

Article

Effects of Total Quality Management (TQM) Dimensions on Innovation—Evidence from SMEs

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Abstract: This research study aims to study and identify which dimensions of TQM have influence on and support innovation strategies within the Portuguese small and medium enterprises (SMEs), in the context of products or services' innovation and process innovation, as well as to analyze the extent to which this relationship occurs. To examine the linkage between TQM dimensions and innovation strategies, concerning innovation products and innovation processes, a multiple linear regression analysis was chosen and an eight-predictor multiple linear regression model was proposed. The data was collected through a questionnaire sent by email. This research study allows to conclude that several dimensions of TQM, such as benchmarking, quality/conception and product design, and continuous improvement, have a significant and positive association with product innovation. Although the data analysis/measurement of the results dimension has a significant association with product innovation, this association is negative. Conversely, several TQM dimensions, such as leadership/management's commitment, benchmarking, involvement/empowerment of employees, and continuous improvement, revealed a positive and significant association with process innovation. Our research is of crucial importance for the knowledge of Portuguese SMEs and the fundamental factors that companies must address to both improve their efficiency and be more competitive, thereby increasing profitability and ensuring financial sustainability in the medium and long term.

Keywords: total quality management; product innovation; process innovation; SMEs; continuous improvement; customer focus



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1. Introduction

In the current business environment, which is characterized by extremely competitive and aggressive markets, the basis of companies' competitive advantage has focused on quality management and innovation [1–3]. Innovation allows companies to adapt quickly to changes that arise in the environment and helps to find new products and markets, allowing companies to protect themselves from an unstable environment [4]. However, the question that arises in this approach is that a company cannot be successful following innovation strategies if it is not concerned with providing products and/or services that meet acceptable and demanding standards of quality, considering the expectations and needs of potential customers [5]. In this way, the implementation of total quality management (TQM) plays a key role, as it can be a starting point for the definition of innovation strategies.

The sample chosen for this study focused on Portuguese small and medium-sized enterprises (SMEs), as they play a fundamental role in the economies of all countries in the world, which is also the case in Portugal. Its contribution to national economic growth and employment is of enormous importance, also representing an opportunity for entrepreneurship, innovation, and providing the creation of new jobs. In the Portuguese context, the

business structure is characterized by 99% of SMEs, which highlights the importance of these kinds of corporations. SMEs create job opportunities, stimulate innovation processes, support entrepreneurial activities, and help to introduce new business models. However, these types of companies are subject to enormous competitive pressure, as the environments and markets in which they operate, as well as the local and global economy, are extremely aggressive. In this way, knowledge of the best competitive skills and competences of SMEs is of critical importance to guarantee their survival and sustained development.

TQM has been widely accepted by quality managers and professionals, and is seen as a quality approach to change management [6], playing a vital role in the development of management practices [7]. TQM is considered an approach to improve the effectiveness, flexibility, and competitiveness of enterprises to meet customer requirements [8]. It is also recognized as a source of sustainable competitive advantage for organizations [9], a viable way to achieve excellence, acquire efficient business solutions, and enchant customers and suppliers [10]. Above all, TQM is recognized as a source of organizational performance improvement through continuous improvement in the organization's activities [2,3,11,12].

According to Jimenez-Jimenez et al. [13], innovation is fundamental for the economic efficiency of not only companies but also nations. The impact of innovation strategies on company performance will have effects on sales volume and, likewise, on productivity and efficiency changes, allowing for more effective operational management practices. Currently, companies need to develop their knowledge to adapt to new products and technologies, as well as to continuously disseminate this knowledge to all employees. Based on the internal factors of an organization, the nature of innovation may involve technical, product, and/or process innovation.

In the existing literature, there are several research studies which show that TQM supports innovation, suggesting that the implementation of TQM practices emerges as the first step towards the development of an environment and culture of support for innovation [2,9,14]. Innovation is seen as fundamental and necessary for organizations that want to increase the productivity and quality of their products, and it is this perspective that puts the central elements of innovation in line with the objectives of TQM [14].

However, this research study intends to develop a more detailed analysis of this relationship as TQM is characterized by several dimensions, such as the leadership/management's commitment, focus on the customer, benchmarking, involvement/empowerment of employees, development/employees training, quality/conception and product design, data analysis/measurement of results, and continuous improvement. Considering the increasingly competitive economic environment, SMEs are forced to deal with major challenges with a view to their survival and, inevitably, they will have to pay the greatest amount of attention to these perspectives. Thus, most of these types of companies place great focus on quality systems, focusing on TQM and continuous improvement, to achieve an excellent performance. Organizations that adopt TQM can eliminate defects and avoid waste, improve their processes, and reduce their costs. In this way, companies can achieve higher levels of productivity, increasing their profitability [15]. In addition to these aspects, TQM is also able to strengthen the company's competitive position, improve its image in the market, and improve its adaptability to changes or emerging market conditions [16].

In addition, innovation plays a very important role as only companies that manage to be innovative can acquire a dominant position in the market, focusing on innovation in terms of not only the products and services they offer their customers, but also on how they carry out their activities. Thus, this investigation seeks to develop a new approach, comparing the results found with other studies already carried out, but in a reality that has never been studied, focused on Portuguese SMEs.

Thus this research study aims to identify which dimensions of TQM have influence on and support the definition of innovation strategies within Portuguese SMEs, namely product and process innovation, as well as to analyze the extent to which this relationship occurs.

2. The Linkage between TQM Dimensions and Innovation Strategies

SMEs that adopt TQM can achieve continuous quality improvements in various dimensions of the company, with a view to offering better products and services, thus meeting the needs of customers. To achieve success in implementing these practices, it will be essential that all hierarchical levels of the organization take part in the effort to improve processes and products, as well as the culture in which they operate. The TQM philosophy is a revolutionary approach that adopts systematic quality improvements with the aim of increasing customer satisfaction, increasing productivity, and enabling greater profitability to be achieved [17]. TQM practices enable organizations to achieve long-term goals, improving the organization's ability to respond more efficiently to customer demand in terms of quality, innovation, and price, while also allowing for more accurate handling of the adversity of markets [18,19]. In this sense, TQM is seen to distinguish an SME from its competitors, allowing to achieve a better result in increasingly competitive environments [18,20]. In another perspective, TQM is a program that aims to manage the entire organization, standing out in all dimensions of products and services that are important to customers [2,21,22]. It is defined as a philosophy and set of guiding principles that represent an organization based on continuous improvement.

In addition, innovation can help companies to create a new market segment to improve their tools and production methods to innovate new products and services [23]. Innovation can be classified into two categories, namely product innovation and process innovation [24]. Product innovation is defined as a way of introducing improvements in new products or services and, in this way, customer expectations can be easily met when an organization has produced an innovative and high-quality product [25]. Process innovation can be defined as implementation and changes in the production method of products or services. Process innovation attempts to redesign or improve the business process to increase business efficiency and customer satisfaction, including new and working methods in the processes. Furthermore, Kirner et al. [26] expressed that the concept of innovation can be defined in two major groups, namely product or service innovation and process innovation. Regarding product or service innovation, this concept covers physical or intangible products, and regarding process innovation, they refer to technological or organizational aspects.

Innovation is one of the most efficient tools for developing the competitive advantage of organizations and is an essential factor to ensure success in the medium and long term [18,27]. According to Martínez-Costa et al. [28], innovation management is a fundamental aspect for organizations, as it provides the definition of an effective process of routines and techniques that boost creativity and knowledge creation. Wang and Dass [29] defined the concept of innovation as the ability of an organization to create an innovative vision to drive the organization's success in a changing environment, which consists of implementing new ideas and transforming ideas into processes, procedures, and products. Innovation is a systematic process used by organizations to improve their existing products and services, and to create new marketing strategies. It is based on the development of a network environment and focuses on managing talented employees to encourage them to generate creative ideas within the organization [30]. Innovation management is considered a multidimensional approach that includes vision, leadership, culture, knowledge, people, technology, and the organizational structure itself. Organizations must be open to smart and creative ideas, and must design a mechanism that starts with supporting human resources. This is a key point that allows for considering the close relationship between TQM and its dimensions within innovation.

The relationship between TQM and innovation has been the subject of several investigations over the years [23,31,32]. Based on previous research, there are positive relationships between TQM and innovation [33]. The relationships between the practices of TQM and innovation that focused on innovation performance [23,25], product and process innovation [33–35], and process design and improvement [36] have been studied.

However, there are other approaches that have only a partial relationship between TQM and innovation [31,37].

3. Materials and Methods

The relationship between the perspective of the customer focus dimension and innovation has been widely referred to in the existing literature. This relationship assumes that companies must be innovative to meet customer needs through the development and launch of new products or services [38]. According to Hoang et al. [38], only three variables (leadership and people management, strategic and process management, and open organization) revealed a positive impact on innovation. Education and training revealed a positive effect on the number of new products and services; however, they had a negative relationship with the level of novelty. Specifically, innovation offers an opportunity to improve the relationship with customers, as it can more easily meet the needs and expectations of customers when developing products or services [39,40].

Jong and Hartog [41] stated that, based on innovation strategies, customer feedback can help in the definition of a strategy that aims to increase the success rate of introducing new products in the market. In addition, top management leadership is considered as the most important factor of quality performance [42], as top management attitudes and behaviors are related to quality management practices in corporations [43]. The leadership style was highlighted as one of the most significant aspects in a company's innovative performance because leaders can develop new ideas in the organization, thus managing to define objective goals and promote innovation initiatives among all employees of the organization [44]. Thus, it is considered that leadership is a key aspect for a culture of innovation, in which all employees must have autonomy to both make decisions and make the best use of their creative capacity [45].

Prajogo and Sohal [46] used the following arguments to support a positive relationship between TQM and innovation. According to these authors, the focus on the customer encourages organizations to have innovative because they must look for a way to better know and satisfy the needs of customers. The focus on the customer leads to a clear focus on innovation, relating innovation to the needs of customers. Regarding continuous improvement, the authors said that it will promote change, innovation, and creative thinking in the way work is organized and conducted. Additionally, regarding empowerment, the authors stated that this dimension makes people feel that they have a certain degree of autonomy and are less limited by technical aspects in carrying out their work, which makes them more innovative in their performance. Cross-functional teamwork in the organization is one of the most effective forms of communication, with communication recognized as one of the main determinants of organizational innovation. In a similar manner, people management and teamwork are innovative success factors that can provide innovative activities in the organization [46]. In addition, the orientation towards the markets and the focus on the customer lead the organizations to turn to the information of the customers' needs, leading to new ideas to better know these markets [47,48]. According to Perdomo-Ortiz et al. [48], there is a positive and significant relationship between the practices of TQM and the capacity for innovation of a business. There are three TQM practices that are more important than others, namely process management, product design, and human resource management, which means that TQM's mechanistic practices are also very significant in building the innovation capacity of a business.

Based on this theoretical framework, the following research hypotheses are defined:

Hypothesis 1a (H1a). *Leadership/management's commitment has a significant association with product innovation.*

Hypothesis 1b (H1b). *Leadership/management's commitment has a significant association with process innovation.*

Hypothesis 2a (H2a). *A focus on the customer has a significant association with product innovation.*

Hypothesis 2b (H2b). *A focus on the customer has a significant association with process innovation.*

Hypothesis 3a (H3a). *Benchmarking has a significant association with product innovation.*

Hypothesis 3b (H3b). *Benchmarking has a significant association with process innovation.*

Hypothesis 4a (H4a). *The involvement/empowerment of employees has a significant association with product innovation.*

Hypothesis 4b (H4b). *The involvement/empowerment of employees has a significant association with process innovation.*

Hypothesis 5a (H5a). *Development/employees' training has a significant association with product innovation.*

Hypothesis 5b (H5b). *Development/employees' training has a significant association with process innovation.*

Hypothesis 6a (H6a). *Quality/conception and product design has a significant association with product innovation.*

Hypothesis 6b (H6b). *Quality/conception and product design has a significant association with process innovation.*

Hypothesis 7a (H7a). *Data analysis/measurement of results has a significant association with product innovation.*

Hypothesis 7b (H7b). *Data analysis/measurement of results has a significant association with process innovation.*

Hypothesis 8a (H8a). *Continuous improvement has a significant association with product innovation.*

Hypothesis 8b (H8b). *Continuous improvement has a significant association with process innovation.*

Figure 1 represents the conceptual model defined in this study, illustrating the relationship between the studied variables and the research hypotheses.

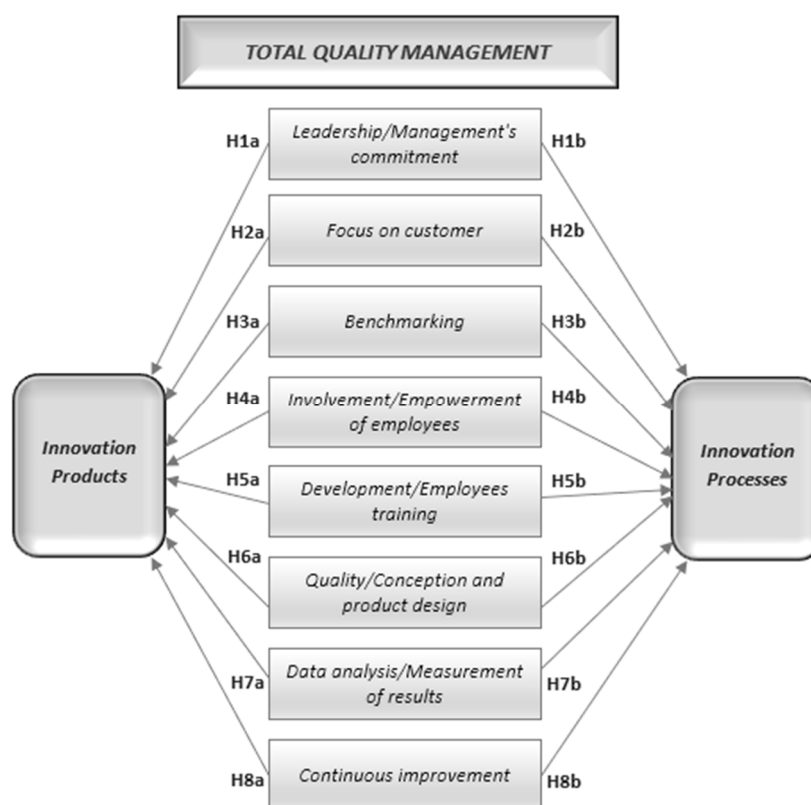


Figure 1. Conceptual Model and research hypotheses. Source: own elaboration.

4. Empirical Research

4.1. Sample Characterization and Questionnaire Development

Data of the companies used for this research study were obtained through the SABI database (Analysis System of Iberian Balances). Small and medium-sized Portuguese companies were selected, with available and valid email contact information. The data were collected through a questionnaire sent by email and the answers were received between May and June of 2015. The total sample consisted of 946 companies and 287 completed questionnaires were received, which accounted for 30.34%. The invitation to participate in the research study was sent through an email with a link to access the questionnaire (Appendix A), which was the instrument of data collection. The questionnaire was designed with closed questions using a Likert scale of five points for the evaluation of the answers of respondents concerning the considered dimensions, in which respondents selected for each answer one of the options available on a scale from '1 = strongly disagree' to '5 = strongly agree'.

4.2. Data Analysis

To examine the linkage between TQM dimensions and innovation strategies, concerning process innovation and product innovation, a multiple linear regression analysis was chosen. According to Marôco [49], it is a practical statistical tool that examines the linkages between a set of independent variables and one dependent variable. In this study, an eight-predictor multiple linear regression model was proposed. The eight predictor variables are leadership/management's commitment (X1), focus on the customer (X2), benchmarking (X3), involvement/empowerment of employees (X4), development/employees training (X5), quality/conception and product design (X6), data analysis/measurement of results (X7), and continuous improvement (X8). The equation of the proposed multiple linear regression model is illustrated as follows:

$$Y(P1) = b0 + b1(X1) + b2(X2) + b3(X3) + b4(X4) + b5(X5) + b6(X6) + b7(X7) + b8(X8) + e$$

and

$$Y(P2) = b0 + b1(X1) + b2(X2) + b3(X3) + b4(X4) + b5(X5) + b6(X6) + b7(X7) + b8(X8) + e$$

where

Y (P1) = Dependent variable (innovation products), b0 = Constant, e = Error

Y (P2) = Dependent variable (innovation processes), b0 = Constant, e = Error

Table 1 provides the correlations between each pair of the ten variables under study and the associated significance. It was found that all variables correlate with each other moderately and positively, in general, and all revealed to be statistically significant. The correlations between the explanatory variables and the two dependent variables were higher when analyzed in relation to the dependent variable “Innovation Process” (INOVPC), the highest being that established with the explanatory variable “Continuous Improvement” (CI). However, the highest correlation is that between “Continuous Improvement” (CI) and “Data Analysis/Measurement of Results” (DA/MR).

Table 1. Correlations of explanatory variables and dependent variables.

	L_MC	FC	B	I_EE	D_ET	Q_CPD	DA_MR	CI	INOPD	INOVPC
L_MC	1									
FC	0.693 **	1								
B	0.543 **	0.586 **	1							
I_EE	0.685 **	0.668 **	0.615 **	1						
D_ET	0.738 **	0.627 **	0.512 **	0.732 **	1					
Q_CPD	0.733 **	0.605 **	0.537 **	0.722 **	0.762 **	1				
DA_MR	0.747 **	0.755 **	0.564 **	0.785 **	0.778 **	0.778 **	1			
CI	0.760 **	0.749 **	0.596 **	0.721 **	0.737 **	0.757 **	0.842 **	1		
INOVPD	0.405 **	0.364 **	0.428 **	0.413 **	0.356 **	0.488 **	0.377 **	0.479 **	1	
INOVPC	0.575 **	0.572 **	0.565 **	0.639 **	0.527 **	0.549 **	0.579 **	0.647 **	0.651 **	1

** Correlation is significant at the 0.01 level (two-tailed).

As all variables were statistically correlated, it is difficult to answer whether, for example, “Leadership/Management’s Commitment” is really related to “Process Innovation” (INOVPC) or if the observed correlation between the two variables results from the relationship of other variables. When trying to separate the relationships involved in a set of variables, it is often useful to calculate the partial correlation coefficients. Such coefficients measure the strength of the linear relationship between two continuous variables that is not attributed to one or more confounding variables.

The strength of the relationships between our dependent variables, namely “Product Innovation” (INOVPD) and “Process Innovation” (INOVPC), as well as each explanatory variable, after adjusting for the effects of the other explanatory variables is expressed in Tables 2 and 3.

Table 2. Partial correlations associated with the INOVPD variable.

INOVPD	L/MC	I/EE	FC	B	D/ET	Q/CPD	DA/MR	CI
Correlation	0.016	0.063	−0.005	0.164	−0.089	0.236	−0.154	0.199
Significance (two-tailed)	0.795	0.292	0.938	0.006	0.139	0.000	0.010	0.001

Table 3. Partial correlations associated with the INOVPC variable.

INOVPC	L_MC	I_EE	FC	B	D_ET	Q_CPD	DA_MR	CI
Correlation	0.075	0.248	0.063	0.184	−0.045	0.005	−0.096	0.230
Significance (two-tailed)	0.208	0.000	0.296	0.002	0.452	0.940	0.109	0.000

Table 2 shows the partial correlation coefficients between each explanatory variable and the dependent variable INOVPC, associating their respective significance. The estimated partial correlations revealed to be lower than the unadjusted correlation coefficient, expressed in Table 1, due to part of the relationship being attributed to the other explanatory variables. It can also be observed that three correlations were negative, with only the correlation of the explanatory variable DA/MR being statistically significant for an alpha value of less than 0.05. The variables CI, Q/CPD, and B, although they have low relational values, were statistically significant.

The data recorded in Table 3 refers to the partial correlation coefficients between each explanatory variable and the dependent variable INOVPC. Table 1 gave an indication that the correlations between the explanatory variables and the INOVPC variable were stronger than with the INOVPC variable. However, when the partial correlations are computed, we find that the identified difference disappears, with only the relationships of the variables I/EE, B, and CI being statistically significant. It is possible to verify that the correlations of the variables CI and B are weak but statistically significant in both dependent variables.

Consequently, reliability and validity tests were performed for the variables under study. Reliability was measured by Cronbach's alpha. All values were greater than 0.84, which means that there is an excellent internal consistency and that the measurement instrument is reliable (Table 4).

Table 4. Cronbach's alpha.

Dimensions	Number of Questions	Cronbach's Alpha
Product innovation	Q1, Q2, Q3, Q4	0.858
Process innovation	Q5, Q6, Q7, Q8	0.894
Total quality management		
Leadership/management's commitment	Q9, Q10, Q11, Q12	0.875
Focus on customer	Q13, Q14, Q15, Q16	0.842
Benchmarking	Q17, Q18, Q19, Q20	0.927
Involvement/empowerment of employees	Q21, Q22, Q23, Q24	0.851
Development/employees training	Q25, Q26, Q27, Q28	0.924
Quality/conception and product design	Q29, Q30, Q31, Q32	0.859
Data analysis/measurement of results	Q33, Q34, Q35, Q36	0.947
Continuous improvement	Q37, Q38, Q39, Q40	0.939

Concerning the validity verification, the confirmatory factorial analysis was performed; Table 5 presents its results. Through the Kaiser–Meyer–Olkin test (KMO), it is concluded that the factor analysis is adequate to the data considering its value is greater than 0.74. Thus, it is confirmed that only one factor should be considered for the set of indicators related to each variable. For all cases, the resulting factor represents more than 68% of the variance and in some cases, it is greater than 81%. In this way, the scores of each of the factors were calculated using the loadings of each item (variable), which makes up the factor.

Table 5. Confirmatory factorial analysis.

Component	Eigenvalues	Percentage of Variance	Loading Item—Factor	
Product innovation (Y1) (KMO = 0.823)			items	Loading-weights
1	2.816	70.393	Q1	0.855
2	0.467	11.675	Q2	0.855
3	0.362	9.044	Q3	0.818
4	0.356	8.888	Q4	0.827
Process innovation (Y2) (KMO = 0.811)				
1	3.039	75.984	Q5	0.858
2	0.398	9.943	Q6	0.876
3	0.337	8.429	Q7	0.882
4	0.226	5.645	Q8	0.870
Leadership/management's commitment (X1) (KMO = 0.773)				
1	2.920	72.997	Q9	0.810
2	0.559	13.965	Q10	0.866
3	0.304	7.611	Q11	0.889
4	0.217	5.426	Q12	0.851
Focus on customer (X2) (KMO = 0.746)				
1	2.728	68.196	Q13	0.844
2	0.681	17.014	Q14	0.857
3	0.337	8.423	Q15	0.860
4	0.255	6.367	Q16	0.736
Benchmarking (X3) (KMO = 0.858)				
1	3.282	82.040	Q17	0.877
2	0.307	7.676	Q18	0.919
3	0.233	5.817	Q19	0.900
4	0.179	4.467	Q20	0.926
Involvement/empowerment of employees (X4) (KMO = 0.763)				
1	2.784	69.604	Q21	0.817
2	0.610	15.255	Q22	0.835
3	0.328	80.207	Q23	0.834
4	0.277	6.934	Q24	0.850
Development/employees training (X5) (KMO = 0.838)				
1	3.263	81.576	Q25	0.903
2	0.324	8.097	Q26	0.931
3	0.258	6.456	Q27	0.905
4	0.155	3.872	Q28	0.873
Quality/conception and product design (X6) (KMO = 0.793)				
1	2.829	70.730	Q29	0.862
2	0.494	12.342	Q30	0.849
3	0.402	1.062	Q31	0.830
4	0.275	6.867	Q32	0.823

Table 5. Cont.

Component	Eigenvalues	Percentage of Variance	Loading Item—Factor	
Data analysis/measurement of results (X7) (KMO = 0.859)				
1	3.454	86.342	Q33	0.901
2	0.258	6.460	Q34	0.941
3	0.156	3.899	Q35	0.933
4	0.132	3.299	Q36	0.941
Continuous improvement (X8) (KMO = 0.840)				
1	3.381	84.534	Q37	0.913
2	0.294	7.338	Q38	0.933
3	0.177	4.425	Q39	0.919
4	0.148	3.703	Q40	0.912

Subsequently, to evaluate the impact of each TQM variable on product innovation and process innovation, the multiple linear regression methodology was used. Multiple linear regression considers some assumptions so that its results are considered valid. The first is related to the independence of the observations, which is guaranteed. The second concerns the homoscedasticity of the residues, that is, the residues must have a homogeneous and constant variance. The third assumption is related to the normality of the residues, while the fourth assumption is that there is no multicollinearity.

When adjusting the least squares regression, we found some outliers and considering these data are not errors, nor are they from a different population than most of the other data, we have no reason to exclude them from analysis. The assumptions of the normality of the residues were not guaranteed. Linear regression models are sensitive to outliers that have a strong effect on the estimated average, thus robust linear regression using M estimators was also performed. Robust regression is an alternative to least squares regression when the data has influential outliers or observations. Robust regression can be a good strategy because its assumption is to weigh the observations differently based on how well-behaved those observations are. In other words, it is a form of weighted least squares regression. Through robust regression, we can conclude with more certainty which factors of TQM have a significant impact on the innovation of products and processes. Thus, the statistical analysis of our investigation was performed using the IBM SPSS Statistics 25 software and the extension for the robust regression “SPSSINC ROBUST REGR” was also used.

Table 6 presents some descriptive measures of the variables under study, observing that the variable “Product Innovation” has a lower average value ($M = 2.92$) compared to the others and “Continuous Improvement” has a higher average value ($M = 3.66$). The variable development/training of employees had the highest standard deviation.

Table 6. Descriptive statistics of the variables under study.

	<i>n</i>	Minimum	Maximum	Mean	Standard Deviation
Product innovation	287	0.84	4.19	2.9296	0.83247
Process innovation	287	0.87	4.36	3.2732	0.83768
Leadership/management's commitment	287	0.85	4.27	3.3305	0.76047
Focus on customer	287	0.82	4.12	3.4826	0.66102
Benchmarking	287	0.91	4.53	3.1152	0.87836
Involvement/empowerment of employees	287	0.83	4.17	3.0599	0.77015
Development/employees training	287	0.90	4.52	3.4055	0.94950
Quality/conception and product design	287	0.84	4.21	3.0945	0.78114
Data analysis/measurement of results	287	0.93	4.65	3.6604	0.90225
Continuous improvement	287	0.92	4.60	3.6680	0.85796

Figures 2 and 3 show the distributions of the dependent variables “Product Innovation” and “Process Innovation”, and of the independent variables, respectively. Only the variables “Development/employees training” and “Quality/conception and product design” were not observed outliers. In the remaining variables, outliers are identified, most of them with values of less than 1. This presence of outliers can lead to less accurate estimates when using the method of ordinary least squares.

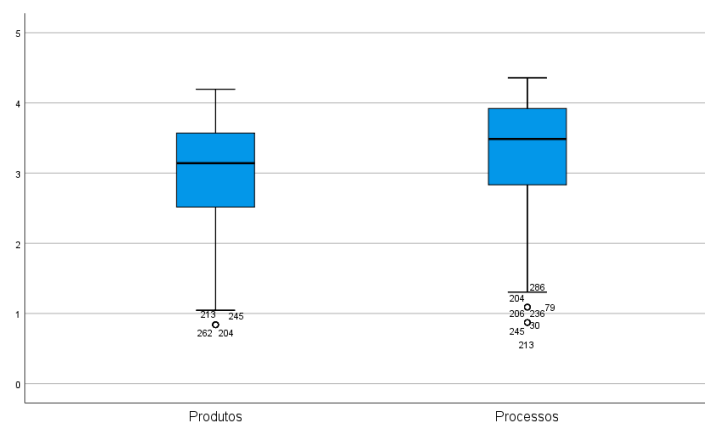


Figure 2. Boxplot of the distribution of the dependent variables “Product Innovation” and “Process Innovation”.

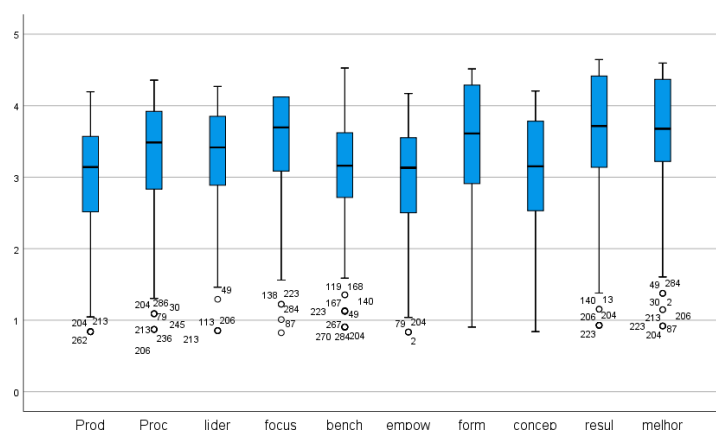


Figure 3. Boxplot of the distribution of the independent variables, namely the “TQM Dimensions”.

In this way, the linear regression coefficients of the models and the respective levels of significance are shown in Table 7 and the models with the dependent variable “Product Innovation” are shown in Table 8. To compare the results, Table 7 shows the least squares method for multiple linear regression, without selecting variables, and robust linear regression. Table 8 shows the model after multiple linear regression, with the selection of stepwise variables, and the coefficients of the robust linear regression. The same is shown in Tables 9 and 10 but for models with the dependent variable “Process innovation”.

Table 7. Multiple and robust linear regression for the dependent variable “Product innovation”.

Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>p</i>	Robust		
	B	Standard Error	Beta			B	Standard Error	<i>t</i> Value
(Constant)	0.927	0.229		4.043	0.000	0.647	0.222	2.914
Leadership/management’s commitment	0.022	0.097	0.020	0.228	0.820	0.022	0.094	0.236
Focus on customer	−0.005	0.106	−0.004	−0.050	0.960	0.062	0.103	0.602
Benchmarking	0.176	0.063	0.186	2.778	0.006	0.171	0.061	2.783
Involvement/empowerment of employees	0.101	0.097	0.093	1.036	0.301	0.064	0.094	0.676
Development/employees training	−0.116	0.080	−0.133	−1.453	0.147	−0.076	0.077	−0.983
Quality/conception and product design	0.397	0.098	0.372	4.045	0.000	0.425	0.095	4.466
Data analysis/measurement of results	−0.274	0.106	−0.297	−2.574	0.011	−0.336	0.103	−3.261
Continuous improvement	0.344	0.102	0.354	3.363	0.001	0.401	0.099	4.054

Table 8. Final multiple and robust linear regression for the dependent variable “Product Innovation”.

Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>p</i>	Robust			
	B	Standard Error	Beta			B	Standard Error	<i>t</i> Value	<i>p</i>
(Constant)	0.959	0.192		4.987	0.000	0.751	0.185	4.053	<0.001
Quality/conception and product design	0.375	0.089	0.352	4.237	0.000	0.408	0.085	4.779	<0.001
Benchmarking	0.192	0.059	0.203	3.237	0.001	0.190	0.057	3.327	<0.001
Continuous improvement	0.333	0.096	0.343	3.481	0.001	0.415	0.092	4.500	<0.001
Data analysis/measurement of results	−0.276	0.092	−0.299	−2.989	0.003	−0.318	0.089	−3.572	<0.001

Table 9. Multiple and robust linear regression for the dependent variable “Process Innovation”.

Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>p</i>	Robust		
	B	Standard Error	Beta			B	Standard Error	<i>t</i> Value
(Constant)	0.423	0.195		2.173	0.031	0.297	0.177	1.676
Leadership/management’s commitment	0.102	0.082	0.093	1.242	0.215	0.200	0.075	2.663
Focus on customer	0.096	0.090	0.075	1.059	0.291	0.067	0.082	0.815
Benchmarking	0.169	0.054	0.177	3.141	0.002	0.134	0.049	2.743
Involvement/empowerment of employees	0.353	0.083	0.324	4.270	0.000	0.304	0.075	4.038
Development/employees training	−0.050	0.068	−0.056	−0.732	0.465	−0.074	0.062	−1.190
Quality/conception and product design	0.004	0.083	0.004	0.050	0.960	−0.013	0.076	−.177
Data analysis/measurement of results	−0.146	0.090	−0.157	−1.615	0.108	−0.104	0.082	−1.264
Continuous improvement	0.344	0.087	0.352	3.961	0.000	0.395	0.079	5.000

Table 10. Final multiple and robust linear regression for the dependent variable “Process Innovation”.

Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>p</i>	Robust			
	B	Standard Error	Beta			B	Standard Error	<i>t</i> Value	<i>p</i>
(Constant)	0.577	0.163		3.532	<0.001	0.371	0.153	2.424	0.002
Leadership/management's commitment	-	-	-	-	-	0.150	0.067	2.222	0.003
Continuous improvement	0.319	0.061	0.326	5.186	<0.001	0.350	0.064	5.476	<0.001
Involvement/empowerment of employees	0.308	0.070	0.283	4.419	<0.001	0.238	0.065	3.657	<0.001
Benchmarking	0.188	0.053	0.197	3.569	<0.001	0.141	0.048	2.952	<0.001

Thus, in Table 7, without the selection of variables, it is concluded that “Benchmarking” (t -Student = 2.778; p -value = 0.006 < 0.05), “Quality/conception and product design” (t -Student = 4.045; p -value < 0.001), “Measurement of results” (t -Student = −2.574; p -value = 0.011 < 0.05), and “Continuous improvement” (t -Student = 3.363; p -value = 0.001 < 0.05) are the variables with a significant impact on “Product Innovation”. By applying the stepwise variable selection method, it is confirmed that the same variables have a significant impact, as well as by using robust linear regression (Table 8).

In other words, from the results of Table 8, it can be concluded that the variables “Quality/Conception and product design” (Beta = 0.375; t -Student = 4.237; p -value < 0.001), “Benchmarking” (Beta = 0.192; t -Student = 3.237; p -value = 0.001 < 0.05), “Continuous improvement” (Beta = 0.333; t -Student = 3.481; p -value = 0.001 < 0.05), and “Data analysis/Measurement of results” (Beta = −0.276; t -Student = −2.989; p -value = 0.003 < 0.05) have a significant impact on “Product Innovation”, with the variable “Data analysis/Measurement of results” having a negative impact.

In comparing the results of the linear regression using the least squares method with those of the robust linear regression, it is noted that the standard errors are slightly smaller for the robust linear regression. It is also verified that the coefficients of the variables “Quality/conception and product design” (Beta = 0.408; t -Student = 4.779) and “Continuous improvement” (Beta = 0.415; t -Student = 4.500) are higher, and the coefficients of “Benchmarking” (Beta = 0.190; t -Student = 3.327) and “Data analysis/measurement of results” (Beta = −0.318, t -Student = −3.572) decreased slightly, all being significant at a level of 1%.

As for the dependent variable “Process innovation”, it is shown in Table 9, without the selection of variables, that “Benchmarking” (t -Student = 3.141; p -value = 0.002 < 0.05), “Involvement/empowerment of employees” (t -Student = 4.270; p -value < 0.001), and “Continuous improvement” (t -Student = 3.961; p -value < 0.001) are the variables with significant impact. By applying the stepwise variable selection method, it is confirmed that the same variables have a significant impact, but the results of the robust linear regression show that “Leadership/management's commitment” is also significant for the model (p -value = 0.003) (Table 10).

That is, from the analysis of the results in Table 10, it is concluded that “Benchmarking” (Beta = 0.188; t -Student = 3.569; p -value < 0.001), “Involvement/Empowerment of employees” (Beta = 0.308; t -Student = 4.419; p -value < 0.001), and “Continuous improvement” (Beta = 0.319; t -Student = 5.186; p -value < 0.001) have a significant and positive impact on “Process Innovation”.

In comparing the results of the linear regression using the least squares method with those of the robust linear regression, it is observed that the variable “Leadership/Management's commitment” (Beta = 0.150, t -Student = 2.222; p -value = 0.003 < 0.05) was included in the model. Standard errors decreased slightly in the robust linear regression, as did the “Involvement/Empowerment of employees” (Beta = 0.238, t -Student = 3.657), and “Bench-

marking" (Beta = 0.141; *t*-Student = 2.952) coefficients. As for "Continuous improvement" (Beta = 0.350), the coefficient increased.

Thus, according to the results of Tables 8 and 10, the equations of the proposed multiple linear regression models are illustrated as follows:

$$\text{Product Innovation}_i = 0.751 + 0.190 \times \text{Benchmarking}_i + 0.408 \times \text{Quality/Conception and product design}_i - 0.318 \times \text{Measurement of results}_i + 0.415 \times \text{Continuous improvement}_i + u_i \quad (1)$$

$$\text{Process Innovation}_i = 0.371 + 0.150 \times \text{Leadership/Management's commitment}_i + 0.141 \times \text{Benchmarking}_i + 0.238 \times \text{Involvement/Empowerment of employees}_i + 0.350 \times \text{Continuous improvement}_i + u_i \quad (2)$$

Concerning the interpretation of Equation (1), its values indicate that the increase of one unit in the variable "Benchmarking" results in an average increase of 0.190 units in the value of the dependent variable "Product innovation"; the increase of one unit in the variable "Quality/conception and product design" implies an increase of 0.408 units in the value of "Product innovation"; an increase of one unit in the variable "Continuous improvement" implies an increase of 0.415 units in the value of "Product innovation"; and an increase of one unit in the "Measurement of results" variable implies a decrease of 0.318 units in the value of "Product innovation".

Concerning the interpretation of Equation (2), its values indicate that the increase of one unit in the variable "Leadership/management's commitment" results in an average increase of 0.150 units in the value of the dependent variable "Process innovation"; the increase of one unit in the variable "Benchmarking" implies an increase of 0.141 units in the value of "Process innovation"; an increase of one unit in the variable "Involvement/empowerment of employees" implies an increase of 0.238 units in the value of "Process innovation"; and an increase of one unit in the "Continuous improvement" variable implies an increase of 0.350 units in the value of the dependent variable "Process innovation".

Thus, considering the data collected and analyzed, it is possible to confirm the following research hypotheses: H1b, H3a, H3b, H4b, H6a, H7a, H8a, and H8b.

5. Conclusions

The relationship between TQM and innovation has been extensively studied, with greater emphasis in recent years largely due to its importance for knowledge and improving the performance of companies. The close relationship between these concepts is recognized and therefore it is important to study how they are related. The concept of TQM is based on a perspective of continuous improvement, with repercussions on the different dimensions that can be found within a business. Conversely, innovation strategies are based on a more disruptive perspective, as placing new products and/or services on the market, totally new for the customer, will always involve some risk.

However, only companies with an innovative capacity can remain competitive in the market and be able to react to the adversities of everyday life. For this reason, our research is of crucial importance for the knowledge of these themes in the Portuguese business context, allowing for the acquisition of knowledge concerning small and medium-sized Portuguese companies, and for discovering how they can adopt more innovation strategies, both at the level of products and services, as well as in terms of processes, that is, in the way they "do things" and how they can be more efficient and effective. Thus, considering the data collected and analyzed, we can conclude that several dimensions of TQM, such as, benchmarking, quality/conception and product design, and continuous improvement have a significant and positive association with product innovation. Although the data analysis/measurement of results dimension had a significant association with product innovation, this association is negative. Furthermore, TQM dimensions such as, leadership/management's commitment, benchmarking, involvement/empowerment of employees, and continuous improvement revealed a positive and significant association with process innovation. The results of this investigation are in line with other conclusions obtained by other investigations, such as Antunes et al. [18] in which they concluded

that TQM practices are a favorable condition for the definition of innovation strategies, both for products and processes. Our results are also supported by the studies of Feng et al. [31], Hoang et al. [38], Perdomo-Ortiz et al. [48], and Martinez-Costa et al. [14]. Hoang et al. [38] concluded that leadership and people management have shown a positive impact on innovation performance. In addition, the study developed by Perdomo-Ortiz et al. [48] showed that the dimensions of TQM favor the development of entrepreneurial innovation capacity. Lastly, Martinez-Costa et al. [14] concluded that TQM promotes innovation strategies because they found evidence that TQM is not only a good way to improve quality but also a very important way to facilitate the innovation process.

However, it is also important to highlight some limitations identified that could lead to an interpretation of the data with some possible reservations. In some situations, it was not possible to identify the person who responded to the questionnaire and obtain confirmation that it was a professional qualified with the knowledge to answer it. In this way, it is worth noting the possible situation of the respondent not being able to answer all the questions, which may bias the veracity of some answers.

In a similar manner, it is also considered pertinent to make some suggestions for future research. One of these suggestions is to develop studies that can analyze Portuguese companies in greater detail, directing them to specific categories of companies, for example, by characterizing them by sector of activity.

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Appendix A

Table A1. Questions/data collection for dimensions and variables in the research study.

Innovation	Questions
Innovation of Products	1. My organization provided in the last two years new products/services completely different and innovative of those already existing in the market.
	2. My organization uses new and innovative technology in the design of new products and in the supply of new services, always creating new products/services different from those of its portfolio.
	3. My organization was the one that placed more innovative products/services on the market in the last two years.
	4. The innovation strategy of products/services is viewed by my organization as a determinant to increasing market share and results.
Innovation of Processes	5. My organization adopts the latest technological innovations in its internal processes.
	6. My organization often modifies its processes, techniques, and technologies to follow an innovative strategy.
	7. The innovation strategy of internal processes is viewed by my organization as a determinant for increasing the efficiency of the organization.
	8. The innovation strategy is communicated clearly and objectively to all employees within the organization so it can be implemented and enforced in all internal processes.

Table A1. Cont.

Innovation		Questions
Total Quality Management Dimensions		Questions
Leadership/management's commitment	9.	The administration/top management considers quality as being more important than the cost.
	10.	The performance assessment defined by the direction/top management depends strongly on the quality.
	11.	The direction/top management provides adequate resources to improve the quality.
	12.	There are quality objectives clearly defined by the direction/top management.
Focus on customer	13.	Production managers are aware of the outcome of the evaluation surveys concerning customer satisfaction.
	14.	Production managers regularly receive information regarding customer complaints.
	15.	To achieve higher levels of customer satisfaction, my organization actively looks for ways to improve its products/services, meeting the needs and preferences of customers.
	16.	The organization has focused on the customer in the past two years.
Benchmarking	17.	My organization is committed to a comprehensive benchmarking analysis of the products/services of its competitors and of those which are similar to its products/services.
	18.	The benchmarking activities of my organization have enabled us to reduce costs.
	19.	My organization has been committed to an extensive benchmarking analysis of business processes from other companies that operate in other industries.
	20.	Benchmarking has contributed to the improvement of our products/services.
Involvement/empowerment of employees	21.	My organization often uses cross-functional teams to improve quality.
	22.	A platform to clarify issues and solve quality-related problems is available to employees.
	23.	All suggestions from employees regarding quality are analyzed.
	24.	Most of the suggestions of employees for quality improvement are implemented.
Development/employees training	25.	In my organization, resources needed for the training of employees in the quality area are available.
	26.	In my organization, quality training sessions designed for employees are often performed.
	27.	Top managers are often involved in the training for the quality area.
	28.	Employees of my organization face new seminars and training sessions concerning quality, as new learning and the acquisition of knowledge are useful exercises for the performance of their duties.
Quality/conception and product design	29.	My organization carries out a detailed review of the quality of products and services before they are sold/provided.
	30.	The quality department directly participates in the design process and in the design of products and services.
	31.	In my organization, the quality of products and services is more important than the costs.
	32.	The organization uses the best quality materials in the design of its products and the best technology/processes in the provision of its services.
Data analysis/measurement of results	33.	Decisions regarding quality improvement are made based on objective data.
	34.	There are specific procedures and tools to ensure the reliability and relevance of quality data.
	35.	My organization often analyzes the data concerning the quality to improve its products, services, and processes.
	36.	The quality data are used as a management tool for quality management.

Table A1. Cont.

Innovation	Questions
Continuous improvement	37. Employees believe that continuous improvement is also their responsibility.
	38. There is a strong commitment to continuous improvement at all levels of the organization.
	39. In my organization, quality improvement programs that aim to reduce waste, promote a better use of resources, and ensure the elimination of activities that do not create value for the products, services, or processes are adopted.
	40. In my organization, continuous improvement is a way to gain competitive advantage over competitors.

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