The role of TQM in strategic product innovation: an empirical assessment

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Abstract
Purpose – The purpose of this paper is to study the effect of total quality management (TQM) resources on strategic product innovation. It addresses the apparent tension between quality management and innovation management and seeks empirical support for the proposition that quality management resources can be used to support strategic innovation. Based on resource-based view, it defines key resources that firms develop during implementation of TQM systems: TQM culture, product design capability, and process improvement capability and assesses the role of these resources in the success of product innovation.

Design/methodology/approach – A survey of 112 manufacturing firms was conducted and the resulting data were analyzed using partial least squares (PLS) to determine how TQM constructs affect strategic product innovation.

Findings – The main finding suggests that only product design capability contributes to strategic product innovation. TQM culture has a direct influence on process improvement and product design capabilities but not on product innovation. The effect of innovation capability and innovation orientation on product innovation was only supported for innovation capability. The effect of innovation orientation is mediated by the development of innovation capability.

Research limitations/implications – The paper focuses on the level of maturity of capability development without taking into consideration the time since adoption. Also, the measure of product innovation is based on the degree of product newness but does not dichotomize in terms of radical vs incremental. Several arguments supporting a negative relationship between TQM and innovation often refer to radical or breakthrough innovation. It would be interesting to test the model while distinguishing between radical and incremental innovation. The use of cross-sectional data is a methodological limitation.

Practical implications – The results suggest that managers can leverage their quality management systems to support product innovation. In particular, the ability to design quality into products leads to higher levels of strategic production innovation. The successful deployment of TQM capabilities

The authors thank participants at POMS 2009 conference for comments on earlier versions of the manuscript. Graça Silva acknowledges the financial support, via ADVANCE, from the Fundação para a Ciência e Tecnologia (FCT Portugal) through the project Pest-OE/EGE/UI4027/2011 and Luís Filipe Lages acknowledges Nova Forum. The authors acknowledge the three anonymous IJOPM reviewers for comments on previous versions of the paper.
requires an integrative and well-structured approach, involving top leadership engagement of employees and customer orientation. While TQM culture is critical to the development of quality management capabilities, it does not directly affect the innovativeness of a firm.

**Originality/value** – The paper explores the relationship between quality management systems and strategic product innovation. Further work is needed to test whether TQM effect on strategic innovation is different for radical and incremental products, and for other innovation outcomes such as process and service innovation.

**Keywords** Innovation, Quality management, Competitive advantage, Survey research, Resource-based view (RBV)

**Paper type** Research paper

1. **Introduction**

The implementation of total quality management (TQM) tools and practices has enabled organizations to reduce costs, increase the productivity of human and physical assets, and improve the quality of their products (Sila, 2007; Hendricks and Singhal, 1997; Flynn et al., 1994). However, as organizations gradually implemented TQM systems, including Six Sigma methodology, the basis of competitive advantage swiftly shifted from quality to innovation. Successful product innovation and the ability of companies to improve their innovation processes rapidly became essential requirements for competitive advantage and long-term growth (López-Mielgo et al., 2009; Perdomo-Ortiz et al., 2009). In particular, the launching of new products is critical to survival in dynamic environment and a significant determinant of firm performance (Zhou et al., 2005; Li and Calantone, 1998). There is an ongoing debate on whether TQM systems support organizational initiatives to improve innovativeness, or on the contrary, may hinder product innovation efforts. Some authors suggest that future TQM research should focus on “how to provide organizational structure that facilitates innovation/knowledge creation process” (Mehra and Agrawal, 2003). This study contributes to that debate by investigating the core assets and capabilities that TQM creates in organizations, and the extent to which these resources leverage or hamper strategic product innovation.

There is an apparent tension between TQM and innovation. TQM is about consistency, standardization and control, whereas innovation is about change, difference, and accepting failure. Some argue that while TQM has built-in mechanisms for learning that will bring about cost reduction and other improvements to established processes, it fails to inspire the changes needed for product innovation. For instance, Toyota, a beacon of TQM implementation, has often been criticized for its proliferation of look-alike cars. Others claim that quality management practices constitute a foundation for product innovation systems: for example, it is argued that at BMW the quality requirements imposed during prototyping for conformance and manufacturability, not only lead the company to savings in labor, reductions in tooling costs and lower warranty expenses, but also contribute to better product design (Pisano, 2002). The questions we ponder are: How do resources developed by organizations with the implementation of TQM impact strategic innovation efforts? Which TQM resources are supporting strategic product innovation and which resources are deterring product innovation?

We adopt a definition of TQM that goes beyond quality assurance and control: TQM is an organized structure that drives improvement of organizational processes and includes structural elements such as supplier management and design of products and services (Schroeder et al., 2008). The successful implementation of TQM requires combination of a series of practices (Kim et al., 2012). Adopting the resource-based view (RBV) perspective, this study views TQM organizational
capabilities as fragmented and embedded in organizational routines (cf. Peng et al., 2008; Barney, 1991). Hence, we discard the notion of TQM as a single firm-level capability, and based on a review of previous research (e.g. Prajogo and Sohal, 2004; Ho et al., 2001; Flynn et al., 1994, 1995) suggests a partition of TQM into distinct resources: TQM as a corporate asset embedded in the organizational culture of the firm, TQM as process improvement capability, and TQM as product design capability.

By anchoring our research on resource-based theory, we provide a theoretical grounding for the study of quality management practices that is often missing in the TQM literature (Sousa and Voss, 2002; Dean and Bowen, 1994). Our findings shed new light on the controversy concerning the relationship between quality management and innovation (Benner, 2009). The results support a positive relationship between product design capability and strategic product innovation. Other TQM resources are not significantly associated with positional advantage through product innovation. Moreover, our study offers a more comprehensive model for understanding the relationship between TQM resources and product innovation, controlling for alternative explanations of innovation outcomes, namely, innovation capabilities and organizational assets.

This paper is organized as follows. First, we review key elements of TQM models and empirical studies linking TQM practices and innovation. We then present our model for estimating the impact of TQM resources on product innovation and present the formal hypotheses. Next we describe the research methods used to test the hypotheses and present the empirical results of the measurement model. The final section presents a discussion of the findings, and offer suggestions for future research.

2. Theoretical background
TQM systems extend quality improvement methods and techniques to all functions and management levels within an organization. This body of methods and techniques or managerial practices emerged from the early work of quality gurus such as Deming, Taguchi, and Juran, and their primary goal is to better meet customer expectations through improvements in the quality of products and processes. Wilkinson (1992) proposed a distinction between “soft” and “hard” TQM practices. The “soft” side of TQM is largely concerned with creating customer awareness within an organization, and emphasizes leadership, employee involvement and commitment. TQM “hard” practices involve production techniques, including statistical process control, quality function deployment (QFD), design processes, and just-in-time inventory control. A significant body of research has studied the link between TQM practices and firm performance as further detailed later in this section.

Several theoretical lenses have been used in the analysis of TQM systems. Sitkin et al. (1994) distinguish control from learning goals in the implementation of TQM; Hackman and Wageman (1995) use organizational routine and work design theories to illustrate the benefits obtained from TQM; Westphal et al. (1997) adopt an institutional and network perspective to explain differences in the adoption of TQM. Linderman et al. (2004) use a knowledge-based view perspective to provide a deeper understanding of how quality practices can lead to knowledge creation and retention, which leads to organizational performance. More recently, Singh et al. (2011) adopt resource dependence theory to show that the link between ISO9000 implementation and process performance depends on elements of the task environment. Powell’s (1995) germinal work on the link between TQM and competitive advantage grounded the analysis on RBV.

This paper relies on RBV of the firm to define resources developed by firms through the implementation of TQM.
2.1 RBV of TQM
RBV is a comprehensive framework for understanding how competitive advantage is achieved through firm resources and capabilities. Firm level resources consist both of assets (physical, financial, culture, reputation, etc.) and organizational capabilities, described as high-level routines or bundles of routines that confer an organization options for producing significant outputs (Peng et al., 2008; Barney, 1991). When resources are tacit or socially complex, bundling has been demonstrated to be more effective than deploying a resource in isolation (Barney, 1992). Capabilities are embedded in the dynamic interaction of multiple knowledge sources, are more specific and less transferable, and form the primary base for competition between firms leading to competitive advantage (Peng et al., 2008).

TQM has been recognized as a firm-level capability as early as Day (1994). TQM practices are imperfectly imitable and can be considered a potential source of competitive advantage (Douglas and Judge, 2001; Powell, 1995). Still, most studies that investigated the relationship between quality management and firm performance focus on isolated TQM practices or TQM as a single construct (see Nair, 2006 for a review). One exception is Peng et al. (2008), who define improvement capabilities as including continuous improvement, process management, and leadership involvement in quality. Following Peng et al. (2008) and Powell (1995) we suggest that it may be more useful to analyze TQM considering the tacit resources it creates within the organization.

While studying organizational capabilities one is faced with the challenge of not blending routines that have different characteristics and deliver different results (Becker et al., 2005). To determine distinct TQM resources, we conducted a review of TQM models that propose bundles of TQM practices and the associated multidimensional measurement scales (e.g. Ahire et al., 1996; Flynn et al., 1994, 1995). Different terminologies have been proposed for the bundles of TQM practices or TQM dimensions: organic and mechanistic practices (Prajogo and Sohal, 2004; Spencer, 1994), supportive and core TQM practices (Flynn et al., 1995), infrastructure and core TQM practices (Ho et al., 1999), TQM control and TQM learning (Sitkin et al., 1994). To a great extent the dimensions proposed reflect the early distinction between “soft” and “hard” TQM practices. Recent studies use groups of TQM practices previously proposed in the literature. For instance, Ho et al. (2001) divides TQM practices into supportive and core, Laohavichien et al. (2011) into infrastructure and core. The review led us to conceptualize TQM practices as a set of integrated organizational resources that contribute to achieving and sustaining competitive advantage. The specific constructs are presented in the conceptual model section.

Firm-specific resources may have impact in distinctive advantages and not necessarily in firm performance (Ray et al., 2004). In this way we examine the effect of TQM resources in product innovation as a source of competitive advantage. The next section presents a review of the body of research exploring the link between TQM and innovation outcomes.

2.2 TQM and innovation
The influence of TQM on innovation appears to be complex with arguments suggesting both negative and positive effects. For instance, continuous improvement, performance measurement, and an “open” culture are seen as important aspects of both TQM and innovation (Prajogo and Sohal, 2001). These commonalities suggest that organizations that implement TQM could be more innovative than organizations that do not (Singh and Smith, 2004). On the other hand, the “tyranny of the market” to which
quality management is subject may have negative consequences on innovative performance (Perdomo-Ortiz et al., 2006).

We conducted a review of empirical studies that test the link between TQM and innovation outcomes, including product, process and administrative innovation (a summary of the findings is presented on Table I). Using TQM as a single construct, some studies have found TQM an appropriate resource to foster innovation (Martínez-Costa and Martínez-Lorente, 2008; Santos-Vijande and Álvarez-González, 2007) while others find no evidence of a positive relationship (Singh and Smith, 2004). Few studies consider distinct TQM dimensions and explore the relationship between these dimensions and product innovation, as suggested by Sitkin et al. (1994). Prajogo and Sohal (2004) find that organic elements of TQM (soft side) are associated with innovation performance while mechanistic elements (hard side) are only associated with quality, a result also supported by Perdomo-Ortiz et al. (2009). None of these studies consider innovation outcomes as a source of competitive advantage, i.e, looking at performance vs competitors.

3. Conceptual model and hypotheses
The model, presented in Figure 1, explores the impact of TQM resources on competitive advantage through product innovation while controlling for innovation capabilities, other resources available to the organization, and contextual factors.

Based on RBV, the model proposes a multidimensional view of TQM. The implementation of TQM practices designated as “soft” is viewed as leading to an organizational culture embedded with TQM values and beliefs. Early work on RBV suggested that organizational culture, or a given sub-culture may become a firm-specific asset and a source of sustained competitive advantage (Barney, 1991). The implementation of core or “hard” TQM practices is conceptualized as resulting in two distinctive TQM capabilities: an organizational capability to improve production processes, and an organizational capability to obtain product quality by design. Product design and process improvement differ in their improvement targets, visibility, procedures, and tools (Ahire and Dreyfus, 2000), hence, we consider them as different organizational capabilities. Using a partition of TQM capabilities based on the objectives and results those capabilities deliver (Becker et al., 2005) we obtained a set of TQM capabilities that diverge from the traditional separation of TQM practices across people and technical elements. Capabilities defined as bundles of assets and routines include both people and technical elements (Figure 1).

Following Flynn et al. (1995), and Ho et al. (2001), we view TQM culture as an organizational asset, a developmental culture within the organization that is facilitated by top management, creates a common language that improves communication, emphasizes the participation of all employees, and focuses all the organization on customer requirements and continuous improvement. A review of the literature conducted by Gutiérrez et al. (2012) finds that these same TQM mechanisms, namely, teamwork, communication, shared vision and leadership are related to absorptive capacity of the firm, defined as “the ability of a firm to recognize new, external, information, assimilate it, and apply it to commercial ends” (Cohen and Levinthal, 1990), an important antecedent for new knowledge creation. Moreover, the quest for organizational improvement must be nurtured by top management and requires a concentrated effort to define and achieve quality goals, to ensure that the necessary resources are available, to create a work environment conducive to employee involvement in the process of change (Naor et al., 2008; Kaynak, 2003; Ahire et al., 1996;
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<tr>
<td>Flynn (1994)</td>
<td>Top management quality leadership, rewards for quality, process control, feedback, cleanliness and organization, new product quality, product design characteristics, interfunctional design efforts, supplier relationship, customer interaction</td>
<td>Speed of product development</td>
<td>The use of product design practices is associated with faster product innovation</td>
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<td>Prajogo and Sohal (2003)</td>
<td>TQM (2nd order factor) Leadership; strategic planning; customer focus; information and analysis; people management; process management</td>
<td>Product innovation (6): the level of newness of new products, the use of latest technological innovations in new product development, the speed of new product development, the number of new products introduced to the market, the number of new products that is first-to-market Process innovation (4): the technological competitiveness, the novelty of technology used in processes, the speed of adoption of the latest technological innovations in processes, and the rate of change in processes, techniques and technology</td>
<td>TQM practices significantly and positively relates to product and process innovation</td>
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<td>Prajogo and Sohal (2004)</td>
<td>Mechanistic elements (2nd order construct) Strategic planning; customer focus; information and analysis; process management Organic elements (2nd order construct) Leadership; people management</td>
<td>Product Innovation (5): the number of innovations, the speed of innovation, the level of innovativeness, latest technology used, and being the first in the market</td>
<td>Mechanistic elements of TQM associated with quality performance and the organic elements with innovation performance</td>
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<td>Singh and Smith (2004)</td>
<td>Top management leadership; Customer focus; Employee relations; Relationship with suppliers; Competitors; Communication/ Information systems; Product/process management.</td>
<td>Innovation (4): commercialized processes/products/services, developed world-class techniques/technologies, the rate of innovation of new operational processes, the rate of introduction of new products/services Actual innovation output (3): number of new products and the share of the current annual turnover Level of newness (7): use of new materials or intermediate products, entirely new product or new service, new method of production, entering a new market, new source of supply, new ways of organizing, and new functional solution for an existing product or additional service based on an existing service</td>
<td>Insufficient statistical evidence to suggest that TQM is related to innovation</td>
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<td>Hoang et al. (2006)</td>
<td>TQM (2nd order factor) and each TQM practice Top management commitment; employee involvement; employee empowerment; education and training; teamwork; customer focus; process management; information and analysis system; strategic planning; open organization; service culture</td>
<td>Additional outcomes based on research, such as business innovation capability (BIC) (6): planning and commitment on the part of management, behavior and integration, projects, knowledge and skills, information and communication, and external environment</td>
<td>Only leadership and people management, process and strategic management, and open organization showed a positive impact on innovation. Education and training, while showing a positive effect on the number of new products and services, had a negative relationship with the level of newness</td>
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<td>Perdomo-Orta et al. (2006)</td>
<td>Management support; information for quality; process management; product design; human resources management; relationship with suppliers and customers</td>
<td>Business innovation capability (BIC) (6): planning and commitment on the part of management, behavior and integration, projects, knowledge and skills, information and communication, and external environment</td>
<td>Positive and significant relationships was found between all TQM dimensions and BIC. Three TQM dimensions (process management, product design, and human resource management) are highly significant in the building of business innovation capability (BIC) (continued)</td>
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<td>Santos-Vijande and Álvarez-González (2007)</td>
<td>TQM (2nd order factor) Leadership; people; Policy and strategy; processes and resources; partnerships</td>
<td>Technical innovation (4): number of product and service innovations and number of production processes or service operations innovations introduced by the firm in the last five years (Intensity/Novelty). Innovativeness (5): Innovation proposals are welcome in the organization, management actively seeks innovative ideas, innovation is perceived as too risky and is resisted (R), people are not penalized for new ideas that do not work, program/project managers promote and support innovative ideas, experimentation and creative processes. Administrative innovation (4): number of managerial innovations and number of marketing innovations introduced by the firm in the last five years (intensity/novelty).</td>
<td>TQM strongly influences firm’s innovative culture and higher administrative innovation levels. The mediating role of innovativeness is required for TQM to achieve this impact on technical innovation. Only three QM practices (communication, teamwork and supportive people management practices) have a positive and significant impact on technological innovation. No significant relationship between two QM practices (autonomy and consultation) and technological innovation. A strong positive relationship was found between TQM and process innovation and TQM and product innovation.</td>
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<td>Abrunhosa and Sá (2008)</td>
<td>Autonomy; communication; consultation; teamwork; supportive people management practices</td>
<td>Process-based technological innovation (2): mean time of adoptions of innovation and mean number of innovations adopted over time</td>
<td>Only human resources management has a positive relationship with technological innovation. The effect of human resource management practices on technological innovation is mediated by BIC.</td>
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<td>Martínez-Costa and Martínez-Lorente (2008)</td>
<td>TQM (2nd order construct) Continuous improvement activity; use of tools for quality improvement in teamwork; statistical process control; supplier selection based on quality criteria; employee training in quality management; quality leadership; total preventive maintenance; meetings with customers to evaluate product quality</td>
<td>Product innovation (3): number of new products/services introduced in one year, pioneering disposition to introduce new products/services, spent hours/person, teams and training dedicated to obtain new products/services. Process Innovation (3): number of changes in the process introduced in one year, pioneering disposition to introduce new processes, fast response to the new processes introduced by other companies within the same sector.</td>
<td>Only three QM practices (communication, teamwork and supportive people management practices) have a positive and significant impact on technological innovation. No significant relationship between two QM practices (autonomy and consultation) and technological innovation. A strong positive relationship was found between TQM and process innovation and TQM and product innovation.</td>
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<td>Perdomo-Ortiz et al. (2009)</td>
<td>Management support; information for quality; process management; product design; human resources management; relation with suppliers and customers</td>
<td>Technological innovation (4): range of products and launch rhythm, technical novelty in production systems, expenditure on technological innovation, generation of patents. Business innovation capability (BIC) (6): planning and commitment of the management, behavior and integration, projects, knowledge and skills, information and communication, and external environment.</td>
<td>Only human resources management has a positive relationship with technological innovation. The effect of human resource management practices on technological innovation is mediated by BIC.</td>
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<td>López-Mielgo et al. (2009)</td>
<td>Hard components of TQM</td>
<td>Innovation capabilities (3): innovation experience firm i generates a product innovation and firm i generates a process innovation in period t, R&amp;D (firm i’s R&amp;D expenditures are positive in period t), technological level (number of advanced technologies of firm i in period t).</td>
<td>Product innovation has no significant influence on S&amp;QC, while process innovation has a positive and high significant effect. R&amp;D activities and technological sophistication of the manufacturing process also increase the likelihood of carrying out S&amp;QC.</td>
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<td>Hung et al. (2011)</td>
<td>TQM (2nd order factor) Top management support; employee involvement; continuous improvement; customer focus</td>
<td>Innovation performance (2nd order factor): Product and service (6): the speed of R&amp;D of our company, the speed of production improvement, and the speed of innovating a new logistic way are faster than our competitors. R&amp;D has improved production innovation skills, compared to our competitors, production in our company is more customized to the customers and the production in our company offers more innovative products to the customers. Process innovation (5): the company has continuously used innovative technology to improve the quality and speed of production and services to our customers, the latest Human resource practices are adopted in this organization, the job design innovation is more diverse than our competitors, the organizational structure innovation is more flexible than the competitors, during the last three years, our patent registration has increased significantly. Overall organizational innovation (5): (during the last three years) the comparative advantage of our company has significantly improved, our company profitability has improved, our company's unit cost of production or service has decreased, turnover of our organization have been improved significantly, employee productivity has improved significantly.</td>
<td>TQM and organizational learning have both positive and significant effect on innovation performance. Moreover, organizational learning only partially mediated the effect of TQM on innovation performance.</td>
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<td>Kim et al. (2012)</td>
<td>Management leadership; training; employees relations; supplier quality management; customer relations; Quality data and reporting; process management; product/service design</td>
<td>Radical product innovation (5): Our new products differ substantially from our existing products, we introduce radical product innovations into the market more frequently than our competitors, our percentage of radical product innovations in the product range is significantly higher compared to the competition, the percentage of total sales from radical product innovations is up substantially, we are well known by our customers for radical product innovations Incremental product innovation (5): our new products differ slightly from our existing products, we introduce incremental product innovations into the market more frequently than our competitors, our percentage of incremental product innovations in the product range is significantly higher compared to the competition, the percentage of total sales from incremental product innovations is up substantially, we are well known by our customers for incremental product innovations Radical process innovation (3): Our organization has introduced new or significantly improved machinery and equipment for producing products or services, our organization has introduced new or significantly modified productive processes for producing products or services, our organization has introduced new or significantly improved information technologies for producing products or services Incremental process innovation (3): Our organization introduced minor or incrementally improved machinery and equipment for producing products or services, our organization introduced minor or incrementally modified productive processes for producing products or services, our organization introduced minor or incrementally improved information technologies for producing products or services Administrative innovation (4): Our organization implemented new or improved existing computer-based administrative applications, our organization implemented new or improved existing employee reward/training schemes, our organization implemented new or improved existing structures such as project team or departmental structures, within or in between existing structures</td>
<td>Process management directly and positively relates to radical, incremental, and administrative innovation</td>
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An organizational culture embedded with TQM embraces employee involvement, top management commitment and customer focus. A firm with a strong customer focus that exhibits superiority in understanding the factors that influence customers’ choices will be able to achieve higher level of product differentiation (Prahalad and Ramaswamy, 2000; Day, 1994). This ability requires skill at building strong relationship with customers, which is a complex undertaking (Deshpande et al., 1993). Such resource, once built, is not easily imitated or transferable since it has a high level of tacitness.

Process improvement capability involves the firm ability to continuously improve manufacturing techniques and processes performance, and includes routines such as statistical process control (SPC) and benchmarking. The inclusion of SPC as a process improvement capability is coherent with definition of process management exploitation presented by Peng et al. (2008) that focuses on increasing control and consistency of processes and use items such “we monitor our processes using statistical process control” to measure it. We also consider benchmarking as an important quality tracking mechanism providing information about external processes for continuous improvement. It is a primary mechanism for market-based learning, which is an important source of competitive advantage (Vorhies and Morgan, 2005).

Product design capability consists of the firm’s ability to design quality into its products (Flynn et al., 1995). It encompasses a set of routines enabling improvements in product design from a functional variety, reliability and manufacturing process perspective, namely, design quality management, reliability engineering and concurrent development (Flynn et al., 1994). Taguchi (1986) advocated the importance of design quality in managing variation leading to more robust products, i.e., with lower failure rate and increased reliability. The use of failure mode and effect analysis (FMEA), a systems engineering tool for analysis of reliability, also contributes to catering of customer specifications, avoiding redesign and modifications, and eliminating many tests.
Flynn et al. (1995) argue that suppliers’ inclusion in product design teams will contribute to product quality advantage by providing input about the capabilities of prospective materials and parts. Ragatz et al. (2002) state that “managers seeking to reduce concept to customer development time while increasing quality should seek to make suppliers part of the team, through co-location or frequent participation on team meetings.” Kaynak (2003) refers that quality problems can be further reduced by including customer requirements in new product design reviews prior to production, using tools such as QFD. All this process entails the integration and coordination of a complex set of tasks – combining information from different functional departments and suppliers, components and materials from different sources – while enabling the firm to offer a final product better than competitors.

While recognizing that quality management is an integrative management philosophy, our partition is aligned with the key building blocks of TQM: “the building of quality into products and processes, and making quality a concern and responsibility of everyone in the organization” (Ahire et al., 1995, p. 278). It is also consistent with definitions of Six Sigma methodology as a disciplined approach for managing process and product quality that requires a cultural change in the organization (Schroeder et al., 2008).

3.1 TQM resources
We suggest that TQM culture is a foundation for process improvement and product design capabilities. A common reason given for TQM failure is that organizational cultural values are incompatible with the values underlying quality management (Detert et al., 2000). Employees may resist to a quality initiative because it conflicts with the prevailing “ways things are done.” Limited success of quality improvement initiatives is also attributed to lack of top management commitment to quality, seen as instrumental for changing organizational culture in order to develop continuous improvement practices (Kaynak, 2003). Elements of a TQM culture such as teamwork/respect for people, employee training have also been considered crucial to an effective TQM system (Baird et al., 2011; Kaynak, 2003; Ahire and Dreyfus, 2000). Employee training and empowerment lead to a positive employee’s attitude and provide the confidence necessary to solve quality problems and enhance product quality levels. For instance, without adequate employee quality training, the usage of SPC tools will add to the bureaucracy instead of driving process improvement.

Similarly, employee involvement facilitated by top management commitment is an important determinant of product design (Naor et al., 2008; Flynn et al., 1995). Moreover a sharp focus on market and customer needs inculcated by a TQM culture is critical for product design (Flynn et al., 1995; Hackman and Wageman, 1995). In this way, effective management of customer feedback should contribute to designing products that best meet customers’ needs. Based on the above discussion, we present the following hypotheses:

H1. TQM Culture is positively related to process improvement capability.

H2. TQM Culture is positively related to product design capability.

3.2 TQM resources and product innovation
A TQM culture provides the necessary platform for inculcating innovation in organizations (Singh and Smith, 2004) and acts as a catalyst in postulating the innovation performance (Powell, 1995). Flynn (1994) finds that top management quality leadership facilitates speed of product innovation. Customer focus helps organizations to consistently search for new customer needs and expectations, and therefore, search
and develop new products to meet changing needs and to ensure that innovation creates customer value (Zhou et al., 2005; Juran, 1988). Employee involvement contributes to product innovation by fomenting technical communication and information flows, quality teams and quality goals push behavior toward innovation and improvement (Naveh and Erez, 2004). Martínez-Lorente (2008) state that TQM is able to provide a suitable environment that outweighs the possible barriers it may create against innovation. Perdomo-Ortiz et al. (2009) found that human resource management that includes quality training, problem solving teams, etc., has a positive impact on technological innovation. The routines embedded in TQM Culture, namely, teamwork and the development of a shared vision, are related to the absorptive capacity of the firm (Gutiérrez et al., 2012) an important antecedent to product innovation (Cohen and Levinthal, 1990). Hence, the following hypothesis is presented:

**H3.** Product innovation is positively influenced by TQM culture.

There are contradicting arguments regarding the role of process improvement capability on innovativeness. Process improvement requires standardization, reinforcing existing routines and reducing task ambiguity, which may create rigidities that hinder innovation (Benner and Tushman, 2003). However, the analysis of multiple cases across industries showed that, contrary to expectations, process standardization can spur innovation by helping codify technological experience and by promoting collaboration to reduce task uncertainty (Allen and Sriram, 2000). Continuous improvement can encourage change, foster creative thinking, and reduce fear, critical elements for promoting innovation. Hence, the following hypothesis is presented:

**H4.** Product innovation is positively influenced by process improvement capability.

Flynn et al. (1994) find that the use of product design practices is associated with faster product innovation, a key factor for gaining competitive advantage. Many companies in different industries face increasing global competition and markets that demand more frequent innovation and higher quality. One approach taken by these companies to gain competitive advantage is to involve suppliers earlier in the design and development process (Ragatz et al., 2002). Several authors suggest that suppliers’ involvement benefits product innovation (e.g. Song and Di Benedetto, 2008; Afuah, 2000). Suppliers possess valuable information, expertise and specialized capabilities, which can be invaluable to produce a new innovative product or improve existing ones. Song and Di Benedetto (2008) argue that supplier involvement is essential to a new venture seeking to develop a radical innovation. Integration of design across different functions and organizational borders can promote innovation. The use of interdisciplinary teams and suppliers’ involvement in product design are well established as important mechanisms for knowledge transfer, cross-functional learning, and problem solving contributing to new product success (Dow et al., 1999; Clark and Fujimoto, 1991). Hence, we hypothesize a positive relationship between product design and innovation outcomes:

**H5.** Product innovation is positively influenced by product design capability.

### 3.3 Innovation resources

To capture the unique effects of TQM resources our model considers alternative explanations for innovation outcomes, namely, the strategic orientation of the firm and
its informational and product development capabilities. Innovation orientation has been defined as an organization’s openness to new ideas and propensity to change through adopting new technologies, resources, skills, and administrative systems (Hurley and Hult, 1998). Several studies indicate innovation orientation as a major driver of innovation outcomes (e.g. Siguaw et al., 2006; Hurley and Hult, 1998). Similarly, we expect that a strategic orientation towards innovation will be associated with product innovation. Moreover, we expect that a strong strategic orientation should influence organizational activities, providing the aspirations that drive capability development. The following hypotheses are presented:

\[ H6. \] Innovation orientation has a positive impact on innovation capabilities.

\[ H7. \] Innovation orientation has a direct, positive impact on product innovation.

Two key innovation capabilities are the acquisition of customer knowledge (Day, 1994) and the ability to develop new products, i.e., product development capabilities (Kleinschmidt et al., 2007; Clark and Fujimoto, 1991). Morgan et al. (2004) found that both product development capabilities and informational capabilities are associated with product positional advantage. The acquisition of important market information through proficiency in screening, preliminary market and technical assessments, and market research facilitates the development of products features that meet customer requirements better than competitors’ products. The following hypothesis is presented:

\[ H8. \] Innovation capability has a direct, positive impact on product innovation.

4. Methodology
4.1 Data collection
The data for testing the hypotheses come from a self-administered questionnaire sent to a sample of Portuguese manufacturing companies that rely mostly on export markets. For Portugal, exporting is particularly important because of the access to opportunities for scale economies, specialization, and access to technology (Organization for Economic Co-operation and Development, 2008). The unit of analysis is an export venture, a product sent to an importer in a foreign market. The present research focuses on a multi-industry sample in order to increase observed variance and strengthen the generalizability of our findings (cf. Morgan et al., 2004). The data were collected through a mail survey. Before conducting the study we refined all the items using exploratory research. First, several expert judges assessed face validity (Hunt et al., 1982). Following the initial purification process, a revised version of the questionnaire was discussed through a series of structured face-to-face interviews. These interviews involved three export managers, three quality managers, and two managing directors of manufacturing firms operating in different industry sectors. This stage helped evaluate further individual item content, clarify the instructions, design the type of response format and evaluate the respondent’s competence. For example, during these interviews quality managers recommended the inclusion of FMEA in the questionnaire since they consider it as an important quality practice. Moreover, quality managers from chemical industry also recommended to add “test laboratories” in the items used to measure internal quality information usage. For instance, the item IU3 changes from “Quality information is displayed at the work stations” to “Quality information is displayed at the work stations (or test laboratories).” The items used to measure the construct SPCusage also change.
based on quality manager’s suggestion. The items used by Ahire et al. (1996) use the abbreviation SPC without any example. Managers suggest that we should put examples of SPC techniques closed to the abbreviation SPC in order to clarify the meaning of SPC. For instance, item SPC2 change from “SPC has been effective in improving the quality of product” to “SPC (control charts, cause and effect diagram histogram, etc.) has been effective in improving the quality of product.”

The data for the main study are from a random sample of 1,332 exporting manufacturing firms listed in a Portuguese governmental agency database (ICEP, 2004). This database contains the firm’s name, address, telephone number, e-mail, and key contact people for all Portuguese exporting firms. Data collection occurred in 2006 and involved three mailings. In the initial mailing a cover letter, a questionnaire, and a postage-paid business reply envelope were sent to the Manager Director of each firm with two parts of the questionnaire: one for the responsible for quality management and one for the responsible for export operations. The postal service returned 53 questionnaires reducing the sample size to 1,279 companies. Out of these, a total of 112 companies returned both questionnaires yielding a total of 224 valid questionnaires, a raw response rate of 8.8 percent. In order to find out the effective response rate we employed a systematic selection procedure and selected 177 companies (14 percent of the targeted firms) for follow-up contacts via telephone. We started by conducting a first follow-up contact with 77 firms to determine undeliverable rates. This revealed that 32 percent of the envelopes did not reach the managing director to whom they were addressed and 27 percent reported a corporate policy of managers not responding to academic surveys. After considering the undeliverable rates, our initial sample size was reduced to 524 companies. A second follow-up contact with more 100 firms revealed that 20 percent of the companies had one person accumulating quality and export management. Hence, only 80 percent of the sample frame fills the second required criteria. In sum, the two follow-up contacts suggested that as few as 419 of the 1,279 firms surveyed should be considered, yielding an effective response rate of approximately 26.7 percent (112/419).

4.2 Data profile

The size of the export venture varies significantly, about 27 percent of the firms having sales below €1.6M, 67 percent from €1.6M-€46M, and 6 percent over €46M. With regard to number of full-time employees, 11.6 percent have 50 or fewer, 33 percent from 51 to 100, 36.6 percent from 101 to 250, and 18.8 percent have 251 or more employees. The vast majority of participating firms have significant experience in international business: on average, companies have worked for 11 years with the selected importers. The job title of the person responsible for export management included president, exporting director, managing director, marketing director, supply-chain director, and operations management director. Job titles of the person responsible for quality management operations included quality director, quality manager, industrial director, production director, services director, and coordinator of quality and environment. Those responsible for export operations had on average 13 years experience in the firm and had been in the same business function for nine years. Respondents responsible for quality management had on average 12 years experience in the company and had been in the same business function for nine years.

4.3 Assessment of nonresponse and common method bias

We test for nonresponse bias comparing the responses of early respondents (the first 75 percent returning the questionnaires) and late respondents (the last 25 percent).
The lack of significant differences between the early and late respondents suggests that response bias was not a significant problem in the study (Armstrong and Overton, 1977). In order to safeguard against common method bias we followed some of the procedural remedies suggested by Podsakoff et al. (2003). We used paper-and-pencil administrated questionnaires as opposed to face-to-face interviews; we protected respondents’ anonymity to reduce evaluation apprehension; we created simple, specific and concise items; respondents were not aware of our conceptual model; the measures included in the final model come from two different sources (informants). We used the Harman single-factor test, a statistical remedy commonly used to control for common method bias (cf. Podsakoff et al., 2003). The non-rotated solution exploratory factor analysis (EFA) produced 19 factors with eigenvalues > 1. Taken together, the 19 factors explained 80 percent of the variance in the data, with the first extracted factor without rotation accounting for 25 percent of the variance in the data. Given that < 50 percent of the variance can be attributed to the first factor, the results suggest that common method bias is unlikely to be a significant issue. We used two separate method bias EFA tests for different informants. To test for validity, we correlated responses for one covariate included in the model, firm size, with data from the firms’ annual reports. Results show a significant correlation between data (0.540, p < 0.05) for firm size variable.

Finally, we ran Lindell and Whitney’s (2001) test that uses a theoretically unrelated construct (termed a “marker” variable). We conducted the test using tenure of respondents as a marker variable since it is theoretically unrelated to constructs examined in this study. The average correlations between the study’s principal constructs and the tenure of the responsible for export operations (r = 0.039, average p-value = 0.642) and tenure of the responsible for quality management (r = 0.072, average p-value = 0.4093), were low and non-significant, providing no evidence of common method bias.

4.4 Measures
The scales used in this study are shown in detail in Appendix. We adapted scales well established in the literature and refined them through interviews with managers, as suggested by Churchill (1979). All constructs were measured using reflective scales. All variables were measured using a seven-point Likert scale.

Consistent with previous studies, we operationalized TQM resources as second-order factors (e.g. Sila, 2007; Prajogo and Sohal, 2004). Our measures of TQM resources are based on the scale developed by Ahire et al. (1996). We add some dimensions and items to their scale to better measure the underling constructs. We focus on the level of maturity of capability development absent of the time since implementation, recognizing the idiosyncratic outcome of each firm unique history with TQM.

TQM culture is operationalized as a second-order factor that consists of three first-order factors: top management commitment, quality-oriented human resource management, and customer focus. As suggested by Ahire et al. (1996) employee involvement, employee training and employee empowerment were considered to be reflective of a common factor termed quality oriented human resources management.

Process improvement capability is measured as a second-order factor that consists of three first-order factors: SPC usage, internal quality information usage, and benchmarking. SPC usage measures the extent to which an organization uses SPC to detect quality problems, establish the limits of normal variability of the production process, and improve product and process quality. As recognized by Ahire et al. (1996), SPC will only be effective if there is a good dissemination of generated information.
In this way, we need internal quality information usage capabilities to ensure an effective process management. While SPC allows an organization to monitor the quality of internal processes, benchmarking allows it to systematically identify and replicate “best practices” to enhance its business performance (Vorhies and Morgan, 2005).

Product design capability is operationalized as a second-order factor that consists of three first order factors: supplier involvement, FMEA and design quality management. The items related to supplier involvement were drawn from Ahire et al. (1996) and Flynn et al. (1994). We added the use of FMEA tools to improve product design as a third dimension.

Innovation orientation was measured with eight items adopted from Homburg and Pflesser (2000) and Zhou et al. (2005) scales. Innovation capability defined as the ability of an organization to adopt or implement new ideas, processes, or products successfully, were measured as a second-order factor that includes product development capabilities and market sensing capabilities. Scales for product development and market sensing were adapted from Morgan et al. (2004).

Product innovation was defined as the degree of product newness. To measure product innovation we used seven items adopted from Zhou et al. (2005) and Sarin and Mahajan (2001).

Control variables included resource position, firm size, and competitive intensity. We adopted Morgan et al. (2004) scale to measure resource position and treated it as a second-order factor with four first-order factors: experimental resources, scale resources, financial resources and physical resources. Firm size was measured in terms of full time employees. To measure competitive intensity we used four items adapted from Jaworski and Kohli (1993).

5. Analysis and results
The assessment of the measurement model properties, and the structural model, were performed using partial least squares (PLS) with Smart PLS 2.0 (Ringle et al., 2005). Following the guidelines for applying PLS-SEM given by Hair et al. (2012) a bootstrapping re-sampling procedure was used to estimate the significance of the path coefficients. PLS was chosen instead of a covariance-based technique, since it allows the inclusion of variables non-normally distributed and is robust for small-to-moderate sample sizes (Barclay and Smith, 1997). The sample obtained, 112 cases, is adequate for PLS analysis. It satisfies the heuristic that the sample size should be at least ten times the largest number of structural paths directed at any one construct (Hair et al., 2012; Chin, 1998). A PLS model is analyzed and interpreted in two stages: the assessment and reliability of the measurement model, and assessment of the structural model (Hulland, 1999).

5.1 Measurement model
The evaluation of a reflective measurement model (outer model reflective) is made in terms of indicator reliability, internal consistency reliability, convergent validity, and discriminant validity (Hair et al., 2012). Individual item reliability is assessed by examining the standardized indicator loadings of the measures with their respective construct. A rule of thumb is to accept indicators with loadings greater than or equal to 0.7; in exploratory studies loadings of 0.4 are acceptable (Hulland, 1999). As reported in Appendix, loadings are generally above 0.7 for indicators, and first-order factors (dimensions) related to second-order factors. The only exceptions are the loadings for supplier involvement (0.668), for item QOHR1 (0.682) and for item QOHR2 (0.698). When
multiple measures are used for an individual construct, the researcher should be concerned not only with individual measurement indicator reliability, but also with the extent to which the measure demonstrates convergent validity (Hulland, 1999). To access convergent validity and internal consistency reliability, the average variance extracted (AVE) and composite reliabilities (CR) were calculated as per Fornell and Larcker (1981). All AVE values surpass the cutoff of 0.5 suggested by Bagozzi and Yi (1988), with a minimum value of 0.555, suggesting that the explained variance due to the construct is greater than variance due to measurement error. Fornell and Larcker argue that their measure is superior to Cronbach alpha since it uses the indicator loadings obtained within the nomological network (or causal model). Nunnally (1978) suggests 0.7 as a benchmark to “modest” CR, applicable in the early stages of research. The suggested minimum acceptable value for CR was met for all constructs with a minimum value equal to 0.800 (as shown in Appendix), indicating that all of the constructs are reliable.

The methodological complement to convergent validity is discriminant validity (Hulland, 1999), the extent to which indicators of a given construct differ from indicators of other constructs. To access discriminant validity when using PLS, AVE should be compared with the shared variance among the latent variables (i.e. the square root of the AVE should be greater than the correlation between a construct and any other construct) (Chin, 1998; Fornell and Larcker, 1981). Table II reveals that this condition is satisfied for all constructs in the research model. The numbers on the main diagonal, which represent the square roots of AVE for each construct, are greater than the off-diagonal elements in the corresponding rows and columns (the correlations between constructs). A second way to evaluate discriminant validity is to examine the factor loadings of each indicator (Hair et al., 2012; Chin, 1998). Each indicator should load higher on the construct of interest than on any other factor. This condition is satisfied for all the items included in the model, indicating discriminant validity.

5.2 Structural model

Having established confidence in our measurement model, a structural PLS model was run to assess the support of the conceptual model and hypotheses. The model was tested using the variance explained ($R^2$) of the endogenous construct or dependent variables, the intensity of the path coefficients ($\beta$) and applying the non-parametric bootstrap technique to assess the precision and stability of the estimations obtained. The condition for the variance explained values of the dependent variables ($R^2$) is that it should be greater than or equal to 10 percent (Falk and Miller, 1992). More recently Hair et al. (2012) state that acceptable levels depends on research context. The values of $R^2$ were calculated for all endogenous constructs. The maximum value obtained was 49 percent for innovation capability and the minimum 29 percent for product design capability. Consistent with Chin (1998) a bootstrap test (500 sub-samples) was used to generate the standard error and $t$-values of the parameters. Table III summarizes the PLS structural analysis for the hypothesized relations and Figure 2 provides a graphical representation of the results.

A strong support was found for hypotheses $H1$ and $H2$ that process improvement capability ($\beta = 0.574, p < 0.001$) and product design capability ($\beta = 0.509, p < 0.001$) are positively affected by TQM culture. Regarding the impact on innovation outcomes, we find that only product design capability is significantly associated with product innovation ($\beta = 0.259, p < 0.05$) supporting $H5$. TQM Culture and process improvement capability have no significant effect on product innovation. Thus no support was found for $H3$ and $H4$. 

Role of TQM in strategic product innovation
### Table II
Correlation matrix (discriminant validity check)

| (1) Innovation orientation | 5.404 | 1.122 | 0.886 |
| (2) Innovation capability | 4.670 | 0.929 | 0.409 | 0.881 |
| (3) TQM culture | 5.533 | 0.832 | 0.700 | 0.309 | 0.869 |
| (4) Product design capability | 3.568 | 1.237 | 0.404 | 0.253 | 0.529 | 0.797 |
| (5) Process improvement capability | 4.344 | 1.254 | 0.445 | 0.192 | 0.584 | 0.731 | 0.804 |
| (6) Product innovation | 4.457 | 1.321 | 0.352 | 0.511 | 0.270 | 0.392 | 0.302 | 0.866 |
| (7) Resource position | 4.436 | 0.870 | 0.212 | 0.643 | 0.271 | 0.211 | 0.195 | 0.348 | 0.824 |
| (8) Competitive intensity | 5.058 | 1.342 | 0.101 | 0.049 | 0.045 | 0.051 | −0.036 | 0.166 | 0.010 | 0.847 |
| (9) Firm size | 186.65 | 243.739 | 0.062 | −0.132 | 0.071 | 0.050 | 0.207 | −0.018 | −0.036 | −0.169 | NA |

**Note:** Italicface numbers are the square roots of AVE.
Hypothesized relations

<table>
<thead>
<tr>
<th>Hypothesized relations</th>
<th>Path coefficient</th>
<th>t-value (bootstrap 500 sub-samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: TQM culture → process improvement capability</td>
<td>0.574</td>
<td>8.476***</td>
</tr>
<tr>
<td>H2: TQM culture → product design capability</td>
<td>0.509</td>
<td>6.752***</td>
</tr>
<tr>
<td>H3: TQM culture → product innovation</td>
<td>-0.121</td>
<td>1.017</td>
</tr>
<tr>
<td>H4: Process improvement capability → product innovation</td>
<td>0.044</td>
<td>0.356</td>
</tr>
<tr>
<td>H5: Product design capability → product innovation</td>
<td>0.259</td>
<td>2.199*</td>
</tr>
<tr>
<td>H6: Innovation orientation → innovation capability</td>
<td>0.286</td>
<td>3.406***</td>
</tr>
<tr>
<td>H7: Innovation orientation → product innovation</td>
<td>0.125</td>
<td>1.191</td>
</tr>
<tr>
<td>H8: Innovation capability → product innovation</td>
<td>0.422</td>
<td>5.104***</td>
</tr>
</tbody>
</table>

Control paths

Firm size → product innovation 0.035 0.467
Competitive intensity → product innovation 0.134 1.482
Resource position → product design capability 0.074 0.978
Resource position → process improvement capability 0.039 0.490
Resource position → innovation capability 0.583 8.929***

Notes: ***,*** Significant at \( p < 0.05; p < 0.01 \) and \( p < 0.001 \) levels, respectively (two-tailed test)

Table III. Estimated path coefficients and \( t \)-values

Figure 2. Model results

Notes: ***,*** Significant at 0.01, 0.05 and 0.001 level, respectively
H6 predicted a positive effect of innovation orientation on innovation capability. This hypothesis was strongly supported ($\beta = 0.286, p < 0.001$). Although both innovation orientation and innovation capability were positively associated to product innovation, only the impact of innovation capability is significant ($\beta = 0.422, p < 0.001$) providing support for H8.

From all control paths analyzed only the impact of resource position on innovation capability was significant ($\beta = 0.583, p < 0.001$). Firms with resource positional advantage tend to be more apt at developing innovation capabilities.

Post hoc examination
In addition to providing information on the hypothesized relationships, we tested the relationship between product innovation and economic performance. This variable was measured on a seven-point scale adapted from Morgan et al. (2004), and considers the extent to which firms achieve economic and financial results relative to their competitors (see Appendix). Results show that product innovation has a strong positive impact on economic performance ($\beta = 0.337, p < 0.001$) supporting the use of this measure as an indicator of competitive advantage. This result also reinforces the idea that advantage through innovation is a strong determinant of economic rents vs competitors.

6. Discussion of results, limitations, and future research issues
The quality management literature suggests some tension between the implementation of TQM systems and innovation outcomes of the firm. In this study we explored two related questions: how can we partition TQM systems from a RBV perspective; and how do these resources contribute to competitive advantage through innovation?

The main finding of this research suggests that the ability to design quality into products is a critical capability for product innovation. We offer two explanations for this finding: first, product design capability could be an important foundational element for product innovation, ensuring faster and more effective translation of new ideas into product features that customers value, and into technical specifications for new products; secondly, the deployment of product design routines in the context of innovation could be embedded with idiosyncratic elements that increase the level of firm-specificity and inimitability conferring a technological or market advantage to the firm's new products.

The second key finding is that TQM culture has a direct influence on process improvement and product design capabilities but not on product innovation directly. The finding that TQM culture has no impact on product innovation challenges previous empirical studies that report a positive association between soft quality management practices and innovation outcomes (Prajogo and Sohal, 2004; Flynn, 1994). Contrary to previous studies, we control for alternative explanations of innovation outcomes, namely innovation capabilities, resource position and competitive intensity of the market. The finding is also consistent with the idea that assets need to become embedded in capabilities to become a source of competitive advantage (Sirmon et al., 2007; Day, 1994), and supports our argument that TQM culture builds absorptive capacity within the firm, enabling the development of specific quality management capabilities.

Our findings also indicate that innovation orientation is an important catalyst for the level of firm innovativeness. Results support a strong link to the development of innovation capability. Competitive intensity and firm size were not important for
positional advantage a result consistent with prior empirical results (Morgan et al., 2004). The availability of resources to the firm had a significant positive association with the development of innovation capabilities, but was not important for the development of TQM capabilities.

Among the limitations of our study we must include the fact that innovation outcomes are focused on product innovation. Product innovation is rather limiting, we could split innovation into radical and incremental, and a wider range of innovation outcomes may be added in future investigation such as process innovation and service innovation. The use of cross-sectional obtained from a limited number of participant firms limits generalization of our results. Further, although the questionnaire sought responses from more than one key informant, the study still did not embrace wider views. Future research could potentially include multiple informants with involvement in different aspects of the business operations. One opportunity is to include multiple informants across the vertical structure, including floor level employees to obtain a better sense of the depth of implementation of TQM practices. Finally, the analysis at the firm level does not consider the use of intermediate organizational structures to drive different innovation projects. Future research should consider the impact of entrepreneurial driven project level structures, which may be able to better navigate through the constraints imposed by firm level TQM systems.

Despite these limitations, the study contributes to the development of the literature in two distinct ways: first it enhances our understanding of how TQM practices relate to each other in building firm level assets and capabilities, and result in product innovation; second, it promotes the use of covariates to better capture the relationship between TQM and product innovation. In our model we control for innovation capabilities and organizational assets.

As mentioned above, one area for future research is the study of the linkages between the distinct TQM resources and different types of innovation. One opportunity is to include wider concepts of innovation outcomes, including radical vs incremental product innovation, and process innovation. Future studies can examine whether the degree of product novelty moderates the relationship between TQM capabilities and product innovation. Future research could also examine the relationship between TQM capabilities and process innovation outcomes. A recent study suggests that knowledge creation enabled by TQM process improvement capability could enable process innovation that gives firms a competitive advantage (Kim et al., 2012).

There are two other interesting avenues for future research. Longitudinal research could observe temporal effects of knowledge acquisition and assimilation mechanisms associated with TQM capabilities on product and process innovation outcomes. It would also be promising to test our model in the context of service firms. The first-order factors need to be adapted to capture the dimensions of quality improvement in the service context, and subsequently the second-order constructs capturing TQM capabilities can be related to service innovation outcomes.

Our study also has important implications for managers and policy. Based on our findings managers might better understand the important role of TQM practices in achieving firm strategic advantage through innovation. The findings offer a justification for investment in TQM resources to promote strategic product innovation, establishing a supporting framework for capability development, and allocating resources effectively. Government policies in less advantaged regions should regard their support to training and development in TQM methods as a foundational element to foster innovation. We found evidence to support the argument that firms must
develop a TQM culture in order to deploy other TQM capabilities. In this way, without top management support, the implementation of TQM practices may not have any positive results. In a dynamic business environment, where firms are under pressure to innovate, a better understanding of the impact of TQM capabilities can enable managers to leverage them more selectively to address change and gain competitive advantage.

References


Appendix. Measurement scales and loadings

**INNOVATION ORIENTATION** (AVE = 0.785/CR = 0.967/α = 0.959)
(Adapted from Homburg and Pfleffer, 2000)

**Question:** With regard to your company situation, to what extent did you agree or not with the following sentences?
(Scale: 1 = “strongly disagree,” and 7 = “strongly agree”)

- **IO1** We particularly emphasize innovativeness and creativity: 0.878
- **IO2** We are very open toward innovations (e.g., related to product or process): 0.878
- **IO3** Our company pays close attention to innovation: 0.901
- **IO4** Our company emphasizes the need for innovations for development: 0.910
- **IO5** Innovation principles are communicated to everyone within the organization: 0.834
- **IO6** Managerial decisions usually reflect the views of the responsible for innovation: 0.891
- **IO7** Top management formally promotes and encourages innovation: 0.896
- **IO8** Relative to other functions within your firm, the innovation activity is considered important to the success of the firm: 0.898

**TQM CULTURE** (AVE = 0.755/CR = 0.902)
Second order factor

**Question:** With regard to your company situation, to what extent did you agree or not with the following sentences?
(Scale: 1 = “strongly disagree,” and 7 = “strongly agree”)

**Top Management Commitment** (AVE = 0.717/CR = 0.910/α = 0.865)
(Adapted from Ahide et al., 1996)

- **TC1** Our performance evaluation by top-level management depends heavily on quality: 0.727
- **TC2** Top-level managers allocate adequate resources toward efforts to improve quality: 0.897
- **TC3** We have clear quality goals identified by top-level managers: 0.882
- **TC4** At company-wide meetings top-level managers often discuss the importance of quality: 0.869

**Customer focus** (AVE = 0.625/CR = 0.869/α = 0.792)
(Adapted from Ahide et al., 1996)

- **CF1** Manufacturing managers are aware of the results of customer satisfaction surveys: 0.771
- **CF2** A summary of customer complaints is given to manufacturing managers regularly: 0.802
- **CF3** To achieve greater customer satisfaction, our company actively seeks ways to improve our products: 0.809
- **CF4** Our company has been customer focused for the past two years: 0.778

**Quality Oriented Human Resources Management** (AVE = 0.555/CR = 0.882/α = 0.825)
(Adapted from Ahide et al., 1996)

- **QOHR1** All employee suggestions are evaluated: 0.682
- **QOHR2** Resources are available for employee quality training in our plant: 0.698
- **QOHR3** Plant Managers are often involved in quality training: 0.723
- **QOHR4** Line workers are encouraged to fix problems they find: 0.803
- **QOHR5** Line workers are given the resources necessary to correct quality problems they find: 0.789
- **QOHR6** Line workers have technical assistance available to them to help them solve quality problems: 0.768
**PRODUCT DESIGN CAPABILITY**

Second-order factor (AVE = 0.635/CR = 0.837)

**Question:** With regard to your company situation, to what extent did you agree or not with the following sentences?

(Scale: 1 = “strongly disagree,” and 7 = “strongly agree”)

**Failure Mode and Effect Analysis (AVE = 0.924/CR = 0.974/α = 0.958)**
(Adapted from Ahire et al., 1996)

| FM1 | Our company uses FMEA to solve quality problems | 0.965 | 108.327 |
| FM2 | FMEA has been effective in improving the quality of our products | 0.966 | 116.434 |
| FM3 | Our employers are well trained to use FMEA | 0.953 | 87.463 |

**Design Quality Management (AVE = 0.623/CR = 0.868/α = 0.789)**
(Adapted from Ahire et al., 1996)

| DQM1 | We use extensively Taguchi methods and design of Experiments | 0.801 | 20.658 |
| DQM2 | We use error prevention techniques in designing the manufacturing process | 0.809 | 21.583 |
| DQM3 | There are engineers from other functional departments on a design team | 0.720 | 11.838 |
| DQM4 | We use Quality Function Deployment (QFD) in the design of our products. | 0.823 | 22.168 |

**Supplier Involvement (AVE = 0.573/CR = 0.800/α = 0.698)**
(Adapted from Ahire et al., 1996; Flynn et al., 1994)

| SI1 | Our suppliers are actively involved in our new product development process | 0.700 | 8.683 |
| SI2 | We conduct quality audits to our suppliers | 0.763 | 12.395 |
| SI3 | We provide technical assistance to our suppliers | 0.803 | 15.134 |

**PROCESS IMPROVEMENT CAPABILITY (AVE = 0.646/CR = 0.846)**
Second-order factor

**Question:** With regard to your company situation, to what extent did you agree or not with the following sentences?

(Scale: 1 = “strongly disagree,” and 7 = “strongly agree”)

**Statistical Process Control Usage (AVE = 0.877/CR = 0.955/α = 0.929)**
(Adapted from Ahire et al., 1996)

| SPC1 | SPC is used extensively in our plant | 0.928 | 48.114 |
| SPC2 | SPC (control charts, cause and effect diagram histogram, etc) has been effective in improving the quality of product | 0.964 | 123.775 |
| SPC3 | We will continue to use SPC (control charts, cause and effect diagram histogram, etc) in the manufacture of our products | 0.917 | 34.334 |

**Internal Quality Information Usage (AVE = 0.797/CR = 0.940/α = 0.914)**
(Adapted from Ahire et al., 1996)

| IU1 | Scrap rates of our products are readily available on the work stations (or test laboratories) | 0.908 | 46.824 |
| IU2 | Rework rates of our products are readily available on the work stations (or test laboratories) | 0.871 | 23.039 |
| IU3 | Quality Information is displayed at the work stations (or test laboratories) | 0.908 | 41.105 |
| IU4 | Progress toward quality-related goals is displayed in our plant | 0.884 | 35.637 |
Role of TQM in strategic product innovation

Benchmarking (AVE = 0.693/CR = 0.900/α = 0.849)
(Adapted from Ahire et al., 1996)

BM1 We are engaged in extensive benchmarking of competitors’ products
that are similar to our products 0.860 27.837
BM2 Our benchmarking activities have reduced costs 0.835 13.905
BM3 We have engaged in extensive benchmarking of other companies’
business processes in other industries 0.740 13.831
BM4 We will definitely continue benchmarking 0.886 35.510

INNOVATION CAPABILITY (AVE = 0.776/CR = 0.873)
Second -order factor

Question: How do you evaluate the following capabilities of your company compared with your main competitors?
(Scale: 1 = “much worse,” and 7 = “much better”)

Market Sensing (AVE = 0.763/CR = 0.928/α = 0.895)
(Adapted from Morgan et al., 2004)

MS1 Identification of prospective customers 0.851 26.168
MS2 Capturing important market information 0.909 36.272
MS3 Acquiring export market-related information 0.869 16.850
MS4 Making contacts in the export-market 0.864 34.911

Product Development (AVE = 0.797/CR = 0.922/α = 0.872)
(Adapted from Morgan et al., 2004)

PRD1 Development of new products for our importers 0.907 42.274
PRD2 Building of the product to designated or revised specifications 0.876 23.196
PRD3 Adoption of new methods and ideas in the manufacturing process 0.895 40.129

PRODUCT INNOVATION* (AVE = 0.749/CR = 0.947/α = 0.932)
(Adapted from Zhou et al., 2005; Sarin and Mahajan, 2001)

Question: When considering the product of the selected export venture, what is your opinion concerning
the following sentences?
(Scale: 1 = “strongly disagree,” and 7 = “strongly agree”)

P11 High-quality technical innovations were introduced during the
development of this product 0.789 20.064
P12 Compared to similar products developed by our competitors, our product
will offer unique features/attributes/benefits to the customers 0.872 31.869
P13 Our product introduces many completely new features to this class of
products 0.920 52.403
P14 Compared to similar products developed by our organization, our
product will offer unique features/attributes/benefits to the customers 0.847 14.979
P15 Our product is highly innovative, replacing an inferior alternative 0.896 41.009
P16 Our product incorporates a radically new technological knowledge 0.864 22.543

RESOURCE POSITION (AVE = 0.679/CR = 0.894)
Second -order factor

Question: How do you evaluate your company compared with your main competitors in terms of:
(Scale: 1 = “much worse,” and 7 = “much better”)

Experimental (AVE = 0.729/CR = 0.915/α = 0.876)
(Adapted from Morgan et al., 2004)
| EXP1 | Knowledge of export venture market | 0.793 | 16.328 |
| EXP2 | Length of firm’s export experience | 0.879 | 27.204 |
| EXP3 | Number of export ventures in which the firm has been involved | 0.864 | 40.544 |
| EXP4 | Past export performance | 0.876 | 39.656 |

**Scale (AVE = 0.670/CR = 0.858/α = 0.749)**  
(Adapted from Morgan et al., 2004)

| SCL1 | Annual turnover with export activities | 0.703 | 8.655 |
| SCL2 | Number of full-time employees involved in export activities | 0.897 | 41.129 |
| SCL3 | Percentage of employees mainly involved in the export function | 0.843 | 26.268 |

**Physical (AVE = 0.760/CR = 0.904/α = 0.843)**  
(Adapted from Morgan et al., 2004)

| PHY1 | Use of modern technology and equipment | 0.901 | 47.021 |
| PHY2 | Preferential access to valuable sources of supply | 0.876 | 29.657 |
| PHY3 | Production capacity availability | 0.836 | 17.343 |

**Financial (AVE = 0.921/CR = 0.959/α = 0.915)**  
(Adapted from Morgan et al., 2004)

| FIN1 | Availability of financial resources to be devoted to export activities | 0.964 | 99.318 |
| FIN2 | Availability of financial resources to be devoted to the export venture | 0.956 | 57.556 |

**COMPETITIVE INTENSITY**  
(Adapted from Jaworski and Kohli, 1993)

**Question:** When considering the export market characteristics of your company, what is your opinion concerning the following sentences?  
(Scale: 1 = “strongly disagree,” and 7 = “strongly agree”)

| CI1 | Price competition is hallmark of our export market | 0.717 | 2.611 |
| CI2 | One hears of a new competitive move almost every day | 0.959 | 4.430 |

**ECONOMIC PERFORMANCE**  
(Adapted from Morgan et al., 2004)

**Question:** How do you evaluate your company compared with your main competitors in terms of:  
(Scale: 1 = “much worse,” and 7 = “much better”)

| EP1 | Export sales volume | 0.933 | 25.000 |
| EP2 | Export market share | 0.933 | 48.099 |
| EP3 | Profitability | 0.917 | 30.818 |
| EP4 | Percentage of sales revenue derived from products introduced in this market during the past three years | 0.917 | 41.381 |

**Notes:**
(R) – reversed item
(†) Items dropped from the scale during measure purification phase are not shown.
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