

Álvarez, J.; Miguel-Dávila, J.A.; & Nieto, M. (2017): "The innovation strategies for managing a specific paradox: exploration/exploitation", *Management & Business Excellence* (en prensa).

THE INNOVATION STRATEGIES FOR MANAGING A SPECIFIC PARADOX: EXPLORATION/EXPLOITATION

Abstract

The present era requires new research in order to manage the current exploration/exploitation paradoxes. The paper analyzes the influence of Total Quality Management (TQM) on exploratory and exploitative strategies. The study tests the hypotheses empirically using a sampling of over 12000 Spanish firms, by performing several logistic regressions to analyze the impact of TQM on each type of strategy innovation.

Organizational innovations based on TQM have been very important in Spain in the last years. Managers can use the potential inherent in TQM to meet the exploration-exploitation paradox. TQM contains values pertaining to exploration and exploitation which are useful for promoting strategies for innovation processes, but means a greater weakness for promoting exploration in strategic formulation. When a company engages in internal R&D activities within a TQM environment, its capacity to make commitments and establish objectives in terms of exploration and exploitation is reinforced.

Keywords TQM, Innovation Strategy, Exploration, Exploitation.

THE INNOVATION STRATEGIES FOR MANAGING A SPECIFIC PARADOX: EXPLORATION/EXPLOITATION

Introduction

Constant improvement, renewal and adaptation can be achieved in companies by focusing their efforts on quality and innovation. Many studies have been oriented towards, and continue with, a deepening of the knowledge of the relationships between both constructs (Prajogo and Sohal, 2001; 2004; Kim *et al.*, 2012; Zehir *et al.*, 2012; Moreno-Luzón *et al.*, 2013; Zeng *et al.*, 2015). This research indicates incremental tendencies of some key practices of quality management, which suggest adopting precautions for its coexistence along side the innovation process (Benner and Tushman, 2002; Naveh and Erez, 2004). Given this approach, many companies have come to understand that quality management can reduce the capacity for more ambitious changes using R&D (Brennan, 2001).

Identifying key practices of TQM has been one of the challenges of the literature pertaining to quality in recent years. Furthermore, it has served as a basis for identifying key elements of quality management. The study by Hackman and Wageman (1995) with a focus on the TQM approach emphasizes the desire to reduce variability within the philosophy of quality management. The principles of variability control found in the classic conceptualization of quality can inhibit revolutionary, though uncertain, innovations (Benner and Tushman, 2002; 2003). These practices tend to exploit companies' abilities but avoid assuming the risks of exploring new opportunities. March's seminal study (1991) on exploration and exploitation marks the values of both extremes of management theory. Thus, the difficulty of identifying the most relevant practices of TQM is added to that of determining for each if there is a trend towards exploration or exploitation (Moreno-Luzón *et al.*, 2013; Zhang *et al.*, 2014). TQM denotes a “difficulty in addressing the multitude of performance outputs desired from a quality management system” (Leavengood *et al.*, 2014: 1130).

This era raises multiple tensions and requires new paradoxical strategic research (Benner and Tushman, 2015), which must include the tensions between quality and innovation. Some quality practices converge with the values of exploitation (Kim *et al.*, 2012; Moreno-Luzón *et al.*, 2013); however, companies need strategies that incorporate values in exploration and exploitation (He y Wong, 2004). Recent literature uses a paradoxical approach to analyze the

dual relationship exploration – exploitation (O'Reilly and Tushman, 2013). TQM practices and strategy innovation can exist simultaneously and persist over time but they can generate the tensions and contradictions of a paradox. We explored the challenges of engaging in activities (TQM and R&D) within one organization in a way that meets conflicting requirements (exploratory and exploitative strategies). Our aim was to find a possible synergistic effect between R&D and TQM practices for managing the exploration/exploitation specific paradox. As Lewis et al., (2014: 62) point out managing paradox therefore requires a creative approach that leverages the benefits of each side separately, while also tapping into their synergistic potential.

It may be possible to use TQM practices for exploration (Wu *et al.*, 2011; Kim *et al.*, 2012; Moreno-Luzón *et al.*, 2014; Zhang *et al.*, 2014) and to go beyond mere incremental innovations based on exploitation. This research paper verifies the possibilities of TQM to operate with innovation process strategies based on exploration and exploitation, as well as its synergistic effect on internal R&D activities. Furthermore, this paper responds to the need to delve deeper into the study of the functions that characterize companies capable of operating in exploration-exploitation dimensions (Lavie *et al.*, 2010; O'Reilly and Tushman, 2013; Benner and Tushman, 2015). This is particularly the case when there is a strong commitment to TQM practices, while conserving the attributes described in March's research (1991) and searching for a possible synergistic effect between TQM and R&D.

Theoretical framework and research model

Total Quality Management (TQM)

TQM is a form of integrated management (Hackman and Wageman, 1995; Powell, 1995) focused on customer satisfaction through continuous process improvement (Dean and Bowen, 1995; Sitkin *et al.*, 1994). TQM unfolds a control and improvement system “to reduce variance or errors in order to more effectively meet customer needs” (Sitkin *et al.*, 1994: 542), based on different principles, practices and techniques (Dean and Bowen, 1995). Variability must be watched and analyzed to avoid quality-related problems. “A fundamental premise of TQM is that the costs of poor quality (such as inspection, rework, lost customers, and so on) are far greater than the costs of developing processes that produce high-quality products and services” (Hackman and Wageman, 1995: 310). Reducing variability is a tenet of quality.

The repercussions of the TQM movement have not gone unnoticed in research on innovation. Several research projects have focused on the relationship between these two constructs (Prajogo and Sohal, 2001; Hoang *et al.*, 2006). According to the Oslo Manual (OECD, 2005), organizational innovations based on quality management contribute to the introduction of new practices that can favor the learning and distribution of knowledge in companies. Quality shares a common scope with innovation processes, creativity and the development of new ideas (Prajogo and Sohal, 2001), seen however from the view point of a philosophy of control, rationalization and variability reduction (Hackman and Wageman, 1995).

Actually, “broader questions on how organizations effectively manage strategic paradox remain even as the number of paradoxical pressures facing organizations has substantially increased” (Benner and Tushman, 2015: 509). Benner and Tushman (2002; 2003) expressed caution regarding the incremental tendency some key TQM practices can exert on the innovation process. That tendency contrasts with evidence from more recent research. Kim *et al.* (2012) indicate the possibility of developing radical innovations operating under quality principles when there is a profound transformation of values (Moreno-Luzón *et al.*, 2013; 2014; Asif *et al.*, 2015). The absence of conclusive results makes it necessary to explore the recent possibilities of using “TQM to obtain strategic innovation objectives” (Moreno-Luzón *et al.*, 2013:1161) in depth.

Exploratory and exploitative strategies

March (1991) assigned a set of attributes to the terms exploration and exploitation that have allowed the literature on management to pursue further study of both constructs. The coexistence of the two is associated positively with the growth of sales, performance, innovation and the survival of companies (O'Reilly and Tushman, 2013). Both dimensions have been used in different academic works as a means of explaining phenomena that favor 1) competitive advantage (He and Wong, 2004; Rothaermel and Alexandre, 2009), 2) strategic alliances (Rothaermel and Deeds, 2004), 3) criteria for organizational design (Jansen *et al.*, 2006), 4) tendencies of innovation processes (Rosenkopf and Nerkar, 2001; Benner and Tushman, 2002) and, more recently, 5) to explain the results of quality management (Wu *et al.*, 2011; Zhan *et al.*, 2014).

Exploration is associated with new alternatives, research, variation, risk-taking, experimentation, discovery, and, as a result, with uncertainty, results distant in time, and

often, negatives. **Exploitation** converges with refinement, efficiency, implementation, execution and allows purifying technological competences acquired and predicting results in the short term. “The essence of exploitation is the refinement and extension of existing competences, technologies, and paradigms”, whereas “the essence of the exploration is experimentation with new alternatives” (March, 1991: 85). Exploitation is associated with the use and development of already well-known aspects, whereas exploration is associated with the quest for new knowledge. But their coexistence generates a dilemma: “The basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability” (Levinthal and March, 1993:105).

Those companies classified as **ambidextrous** are able to surmount the tensions created between the exploration-exploitation poles. They operate in both settings. They are able to interrupt present competitive advantage in favor of emergent opportunities (Tushman and O'Reilly, 1996). The dilemma of ambidextrous companies is part of the conflicts that can arise during company strategy formulation (Hitt *et al.*, 2011; Siren *et al.*, 2012). While exploratory strategies pursue the proactive advantage of new opportunities, uncertain benefits and a high risk of failure, exploitative strategies respond to the existing needs of the market by means of refinement and development of existing routines with greater short term security (O'Cass *et al.*, 2014).

Research question

Research directed towards understanding the relationship of exploration-exploitation and innovation processes has generated a variety of conclusions and mixed results due to the multidimensional nature of TQM (Prajogo and Sohal, 2001, 2004; Martínez-Costa and Martínez-Llorente, 2008; Zehir, *et al.*, 2012). “Although empirical support for a positive relation is stronger than for a negative one, conclusive results are yet to appear” (Moreno-Luzón *et al.*, 2013: 1150). Recently, recognition has been given to the possibilities of TQM regarding the ability to adapt and operate in exploratory and exploitative contexts (Zhang *et al.*, 2014; Wu *et al.*, 2011). This new approach of TQM could leave the tendency, suggested by Benner and Tushman (2002; 2003), towards the exploitation of key practices behind.

This research aims at understanding the utility of **TQM** for companies that decide to operate simultaneously in the dimensions of exploration and exploitation, whether in isolated form or

in coexistence with **internal R&D**. He and Wong (2004) consider the strategy of the innovation process to be previous (ex-ante) to results (ex-post). With this in mind, we believe that companies that achieve radical and incremental innovations have previously promoted strategic objectives pertaining to both types of innovations. Independent of the success of the result, it is to be expected that TQM, on its own, is able to design objectives based on incremental or exploitative innovations, as well as on radical or exploratory innovations.

Thus, the research question is: How do organizational innovations based on TQM and an internal R&D function affect the adoption of innovation process strategies based on exploration and/or exploitation? Figure 1 displays the research model used.

----- Figure 1 near here -----

Formulation of hypotheses

TQM values based on exploitation

Exploitative strategies respond to existing market needs having minimally ambitious innovations while offering an assured benefit in the short term (Siren *et al.*, 2012; O'Cass *et al.*, 2014). TQM promotes initiatives that will be perceived as satisfactory by customers and which facilitate the adoption of incremental innovations (Kim *et al.*, 2012; Moreno-Luzón *et al.*, 2013). The principles of exploitative strategies are in alignment with the incremental tendency that TQM promotes. This suggests the formulation of the following hypothesis:

- H1a - *Those companies that carry out organizational innovations based on TQM tend to adopt innovation strategies based on exploitation.*

TQM builds on continuous process improvement in order to raise customer satisfaction (Sitkin *et al.* 1994; Powell, 1995). The optimization of processes reduces variability and activity time, allowing improvements in terms of effectiveness and efficiency. Once processes have improved, they are standardized as better practices and become organizational routines (Benner and Tushman, 2002; Hackman and Wageman, 1995). The TQM culture transforms the best practices into routines so that they are maintained longer and are integrated into the company's activity.

Exploitative innovations satisfy customer needs, which are recognized which are understood better and faster. The objectives that promote these innovations are likely to become

organizational routines in TQM environments. This being so, the following modified hypothesis is formulated:

- H1b - *Companies that carry out organizational innovations based on TQM tend to maintain exploitative innovation strategies over time.*

TQM values based on exploration

Quality management models have evolved according to the needs of companies and markets. TQM has demonstrated its capacity to adapt to contextual variables. Considering TQM as a model which is “one-size, may not lead to optimal outcomes” (Zhang *et al.*, 2012: 12). The new TQM approach emphasizes “customization” of its practices to operate in exploratory and exploitative dimensions (Wu *et al.*, 2011; Zhang *et al.*, 2014; Moreno-Luzón *et al.*, 2014).

This capacity for adaptation is linked to the existence of values for exploration within the classic TQM conceptualization (Douglas and Judge, 2001) and of creative links and the renewal of ideas with the innovation process (Prajogo and Sohal, 2001). TQM also can pursue more ambitious innovations than those based on exploitation (Kim *et al.*, 2012). Companies can transform TQM practices and adapt them over time to converge with strategic values pertaining to exploitation and exploration (Zhang *et al.*, 2012); TQM does not create an unbalanced sway towards exploitation (Moreno-Luzón and Valls, 2011: 929).

If companies have managed to operate in the field of exploration in keeping with TQM philosophy (Moreno-Luzón and Valls, 2011; Kim *et al.*, 2012), it is only logical to think of a strategic formulation beyond incremental innovation and exploitation, since strategic formulation must be considered (ex-ante), (He and Wong, 2004). We believe TQM is not a barrier to formulating explorative strategies. Companies committed to quality perceive the importance of exploration and undertake commitments in that area. Considering the previously-mentioned points the following hypothesis can be formulated:

- H2a - *Companies that carry out organizational innovations based on TQM tend to adopt exploratory innovation strategies.*

Inasmuch as the values pertain to the TQM culture, they are permanently integrated as routines (Hackman and Wageman, 1995). Currently, the focus of TQM in literature maintains this integrating character, which at the same time is synergistic, in order to operate in the dimension of exploration and exploitation (Wu *et al.*, 2011; Kim *et al.*, 2012; Zhang *et al.*, 2014). Ambidextrous companies operating in both dimensions are characterized by

maintaining that behavior for a certain period of time (O'Reilly and Tushman, 2013). Therefore, if companies committed to quality are able to operate as ambidextrous companies (Moreno-Luzon and Valls, 2011), they must maintain their commitment to exploration over time. Taking into consideration the above, the hypothesis is formulated as follows:

- H2b - *Companies that carry out organizational innovations based on TQM tend to maintain exploratory innovation strategies over time.*

Internal R&D activities in TQM environments

Ambidextrous companies capable of operating in terms of exploration and exploitation are able to assume values pertaining to both contexts. The essential practices of TQM have demonstrated a clear affinity with innovations which are incremental or exploitative (Naveh and Erez, 2004; Benner and Tushman, 2002). More recent research extends this affinity to radical innovations based on exploration (Kim *et al.*, 2012), although this may require profound transformations in beliefs and values (Moreno-Luzón *et al.*, 2013).

The innovation process strategy precedes its results (He and Wong, 2004). The success of ambidextrous innovation action requires facing the strategic dilemma of operating within its accumulated knowledge and simultaneously exploring new possibilities (Cantarello *et al.*, 2012: 28). The adoption of exploratory and exploitative innovations requires unconditional commitment to both strategies. “The implementation of exploratory and exploitative strategies depends on distinctive capabilities that are exploratory and exploitative in nature” (O’Cass *et al.*, 2014: 863). TQM promotes exploratory and exploitative capacities, but it is insufficient in itself to achieve ambitious innovations (Moreno-Luzón *et al.*, 2013).

“TQM needs to be complemented by other resources to more effectively realize the strategy and achieve a high level of performance” (Lin and Chai, 2012: 1125). Prajogo and Sohal (2006) suggest that the coexistence of TQM and R&D produces a synergetic effect on quality and innovation. The internal function of R&D favors the exploration of the environment for the search and evaluation of external knowledge (Tsai and Wang, 2008; Higgins and Rodriguez, 2006) and can compliment the weaknesses of TQM at the exploratory end. We suggest that the existence of internal units of R&D in TQM environments can promote values pertaining to the exploratory domain. This combination reinforces the innovation process strategies based on exploration and exploitation in time and form. The hypothesis is formulated as follows:

- H3a - *Companies with internal R&D activities that carry out organizational innovations based on TQM tend to adopt exploratory innovation strategies.*

TQM environments are favorable for incremental innovation and able to operate under the conditions imposed by exploitation (Moreno-Luzon et al., 2013). Variability control and continuous improvement converge with exploitative innovations and consequently, with the assumption of commitments in this area. At the same time, R&D includes exploratory and exploitative activities (Rothaermel and Deeds, 2004; Mudambi and Swift, 2014). It is foreseeable that the coexistence of TQM and an internal R&D function will also produce a synergetic effect at the exploitative end, facilitate the adoption of strategies in that dimension. In view of the above, the following hypothesis is formulated:

- H4a - *Companies engaging in internal R&D activity that carry out organizational innovations based on TQM tend to adopt exploitative innovation strategies.*

Exploration and exploitation are part of the new approach attributed to TQM in most recent literature. Companies have transformed the practices of TQM to better serve their needs and the challenges of their environments (Wu et al., 2011). The values for exploration and exploitation which TQM provides should be implemented as part of the routines of the organization, as the conversion of best practices into routines and beliefs of the organization is an essential element of TQM (Dean and Bowen, 1995; Sitkin et al., 1994). On the other hand, TQM promotes decentralization (Hackman and Wageman, 1995) and thus work is enriched (Moreno-Luzon and Valls, 2011). Coexistence with internal R&D and the synergistic effect between the two functions suggested by Prajogo and Sohal (2006) therefore should not alter the basic principles of TQM. We suggest that companies committed to TQM remain committed to exploration and exploitation over time when there is an internal R&D function. In accordance with the aforementioned, the hypotheses are formulated as follows:

- H3b - *Companies with internal R&D activities that carry out organizational innovations based on TQM tend to maintain exploratory innovation strategies over time.*
- H4b - *Companies engaging in internal R&D activity that carry out organizational innovations based on TQM tend to maintain exploitative innovation strategies over time.*

Methodology

Sampling and methods

An empirical study has been done using the information of the Survey on Innovation in Companies. The database makes it possible to monitor innovation activities in Spanish companies. The survey provides information on companies' technological strategy and the importance granted to organizational innovations carried out. The surveys used concerned the period from 2008 to 2011, which was the data available at the time of initiating research. Data provided by the surveys was processed by colleagues from the research group in such a way as to maintain the order of business relationships in the database, while preserving confidentiality regarding data used (names, addresses, etc.). The database has been set up as to allow access to data from the same companies chronologically. This makes it possible to observe the assessment and the most significant trends/changes of organizations.

The data used encompasses to 12813 observations between 2008 and 2011. This is the most recent period available for research regarding the evolution of innovation strategies in companies committed to TQM

The TQM-measurement items are based on organizational innovations related to quality management and were carried out by the companies in 2008.

The TQM founders, W. Edwards Deming, Joseph Juran and Haoru Ishikawa, favored constantly challenging an organization's control of quality costs in order to diminish failure rates, avoid repetitions and ensure that work was carried out correctly the first time (Hackman and Wageman, 1995). The control of quality costs is one of TQM's essential factors (Tari, 2005; Pinho, 2008) which can influence the innovation process (Prajogo and Sohal, 2001). The design of proxy variables in TQM (*tqm108*) is completed by items related to continuous quality improvement and interfunctionality because they are central elements of TQM (Hackman and Wageman, 1995). Prajogo and Sohal (2001) argued both for and against them with respect to their positive relation to innovation processes.

Independent variables

The Survey of Innovation in Companies provides information on the organizational innovations adopted by the companies. These proxy practices in TQM are related to the reduction of costs for poor quality, continuous quality improvement and interfunctionality.

According to the Spanish National Institute of Statistics (INE) the period in question is characterized by a gradual reduction of the internal cost of R&D (from 8,073 million euros to 7,396 million euros) and the increasing importance of certain organizational innovations (quality and costs) as of 2008, but also by a slight reduction of those innovations related to interfunctionality (table 1).

----- Table 1 near here -----

The independent dichotomous variable *tqm108*, proxy for TQM, is made up of those observations that were attributed to be of great importance (A=1) to the organizational innovations (section I.3 of the survey) in 2008 based on: i) smaller costs per unit produced, proxy for cost reduction of non-quality costs; ii) greater quality of its goods and services, proxy for the continuous quality improvement; or, iii) improvement of the information exchange or of communication, proxy for the interfunctionality. The variable is assigned the value 1 when the importance attributed is high and 0 for the contrary case. In this first part of the analysis those companies were selected that did not engage in internal R&D activity in order to know how far they tended towards process innovation strategies based on exploration and exploitation when TQM operated separately.

The second part of the analysis studies companies that granted high importance (A=1) to organizational innovations of TQM and carried out internal R&D activities, represented by proxy variable *itqm108*.

Dependent variables

The dependent dichotomous variables *oexploreA_XY* and *oexploitA_XY* represent companies that placed high importance (A=1) on the objectives (section E.6 of the survey) that constitute the variables in 2009 (XY=09), 2010 (XY=10) and 2011 (XY=11), in which case the value 1 was assigned and 0 for the contrary. Companies that described these objectives as average, of low importance or irrelevant were rejected.

The variables have been designed incorporating proxy variables of the measures used by He and Wong (2004) for the exploratory and exploitative strategies of innovation processes (Table 2). In this way the research remains in alignment with the existing approach from

March's research (1991). This continuity sidesteps the use of different phenomena or contexts of exploration-exploitation and maintains the sense suggested by O'Reilly and Tushman (2013).

----- Table 2 near here -----

Control variables

The control variables used have been used in other academic works related to the research, such as size (O'Cass *et al.*, 2014; Zhang *et al.*, 2014), represented by the variable *size08*, the technological intensity of the sector in which the company operates (Leiponen and Helfat, 2011), which is divided into high (*htec08*), medium (*mtec08*) and low technology (*ltec08*), innovation costs (*costs08*) (Grimpe and Kaiser, 2010) and exporting activity (*exporta08*) (Lisboa *et al.*, 2013).

As the study was conducted on Spanish companies, the location is included as a control variable because the distribution of resources and the intensity of R&D activity is not uniform within the country (Herrera and Sanchez, 2013). In Spain, as in many other developed countries, innovating activity is confined to certain regions. The Survey on Innovation in Companies demonstrates that Madrid and Catalonia invest a substantial part of their business expenditure in R&D in Spain and contains technological indicators that perceptively differentiate them from the remaining regions (Herrera, 2012). The data allows distinguishing among the companies located in Madrid (*mad08*), Catalonia (*cat08*) and the remaining regions (*rest08*).

Descriptive statistics: multicollinearity and correlation

Checking multicollinearity allows verifying the absence of correlation between the independent variables. The analysis was performed by means of the Variance Inflation Factor (VIF) and reveals the absence of multicollinearity, with the greatest factor being 1.54.

The solution adopted in this research has been to restrict certain central variables related to the technological sector, maintaining the extremes of the control variables to identify possible tendencies. The results of multicollinearity and the VIF-coefficient for the independent variables used in the research models are detailed in Table 3.

----- Table 3 near here -----

The correlation coefficients between the variables used in the research model used are listed in Table 4.

----- Table 4 near here -----

Results and discussion

TQM

Tables 5 and 6 display the data collected in the logistic regressions that relate the explanatory variables related to TQM and R&D to the dependent variables: *oexplora1_XY*, proxy for exploratory strategies and *oexploita1_XY*, proxy for exploitative ones, in (XY) 2009, 2010 and 2011 from 12813 observations.

The goodness of fit has been validated by means of $PseudoR^2$ to verify the precision of the approximation of both models to the data used. With the object of correcting possible effects of heteroscedasticity, the values of standard errors have been obtained from the option *robust* of the regression. The recessions demonstrate the percentage of variation of the probability calculated by means of the expression $(\exp[\beta]-1) \times 100$.

The results of Table 5 display a positive and statistically significant relation between the variable *tqm108* and the dependent variables *oexplora109*, *oexplora110*, *oexploita109* and *oexploita110*, proxy variables for the strategies of the innovation process based on exploration and exploitation in 2009 and 2010. This relationship only allows verifying hypotheses *H1a* and *H2a*. The lack of statistical significance in 2011 forces us to only partially accept the hypotheses *H1b* and *H2b*. The percentages of probability reflect that commitment to TQM is much clearer with targets for exploitation. TQM does not inhibit the commitment to exploratory and exploitative goals. As suggested by Moreno-Luzón and Valls (2011), TQM is able to cause a synergistic effect favoring ambidextrous behavior. Positive coefficients indicate the possibility that TQM may be able to converge with the beliefs and commitments of exploration and exploitation (Moreno-Luzón and Valls, 2011; Kim et al, 2012), although this trend is not constant over the observation period.

As expected, TQM promotes exploitative values for strategic planning, as well as exploratory values. However, the percentual influence of TQM on the adoption of exploratory and exploitative strategies is appreciably different: the commitment to organizational innovations based on TQM increased the adoption of exploratory strategies by 53% in 2008, exploitative ones by 91% in 2009, and by 40.4% and 60.3% respectively in 2010.

This verified that belonging to a high-technology sector can influence the adoption of exploratory strategies negatively, whereas size can influence exploitative strategies positively when a high commitment to TQM is present.

Substantial differences related to the location of the companies have not been obtained, while positive and statistically significant coefficients were present throughout the period. As far as exports and innovation costs are concerned, they favor the adoption of both types of strategies, although they promote exploratory TQM values to a greater degree.

Coexistence of TQM and internal R&D function

Table 6 contains the values of the obtained regressions for the analyzed companies which combine internal R&D activities and high commitment to TQM. In general terms, a high potential for adopting and maintaining both types of strategies is verified when companies with internal R&D activity are committed to TQM. The effectiveness of the complementary resources suggested by Lin and Chai (2012) in the strategic dimension is verified; in this case, in the shape of internal R&D activities and their synergetic effect on TQM (Prajogo and Sohal, 2006). The positive and statistically significant results allow checking and verifying *H3a*, *H4a*, *H3b* and *H4b*. From the verification of these hypotheses it can be concluded that there is a commitment to exploratory and exploitative objectives over the period of study when internal R&D coexists alongside a commitment to TQM. Internal R&D overcomes the shortcomings of TQM in order to operate alone in the dimension of exploration (hypotheses *H2b* is only partially accepted) during the period of study.

The underlying synergistic effect between internal R&D and TQM (Prajogo and Sohal, 2006) favors the interest of companies to operate in exploration and exploitation scenarios simultaneously. TQM is an accessible platform for ambidexterity (Moreno - Luzon and Valls,

2011), which allows exploration and exploitation at the same time, and thereby addresses tensions of this paradox. Research results suggest that they confirm synergies inherent to TQM, but these are favored by the existence of internal R&D units and allow to maintain that behavior throughout the period of study.

----- Table 6 near here -----

The coexistence within the company of strongly committed TQM environments and internal R&D units promote strategic targets for exploration and exploitation which are maintained over time. This combination increases the probability of exploratory innovation process strategies being adopted by 109%, thereby reinforcing the probability of adoption, but also at the exploitative pole by 166%, superior to companies without internal R&D function. Although over time these percentages decrease, they retain a positive and statistically significant relationship. The coexistence of TQM and internal R&D promotes exploratory and exploitative objectives more intensely than TQM by itself (see previous table 5).

This tendency allows companies to formulate strategies of ambidextrous innovation processes; but there continues to be a significant tendency towards exploitation. This phenomenon might be due to:

- the reduction of internal R&D investment during the period studied, reducing exploration efforts of R&D to harness those based on exploitation.
- the tendency towards exploitation within the classic conceptualization of TQM.

The fact that it belongs to the high-technology sector continues exerting a negative effect on the formulation of exploratory strategies, although the statistical relevance for this control variable is not maintained over time as it is in the isolated study of TQM. The size is significantly and positively related to exploitative strategies.

Nor have substantial differences related to the location of the companies been detected. Exports and innovation costs continue favoring the adoption of both types of strategies, though those related to exploration are favored to a greater degree.

Table 7 presents a summary of the fulfillment and the total or partial acceptance of the hypotheses raised according to the results obtained.

----- Table 7 near here -----

Conclusions

Our research has analyzed the repercussions of organizational innovations based on TQM carried out in 2008 on the strategies of exploratory and exploitative innovation processes in 2009, 2010 and 2011. The analysis conducted upstream (ex-ante), concretely, at the moment of strategic formulation of the process (He and Wong, 2004), attributes abilities to TQM so that companies can design objectives for exploration and exploitation.

It has been verified that commitment to TQM allows promoting exploratory and exploitative objectives for the formulation of innovation process strategies. This potential is favored when the company has internal R&D departments.

TQM contains cultural values pertaining to the domain of exploration and exploitation. Results point to their being ambidextrous, though beliefs and values are weaker regarding the fostering of exploratory objectives. TQM means a greater weakness for promoting exploration in strategic formulation. Quality-oriented firms view innovation primarily as ‘technology’, i.e., the end, rather than a means to some broader goal for innovation (Leavengood et al., 2014). This observation contributes to confirming the results by Moreno-Luzón, *et al.* (2013: 1161) regarding “the impossibility of obtaining radical innovations by means of the application of TQM, which is clearly insufficient by itself”. We suggest that divergences of TQM with radical innovations take place as a result of the weak relation they bear to explorative strategies. Strategic formulation must be considered (ex-ante), as opposed to results of the innovation process (ex-post) (He and Wong, 2004); it is reasonable to think that in spite of the emphasis that TQM puts on exploratory strategies it might not be sufficient to obtain results in this field (exploratory innovations).

Results demonstrate that internal R&D functions improve company commitment to innovation strategies in environments committed to TQM. This effect is verified on both the exploratory and the exploitative end. Values of internal R&D for exploration and exploitation produce a synergetic effect on TQM values: The coexistence of internal R&D and TQM enables the acceptance of paradoxical tensions between exploration and exploitation. It is noteworthy that there has been a growing importance of quality practices and a significant reduction in investment in R&D during the period of study. Although this is a scenario seemingly conducive to exploiting well-known certainties and developing gained knowledge, it allows further strategic exploratory objectives despite the commitment to quality.

Results reveal a high commitment to TQM have a negative effect on high-technology sectors, both in isolated form and in combination with internal R&D activities. This phenomenon is a result of the constant exploratory effort that must be exerted in technology-intensive sectors. On the other hand, the size of the company favors the adoption of exploitative strategies and the maintaining of these values over time.

A TQM environment could reduce commitment to exploratory objectives. When exploration is a strategic resource, organic forms of control and flexibility must be adopted. Management and members of the innovation team will be able to share the interest and value of any project independently of its scope, thereby improving relationships and promoting cooperation among different functional units (Ylinen and Gullkvist, 2014).

Exploration and exploitation innovations are fundamentally different logics that require very different processes, strategies and structures and the resulting tensions between the two are difficult to manage. We have employed a paradoxical focus of the dual relationship exploration - exploitation to explain the phenomenon of their coexistence in organizations. The paradoxical approach to literature assumes the existence of possible synergies between poles with competing interests. The functions R&D and quality demonstrate ability to reconcile the paradoxical tensions between exploration and exploitation with an underlying synergistic effect over the period of study. Thus, the research helps to identify functional units with a synergistic effect to reduce the tensions between exploration and exploitation reflected in literature.

Implications for management practices

Managers should use the full potential of TQM. Exploitative strategies are aligned with quality practices, and they can coexist without creating variability. TQM also allows a greater leap into the realm of exploration, although additional resources may be required. We suggest that internal R & D have a synergistic effect on TQM, which favors the adoption of exploratory and exploitative strategies.

Exploration causes variability in processes due to its high levels of experimentation and uncertainty. Hackman and Wageman (1995) describe the classic means of variability control displayed by TQM by means of a process-based approach. However, managers can streamline variability control and interpret the information provided by performance indicators. The causes of variability should encourage the means of control and not variability itself. The key

processes must be provided with sufficient flexibility in order to operate in unfamiliar settings during exploratory search and experimentation.

Currently, TQM has shown adaptability that goes beyond control and routines. Quality converges with exploitation without completely suppressing the values, beliefs and commitments needed to develop more ambitious innovations or uncertain ones, which are more characteristic of exploratory targets. Moreover, this transformation of TQM allows its coexistence alongside similar exploratory units (internal R & D) to boost the adoption of objectives and strategies pertaining to exploratory and exploitative extremes.

Limitations and future research lines

The items of the survey do not allow carrying out a complete study on TQM. This clear limitation constitutes a new line of research at the same time. The survey only allows the analysis of quality practices used and does not give the possibility of completing the TQM construct in the terms established in literature. Therefore, it is not possible to incorporate key quality practices into the proxy for TQM used in the research. The multidimensional character of TQM makes it recommendable to complete the TQM construct with more techniques and representative processes, continue analyzing the tendency of its key practices in the different phases of the innovation process and deepen the synergistic effect of each with other functions to balance the tensions of the exploration - exploitation paradox.

Another remarkable limitation is the diminution of resources for the R&D process. The period studied (2009-2011) is characterized by a constant reduction in the investment in internal R&D. This progressive diminution over time might keep the full potential of the R&D function and its possible synergetic effects on TQM from being known.

Research has also failed to identify the functions fulfilled by R&D during the period of study: research linked to exploration or development during moments of exploitation. The survey used produces no information on these points; it seems reasonable to think that the decline in investment in R&D during the period could be related to more intense moments of exploitation. A further limitation of the research is the impossibility of knowing the synergistic effect between TQM and the internal R&D function when the latter operates in the field of exploration or exploitation.

It would be desirable to know the results of those companies that try to balance the tensions between exploration and exploitation, in order to compare them with those that choose to

focus on one or the other area. The role that TQM plays could be different in each case. We suggest that companies committed to key TQM practices and internal R&D have a greater willingness to operate in both dimensions and greater ease to cope with potential contradictions due to synergies. However, in order to qualify two functions as synergistic it is necessary to take a close look at them over time. Future research should test the effect of other trends in R&D and Quality functions on the strategic objectives of exploration and exploitation, e.g., during more recent periods of study. Finally, the survey used does not reveal the structural design of organizations. This limitation prevents us from verifying whether the limitations of TQM on structural ambidexterity suggested by Moreno- Luzon and Valls (2011) (Structural ambidexterity allows organizations to separate its exploration units from its exploitation units) are applicable to internal R&D units.

We suggest new research to find out about functional units and additional resources that reinforce TQM capacity to operate in the areas of exploration and exploitation.

REFERENCES

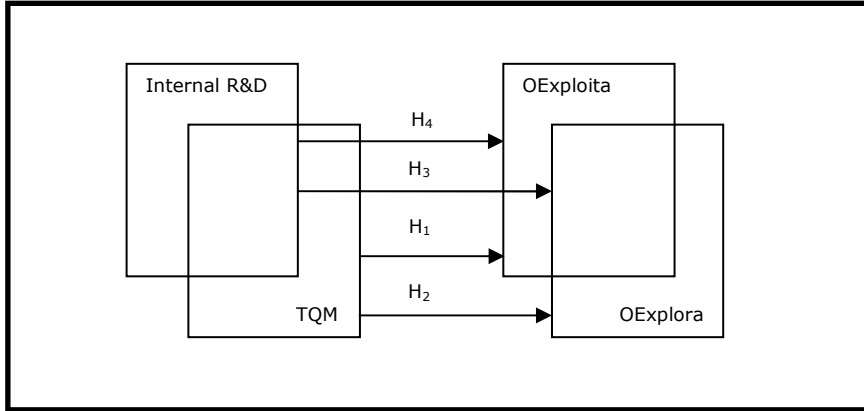
- Asif, M. & de Vries, H.J. (2015). Creating ambidexterity through quality management. *Total Quality Management & Business Excellence*, 26 (11-12), 1226-1241.
- Benner, M.J. & Tushman, M.L. (2002). Process management and technological innovation: A longitudinal study of the photography and paint industries. *Administrative Science Quarterly*, 47 (4), 676-707.
- Benner, M.J. & Tushman, M.L. (2003). Exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of Management Review*, 28 (2), 238-256.
- Benner, M.J. & Tushman, M.L. (2015). Reflections on the 2013 Decade Award: "Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited" ten years later. *Academy of Management Review*, 40 (4), 497-514.
- Brennan, L. (2001). Total quality management in a research and development environment. *Integrated Manufacturing Systems*, 12 (2), 94-102.
- Cantarello, S., Martini, A. & Nosella, A. (2012). A Multi-Level Model for Organizational Ambidexterity in the Search Phase of the Innovation Process. *Creativity and Innovation Management*, 21 (1), 28-48.
- Dean Jr., J.W. & Bowen, D.E. (1994). Management theory and total quality: improving research and practice through theory development. *Academy of Management Review*, 19 (3), 392-418.

- Douglas, T.J. & Judge, W.Q. (2001). Total quality management implementation and competitive advantage: the role of structural control and exploration. *Academy of Management Journal*, 44 (1), 158-169.
- Grimpe, C. & Kaiser, U. (2010). Balancing Internal and External Knowledge Acquisition: The Gains and Pains from R&D Outsourcing. *Journal of Management Studies*, 47 (8), 1483-1509.
- Hackman, J.R. & Wageman, R. (1995). Total Quality Management: Empirical, Conceptual and Practical Issues. *Administrative Science Quarterly*, 40 (2), 309-342.
- He, Z.L. & Wong, P.K. (2004). Exploration vs. Exploitation: An Empirical test of the ambidexterity hypothesis. *Organization Science*, 15 (4), 481-494.
- Herrera, L.(2012). El efecto diferenciado de la financiación pública de la innovación: regiones centrales versus periféricas. *ICE- Información Comercial Española*, 869, 81-98
- Herrera, L. & Sánchez, G. (2013). Firm size and innovation policy. *International Small Business Journal*, 31 (2), 137-155.
- Higgins, M. & Rodriguez, D. (2006). The outsourcing of R&D through acquisition in the pharmaceutical industry. *Journal of Financial Economics*, 80 (2), 351-383.
- Hitt, M.A., Ireland, R.D., Sirmon, D.G. & Trahms, C.A. (2011). Strategic entrepreneurship: creating value for individuals, organizations, and society. *The Academy of Management Perspectives*, 25 (2), 57-75.
- Hoang, D.T., Igel, B. & Laosirihongthong, T. (2006). The impact of total quality management on innovation: Findings from a developing country. *International Journal of Quality & Reliability Management*, 23 (9), 1092-1117.
- INE. Instituto Nacional de Estadística. [web]. 2013. Madrid: INE. [19 January 2015]. <http://www.ine.es/>
- Jansen, J.J., Van Den Bosch, F.A. & Volberda, H.W. (2006). Exploratory Innovation, Exploitative Innovation, and Performance: Effects of Organizational Antecedents and Environmental Moderators. *Management Science*, 52 (11), 1661-1674.
- Kim, D.Y., Kumar, V. & Kumar, U. (2012). Relationship between quality management practices and innovation. *Journal of Operations Management*, 30 (4), 295-315.
- Lavie, D., Stettner, U. & Tushman, M.L. (2010). Exploration and exploitation within and across organizations. *Academy of Management Annals*, 4 (1), 109–153.
- Leavengood, S., Anderson, T.R. & Daim, T. U. (2014). Exploring linkage of quality management to innovation. *Total Quality Management & Business Excellence*, 25 (9-10), 1126-1140.
- Leiponen, A. & Helfat, C.E. (2011). Location, Decentralization, and Knowledge Sources for Innovation. *Organization Science*, 22 (3), 641-658.
- Levinthal, D.A. & March, J.G. (1993). The myopia of learning. *Strategic Management Journal*, 14 (2), 95-112.
- Lewis, M.W., Andriopoulos, C., & Smith, W.K. (2014). Paradoxical leadership to enable strategic agility. *California Management Review*, 56 (3), 58-77.

- Lin, C. & Chai, K.W. (2012). Exploration of the key evolutionary operational improvement activities. *Industrial Management & Data Systems*, 11 (7), 1123-1141.
- Lisboa, A., Skarmeas, D. & Lages, C. (2013). Export market exploitation and exploration and performance: Linear, moderated, complementary and non-linear effects. *International Marketing Review*, 30 (3), 211-230.
- March, J.G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2 (1), 71-87.
- Martínez-Costa, M. & Martínez-Lorente, A.R. (2008). Does quality management foster or hinder innovation? An empirical study of Spanish companies. *Total Quality Management*, 19 (3), 209-221.
- Moreno-Luzón, M.D., & Valls-Pasola, J. (2011). Ambidexterity and total quality management: towards a research agenda. *Management Decision*, 49 (6), 927-947.
- Moreno-Luzón, M.D., Gil-Marques, M. & Valls-Pasola, J. (2013). TQM, innovation and the role of cultural change. *Industrial Management & Data Systems*, 113 (8), 1149-1168.
- Moreno-Luzón, M.D., Gil-Marques, M. & Arteaga, F. (2014). Driving organizational ambidexterity through process management. The key role of cultural change. *Total Quality Management & Business Excellence*, 25 (9-10), 1026-1038.
- Mudambi, R. & Swift, T. (2014). Knowing when to Leap: Transitioning Between Exploitative and Explorative R&D. *Strategic Management Journal*, 35 (1), 126-145.
- Naveh, E. & Erez, M. (2004). Innovation and Attention to Detail in the Quality Improvement Paradigm. *Management Science*, 50 (11), 1576-1586.
- O'Cass, A., Heirati, N. & Ngo, L.V. (2014). Achieving new product success via the synchronization of exploration and exploitation across multiple levels and functional areas. *Industrial Marketing Management*, 43 (5), 862-872.
- O'Reilly C.A. & Tushman, M.L. (2013). Organizational Ambidexterity: Past, Present and Future. *Academy of Management Perspectives*, 27 (4), 324-338.
- OECD (2005). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data. OECD/EC: París.
- Pinho, J.C. (2008). TQM and performance in small medium enterprises: the mediating effect of customer orientation and innovation. *International Journal of Quality & Reliability Management*, 25 (3), 256-275.
- Powell, T.C. (1995). Total quality management as competitive advantage: a review and empirical study. *Strategic Management Journal*, 16 (1), 15-37.
- Prajogo, D.I. & Sohal, A.S. (2001). TQM and innovation: a literature review and research framework. *Technovation*, 21 (9), 539-558.
- Prajogo, D.I. & Sohal, A.S. (2004). The multidimensionality of TQM practices in determining quality and innovation performance - an empirical examination. *Technovation*, 24 (6), 443-453.
- Prajogo, D.I. & Sohal, A.S. (2006). The integration of TQM and technology/R&D management in determining quality and innovation performance. *Omega*, 34 (3), 296-312.

- Rosenkopf, L. & Nerkar, A. (2001). Beyond Local Search: Boundary Spanning, Exploration, and Impact in the Optical Disk Industry. *Strategic Management Journal*, 22 (4), 287-306.
- Rothaermel, F.T. & Alexandre, M.T. (2009). Ambidexterity in technology sourcing: The moderating role of absorptive capacity. *Organization Science*, 20 (4), 759-780.
- Rothaermel, F.T. & Deeds, D.L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, 25 (3), 201-221.
- Sitkin, S., Sutcliffe, K.M. & Schroeder, R.G. (1994). Distinguishing control from learning in Total Quality Management: A contingency perspective. *Academy Management Review*. 19 (3), 537-564.
- Siren, C.A., Kohtamäki, M. & Kuckertz, A. (2012). Exploration and exploitation strategies, profit performance, and the mediating role of strategic learning: Escaping the exploitation trap. *Strategic Entrepreneurship Journal*, 6 (1), 18-41.
- Tarí, J.J. (2005). Components of successful total quality management. *The TQM Magazine*, 17 (2), 182-194.
- Tsai, K. & Wang, J. (2008). External technology acquisition and firm performance: A longitudinal study. *Journal of Business Venturing*, 23 (1), 91-112.
- Tushman, M.L. & O'Reilly, C.A. (1996). Ambidextrous organizations: Managing evolutionary and revolutionary change. *California Management Review*, 38 (4), 8-30.
- Wu, S.J., Zhang, D. & Schroeder, R.G. (2011). Customization of quality practices: the impact of quality culture. *International Journal of Quality & Reliability Management*, 28 (3), 263-279.
- Ylinen, M. & Gullkvist, B. (2014). The effects of organic and mechanistic control in exploratory and exploitative innovations. *Management Accounting Research*, 25 (1), 93-112.
- Zhang, D., Linderman, K. & Schroeder, R.G. (2012). The moderating role of contextual factors on quality management practices. *Journal of Operations Management*, 30 (1), 12-23.
- Zhang, D., Linderman, K. & Schroeder, R.G. (2014). Quality Management Practices: A Conceptual and Measurement Framework. *Decision Sciences*, 45 (1), 81-114.
- Zehir, C., Ertosun, Ö.G., Zehir, S. & Müceldilli, B. (2012). Total Quality Management Practices Effects on Quality Performance and Innovative Performance. *Procedia-Social and Behavioral Sciences*, 41, 273-280.
- Zeng, J., Phan, C.A. & Matsui, Y. (2015). The impact of hard and soft quality management on quality and innovation performance: An empirical study. *International Journal of Production Economics*, 162, 216-226.

Figure 1. Research model.



Fuente: the authors of this article

Table 1. Evolution of organizational innovations regarding TQM in Spain

INDUSTRY	YEAR			
	2008	2009	2010	2011
% companies that consider this of great importance:				
Smaller costs per unit produced	29,52	32,23	34,04	35,02
Greater quality of goods and services	55,06	54,73	55,08	55,63
Improvement of information exchange or communication	40,14	40,93	39,20	39,07

Source: INE. Spanish National Institute of Statistics.

Table 2. Exploratory and exploitative innovation strategies

EXPLORATORY INNOVATION STRATEGY	EXPLOITATIVE INNOVATION STRATEGY
Introduce new generation of products	Improve existing product quality
Extend product range	Improve production flexibility
Open up new markets	Reduce production costs
Enter new technology fields	Improve yield or reduce material consumption

Source: Compiled by authors based on He y Wong (2004: 486).

Table 3. Analysis of Multicollinearity

	tqm108	itqm108
	1.03	1.19
size08	1.54	1.52
ltec08	1.06	1.06
mtec08	1.03	1.03
htec08	1.01	1.01
mad08	2.15	2.15
cat08	2.27	2.27
rest08	2.56	2.56
exporta08	1.21	1.21
costs08	1.28	1.43
VIF	1.51	1.54

Source: the authors of this article

Table 4. Correlation coefficients

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	oexplore109	1.0000															
2	oexplore110	0.7329*	1.0000														
3	oexplore111	0.5789*	0.6967*	1.0000													
4	oexploit109	0.6479*	0.5310*	0.4601*	1.0000												
5	oexploit110	0.5384*	0.6633*	0.5304*	0.7164*	1.0000											
6	oexploit111	0.4662*	0.5349*	0.7067*	0.5535*	0.6781*	1.0000										
7	tqm108	-0.0030	-0.0014	-0.0237*	0.0310*	0.0228*	-0.0045	1.0000									
8	itqm108	0.7322	0.8716	0.0073	0.0004	0.0100	0.6076		1.0000								
9	size08	0.3267*	0.3116*	0.2886*	0.3635*	0.3402*	0.3032*	0.3822*	0.0000	1.0000							
10	ltec08	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000						
11	mttec08	0.0841*	0.0705*	0.0568*	0.0559*	0.0456*	0.0427*	0.0023	0.0344*	0.1261*	0.0000	1.0000					
12	httec08	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7944	0.0001	0.0000	0.0000	0.0000	1.0000				
13	mad08	0.0543*	0.0648*	0.0660*	0.0470*	0.0564*	0.0553*	-0.0018	0.0406*	0.0879*	-0.0837*	1.0000					
14	cat08	-0.0060	0.0010	-0.0046	0.0039	0.0039	0.0114	0.0052	0.0063	0.0366*	-0.0483*	-0.0181*	1.0000				
15	rest08	0.4971	0.9098	0.6014	0.6570	0.6626	0.1983	0.5551	0.4757	0.0000	0.0000	0.0410	0.0000	1.0000			
16	exporta08	-0.0225*	0.0081	0.0062	0.0141	0.0316*	0.0256*	0.0325*	0.0330*	0.2538*	-0.0146	-0.0015	-0.0135	1.0000			
17	costs08	0.0107	0.3599	0.4839	0.1113	0.0003	0.0037	0.0002	0.0002	0.0000	0.0977	0.8627	0.1256	0.0000	1.0000		
18	Mean	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	S.D.	0.1063*	0.0945*	0.0842*	0.0719*	0.0695*	0.0688*	-0.0016	0.0223*	0.1302*	0.0451*	0.0308*	0.0026	-0.2267*	1.0000		
20	Min.	0.1161*	0.0992*	0.0987*	0.1142*	0.0993*	0.0928*	0.0361*	0.0895*	0.1160*	0.0871*	0.0253*	0.0288*	-0.3930*	-0.4590*	1.0000	
	Max.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042	0.0011	0.0000	0.0000	0.0000	0.0000
		0.2659*	0.2525*	0.2456*	0.2245*	0.2171*	0.2215*	-0.0380*	0.1442*	0.2359*	0.1504*	0.0923*	-0.0193*	-0.0332*	0.2022*	0.0463*	1.0000
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0292	0.0002	0.0000	0.0000	0.0000
		0.5591*	0.5254*	0.4965*	0.5460*	0.5152*	0.4857*	-0.0588*	0.3935*	0.3240*	0.0713*	0.1058*	0.0232*	0.0286*	0.1391*	0.1281*	0.3395*
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0086	0.0012	0.0000	0.0000	0.0000	0.0000
		.3752048	.367912	.3266292	.361473	.3587084	.3241347	.0772653	.2388199	3.613.636	.1827831	.0303598	.010302	.1625693	.2093187	.4431437	.2985249
		.4841946	.4822561	.4689986	.4804459	.4796401	.4680689	.2670223	.4263791	2.110.117	.3865037	.171582	.1009787	.3689866	.4068381	.4967762	.4576288
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	1	1	1	1.062.542	1	1	1	1	1	1	1
																	2.003.076

* Significant correlation $p < .05$

Source: the authors of this article

Table 5. Logistic regression. TQM strategies for exploratory and exploitative innovation processes

VARIABLES	oexplore1_09		oexplore1_10		oexplore1_11		oexploit1_09		oexploit1_10		oexploit1_11	
	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%
tqm108	.4279339*** (.0953368)	53.4	.3393257*** (.0913254)	40.4	-.0568107 (.0917292)	5.8	-.6457947*** (.0905111)	90.8	-.4719423*** (.0874533)	60.3	-.1651087 (.0887214)	18.0
size08	-.0588653*** (.0135285)	-5.7	-.0090211 (.0131042)	-0.9	.0324114*(.01336 57)	3.3	.0467549*** (.0128679)	4.8	.0851065***(.0126 744)	8.9	.1211547*** (.0131061)	12.9
btec08	.2222034*** (.0584475)	24.9	.1370842* (.0557019)	14.7	.0458634 (.0549821)	4.7	.0297206 (.0578936)	3.0	-.0290721 (.0557707)	-2.9	-.0426824 (.055704)	-4.2
mtec08	-.1147709 (.1235195)	-10.8	.0653585 (.1226341)	6.8	.0666249 (.1228646)	6.9	-.2463243* (.1232448)	-21.8	-.0892187 (.1246686)	-8.5	-.1010824 (.1242697)	-9.6
htec08	-.4627386* (.2231778)	-37.0	-.2543531 (.2165735)	-22.5	-.4297758 (.2311096)	-34.9	-.2910325 (.2260696)	-25.3	-.2815088 (.2226464)	-24.5	-.0777469 (.2302436)	-7.5
mad08	.3619268*** (.0954937)	43.6	.5175675*** (.0935696)	67.8	.4412224***(.095 7873)	55.5	.3525815*** (.0905542)	42.3	.4206317***(.0900 698)	52.3	.3300077*** (.0937616)	39.1
cat08	.669532*** (.0884165)	95.3	.6017308*** (.0868822)	82.5	.531591***(.0893 596)	70.2	.3583051*** (.0851032)	43.1	.3481514***(.0847 532)	41.6	.3214096*** (.0888247)	37.9
rest08	.7084951***(.07989 71)	103.1	.641723*** (.0787861)	90.0	.6246679***(.081 7777)	86.8	.5449238*** (.075234)	72.4	.4957354***(.0756 088)	64.2	.4631535*** (.0802689)	58.9
exporta08	.4334319*** (.0507156)	54.3	.3974551*** (.0491658)	48.8	.3901404***(.048 4552)	47.7	.2146896*** (.0505843)	23.9	.2089047***(.0491 72)	23.2	.2681887*** (.0483568)	30.8
costs08	.2120914*** (.0045301)	23.6	.1874562*** (.0042048)	20.6	.1782749***(.004 3224)	19.5	.1994905*** (.0042591)	22.1	.1804384***(.0040 654)	19.8	.1709787*** (.0041769)	18.6
Waldchi2	3423.97		3047.84		2659.23		3345.20		2979.61		2618.34	
Prob>chi2	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
PseudoR²	0.2762		0.2395		0.2226		0.2548		0.2280		0.2143	
Log Pseud	-6067.8446		-6361.3402		-6275.1483		-6318.5729		-6508.1252		-6359.1076	
%Co..Clasif	76.44		75.07		74.66		75.45		74.39		73.70	

*p<.05; **p<.01; ***p<.001

Source: the authors of this article.

Table 6. Logistic regressions. TQM - R&D strategies for exploratory and exploitative innovation processes

VARIABLES	oexplorel_09		oexplorel_10		oexplorel_11		oexploitl_09		oexploitl_10		oexploitl_11	
	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%	Coef (Robust Std. Err)	%
itqm108	.7375408*** (.0529613)	109.1	.6778295*** (.0512414)	97.0	.560961*** (.0499637)	75.2	.9782523***(.052 0863)	166.0	.8560856*** (.0505918)	135.4	.6490305***(.0494 853)	91.4
size08	-.0624153*** (.0135796)	-6.1	-.0130313 (.0131422)	-1.3	.0249372 (.0134343)	2.5	.0455745***(.012 9446)	4.7	.0826027*** (.0127004)	8.6	.1161138***(.0131 595)	12.3
btec08	.2267994*** (.0587637)	25.5	.1404444* (.0560764)	15.1	.0495341 (.0552694)	5.1	.0308428 (.058568)	3.1	-.0287713 (.05655)	-2.8	-.0405488 (.0561804)	-4.0
mtec08	-.1025163 (.124167)	-9.7	.0799564 (.1227365)	8.3	.0802379 (.1232593)	8.4	-.2385713 (.1245369)	-21.2	-.0769542 (.1250634)	-7.4	-.089879 (.1243684)	-8.6
htec08	-.4436981* (.224043)	-35.8	-.2326871 (.2154254)	-20.8	-.4069215 (.2308746)	-33.4	-.2626595 (.2290608)	-23.1	-.2552245 (.2237638)	-22.5	-.0504708 (.2289141)	-4.9
mad08	.3728689 *** (.0962058)	45.2	.5287734*** (.0941549)	69.7	.4456127*** (.0962147)	56.1	.3679748***(.091 8362)	44.5	.4333043*** (.0910636)	54.2	.3353978***(.0946 247)	39.8
cat08	.7205041*** (.0886617)	105.5	.6445541*** (.087164)	90.5	.5639095*** (.0895655)	75.8	.4179753***(.085 8339)	51.9	.3970719*** (.0853593)	48.7	.3573895***(.0896 772)	43.0
rest08	.7231396*** (.0801957)	106.1	.6505798*** (.0791287)	91.7	.6258154*** (.0820546)	87.0	.5617866***(.076 1145)	75.4	.5049761*** (.0763689)	65.7	.4648548***(.0811 803)	59.2
exporta08	.4261246*** (.0511904)	53.1	.3913941*** (.0494948)	47.9	.3918706*** (.0486605)	48.0	.1989482***(.051 4749)	22.0	.1969864*** (.0498384)	21.8	.2647929***(.0487 54)	30.3
costs08	.1935383*** (.0046226)	21.4	.1705088*** (.0043213)	18.6	.1649915*** (.0044629)	17.9	.1754545***(.004 3005)	19.2	.1594333*** (.004146)	17.3	.1552588***(.0043 055)	16.8
Waldchi2	3446.52		3099.55		2714.46		3417.73		3080.76		2698.76	
Prob>chi2	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
PseudoR²	0.2871		0.2494		0.2306		0.2730		0.2435		0.2249	
Log Pseud	-5977.1449		-6278.269		-6211.0503		-6164.3979		-6377.6145		-6273.9957	
% Co.Clasif	77.23		75.42		75.01		76.14		74.74		74.82	

*p<.05; **p<.01; ***p<.001

Source: the authors of this article.

HYPOTHESIS	ACCEPTANCE
H1a - <i>Companies that carry out organizational innovations based on TQM tend to adopt innovation strategies based on exploitation.</i>	ACCEPTED
H1b - <i>Companies that carry out organizational innovations based on TQM tend to adopt maintain exploitative innovation strategies over time.</i>	PARTIALLY ACCEPTED
H2a - <i>Companies that carry out organizational innovations based on TQM tend to adopt innovation strategies based on exploration.</i>	ACCEPTED
H2b - <i>Companies that carry out organizational innovations based on TQM tend to adopt maintain exploratory innovation strategies over time.</i>	PARTIALLY ACCEPTED
H3a - <i>Companies with internal R&D activities that carry out organizational innovations based on TQM tend to adopt exploratory innovation strategies.</i>	ACCEPTED
H3b - <i>Companies with internal R&D activity that carry out organizational innovations based on TQM tend to exploratory innovation strategies over time.</i>	ACCEPTED
H4a - <i>Companies with internal R&D activity that carry out organizational innovations based on TQM tend to adopt exploitative innovation strategies.</i>	ACCEPTED
H4b - <i>Companies with internal R&D activity that carry out organizational innovations based on TQM tend to maintain exploitative innovation strategies over time.</i>	ACCEPTED

Table 7. Verification of hypotheses

Source: the authors of this article.