may limit sustained and systematic development of innovation. An investigation that clarifies the impact of TQM variables in innovation performance may provide some contribution in this field of research. According to Camisón and Villar-Lopez (2014), it is relevant to study the innovation performance of companies. After briefly framing the justification

and importance of the subject, the central question of research may be pointed out: What is the impact that each of the TQM variables has on each of the variables associated to innovation performance of organizations?

This research aims to study the possible impact of TQM dimension variables in the variables of innovation performance. Empirical data collected from 218 certified Portuguese organizations according to ISO 9001:2008 are used.

Besides this first introductory section, the chapter consists of four other sections. In the second section, a brief review of the literature on the impact of the adoption of TQM in innovation is presented, and a conceptual model of causal relations among variables associated with TQM and innovative performance of the organization is proposed. In the third section, the methodology used in the research is presented. In the fourth section, the data are analyzed and the results are discussed. In the last section, research findings and proposals for future works are presented.

## 2 LITERATURE REVIEW

The literature review presented in this section supports the formulation of a set of assumptions about the impact of TQM in innovative performance of organizations. The Oslo Handbook (OECD, 2005) typifies innovation in four different ways: product innovation, process innovation, marketing innovation and organizational innovation. In the work of Satish and Srinivasan (2010), the authors considered five concepts associated with innovation performance of organizations: R&D and technological innovation, product innovation, process innovation, organizational innovation and management innovation. The innovation performance of organizations is, in this study, associated to six concepts that represent various forms of presentation of innovative activities carried out by organizations: R&D and technological innovation, product innovation, process innovation, organizational innovation,

management innovation and marketing innovation.

TQM is a management philosophy which includes the application and integration of eight quality management principles throughout the organization (EVANS, WILLIAM, 2004; DALE; WIELE; IWAARDEN, 2007), which takes into account all the interactions among the various elements of the organization that focus on improving the efficiency and responsiveness of response to customer needs (FERNANDES; FELGUEIRA; LOURENÇO, 2010). In this work, eight TQM principles are considered.

### 2.1 TQM determining innovation

several studies have examined to which extent organizations implementing TQM principles tend to be more innovative (ZAIRI, 1994; PRAJOGO; SOHAL, 2001, 2003, 2004a, 2004b, 2006a, 2006b; SINGH; SMITH 2004; HOANG; IGEL; LAOSIRIHONGTHONG, 2006; PINHO, 2008; ABRUNHOSA; SÁ, 2008; PRAJOGO; HONG, 2008, VIJANDE; GONZÁLEZ, 2008; PERDOMO-ORTIZ, GONZÁLEZ-BENITO, GALENDE, 2009a, 2009b; FERNANDES; FELGUEIRA; LOURENÇO, 2010; FERNANDES; LOURENÇO, 2011). Differences in the results presented by researchers show the existence of two schools of thought with different views on the relationship between TQM and innovation (PRAJOGO; SOHAL, 2003; MUSHTAQ; PENG; LIN, 2011).

The positive school of thought suggests that the implementation of TQM principles creates an organizational culture favorable to the development of innovation activities (ZAIRI, 1994) and claims that the TQM principles are similar to the principles of innovation (PRAJOGO; SOHAL, 2003 2004a, 2004b). Ongoing improvement, employee participation in decision-making processes, the support of top management, teamwork and an “open” culture by the organization are key elements common to TQM and innovation, so that the implementation of principles of TQM may

result in the incorporation of key elements to the establishment and development of innovation (PRAJOGO; SOHAL, 2003, 2004a, 2004b). TQM may therefore be considered a management model that promotes and manages innovation (PRAJOGO; SOHAL, 2001). In the research conducted by Hoang, Igel and Laosirihongthong (2006), TQM has a positive impact on innovation performance of organizations. Prajogo and Hong (2008) found that TQM has a positive impact on product innovation. Prajogo and Sohal (2004), in a study conducted with manufacturing and service companies, found a significant positive relation between TQM practices and product and process innovation. The negative view on the relationship between TQM and innovation stems from the fact that there is no clear evidence that statistically proves the positive effects of adopting TQM principles in innovation (SINGH; SMITH, 2004).

In a research conducted by Pine (2008) in Portuguese SME, a positive relationship between TQM and innovation was not observed. Singh and Smith (2004), in a study from data of 418 Australian organizations, did not empirically confirm the existence of a linear relation between TQM and innovation. Abrunhosa and Sá (2008), in an investigation in Portuguese footwear companies, found that not all TQM principles play a key role in innovation. The authors confirmed, however, the existence of positive relations among three principles of TQM (communication, teamwork, top management support) and technological innovation. In an investigation involving 93 companies in the services sector and processing industry of the autonomous region of Astúrias, Vijande and González (2008) concluded that TQM, by itself, is capable of promoting organizational innovation activities. Regarding the effect of TQM on innovation of products and processes, the authors found that the effect is mediated by a corporate culture favorable to innovation.

The literature review, therefore, suggests the existence of different arguments that can be explained by the multidimensional nature of TQM and innovation, so the impact of TQM on

innovation depends both on considered TQM variables and on the type of innovation. Different TQM principles may have different impacts on innovation (PRAJOGO; SOHAL, 2001, 2004a, 2004b; PERDOMO-ORTIZ, GONZÁLEZ-BENITO, GALENDE, 2009a, 2009b). For example, while human resources management practices suggested by TQM have a positive effect on innovation, improvement and control practices may harm innovative activities of the organization (PERDOMO-ORTIZ, GONZÁLEZ-BENITO; GALENDE, 2009a, 2009b). In this context, it is considered appropriate to investigate the impact of each of the variables associated with TQM, which may not deliver an innovation performance to the organization.

**2.2 Concepts associated with tqm and innovative performance**

Although many authors have discussed the TQM concept, there is not a measuring instrument to assess it or any agreement on the variables that should constitute it (SILA; EBRAHIMPOUR, 2002). Some researchers measure TQM through “mean” criteria of EFQM’s European Excellence Model (VIJANDE; GONZÁLEZ, 2008, 2009). The “mean” criteria (leadership, strategy, people, partnerships and resources, processes, products and services) represent what the organization does. According to EFQM’s model of excellence, TQM is understood as behavior, activities and initiatives that are based on eight fundamental concepts: achieve balanced results, add value for customers, lead with vision, inspiration and integrity, management by processes, succeed with people, encourage creativity and innovation, build partnerships, and take responsibility for a sustainable future. These fundamental concepts incorporate the eight quality management principles identified by the ISO 9000 standard, which can be adopted by the top management of an organization so that it is directed towards a better performance. The variables commonly used in the measurement of TQM are inspired both by the fundamental concepts of the EFQM model as by quality management principles

identified in the ISO 9000 model (HAN; CHEN; EBRAHIMPOUR, 2007; PINHO, 2008; ABRUNHOSA; SÀ, 2008; HUNG et al., 2010; SATISH; SRINIVASAN, 2010). Depending on the nature and the objectives of the study, researchers associate with TQM the concepts that best fit the research work that they conduct. From the concepts associated with TQM used in several empirical investigations (HAN; CHEN; EBRAHIMPOUR, 2007; PINHO, 2008; HUNG et al., 2010;. SATISH; SRINIVASAN, 2010), 8 concepts are considered in this research. They are briefly described in Chart 1.

**CHART 1** – Concepts associated with TQM

Leadership	Associated with top management’s commitment to management culture by quality
Focus on Customer	Associated with how the organization determines the requirements, needs, expectations and preferences of customers
Involvement and Development of people	Associated with the way the organization engages employees and encourages their participation in and commitment to organization’s activities
Management by processes	Associated with how the organization identifies, manages and develops its processes
Ongoing improvement	Associated with the review of organization’s processes, having as objective an ongoing improvement
Relations with suppliers	Associated with how the organization relates to its suppliers
Results measurement	Associated with how the organization selects, collects and analyzes data related to quality management
Product design	Associated with the use of quality tools and techniques in the design and development of products

**Source:** Own elaboration

The innovation performance of organizations is usually associated with various concepts that represent various manifestations of innovative activities. Satish and Srinivasan (2010) considered five associated concepts: R&D and



technological innovation; product innovation; process innovation; organizational innovation; management innovation. In addition to these, in this research, marketing innovation is considered related to the introduction of a new marketing method (OECD, 2005). A brief description of each of the six concepts is in chart 2.

**CHART 2** – Concepts associated with innovative performance

R&D and technological innovation	Associated with the creation and existence of a department of research and technological development (creation of or maintaining a department of Research & Development)
Product innovation	Associated with the introduction of a good, or new or significantly improved service (new or significantly improved products)
Process innovation	Associated with the implementation of a new or significantly improved method of production or delivery of product (new manufacture or production methods significantly improved)
Organizational innovation	Associated with the implementation of a new organizational method (new practices in “leanproduction”, quality management, team work, decentralization, integration or disintegration of services, training systems, first use of alliances, partnerships, outsourcing procedures)
Management innovation	Associated with the implementation of a new management method (administrative computerization, motivation and remuneration systems, new departments, implementation of management methodologies of knowledge and information)
Marketing innovation	Associated with the implementation of a new marketing method (significant changes in aspect/aesthetic or products’ packaging, new techniques or media for products’ marketing, new distribution methods and placement of new products or sales channels)

**Source:** Own elaboration

### 2.3 Research hypotheses and proposal of a conceptual model

Several researchers report that top management leadership has a positive impact on organization’s innovation activities (FENG et al., 2006; PERDOMO-ORTIZ, GONZÁLEZ-BENITO; GALENDE, 2009a, 2009b). For Hung et al. (2010), top management support is a critical success factor in organizational innovation. The leadership seems to have an impact on innovation performance of organizations, resulting in the formulation of the first hypothesis of research:

**H1:** Leadership has an impact on Innovative Performance of the organization

The focus on customer suggests that the organization offers products constantly adapted to the evolution of market requirements. This approach may, however, result in a short-term management, which overlooks extended market research and proactive stance for fear that the relationship with customers, based on a completely particular offering, may be changed. In an optimistic perspective, the focus on customer principle presupposes obtaining additional information about current and future needs, and it can benefit the propensity of the organization to provide new products that anticipate demand (HUNG et al., 2010; HAN; KIM; SRIVASTAVA, 1998). Some studies show that the orientation to market (concept based on the focus on customer) is an antecedent to the organization’s receptivity to new ideas and to a “culture” favorable to the development of new products (VÁSQUEZ; SANTOS; ALVAREZ, 2001). Satish and Srinivasan (2010) found that the focus on customer has an impact on process innovation. The focus on customer may however play an excessive impact on incremental innovation and neglect the development of more radical innovations (PRAJOGO; SOHAL, 2001). Bannett and Cooper (1981) argue that the orientation to customer promotes only incremental innovations, being the development of products based only on benchmarks relating to

current customers. Given the above, the second research hypothesis is formulated:

**H2:** The Focus on Customer has an impact on Innovative Performance of the organization

The Involvement and Development of People, associated with the delegation of responsibilities and commitment to quality from the perspective of work teams, is reflected in the increase of employee's autonomy and motivation that may favour many aspects of innovation (PRAJOGO and SOHAL, 2003; FENG et al., 2006; PERDOMO-ORTIZ, GONZÁLEZ-BENITO; GALENDE, 2006; SATISH; SRINIVASAN, 2010). The Teamwork is also widely recognized as a factor that favors the commitment to innovation (COOPER; KLEINSCHMIDT, 1990). Given the above, the third research hypothesis is formulated:

**H3:** The Involvement and Development of People has an impact on Innovative Performance of the organization

Perdomo-Ortiz, González-Benito and Galende (2006) analyzed the variable Management by Processes, associated with standardization, and concluded that it is crucial for destructive innovation to actually occur, contrary to previous arguments stating that organizations managed by principles of quality management are less flexible and have less desire to innovate. Satish and Srinivasan (2010) found that management by processes has an impact on product innovation and process innovation. This leads to the fourth research hypothesis:

**H4:** The Management by Processes has an impact on Innovative Performance of the organization

The Ongoing Improvement requires some standardization of processes and activities that may have a deterrent effect on innovation activity in that employees, given the installed organizational

conformity, do not risk changing certain routines or following alternative thoughts (PRAJOGO; SOHAL, 2001). The concern of total use of material resources and total occupation of the equipment, inherent to the ongoing improvement approach, may result in the lack of resources essential to the innovation process (NIJHOF; KRABBENDAM; LOOISE, 2002). In another perspective, it is important to note that the fact that all members of the organization are involved in achieving performance improvement goals encourages creative thinking and an attitude of learning and cooperation among employees, resulting in a greater involvement in innovation activities (HUNG et al., 2010; MCADAM, 2004). For these reasons, the fifth research hypothesis is formulated:

**H5:** The Ongoing Improvement has an impact on Innovative Performance of the organization

The importance of Relations with Suppliers in product development processes was originated in the automotive industry and in Japan's electronics industry (NISHIGUSHI, 1994). It is an important source of new ideas to the extent that suppliers of raw materials and subsidiaries are specialists in these products and encourage the use of "novelties" in their sectors. Equipment and new technologies suppliers are also an important source of new ideas and product processes. Service providers and consultants may be considered as a source of ideas for new work organization methods and activities management (SARAIVA; OREY, 1999). It is therefore suggested that organizations that develop effective relationships with its suppliers acquire competitive advantages in innovation activities. Therefore, the sixth research hypothesis is presented:

**H6:** Relations with Suppliers have an impact on Innovative Performance of the organization

The Results Measurement is extremely useful to the organization as the collection,

processing and use of data concerning TQM may benefit many aspects of the organization, including innovation activities. Systems and tools used by TQM may prove themselves very useful in support and effective management of innovation programs (KEATHLEY; OWENS, 2010). In the seventh research hypothesis, it is suggested that results measurement influence innovation performance of organizations:

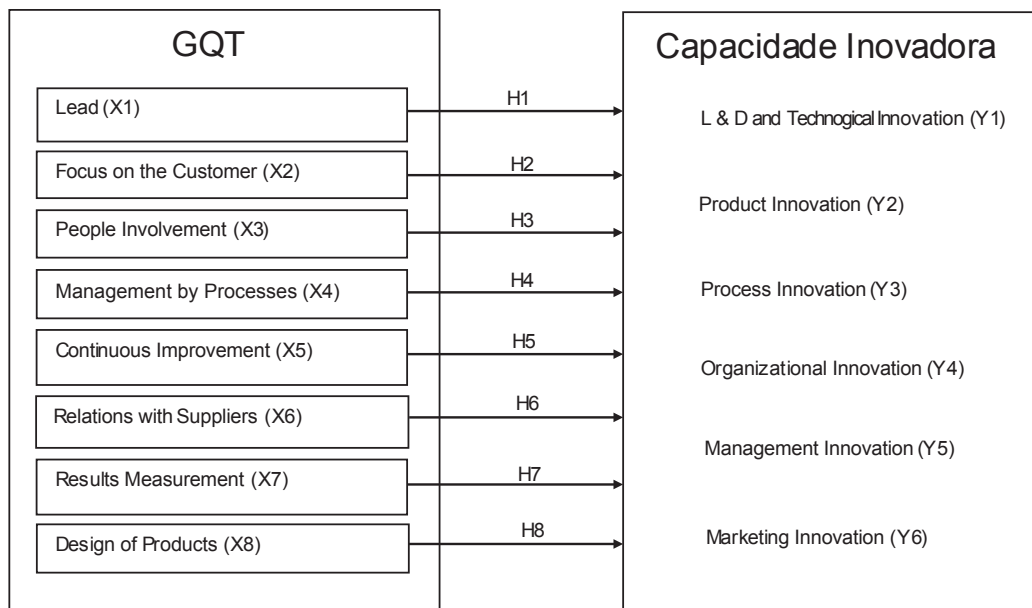
**H7:** Results Measurement has an impact on Innovative Performance of the organization

The process of design and product development is a critical activity of organizations, process that involves risks and considerable efforts. The use of techniques and quality tools in

Product Design may have some positive impact on innovation activities. Perdomo-Ortiz, González-Benito and Galende (2006) concluded that the activities related to product design have a positive direct relationship with innovation. Efforts of organizations towards the use of techniques and quality tools in product design may influence innovative performance, due to which the eighth research hypothesis is considered:

**H8:** Product Design has an impact on Innovative Performance of the organization

Figure 1 proposes the conceptual model that aims to assess eventual facilitator or inhibitor effects that each of the concepts associated with TQM may have in terms of innovative performance of the organization.



**FIGURE 1** – Conceptual model of tqm’s impact in innovative performance

**Source:** Own elaboration

### 3 METHODOLOGY

#### 3.1 Sample and data collection

The research was developed from information gathered from 218 certified Portuguese organizations according to ISO

9001:2008. The decision to consider only certified organizations allowed an interest in the topic of quality management by organizations as well as familiarity with the concepts used in the questionnaire sent to the organizations (CURRY; KADASAH, 2002). Similar to the work conducted by several researchers (PRAJOGO;



SOHAL, 2004a,b, 2006a,b; SINGH; SMITH, 2004), the sample consisted of organizations from different sectors of activity. An electronic questionnaire that allowed information collection about top management perception of each organization on different aspects related to TQM and innovation was sent to organizations. It was organized in statement groups (indicators) according to the variables considered. Since it is a closed type questionnaire, the respondent selected, for each indicator, its 'agree level' with the statement among 10 possible alternatives (from 1 - Totally disagree to 10 - Totally agree). The use of a 10-point scale is in agreement with Kangi and Wallace (1998) and Fornell and Cha (1994). The first authors state that this type of score contributes to a greater reliability; the latter consider that the use of a 10-point scale, compared to a 5 or 7-point scale, enables a greater discrimination in terms of response by the respondents, reducing statistical asymmetry problems. After the development of the first version of the questionnaire, a pre-test with some top managers was applied. This procedure allowed

the investigation of some inherent flaws, including difficulties in the interpretation of statements and assessment of the length of the questionnaire, allowing the development of some suggestions for improvement.

### 3.2 Implementation and validation of variables

As presented in Figure 1, all eight concepts of TQM were considered as independent variables (variables from X1 to X8) and all six concepts of innovative performance were considered as dependent variables (variables from Y1 to Y6).

The variables were subjected to reliability and validity tests. Reliability (measurement of the consistency degree of indicators associated with each variable) was measured by *Cronbach's* alpha. This statistical indicator has an inferior reference limit of 0.70; however, the value of 0.60 may be accepted in exploratory research (HAIR, et al., 2006). Table 1 presents the values of *Cronbach's* alpha calculated using SPSS software. The lowest value is equal to 0.767, which confirms that the measurement instrument is reliable.

**TABLE 1** – Reliability - *cronbach's* alpha

TQM			Innovative Performance		
Variable	# of Indicators	Cronbach's Alpha	Variable	# of Indicators	Cronbach's Alpha
Leadership	7	0.963	R&D and Technological innovation	2	0.767
Focus on Customer	4	0.913	Product innovation	1	--- *
People involvement	6	0.877	Process innovation	1	--- *
Management by processes	6	0.884	Organizational innovation	3	0.884
Relations with suppliers	4	0.889	Management innovation	2	0.884
Results measurement	4	0.812	Marketing innovation	4	0.871
Results measurement	3	0.879			
Product design	4	0.887			

**Source:** Own elaboration

\* Not Applicable

The validity allows to measure if the set of indicators accurately represents the variable (concept) that is of interest to the study (HAIR et al., 2006). Several authors (GONZÁLEZ-ALVAREZ; NIETO-ANTOLÍN, 2007; ABRUNHOSA; SÁ, 2008) recommend

that an analysis of the main factors be made to determine whether the factors and their respective indicators are in line with literature review and with assumptions considered in the preparation of the questionnaire.

Table 2 presents the results of the factor analysis. The Kaiser-Meyer-Olkin (KMO) test allows to conclude that the factor analysis is perfectly suited to the processing of data. The minimum reference value for this test is 0.500 (HAIR et al., 2006).

From data of Table 2, it is concluded that only one factor should be considered for the set of indicators associated with each variable. In

factor analysis, the factors whose *Eigenvalue* (total variance explained by the factor) is greater than 1 (HAIR et al., 2006) should be considered. In all cases, the resulting factor represents more than 66% of the variance, and in many cases is greater than 80%. The variance explained by resulting factor(s) must be at least equal to 60% (HAIR et al., 2006). Given the above, it may be stated that the variables are one-dimensional.

**TABLE 2** – Validity - confirmatory analysis

Component	<i>Eigenvalue</i>	% of variance	<i>Loading item - factor</i>	
			Item	<i>Loading</i>
Leadership (X1) (KMO = 0.938)				
1	5.730	81.856	Lead1	0.880
2	0.344	4.919	Lead2	0.921
3	0.257	3.678	Lead3	0.958
4	0.239	3.420	Lead4	0.929
5	0.204	2.915	Lead5	0.881
6	0.153	2.179	Lead6	0.864
7	0.072	1.033	Lead7	0.896
Focus on customer (X2) (KMO = 0.821)				
1	3.232	80.794	Foc1	0.918
2	0.452	11.308	Foc2	0.800
3	0.211	5.270	Foc3	0.928
4	0.105	2.629	Foc4	0.942
People involvement (X3) (KMO = 0.871)				
1	3.698	73.966	PIn1	0.892
2	0.505	10.094	PIn2	0.788
3	0.409	8.187	PIn4	0.814
4	0.225	4.509	PIn5	0.931
5	0.162	3.245	PIn6	0.867
Management by processes (X4) (KMO = 0.846)				
1	4.042	67.360	MbP1	0.909
2	0.662	11.034	MbP2	0.894
3	0.599	9.991	MbP3	0.882
4	0.392	6.527	MbP4	0.779
5	0.230	3.836	MbP5	0.740
6	0.075	1.251	MbP6	0.697
Ongoing improvement (X5) (KMO = 0.813)				
1	3.031	75.777	OI1	0.981

Component	Eigenvalue	% of variance	Loading item - factor	
			Item	Loading
2	0.427	10.677	OI2	0.867
3	0.345	8.622	OI3	0.860
4	0.197	4.923	OI4	0.834
Relations with suppliers (X6) (KMO = 0.764)				
1	2.665	66.615	Rws1	0.873
2	0.641	16.034	Rws2	0.882
3	0.470	11.758	Rws3	0.802
4	0.224	5.593	Rws4	0.694
Results measurement (X7) (KMO = 0.744)				
1	2.421	80.691	Rm1	0.895
2	0.309	10.284	Rm2	0.906
3	0.271	9.025	Rm3	0.894
Product design (X8) (KMO = 0.823)				
1	3.064	76.601	Pd1	0.896
2	0.515	12.875	Pd2	0.923
3	0.258	6.451	Pd3	0.908
4	0.163	4.073	Pd4	0.764
R&D and technological innovation (Y1) (KMO = 0.500)				
1	1.623	81.130	RDti1	0.901
2	0.377	18.870	RDti2	0.901
Organizational innovation (Y4) (KMO = 0.734)				
1	2.439	81.298	Oi1	0.911
2	0.342	11.416	Oi2	0.918
3	0.219	7.286	Oi3	0.875
Innovation in management (Y5) (KMO = 0.500)				
1	1.792	89.599	Iim1	0.947
2	0.208	10.401	Iim2	0.947
Marketing innovation (Y6) (KMO = 0.751)				
1	2.889	72.225	Mi1	0.880
2	0.593	14.826	Mi2	0.862
3	0.320	7.997	Mi3	0.865
4	0.198	4.952	Mi4	0.789

**Source:** Own elaboration

Concerning factor loadings, except for one indicator related to the variable “involvement and development of people”, removed in the first interaction, all indicators are relevant to the respective factors as they meet the reference value

(greater than 0.70), as suggested by HAIR et al. (2006).

After verification of the assumptions associated with reliability and validity of variables, the “*score components*” of all factors were calculated

using multiple linear regression to assess the impact of each TQM variable in innovation performance variables. The data are analyzed and discussed in the following section.

#### 4 DATA ANALYSIS AND DISCUSSION OF RESULTS

##### 4.1 Multiple linear regression in data analysis

In multiple linear regression, it is assumed that there is a linear relation between a variable Y

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + e \tag{1}$$

However, before obtaining the models, it is necessary to verify compliance with certain conditions associated with linear regression models, so that they may be considered valid. The first assumption is related to the independence of observations that was guaranteed, to the extent that the sample consisted of 218 questionnaires answered by 218 different organizations. The second assumption concerns homoscedasticity residuals. The residuals must have an homogeneous variance around a null value average, and the value of residuals must be constant throughout the observation interval. This assumption was verified by observation of residuals charts, verifying, for the 6 models, a constant variance of residuals and, therefore, homocedasticity (HAIR et al., 2006). The third assumption refers to the normal distribution of residuals. The observation of the normal distribution of residuals chart concluded that the errors are normally distributed for the 6 models. The values fall along the diagonal without substantial or systematic deviations, which indicates a normal distribution of errors (HAIR et al., 2006). The fourth assumption is the existence of multicollinearity, which was assessed using two statistical indicators: Tolerance and *Variance Inflation Factor* (VIF). The Tolerance measures the amount of variance that, in an independent variable, is not explained by other independent variables. If the other variables explain most

(dependent variable) and k independent variables  $X_j$  ( $j=1, \dots, k$ ). It is a suitable method of analysis when the determination of the impact of two or more independent variables in a dependent variable is desired (HAIR et al., 2006). In order to determine the impact of 8 TQM variables in 6 variables of innovation performance of the organization, 6 multiple linear regression models were made according to equation 1:

of the variance of an independent variable in particular, there are problems of multicollinearity. The reference value for the tolerance is typically 0.10, and tolerance values lower than 0.10 indicate multicollinearity problems. VIF is the inverse of tolerance, and the acceptable maximum value is 10 (HAIR et al., 2006). VIF values for independent variables are between the minimum value of 1.547 and maximum 3.574, verifying the absence of multicollinearity.

Multiple linear regression analysis was performed with SPSS software using the *stepwise* method. The estimates of the analysis of 6 models are in Table 3.

**TABLE 3** - Linear regression estimates for the 6 models

Model	R	R <sup>2</sup>	R <sup>2</sup> - adjusted	ANOVA sig.
1	0.369	0.136	0.124	0.000
2	0.547	0.299	0.286	0.000
3	0.435	0.189	0.178	0.000
4	0.563	0.317	0.304	0.000
5	0.524	0.275	0.265	0.000
6	0.400	0.160	0.148	0.000

**Source:** Own elaboration

From the values of R<sup>2</sup> in Table 3.5, the 6 models have reasonable adjustment to the data. The observation of the column relative to



ANOVA analysis allows, for all models, to reject the null hypothesis,  $H_0: \beta=0$ . That is, it can be stated, with 99% confidence, that the dependent variable is linearly related to the independent variables.

#### 4.2 Results and discussion

The coefficients of linear regression of all 6 models and the respective levels of significance are presented in Table 4.

**TABLE 4** – Linear regression coefficients for the 6 models

Model	Dependent variable	Independent variables	Standardized B	Sig.
1	R&D and Technological innovation	Management by processes	-0.323	0.006
		Ongoing improvement	0.370	0.002
		Product design	0.278	0.001
		Focus on Customer	0.246	0.019
2	Product innovation	Ongoing improvement	0.310	0.002
		Relations with suppliers	-0.300	0.002
		Product design	0.298	0.000
3	Process innovation	Ongoing improvement	0.396	0.000
		Relations with suppliers	-0.279	0.004
		Product design	0.282	0.001
		Leadership	0.330	0.000
4	Organizational innovation	Ongoing improvement	0.300	0.006
		Results measurement	-0.171	0.070
		Product design	0.145	0.042
		Leadership	0.314	0.001
5	Innovation in management	Focus on Customer	-0.195	0.054
		Ongoing improvement	0.391	0.000
		Management by processes	-0.276	0.016
6	Marketing innovation	Ongoing improvement	0.384	0.001
		Product design	0.278	0.001

**Source:** Own elaboration

From the analysis of table 6, only the hypothesis H3 is not supported by the data. The impact of the involvement and development of people, associated with the delegation of responsibilities and commitment to improvement, in any variable associated with innovation performance of organizations, was not statistically proven. Although this result is different from expected, it is in line with the research work conducted by Singh and Smith (2004), in which the authors did not statistically confirm the relation between the involvement and development of people and the innovative performance of the organization.

The hypotheses H1, H2, H4, H5, H6, H7 and H8 are supported by empirical data, which

confirms that leadership, focus on customer, management by processes, ongoing improvement, relations with suppliers, results measurement and product design have a significant impact on the innovation performance of organizations. In line with other research (PERDOMO-ORTIZ; GONZÁLEZ-BENITO; GALENDE, 2009a, 2009b; PRAJOGO and SOHAL, 2001, 2004), it is concluded that the impact of each TQM principle is different depending on the innovation performance variable considered.

The figure 2 presents symbolically the impact, positive (+) or negative (-), of each TQM variable in each innovation performance variable.



	I & D e inovação tecnológica	Inovação do produto	Inovação do processo	Inovação organizacional	Inovação na gestão	Inovação de marketing
<i>Liderança</i>				+	+	
<i>Focalização no cliente</i>		+			-	
<i>Gestão por processos</i>	-					-
<i>Melhoria contínua</i>	+	+	+	+	+	+
<i>Relações com fornecedores</i>		-	-			
<i>Medição de resultados</i>				-		
<i>Design de produtos</i>	+	+	+	+		+

**FIGURE 2** – Impacts of tqm variables in innovative performance variables

**Source:** Own elaboration

The results point to a positive impact of top management leadership in organizational innovation and in innovation in management. Leadership attitude of the organization’s top management promotes innovative activities of an organizational and management nature. This finding is consistent with empirical works conducted by several authors (FENG et al., 2006; PERDOMO-ORTIZ; GONZÁLEZ-BENITO; GALENDE, 2006; HUNG et al., 2010). The focus on customer has a positive impact on product innovation levels. The results support the initial idea that the focus on customer, associated with obtaining information on current and future needs of customers, benefits the propensity of the organization for product innovation (HUNG et al., 2010; HAN; KIM; SRIVASTAVA, 1998). Focus on customer has, however, a negative impact on innovation in management. Focus on customer seems to imply a short-term management, fully determined and where innovative activities related to extended market research and proactive attitude cease to be part of the organization’s list of concerns. The Focus on customer approach seems to limit innovation in management levels. Contrary to expectation,

in particular to what Perdomo-Ortiz, González-Benito and Galende (2006) refer, management by processes limits innovative activities related to research, development and technological innovation and marketing innovation. The results show that the management by processes approach inhibits the creation and maintenance of a R&D department and the development of new technologies. Innovation in product packaging, in communication techniques with the customer, in distribution methodologies and in pricing policies are also activities impaired by the management by processes approach. This result may be related to the fact that the empirical data used in research are related to certified organizations according to ISO 9001:2008. The implementation of a quality management system according to this normative reference standard imposes the determination of the processes needed for the quality management system and its application throughout the organization. This approach, in which the organization determines its critical processes, may somehow overlook certain areas considered less important in the process of implementation of quality management system. According to research results, ongoing improvement promotes

the development of innovative activities in all innovation performance variables. This shows that the involvement of employees in ongoing improvement goals favors all innovative activities of the organization, and that is according to a research conducted by Hung et al. (2010) and McAdam (2004). The results suggest that the relations with suppliers limit product and process innovation. On this aspect, a further explanation is important. The results seem to contradict literature reviews that point to a positive impact of relations with suppliers in innovative activities of the organization (especially in product and process levels). A possible explanation for the results is related to the fact that relations with suppliers subject the organization to changes in product and process aiming to a better use/integration adequation of goods and services provided by the supplier. In this context, relations with suppliers may discourage “isolated” innovation of each particular organization. Contrary to expectation, the results measurement appears as a factor inhibiting innovative activities with an organizational nature. The results measurement related to quality management (monitoring processes and conducting internal audits, for example), and the desire to achieve certain completely determined goals may impose strict performance procedures on the organization, which discourages the development of innovative activities in an organizational level.

The results suggest that the use of techniques and quality tools in product design has a positive impact on R&D and technological innovation, product innovation, process innovation, organizational innovation and marketing innovation.

## 5 CONCLUSION AND PROPOSAL FOR A FUTURE WORK

The aim of this study was to empirically test suggestions present in the literature about the importance of adopting TQM principles in innovative performance of organizations. The obtained results generically support the suggestions in the literature and they allow to

conclude that the adoption of TQM has an impact on innovation. However, as mentioned in the literature review, the different principles of TQM have a different impact on innovation performance of organizations. The analysis of the results shows that Ongoing Improvement fosters innovation performance in all *outputs* of innovation considered. In contrast, the results do not prove any impact on the involvement and development of people in innovation performance levels. Regarding other TQM principles, the results prove that its adoption may encourage or hinder innovation. Generically, it can be concluded that the adoption of TQM principles plays a key role in innovation activities. However, it is necessary prudence in identifying innovation outputs that are intended to be strengthened in order to bet on appropriate TQM principles. Otherwise, conflicting results contrary to desirable results may be obtained. On the other hand, it must be recognized that innovation processes are influenced by multiple factors, some of which even exogenous to organizations themselves.

The results obtained in this study were compared with results of other studies. This comparison should however be made with some caution as TQM and innovation performance variables are defined and measured differently, which may involve different final results.

The study has some limitations. Empirical data refer to organizations from different sectors of activity; therefore, the generalization of the results may not be applied to some sectors. Data collection considers the perception of top managers that may not completely match the organization's image.

Concerning future works, it may be interesting to separate the sample into different groups and analyze eventual differences on the impact of the adoption of TQM principles in innovation. The separation of the sample may be made, for example, according to sector or to the size of the organization. On the other hand, the existence of key elements common to TQM and innovation raises the idea that the organization's bet on innovation may be translated as its interest in the development and implementation of TQM.

In this context, it is important to analyze the impact of innovation outputs in the adoption of TQM principles.

It is suggested, for future research, a study that highlights the specificities of Brazilian companies through the replication of the study in the Brazilian context, with data collection of these companies and, later, data analysis and conclusions.

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