BRQ Business Research Quarterly (2015) 18, 4–17

BUSINESS RESEARCH QUARTERLY

www.elsevier.es/brq

ARTICLE

Exploring the relationship between information technology competence and quality management

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Received 19 January 2012; accepted 19 November 2013
Available online 3 April 2014

JEL CLASSIFICATION
M10;
M15

KEYWORDS
Information technology;
Quality management practices;
Structural equation modeling

Abstract The introduction of information technology (IT) has become a necessity to compete in most industries, so simple implementation of an IT strategy is not enough to achieve a better firm performance. Literature review shows IT as a useful tool only when it is combined with other firm resources and practices. The purpose of this paper is to analyze the complementarity between IT and one of the most prevalent and well-established set of organizational practices, Quality management practices (QMP). Structural equation modeling with data collected from managers in 230 Spanish firms shows a positive and significant relationship between IT and QMP. The findings provide us with in-depth understanding of both disciplines and several conclusions for its success.

Introduction

The ability to obtain information on markets and customers can improve firms' predisposition to adapt to changes in the environment and thus to improve their competitive position with respect to competitors who are poorly informed and therefore slower to adapt (Barney, 2001). Many firms have thus begun to develop strategies that understand information technology (IT) as a resource that facilitates the acquisition and use of information (Mata et al., 1995; Tippins and Sohi, 2003). In spite of the growing academic and practical interest in understanding how IT can sustain competitive advantage (Pavlou and El Sawy, 2006), there is no clear understanding of the processes by which IT impacts firm strategy or performance improves (Devaraj and Kohli, 2003; Lee et al., 2008).

Research has conceptualized IT as a useful tool only when it is combined with other resources or practices in the firm (Powell and Dent-Micallef, 1997; Jarvenpaa and Leidner, 1998). In other words, the utility of IT is tied to its complementarity with other organizational resources or practices, developing IT-related resources (Nevo and Wade, 2010). For example, the literature review shows that IT facilitates other business processes, such as new product development (Pavlou and El Sawy, 2006), customer service quality (Ray et al., 2005) and entrepreneurial culture (Benitez-Amado et al., 2010). Despite these advances,

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http://dx.doi.org/10.1016/j.brq.2013.11.003

however, the processes by which IT resources interact with other human and organizational resources, as well as the nature of these resources, have hardly been studied (Ravichandran and Lertwongsatien, 2005; Wade and Hulland, 2004; Nevo and Wade, 2010). Previous research also shows that studies that are undertaken to study IT do not consider the role of IT capabilities, key variables for the proper implementation of IT assets (Kohli and Grover, 2008). It is therefore necessary to develop and study the impact of IT competence (Tippins and Sohi, 2003) or Information Systems strategy (Chen et al., 2010) on the different organizational resources.

When analyzing the complementarity of IT competence with other organizational resources and practices, it is necessary to define a well-structured set of the competences present in the business area. In that sense, quality management (QM) offers one of the sets of organizational practices related to Operations Management that is most frequently and well-established in firms (Sousa and Voss, 2002; Nair, 2006). The literature review shows that QM plays an important role in improving the firm's competitive position (Reed et al., 2000) and that the proper application of IT can influence this relationship (Murray, 1991; Aiken et al., 1996; Cortada, 1995; Forza, 1995; Ahmed and Ravichandran, 1999; Perez-Arostegui et al., 2012). Thus, the development of an IT competence will improve the efficacy of QM practices, enabling firms to achieve a better competitive position (Pearson et al., 1995).

Various studies have examined the relation between IT and QM. Matta et al. (1998) describe a theoretical framework that analyzes the impact of a set of IT tools present in the firm on success in the implementation of QM practices. The main limitation of this study is that it defines IT as a mere possession of these tools. The results of one of the main empirical studies to analyze the relationship between IT and QM, by Forza (1995), show that there is no significant statistical evidence between these variables. This study also provides merely a technical conception of IT. The study by McAdam and Henderson (2004) concludes that the empirical study of the relationship between QM and its antecedents (including IT) should be considered in future research.

Among the more recent studies, we would distinguish those of Sanchez-Rodriguez and Martinez-Lorente (2011), whose results show a positive and significant relationship between IT and QM. Here too, however, the definition of IT limits the degree of implementation of software, hardware, and communications infrastructure in the firm. Finally, the study by Perez-Arostegui et al. (2012) tackles the definition of IT as a competence composed of IT infrastructure, IT technical and managerial knowledge, and the integration of IT with the firm strategy. This study concludes that IT competence has a positive and significant impact on quality performance but does not analyze its impact on QM practices.

The goal of this study was thus to develop a deeper knowledge of the complementarities of IT competence with other organizational resources or practices that have a strong presence in firms, such as QM practices. We will analyze the impact of an IT competence on the implementation of QM, defining this implementation as the development of a set of QM practices. We give this goal concrete form in the following research proposals: (a) to determine the concept of IT competence based on an exhaustive literature review, and (b) to analyze the impact of an IT competence on the implementation of QM, as measured using seven practices (leadership, strategic planning, customer focus, information and analysis, human resources management, process management, and supplier management).

One of the main contributions of this paper is to develop an empirical study of the complementarity of IT competence with other organizational resources. The integrated study model provides a basis for calculating the level of influence of IT strategy on QM practices. Further, our study provides empirical evidence for the development of a second-order factor to evaluate the different dimensions of IT competence, providing new perspectives for researchers who wish to examine the multidimensionality of this variable.

The study also provides a guide for managerial practice by improving existing knowledge of the efficacy of a QM system. The positive impact of IT competence on different QM practices guarantees greater efficacy of the QM program. We also express the need for managers not to limit themselves to mere investment in an IT infrastructure, but to develop a set of IT-related capabilities that facilitate the development of other organizational practices.

To achieve these goals, the following section presents a theoretical review of the study variables, as well as justification of the different hypotheses that give our goal concrete form. Methodology section explains the research methodology, the origin of the scales chosen, their psychometric properties, and the characteristics of the study performed. After analysis and discussion of the theoretical model proposed in analysis and discussion section, the last section synthesizes the main conclusions, as well as the limitations and implications (academic and practical) of the study.

Literature review and hypotheses

Information technology competence

The literature on IT capability or competence analyzes the existence of various resources related to IT, whose combination composes an IT competence or capability that is valuable, non-imitable, and non-substitutable (Mata et al., 1995; Powell and Dent-Micallef, 1997). From this perspective, Bharadwaj (2000, p. 171) defines IT capability as the ability to mobilize and use IT-based resources through the combination or coexistence of other resources and capabilities in the firm. For Tippins and Sohi (2003, p. 748), IT competence represents the degree to which a firm possesses IT knowledge and employs it effectively to manage the information generated in the firm. In other words, the different dimensions of the construct ''IT competence'', composed of IT knowledge management, IT infrastructure (IT objects), and IT operations, represent co-specialized resources that reflect the organization's ability to understand and use IT tools and processes necessary to manage the information derived from customers and from the market.

Along these lines, Bharadwaj et al. (2002, p. 4) redefine IT capability as the firm's ability to acquire, develop, and direct its IT resources to determine and support its business strategies and value chain activities.

Table 1 IT competence dimensions.

Authors				
Mata et al. (1995)	Capital access, Technology property	IT technical knowledge	IT managerial knowledge	
Ross et al. (1996)	Technology assets	IT human resources (IT staff)		The relationship between IT and firm strategy
Powell and Dent-Micallef (1997)	Technology assets	IT human resources (IT staff)		Organizational resources related to IT
Feeny and Willcocks (1998)	IT infrastructure design			IT vision, IT services delivery
Bharadwaj (2000)	IT infrastructure	IT human resources (IT staff)		IT-related Intagible assets
Dehning and Richardson (2002)	IT spending			IT strategy IT management
Tippins and Sohi (2003)	IT objects (hardware, software and IT staff)		IT knowledge management	IT operations (use of IT to manage information)
Melville et al. (2004)	IT infrastructure and IT applications	IT technical knowledge	IT knowledge management	IT synergies
Ray et al. (2005)	Flexible IT infrastructure	IT technical knowledge		knowledge shared
Crawford et al. (2011)	IT infrastructure	IT technical knowledge		IT strategy and firm strategy
Chen et al. (2010)				IT use, IT planning, IT shared vision
Perez-Arostegui et al. (2012)	Flexible IT infrastructure	IT technical knowledge	IT managerial knowledge	IT integration with firm strategy

The study by Chen et al. (2010) develops a new way of evaluating IT competence, coining the concept of ''Information Systems Strategy.'' This study only focuses on how to manage such a strategy, however. The authors define a construct that considers the strategic management of IT through the following: IT use to sustain firm strategy, planning of the IT function, and shared vision of the Information System within the organization. Their definition does not consider either IT infrastructure or IT technical and managerial knowledge.

Table 1 identifies various dimensions that define IT competence based on a prior literature review. We can identify four different dimensions proposed, related to the following: IT infrastructure present in the firm; technical knowledge that the firm's human resources have of IT (IT technical knowledge); IT knowledge at the managerial level (IT managerial knowledge); and, finally, the degree to which IT is integrated into firm strategy (IT integration with firm strategy). We analyze these four dimensions, which are representative of IT capabilities or competences, taking the business unit as the unit of analysis. There are stances in the literature, however, that argue that the unit of analysis should be the process in itself as the level most appropriate for observing the strategic effects of IT (Ray et al., 2005).

IT infrastructure includes the different *software*, *hardware*, shared technological services, etc., for managing information, as well as the specific business applications that this infrastructure uses (Broadbent and Weill, 1997; Melville et al., 2004). A flexible IT infrastructure facilitates the implementation and development of IT applications, improving the firm's capability to respond to new and emerging opportunities and neutralizing possible threats (Ray et al., 2005).

IT technical knowledge refers to the know-how needed to implement IT applications using the technology available. Mata et al. (1995) specify these as knowledge of programming languages, experience in operating systems, and understanding of communication protocols. Tippins and Sohi (2003) conceptualize this measure as the degree to which a firm possesses a body of technical knowledge of IT applications such as computing-based systems. Ravichandran and Lertwongsatien (2005) analyze both technical skill and the specificity of IT human assets.

In contrast, Melville et al. (2004) find that IT managerial knowledge should include the skill to identify and plan IT projects properly, to allocate scarce resources, to direct and motivate the development of teams to implement different projects, and to foster collaboration with other business units. Mata et al. (1995) conceive these skills as the management's skill to conceive, develop, and exploit IT applications that facilitate the implementation of other organizational functions. These authors thus propose that managerial knowledge consists not only of anticipating future IT needs for the organization but also of considering aspects related to the ability to integrate the information system into the firm's vision and strategy and implement it as a facilitator of the labor of agents both inside and outside the firm.

Finally, IT is used not only to acquire, store, and analyze the information generated in the firm (Tippins and Sohi, 2003), which is provided by mere IT implementation, but also to direct the development of firm strategy (Ross et al., 1996). In addition to proper use of IT from a strategic point of view, it is crucial that there be a relationship between those in charge of IT, IT users, and the top management who facilitate communication between the different areas and involve users' greater understanding of the potential of IT (Bharadwaj et al., 1999; Feeny and Willcocks, 1998). Thus, all business units bear responsibility for the proper implementation of an information system in the organization.

Based on the literature review presented, we propose the following research hypothesis:

H1. IT competence is a second-order construct evaluated through the four dimensions identified: flexible IT infrastructure, IT technical knowledge, IT managerial knowledge, and IT integration in the firm's strategy.

Information technology competence and quality management practices

QM is defined as a philosophy of management that seeks excellence through continuous improvement and customer focus. This philosophy takes concrete form in a set of principles whose fulfillment is grounded in a set of practices and techniques (Dean and Bowen, 1994). Sousa and Voss (2002) determine that, at the empirical level, the study of QM should be based on analyzing a set of practices, since principles of quality are too general for empirical research and techniques too detailed to obtain reliable results. QM practices have been widely researched, and the resulting information is synthesized in literature reviews by Nair (2006) and Sousa and Voss (2002), among others. Both studies show the existence of seven practices to implement and evaluate QM: leadership, strategic planning, customer focus, human resources management, information and analysis, process management, and supplier management. These seven practices compose the framework of the study of QM in the papers with high research impact (Sila, 2007; Prajogo and Sohal, 2006, 2003; Kaynak, 2003; Samson and Terziovski, 1999).

The first studies relating IT and QM date back to the 1990s and focus on IT as a facilitator in the implementation of a QM program (Kondstadt, 1990). This initial research conceives IT only in its technical aspect, that is, how the tools that compose IT facilitate data collection in real time and permit the control of internal processes and other measurement systems needed to support the implementation of a total quality management system (TQM) (Aiken et al., 1996; Counsell, 1997; Miller, 1997; Murray, 1991); or, more generally, how IT influences QM through the strategic areas of human and technological resources (Zadrozny and Ferrazzi, 1992). The study by Ayers (1993) is one of the first to relate these two disciplines to each other. This study obtains empirical evidence to establish that QM has a positive impact on IT, since it is a management philosophy that goes beyond mere investment in a specific technology infrastructure. The paper specifies however, that it is very important to define IT correctly so that it pursues QM principles of customer focus and continuous improvement.

Although theoretical evidence exists for the critical role that IT plays in the success of QM implementation (Collins, 1994; Matta et al., 1998; Perez-Arostegui et al. (2012); Zadrozny and Ferrazzi, 1992), there are hardly any empirical or quantitative studies that support these propositions (McAdam and Henderson, 2004). Among the few existing studies, we emphasize several contributions. In the manufacturing sector, Forza (1995) analyzes the impact of information and IT on issues related to quality assurance: continuous improvement, simplicity of process design, process control, and measurement of performance with respect to customers and suppliers. Burges and Gules (1998) also analyze empirically the impact of using generic IT on quality assurance. Ngai and Cheng (1998) analyze the impact of IT on QM in a broad set of organizations and conclude that this impact is low, even when IT is used intensively.

The relationship between IT competence and leadership

Many authors consider management's leadership and top management commitment to be a driving element, that is, an antecedent of QM in an organization (Ravichandran and Rai, 2000; Kaynak, 2003). Top managers are the first to apply the quality focus and must motivate employees in assimilating its principles. Further, leadership must facilitate high levels of organizational performance, the individual development of members of the organization, and organizational learning (Samson and Terziovski, 1999). The participation of top managers includes activities such as communication of the values of quality throughout the company, the reinforcement of these messages, interaction with workers and customers, and receiving and providing the necessary training (Ang et al., 2001). Martínez-Lorente et al. (2004) find that IT facilitates the mission of top management, since it makes support for QM visible to the other business units, facilitates communication among these units and employees, facilitates the means for the different members of the organization to participate in the improvement of processes, and enables the communication of QM values to all members of the organization.

IT literature review shows how various studies have presented the complementarity between IT and top management commitment (Caldeira and Ward, 2003; Powell and Dent-Micallef, 1997; Teo and Ranganathan, 2003; Perez-Arostegui et al., 2012). Kettinger et al. (1994) determine that top management support is vital for guaranteeing the availability of resources that permit the undertaking of these programs, the integration of IT into firm strategy and business processes, and the assurance of continuity in investments over time. Finally, since the introduction of new IT can cause uncertainty and problems with employees and other members of the different business units, leadership must focus on avoiding contradictions between IT requirements and QM principles (Dewhurst et al., 1999). Thus, the vision of the leader, his/her attitude and behavior, will determine the perceptions that the organization's members have of adaptation to IT and the visibility of the results (Ke and Wei, 2008). In sum, IT competence indicates the degree to which the firm knows and uses IT to manage information within the firm (Tippins and Sohi, 2003), such that this

knowledge and use of IT facilitate the communication of QM values and paths of contact between top management and employees.

The relationship between IT competence and strategic planning

According to Barney (1991), a planning system can produce competitive advantages when it permits the firm to recognize and exploit its other resources, and some of these resources are the source of competitive advantage. In the literature on QM, Black and Porter (1996) believe that the development of plans and strategies that take into account questions of quality as well as analysis of the results of performance is key to achieving continuous improvement. In addition, strategic planning is what permits the coordination of quality efforts in an organization (Garvin, 1991). Dumond (1995) finds that quality planning includes, among other issues, the preparation of documentation to develop a quality strategy. These plans must be specific, focused, integrated, and aligned with other business plans (Thiagarajan and Zairi, 1997a).

The existence of IT competence will thus facilitate the identification of questions of quality, gathering and processing of the documentation necessary to carry out quality, the possibility of processing information related to other business units, analysis or measurement of performance, and communication of the objectives and functions of QM to the entire organization (Ang et al., 2001).

The relationship between IT competence and customer focus

Organizations consider IT as an indispensable factor for achieving a high level of implementation of costumer focus (Bharadwaj, 2000). Stone et al. (1996) indicate that there is a growing tendency among customers to manage their relationships with firms through IT.

Customer focus involves direct and continuous contact with customers, gathering information on their tastes, needs, expectations, and levels of satisfaction, as well as diffusing information acquired from improving the products and services provided (Cole et al., 1993; Dean and Bowen, 1994). Chiles and Choi (2000) establish that customer focus consists of satisfying clients' needs and demands through strategic use of the information obtained to identify them. That is, to satisfy customers, the firm must know them and be aware of their needs (Garvin, 1991; Oakland, 1993; Samson and Terziovski, 1999). Organizations oriented to quality constantly gather information on their customers from a wide variety of sources and use diverse quantitative techniques to evaluate customers' performance (Garvin, 1991; Oakland, 1993) in order to exceed their expectations and anticipate their needs. This makes IT competence a key to guaranteeing the development of this practice; it is crucial to manage the information obtained from customers effectively in the organization (Zhang, 2000).

Likewise, IT will facilitate the process of adapting products and services to customers' needs (Gilmore and Pine, 1997), as well as the coordination between the different business units and customer service (Rathnam et al., 1995). In addition, IT will obtain, process, and analyze the information related to customer satisfaction surveys, facilitating the decision-making process related to improvement of existing products and processes or the creation of new ones (Dewhurst et al., 1999). Chandler (1998) argues that the presence of IT encourages feedback of knowledge between both parties. Finally, Martínez-Lorente et al. (2004) determine that the IT implementation encourages identification of clients as well as of their needs, measurement and analysis of their satisfaction, and improvement of communication between the organization and clients.

The relationship between IT competence and information and analysis

Matta et al. (1998) establish that QM is a management system that uses information intensively. Information plays a crucial role, since activities oriented to improving quality are based on decision making (Garvin, 1991; Lin, 1991; Flynn et al., 1994). The databases that the organization manages must therefore be exhaustive and provide information on all critical areas of the organization, such as customers, suppliers, employees, and processes (Atkinson, 1991; Zahedi, 1998). Since managing quality in a firm generates a large quantity of data, it is important to determine what part of this information should be saved and organized in an easily accessible structure. Collins (1994) and Miller and Cardinal (1994) argue that databases should be able to facilitate the manipulation of information and perform the subsequent analyses required to satisfy the needs of all areas – strategic, tactical, and operational – in the organization.

One of the mechanisms used to obtain information is benchmarking. It is defined as a continuous process of comparison and evaluation of the firm's products, services, and practices relative to those applied by competitors recognized as leaders in the sector (Camp, 1993). The information that this practice provides must be available at the right time and be concise and easy to interpret; this information must be gathered and used in a highly precise way (Ahmed and Ravichandran, 1999).

Dewhurst et al. (1999) analyze how IT contributes to the benchmarking process, since it facilitates the following: communication with competing firms, identification of the best firms in the sector in which the organization operates, and simulation and analysis of measurements of performance. Finally, IT enables faster, more flexible planning based on this information, as well as on communication of the data throughout the organization.

The relationship between IT competence and human resources management

Dale et al. (1997) establish that one of the main problems in implementing QM in a firm comes from the lack of employee support for achieving the goals that QM considers. Employees must therefore be informed and encouraged to accept their responsibility fully (Flynn et al., 1994). To achieve this goal, employees must receive the information needed in the form of training and education to improve their knowledge and the tools needed to perform their work according to QM principles (Samson and Terziovski, 1999). Employees must also receive the proper motivation through different compensation mechanisms (Thompson, 1998). In sum, human resources management must promote, among other variables, employees' decision making (primarily, that

related to customer satisfaction and quality), participation, and training (Hill and Wilkinson, 1995).

As Dewhurst et al. (1999) propose, however, there is some controversy about IT contribution to this practice. Authors such as Wilson (1994) find that IT can reduce satisfaction at work and employee skills, as it automates everyday tasks and divides work into small, repetitive, highly specialized tasks. Martínez-Lorente et al. (2004) establish that IT both permits the formation of work teams and information sharing on tasks performed in the business unit and with other units; and supports the planning and training of different units. Further, IT is an element that facilitates motivation as well as evaluation of the employees' contributions to improving quality.

This practice proposes not only influencing their understanding of the main concepts of QM, but also data analysis and techniques of process control (Berry and Parasuraman, 1991), work that is facilitated by the presence of IT competence when it is characterized by flexible infrastructure, a strategic use, and IT technical and managerial knowledge. Further, training must be continuous and must affect all members of the organization (Dean and Bowen, 1994). It is therefore crucial to have feedback on the knowledge possessed by employees. Further, Clinton et al. (1994) propose that training must also be directed to improving decision-making capability, a variable receptive to IT (Pinsonneault and Kraemer, 1997). Finally, Rockart and Short (1989) conclude that a powerful characteristic of IT is its capability to enable people to work in teams. IT transforms firms into organizations with better communication channels and better planning of work teams (Powell and Dent-Micallef, 1997).

The relationship between IT competence and process management

Process management involves statistical control of processes, oriented to measuring the variation in different processes and determining whether and how operations should be performed for those for whom they have been designed (Stocker, 1990). Gathering this information and comparing current with desired performance are necessary to identify lacks and opportunities for improvement (Minnis, 1992). The Six Sigma methodology is a focus that claims to improve quality, understood as the minimization of rates of defects through statistical measurements (Linderman et al., 2003; Raisinghani et al., 2005). Chang-Tseh et al. (2007) analyze how possessing a strategic view of IT in leading the implementation of this QM model will make it easier to incorporate QM principles (customer focus, continuous improvement, teamwork) as part of professionals' daily work. They only obtain empirical support, however, for the effect that the combined use of basic (computing) technologies, network systems and Internet, and the use of specialized software have on the Six Sigma methodology. That is, their study focuses exclusively on the impact of IT infrastructure.

Another benefit of IT competence for process management is that it permits firms to perform the same processes in different geographic areas or countries, providing real data immediately for decision making (Palvia et al., 1996). IT strategy will encourage systems automation, reducing the variation of processes (Dilger, 1997) while enabling greater agility in production processes, which will have a positive influence on improvement of quality (Freund et al., 1997).

The relationship between IT competence and supplier management

The greatest source of problems with both product and process quality is the reception of defective supplies. As a result, most firms consider supplier management to be a key area for the successful implementation of a QM program (Thiagarajan and Zairi, 1997b). Suppliers' participation in the design of products and/or processes is thus a key variable in QM literature. This participation requires the development of understanding and agreement between both parties on the restrictions or limits in design and production (Ravichandran and Rai, 2000). IT competence will facilitate the development of new paths of communication, thanks to electronic data interchange systems (EDI). According to Jonscher (1994), the use of EDI systems facilitates the management of orders and communication of the product's specifications and design details. Powell and Dent-Micallef (1997) argue that EDI systems process information from both intra- and interorganizational environments, facilitating interaction with suppliers. Further, the success of these systems stems from the existence of open relationships of trust between the firm and suppliers (Holland et al., 1992), such that management of an IT competence will require tacit and complex coordination and the development of communication abilities that are difficult for competitors to imitate (Hall, 1993).

On the other hand, Bakos and Brynjolfsson (1993) and Stump and Sriram (1997) argue that IT, in the context of development of a relationship between firm and suppliers, contributes to and even accelerates the reduction of the number of suppliers with which the organization works. Dewhurst et al. (1999) conclude that the benefit that IT brings to supplier management should be evaluated in terms of improvements in communication between the two parties, easy access to databases, and better integration of the software interfaces (that is, integrating the different programs or software in a single system to be used by both firm and supplier).

In conclusion, the literature review performed enables us to establish the following research hypothesis, subdivided into seven subhypotheses that form the theoretical framework proposed in this study and represented visually in Fig. 1:

Research hypothesis (H1): There is a direct and positive relationship between the existence of an IT competence and QM implementation (measured through seven QM practices):

Subhypotheses:

H2. There is a direct and positive relationship between the existence of IT competence and leadership.

H3. There is a direct and positive relationship between the existence of IT competence and strategic planning.

H4. There is a direct and positive relationship between the existence of IT competence and customer focus.

H5. There is a direct and positive relationship between the existence of IT competence and information and analysis.

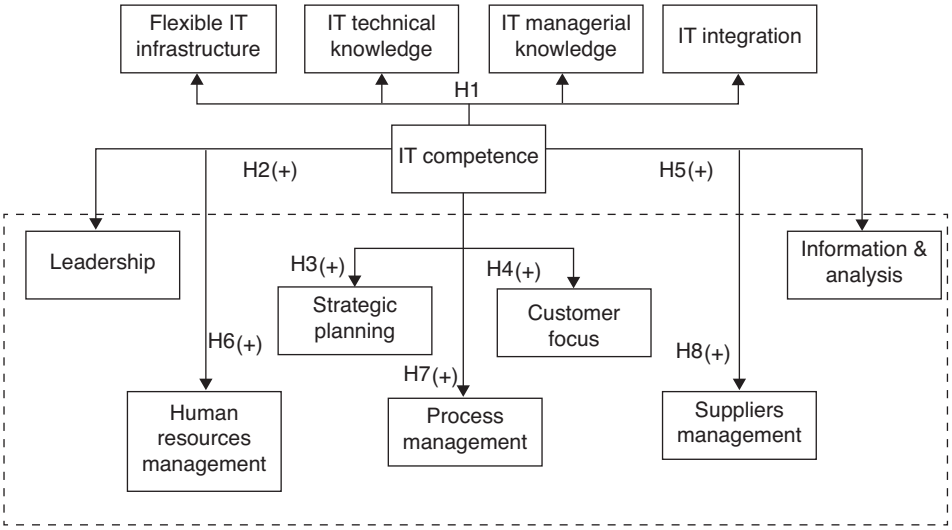

Figure 1

H6. There is a direct and positive relationship between the existence of IT competence and human resources management.

H7. There is a direct and positive relationship between the existence of IT competence and process management.

H8. There is a direct and positive relationship between the existence of IT competence and supplier management.

Methodology

Measurement

Since the data were collected through a survey as the research methodology, the measurement of the variables was adjusted, wherever possible, to the adaptation of existing scales in the literature.

To evaluate the first dimension of IT competence, the *existence of a flexible IT infrastructure*, we adopted the scale proposed by Ravichandran and Lertwongsatien (2005). This scale measures connectivity, velocity, capability, and degree of standardization of the firm's computer networks and platforms. It also measures the degree of accessibility of organizational data, as well as whether the different IS applications are reusable in key applications in the organization. The different questions were accompanied by a 7-point Likert scale (where 1 indicated total disagreement and 7 total agreement).

To evaluate the second dimension proposed in the literature, we measured technical and managerial knowledge related to IT in the organization. *Technical knowledge* refers to the know-how needed to implement IT applications using the technology available. Measurement of this variable was performed using the scale proposed by Ravichandran and Lertwongsatien (2005). The respondents were asked to provide information on the technical knowledge possessed by the IT department members, as well as the degree of adaptation to new IT innovations. The scale also analyzed their integration into the other business units through knowledge of the firm's other processes, procedures, policies, etc. and the relationship they had to colleagues in other areas. These questions were accompanied by a 7-point Likert scale (where 1 indicated total disagreement and 7 total agreement).

To evaluate *IT managerial knowledge*, we adapted the scale proposed by Mata et al. (1995), which proposes that managerial knowledge consists not only of anticipating the organization's future IT needs but also of contemplating aspects related to the abilities to integrate the information system into the firm's vision and strategy and implementing it as a facilitator of the work of the firm's agents, both internal and external. These questions were accompanied by a 7-point Likert scale like those used for the previous variables.

Finally, *IT strategy integration into the business strategy* was measured based on the scale proposed by Ross et al. (1996), in which the authors suggest that the relationship between IT and business strategy should be grounded in high levels of communication between those responsible for IT and the different business units and in high levels of shared knowledge about IT capabilities and firm needs. Like all of the study variables, the questions were accompanied by a 7-point Likert scale.

To measure QM practices, we also adapted different measures from key studies in QM research to guarantee content validity. Each item was accompanied by a 7-point Likert scale (where 1 indicated total disagreement and 7 total agreement). First, the scale for *leadership* was adapted from the study by Samson and Terziovski (1999). This scale evaluates the implementation of a culture of trust and change toward achieving best practices, integration of objectives, search for continuous improvement, and communication with all members of the organization. *Strategic planning* was adapted from the study by Samson and Terziovski (1999) and measures communication of the mission, structuring of processes, search for ''best practices,'' and consideration of the needs of customers and suppliers. *Costumer focus* was adapted from the scale

proposed by Ahire et al. (1996) and takes into account the use of surveys to gather information, complaints, the active search to attend to customers' needs and to improve the products/services provided, and determination of whether this had the case in recent years. The practice of *information and analysis*, adapted from the scale proposed by Prajogo and Sohal (2003), included benchmarking, measurement of performance, availability of data, and the use of information in the decision-making process on all levels of the firm. *Human resources management*, adapted from the scale proposed by Samson and Terziovski (1999), measured the use of the concept of ''internal customer,'' development of training processes, effectiveness of communication processes, employee satisfaction, the importance of quality in daily tasks, and the development of multi-task abilities. *Process management* evaluated the degree of automation of processes, stability in programming of production and the distribution of tasks over time, design of processes in order to minimize possible errors derived from putting them into action at the hands of employees, the use of statistical techniques, and the degree of autonomy of employees to solve problems related to quality. The measurement scale was adapted from scales proposed by Saraph et al. (1989), Anderson et al. (1995), and Flynn et al. (1995). This scale has been used in other recent studies, such as those by Kaynak (2003) and Kaynak and Hartley (2005). Finally, *supplier management*, a scale adapted from that proposed by Flynn et al. (1995), measured the establishment of long-term relationships with suppliers, their involvement in the development of new products, the relationship with a small number of suppliers, and the demand for quality criteria in choosing suppliers.

Sample and data collection

The sample of firms was chosen randomly from the 2008 SABI database, which includes information on the 50,000 main firms operating in Spain. The final population contained the 2133 firms that registered all of the information needed to carry out this study (size, phone number, etc.). Before setting up the questionnaire, we performed a pre-test to revise and develop the different questions. For the pretest, we held four interviews with managers from the areas of IT and QM.

We contacted the firms chosen through a computer-assisted telephone interview (CATI). The questionnaire was addressed either to the person in charge of QM or IT, or to the general manager of the firm (only one informant per firm). Respondents answered the questionnaire in October-November 2008. We obtained 230 valid questionnaires, for a response rate of 10.78%.

Of the 230 firms that make up the sample, 65% were industrial firms, 28% were from the service sector, and 7% belonged to the primary sector. Most of the firms had 51–250 employees (56.52%), 18.70% had 251–1000 employees, and 15.22% had fewer than 50 employees. The remaining percentage was composed of firms with over 1000 employees.

As to implementation of a QM program, 68.43% of the firms in the sample had implemented ISO 9000 standards, whereas 20.42% had developed practices related to total quality management. As to the IT implementation, over 90% of the firms in the sample used basic IT (webpage, office, email, etc.), 43.04% used resource planning systems (ERP/SAP), and 56.96% had implemented data interchange systems (EDI).

In sum, the majority of the firms that composed the sample belonged to the industrial sector, had over 51 employees, had widely implemented QM programs, and made intensive use of the main IT tools.

Finally, the survey included information on the manager's profile responsible for providing the information. The main characteristics registered showed highly qualified managers (92% of those surveyed had studied at the university) with various years of experience in the sector in which their current firm operates (49.6% had worked in the same sector for over 10 years).

Heterogeneity based on differences in firm size (number of employees) in the companies composing the sample is one of the possible causes of the contradictory results identified in the literature review. To analyze the possible impact of firm size on the results, we began with a factor analysis, obtained in validating the scales, adding firm size as a factor. Once we obtained the factors with their respective loadings, we performed a bi-variate correlation analysis. The results of this analysis did not confirm a significant relationship between size and IT competence or QM practices, as the correlation registered was greater than 0.108.

To analyze the possible non-response bias, first, following Podsakoff et al. (2003), the survey began with an introduction that explained the main variables used in the questionnaire, without suggesting any relationship between these variables. The survey also indicated that all responses were anonymous and confidential. The phrasing of the different questions was short and specific.

Second, to guarantee the absence of bias among the respondents due to their different profiles in the firm, we calculated Harman's factor (McFarlin and Sweeney, 1992). This factor consists of developing a confirmatory factor analysis of a model that contains the different variables observed as individual latent factors. For the factor to guarantee absence of bias, the results must show a low fit of the factors estimated. Our results (χ^2/d.f. = 14.11861; NFI = .780; CFI = .822; MFI = .638; RMSEA = .105) suggest that the non-response bias is not a problem.

To analyze the adequacy of the scales' psychometric properties, we evaluated three kinds of validity: content (adapting the measurements of the variables of existing scales from the literature), convergent, and discriminant. The statistical packages used were SPSS 18.0 and EQS 6.2. The validity and reliability of the scales are shown in Table 2. We see that all scales are within acceptable limits, indicating that the measurement model is good.

According to Hair et al. (2004), internal consistency is guaranteed when one obtains Alpha Cronbach coefficients greater than 0.7 for all the variables, values for composite reliability greater than 0.7, and coefficients for the variance extracted greater than 0.5. Table 2 shows the results. Convergent validity is guaranteed by obtaining factor loadings for each variable in the confirmatory factor analysis (CFA) that are greater than 0.4 (and have a reliability indicator of at least 0.5). Finally, Table 3 provides the different correlations between the variables as a guarantee of discriminant

Table 2 Reliability.

Variables	Items	Loadings	Alpha Cronbach	AVE	Composite reliability
Flexible IT infrastructure	7	0.756–0.902	0.938	0.6842	0.9379
IT technical knowledge	7	0.641–0.838	0.918	0.6385	0.9231
IT managerial knowledge	5	0.710–0.801	0.870	0.5208	0.8733
IT integration	6	0.696–0.838	0.892	0.5869	0.8934
Leadership	6	0.760–0.890	0.925	0.690	0.930
Strategic Planning	4	0.721–0.937	0.937	0.710	0.907
Costumer focus	3	0.877–0.924	0.931	0.860	0.95
Information & analysis	4	0.747–0.936	0.923	0.760	0.93
Human Resources Management	5	0.715–0.849	0.873	0.58	0.87
Process Management	3	0.728–0.992	0.828	0.630	0.847
Supplier Management	5	0.703–0.821	0.883	0.604	0.88

Table 3 Correlation between variables.

Variables	1	2	3	4	5	6	7	8	9	10	11
Flexible IT infrastructure	1										
IT technical knowledge	.495	1									
IT managerial knowledge	.548	.526	1								
IT integration	.420	.568	.601	1							
Leadership	.338	.496	.521	.563	1						
Strategic Planning	.304	.457	.466	.563	.654	1					
Costumer focus	.245	.368	.250	.336	.496	.505	1				
Information & analysis	.216	.435	.425	.448	.543	.546	.508	1			
Human Resources Management	.422	.429	.465	.508	.496	.598	.492	.548	1		
Process Management	.289	.257	.365	0.322	.454	.421	.372	.441	.493	1	
Supplier Management	.313	.276	.348	.290	.406	.371	.406	.506	.524	.449	1

All the values are at $p < 0.01$ (bilateral).

validity. The items that did not pass this validation process were eliminated.

Analysis and discussion

To test the hypotheses proposed in the literature review, we performed a structural equations modeling (SEM) analysis using the statistical package EQS 6.2. The results obtained are shown in Tables 4 and 5.

As to Hypothesis 1, Table 4 shows the results that guarantee the goodness of fit for considering IT competence as a second-order variable.

As can be seen, the structural model proposed guarantees that IT competence is composed of the four dimensions defined in the literature review. All of the standardized coefficients are significant at $p < 0.01$. The overall fit measures of the model are more than satisfactory, according to Hair et al. (2004). The measures of absolute fit are correct. The Root Mean Square Residual (RMSR) is close to 0, while the Root Mean Square Error of Approximation (RMSEA) is less than 0.09. The measures of incremental fit are also good, as the different indicators (Adjusted Goodness of Fit Index, AGFI; Normed Fit Index, NFI; Tucker-Lewis Index, NNFI; and Comparative Fit Index) show values greater than 0.9. Finally, parsimony fit is also guaranteed, as we obtain a normed Chi-square between the values of 1 and 5, or 1.4191.

This study thus continues in the line of research begun by Tippins and Sohi (2003), who determine that IT must be analyzed as a multi-dimensional construct. They shed light on one of the main limitations proposed in the literature

Table 4 IT competence as a second-order construct.

Parameters and relationships	Standardized coefficients (*t-value*)	R^2
IT infrastructure → IT competence	0.634** (10,484)	0.402
IT technical knowledge → IT competence	0.735** (13,161)	0.540
IT managerial knowledge → IT competence	0.814** (14,071)	0.663
IT integration → IT competence	0.714** (11,599)	0.510

** Significant at 0.01.
NNFI = 0.96; CFI = 0.972; IFI = 0.971; AGFI = 0.901; RMSEA = 0.043; SRMR = 0.082; χ^2/d.f. = 1.4191 and $p < 0.001$.

Table 5 Results.

Hypothesized paths	Standardized parameters (*t-value*)	R^2
IT competence → Leadership	0.822** (14,105)	0.676
IT competence → Strategic planning	0.783** (12,142)	0.612
IT competence → Costumer focus	0.627** (8878)	0.393
IT competence → Information & Analysis	0.711** (11,037)	0.506
IT competence → Human Resources Manag.	0.864** (10,775)	0.747
IT competence → Process Management	0.621** (7677)	0.386
IT competence → Supplier Management	0.560** (7401)	0.313

* Significant at 0.05.
**Significant at 0.01.
NNFI = 0.937; CFI = 0.941; IFI = 0.942; RMSEA = 0.038; SRMR = 0.086; $\chi^{2/}$d.f. = 1.5496 and $p < 0.001$.

review, stressing the importance of analyzing the role of IT capabilities and not merely IT resources implementation in the firm.

Table 5 presents the results of the structural model corresponding to the remaining hypotheses. This table includes the different coefficients obtained, their *t-values*, and the significance level. Significance levels lower than the recommended minimum of 0.5 do not indicate that there is no causal relationship between the variables, but rather that this value is due to the existence of other variables not considered in the model proposed that have a greater influence on the latent variables. All of the hypotheses proposed are thus positive and significant, and the results confirm the main goal of this study: to demonstrate that the existence of an IT competence facilitates the development of the main QM practices.

We also analyzed the model's goodness of fit. According to the indicators proposed by Hair et al. (2004), the model presents good results in overall terms, and we can extend interpretation to this table, given the different indicators in the model for validating IT competence as a second-order variable.

Thus, the results shown in Table 5 provide empirical support for the existence of a positive relationship between IT competence and QM implementation, measured through seven QM practices. These results are consistent with the prior literature, since IT is defined as a set of resources that facilitate the acquisition and use of information (Bharadwaj, 2000), while QM is characterized as a system that uses information intensively (Samson and Terziovski, 1999). The complementarity of IT assets and capabilities with other organizational practices also increases the value of these practices in the presence of IT competence (Jarvenpaa and Leidner, 1998; Lee et al., 2008), ultimately improving the organization's competitive position. The complementarity that QM practices grant to the different dimensions of IT competence gives all dimensions the attributes of substitutability, low mobility, and low imitability, proposed as determinants that sustain competitive advantage (Wade and Hulland, 2004).

The results obtained thus show, first, that the relationship between IT competence and leadership is significant and positive (with a coefficient of 0.822, a *t-value* of 14.105, significant at $p < 0.01$), confirming hypothesis H2 empirically. The existence of an IT competence based on flexible infrastructure and sufficient managerial and technical knowledge and the presence of this competence at all levels of the firm facilitate the development of actions proper to top management, such as communication, participation of all members of the organization, development of good QM training programs, and the struggle to achieve consciousness of QM. These results are consistent with the results obtained in the literature review (Martínez-Lorente et al., 2004; Perez-Arostegui et al., 2012).

Second, the results indicate a positive relationship between IT competence and strategic planning (*t-value* = 12.142, $p < 0.401$), confirming hypothesis H3 empirically. IT competence will thus facilitate the coordination of quality efforts, development and analysis of action plans, and the management of all documentation involved in this practice. Finally, it will also facilitate communication and planning on all levels of the firm (Ang et al., 2001).

The fourth research hypothesis, H4, is also validated empirically (*t-value* = 8.878, $p < 0.01$), showing the existence of a positive relationship between IT competence and customer focus. IT competence not only permits coordination between the different units of the firm and customer services but also permits the effective analysis and management of information received from clients. In addition, it facilitates contact between firms and customers and provides the firm with results oriented to adapting its products, services, and processes to customers' needs. These results are consistent with those obtained by Dewhurst et al. (1999) and Zhang (2000).

The fifth research hypothesis, H5, proposed a positive relationship between IT competence and the practice of information and analysis. The results confirm this proposition (*t-value* = 11.037, $p < 0.01$), since QM programs make intensive use of information (Matta et al., 1998), and all resources and capabilities that facilitate the collection, processing, and exploitation of this information improve development of this capability.

Sixth, hypothesis H6 (*t-value* = 10.775, $p < 0.460$) is also accepted according to the statistical analysis, which shows a positive impact of IT competence on the development of human resources management practice. IT competence provides employees with the right tools for developing functions related to information analysis, a key variable in QM. Further, IT encourages the proper development of teamgroups. These results are consistent with results provided by Pinsonneault and Kraemer (1997), Martínez-Lorente et al. (2004), and Crawford et al. (2011).

The seventh research hypothesis, H7, which is also accepted (*t-value* = 7.677, $p < 0.01$), refers to the positive impact of IT competence on the development of process management. In this case, the collection and analysis of information from processes are vital to analyzing variation in processes and undertaking corrective action (Lee et al., 2011). Further, IT will enable firms to automate the different processes easily and to develop the same processes in real time in different geographic areas (Dilger, 1997).

Finally, the eighth hypothesis of this set of sub-hypotheses is confirmed empirically (*t-value* = 7.401, $p < 0.01$), showing the positive impact of IT competence on the development of supplier management. In this case, IT competence provides the knowledge and tools needed to communicate with suppliers, encourage involvement with them, manage orders, and specify changes in product specifications (Jonscher, 1994).

Conclusions, contributions and limitations

The data from a sample of 230 Spanish firms show the following: (a) IT competence is a multi-dimensional and complex structure, evaluated through flexible IT infrastructure, IT technical knowledge, IT managerial knowledge, and IT integration in the firm strategy; and (b) the existence of IT competence has a direct and positive impact on QM implementation (measured through seven QM practices). From the results obtained, we derive significant implications for research. First, the literature analyzed agrees that IT alone is incapable of generating a sustainable competitive advantage, as one needs the complementarity of other organizational resources and practices (Powell and Dent-Micallef, 1997; Cagliano and Spina, 2000). In spite of these theoretical advances, the processes by which IT resources interact with other human and organizational resources, as well as the nature of these resources, have received little attention (Ravichandran and Lertwongsatien, 2005; Wade and Hulland, 2004). To clarify this limitation in prior literature, we have conceptualized IT as a competence composed of four dimensions: IT flexible infrastructure, IT knowledge at the managerial and technical levels, and IT integration in the strategies of the firm. In this way, the study is not limited to the existence of a basic infrastructure but also evaluates the effect of other IT-related capabilities, providing an empirically validated second-order multi-dimensional construct that can be used in future studies. We thus continue the research line initiated in the study of Tippins and Sohi (2003).

Another substantial contribution of this study is its analysis of the impact of IT competence on QM practices. This set of practices has wide recognition and diffusion in managerial practice. Joint study of IT and QM permits us to generate useful knowledge for researchers and managers. From the academy perspective, although the relationship between IT and QM has been widely studied, the literature review shows two serious limitations: (a) IT is usually defined from an exclusively technical perspective (analyzing infrastructures, the *hardware* and *software* that firms possess, Matta et al., 1998; Martínez-Lorente et al., 2004; Sanchez-Rodriguez and Martinez-Lorente, 2011), and (b) there is a patent lack of empirical evidence in analysis of this relationship (Dewhurst et al., 1999; McAdam and Henderson, 2004). In response to these limitations, we have developed a multi-dimensional construct to define IT and analyzed a structural model to give empirical validity to the hypotheses proposing the relationships between the variables.

For managers, they must be aware that the impact of IT on competitive performance need not to be direct; it can exert its influence through the complementarity of other organizational practices such as QM practices. Likewise, IT benefits depend on conveiving IT as the firm's ability to acquire, develop and direct its IT resources to support its business strategy. Our study also provides a detailed description of IT-related capabilities key to ensuring the IT implementation success, as well as a analysis of the main QM practices common to the most importants QM programs (ISO, EFQM, Malcolm Baldrige, etc.). Thus, managers are able to take advantage of the synergies derived for implementing both QM and IT programs.

Finally, this study has a series of limitations that require us to accept these conclusions with some caution. First, the data used come from a single informant per unit and a single geographical area. Although the managers' profile surveyed enables us to confirm the reliability of the information obtained, we would have preferred to have two key informants, one specializing in each of the two disciplines examined in this study, IT and QM. Second, this is a transversal analysis. Although the data reflect significant relationships between the variables, they do not strictly prove that these are the only valid relationships. We have attempted to lessen the effect of this limitation by incorporating a temporal dimension in some of the variables.

There are other limitations that can constitute future extensions of this line of research. It would be possible to analyze the influence of IT competence on the effectiveness of the QM practices proposed, that is, to study empirically the moderating effect of IT competence on the impact of implementing QM practices on organizational results. One could also advance the literature on IT business value by analyzing the mediating role of QM practices in the relationship between IT competence and performance. It would be interesting to determine whether IT competence has greater importance in the implementation of a QM system than in the implementation of other practices, tools, strategies, or processes in which IT clearly acts as facilitators, according to the literature review, such as new product development or entrepreneurial culture. One last line could derive from analyzing a heterogeneous sample that permits contrast of the model in subsamples of firms based on variables such as size or sector.

Acknowledgments

This article has had financial support from the Spanish Government (Ministry of Science and Innovation) and the European Union, research project ECO2010-15885.

References

Ahire, S.L., Golhar, D.Y., Waller, M.A., 1996. Development and validation of TQM implementation constructs. Decisions Sciences 27 (1), 23–56.

Ahmed, N.U., Ravichandran, R., 1999. An information systems design framework for facilitating TQM implementation. Inform. Resour. Manage. J. 12 (4), 5–13.
Aiken, M., Hasan, B., Vanjani, M., 1996. Total quality management: a GDSS approach. Inform. Syst. Manage. 13 (Winter), 73–78.
Anderson, J.C., Rungtusanatham, M., Schroeder, R.G., Devaraj, J.S., 1995. A path analytic model of a theory of quality management underlying the Deming management method: preliminary empirical findings. Decision Sci. 26, 637–658.
Ang, C.L., Davies, M., Finlay, P.N., 2001. An empirical study of the use of information technology to support total quality management. Total Qual. Manage. 12 (2), 145–157.
Atkinson, P., 1991. Leadership, total quality and cultural change. Manage. Serv. 35 (6), 16–19.
Ayers, J.B., 1993. TQM and information technology: partners for profit. Inform. Strat. Exec. J. 9 (3), 26–31.
Bakos, J.Y., Brynjolfsson, E., 1993. Information technology, incentives, and the optimal numbers of suppliers. JMIS 10 (1), 37–53.
Barney, J.B., 1991. Firm resources and sustained competitive advantage. J. Manage. 17 (1), 99–120.
Barney, J.B., 2001. Is the resource-based ''View'' a useful perspective for strategic management research? Yes''. Acad. Manage. Rev. 26 (1), 41–59.
Bharadwaj, A.S., 2000. A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Quart. 24 (1), 169–196.
Bharadwaj, A.S., Sambamurthy, V., Zmud, R.W., 1999. IT capabilities: theoretical perspectives and empirical operationalization. In: Hirschheim, R., Newman, M., Degross, J.I. (Eds.), Proceedings of the 19th International Conference on Information Systems. Helsinki, Finland, pp. 378–385.
Bharadwaj, A.S., Sambamurthy, R., Zmud, R., 2002. Firmwide IT capability: An empirical examination of the construct and its links to performance. Working paper. Department of Decision and Information Analysis, Emory University, Atlanta, GA.
Benitez-Amado, J., Llorens-Montes, F.J., Perez-Arostegui, M.N., 2010. Information technology-enabled intrapreneurship culture and firm performance. Ind. Manage. Data Syst. 110 (4), 550–566.
Berry, L.L., Parasuraman, A., 1991. Marketing Service: Competing through Quality. Free Press, New York.
Black, S., Porter, L., 1996. Identification of the critical factors of TQM. Decision Sci. 27 (1), 1–21.
Broadbent, M., Weill, P., 1997. Management by maxim: how business and IT managers can create IT infrastructures. MIT Sloan Mag. Rev. 38 (3), 77–92.
Burges, T.F., Gules, H.K., 1998. Buyer supplies relationships in firms applying advanced manufacturing technology: an empirical analysis of the implementation of hard and soft technologies. J. Eng. Technol. Manage. 15, 127–152.
Camp, R.C., 1993. Benchmarking: The Search for Industry Best Practices that Lead to Superior Performance. ASQC Quality Press, Milwaukee, Wisconsin.
Clinton, R.J., Williamson, S., Bethke, A.L., 1994. Implementing total quality management: the role of human resource management. SAM Adv. Manage. J. 59 (2), 10–16.
Cagliano, R., Spina, G., 2000. Advanced manufacturing technologies and strategically flexible production. J. Oper. Manage. 18 (2), 169–190.
Caldeira, M.M., Ward, J.M., 2003. Using resource-based theory to interpret the successful adoption and use of information systems and technology in manufacturing small and medium-sized enterprises. Eur. J. Inform. Syst. 12 (2), 127–141.
Chang-Tseh, H., Binshan, L., Manduca, B., 2007. Information technology and six sigma implementation. J. Comput. Inform. Syst. 47 (4), 1–10.
Chandler, K., 1998. Quality in the age of the networked society. Qual. Prog. 31 (2), 49–111.
Chen, D.Q., Mocker, M., Preston, D.S., Teubner, A., 2010. Information systems strategy: reconceptualization, measurement, and implications. MIS Quart. 34 (2), 233–259.
Chiles, T.H., Choi, T.Y., 2000. Theorizing TQM: an Austrian and evolutionary economics interpretation. J. Manage. Stud. 37 (2), 185–212.
Cole, R.E., Bacdayan, P., White, B.J., 1993. Quality, participation and competitiveness. California Manage. Rev. 35 (3 Spring), 68–81.
Collins, L.W., 1994. TQM information systems: an allusive goal. J. Qual. Improv. 20, 607–613.
Cortada, J.W., 1995. TQM for Information Systems Management: Quality Practices for Continuous Improvement. McGraw-Hill, New York.
Counsell, J., 1997. Using technology to involve the workforce. Total Qual. Manage. 8 (2–3), 5126–5135.
Crawford, J., Leonard, L.N.K., Jones, K., 2011. The human resource's influence in shaping IT competence. Ind. Manage. Data Syst. 111 (2), 164–183.
Dale, B.G., Boaden, R.F., Wilcox, M., McQuater, R.E., 1997. Sustaining total quality management: what are the issues? TQM Mag. 9, 372–380.
Dean Jr., J.W., Bowen, D.E., 1994. Management theory and total quality: improving research and practice through theory development. Acad. Manage. Rev. 19 (3), 392–418.
Dehning, B., Richardson, V.J., 2002. Returns on investments in information technology: a research synthesis. J. Inform. Syst. 16 (1), 7–30.
Devaraj, S., Kohli, R., 2003. Performance impacts of information technology: is actual usage the missing link. Manage. Sci. 49 (3), 273–289.
Dewhurst, F., Martínez-Lorente, A., Dale, B., 1999. Total quality management and information technologies: an exploration of the issues. Int. J. Qual. Reliab. Manage. 16 (4), 392–405.
Dilger, K., 1997. To protect and preserve. Manuf. Syst. 15 (6), 22–30.
Dumond, E.J., 1995. Learning from the quality improvements processes: experience from US manufacturing firms. Prod. Invent. Manage. J. 36 (4), 7–13.
Feeny, D.F., Willcocks, L.P., 1998. Core IS capabilities for exploiting information technology. Sloan Manage. Rev. 39 (3), 9–21.
Flynn, B.B., Schroeder, R.G., Sakakibara, S., 1994. A framework for quality management research and an associated instrument. Journal of Operations Management 11 (4), 339–366.
Forza, B.B., 1995. The impact of information systems on quality performance: an empirical study. Int. J. Oper. Prod. Manage. 15 (6), 69–83.
Freund, B., Konig, H., Roth, N., 1997. Impact of information technologies on manufacturing. Int. J. Technol. Manage. 13 (3), 215–243.
Garvin, D.A., 1991. How the Baldrige award really works. Harv. Bus. Rev. 69 (6), 80–93.
Gilmore, J.H., Pine, B.J., 1997. The four faces of mass customization. Harv. Bus. Rev. 75, 91–101.
Hair, H.F., Anderson, R.E., Tatham, R.L., Black, W.C., 2004. Análisis Multivariante. Prentice Hall, Madrid.
Hall, R., 1993. A framework linking intangible resources and capabilities to sustainable competitive advantage. Strategic Management Journal 14 (8), 607–618.
Hill, S., Wilkinson, A., 1995. In search of TQM. Employee Relat. 17 (3), 8–25.
Holland, C., Locket, G., Blackman, I., 1992. Planning for electronic data interchange. Strategic Management Journal 13 (7), 539–550.
Jarvenpaa, S.L., Leidner, D.E., 1998. An information company in mexico: extending the resource-based view of the firm to a developing country context. Inform. Syst. Res. 9 (4), 342–361.
Jonscher, C., 1994. An economic study of the information technology. In: Allen, T.J., Scott Morton, M.S. (Eds.), Information

Technology and the Corporation of the 1990s. Oxford University Press, New York, pp. 5–42.
Kaynak, H., 2003. The relationship between total quality management practices and their effects on firm performance. J. Oper. Manage. 21 (4), 405–435.
Kaynak, H., Hartley, J.L., 2005. Exploring quality management practices and high tech firm performance. J. High Technol. Manage. Res. 16, 255–272.
Ke, W., Wei, K.K., 2008. Organizational culture and leadership in ERP implementation. Decis. Support Syst. 45 (1), 208–218.
Kettinger, W., Grover, V., Guha, S., Segars, A., 1994. Strategic information systems revisited: a study in sustainability and performance. MIS Quart. 18 (1), 31–58.
Kohli, R., Grover, V., 2008. Business value of IT: an essay on expanding research directions to keep up with the times. J. AIS 9 (1), 23–37.
Kondstadt, P., 1990. The unending quest for quality. CIO 12 (1–4), 335–377.
Lee, Y.C., Chu, P.Y., Tseng, H.T., 2011. Corporate performance of ICT-enabled business process re-engineering. Ind. Manage. Data Syst. 111 (5), 735–754.
Lee, S.M., Kim, k., Paulson, P., Park, H., 2008. Developing a socio-technical framework for business-IT alignment. Ind. Manage. Data Syst. 108 (9), 1167–1181.
Lin, B., 1991. Quality control information systems in manufacturing: considerations and concerns for management. International Journal of Operations and Production Management 11 (1), 41–50.
Linderman, K., Schroeder, R.G., Zaheer, S., Choo, A.S., 2003. Six Sigma: a goal-theoretic perspective. J. Oper. Manage. 21 (2), 193–203.
Mata, F.J., Fuerst, W.L., Barney, J.B., 1995. Information technology and sustained competitive advantage: a resource-based analysis. MIS Quart. 19 (4), 487–505.
Martínez-Lorente, A.R., Sánchez-Rodríguez, C., Dewhurst, F.W., 2004. The effect of information technologies on TQM: An initial analysis. Int. J. Prod. Econ. 89 (1), 77–93.
Matta, K., Chen, H., Tama, J., 1998. The information requirements of total quality management. Total Qual. Manage. 9, 445–461.
McAdam, R., Henderson, J., 2004. Influencing the future of TQM: internal and external driving factors. Int. J. Qual. Reliab. Manage. 21 (1), 51–72.
McFarlin, D., Sweeney, P., 1992. Distributive and procedural justice as predictors of satisfaction with personal and organizational outcomes. Acad. Manage. J. 35 (3), 626–627.
Melville, N., Kraemer, K., Gurbaxani, V., 2004. Review: information technology and organizational performance: an integrative model of IT business value. MIS Quart. 28 (2), 283–322.
Miller, H., 1997. The multiple dimensions of information quality. Inform. Syst. Manage. 13 (2), 79–82.
Miller, E., Cardinal, L., 1994. Strategic planning and firm performance: a synthesis of more than two decades of research. Acad. Manage. J. 37, 1649–1665.
Minnis, P.A., 1992. How to develop measures for financial work. Natl. Prod. Rev. 11 (2), 153–157.
Murray, R.J., 1991. The quest for world class IT capability: IT is key to achieving quality goals. J. Inform. Syst. Manage. (Summer), 7–15.
Nair, A., 2006. Meta-analysis of the relationship between quality management practices and firm performance: Implications for quality management theory development. J. Oper. Manage. 24 (5), 948–975.
Nevo, S., Wade, M.R., 2010. The formation and value of IT-enabled resources: antecedents and consequences of synergistic relationships. MIS Quart. 34 (1), 163–183.
Ngai, E.W.T., Cheng, T.C.E., 1998. A survey of applications of computer-based technologies in support of quality. Int. J. Qual. Reliab. Manage. 15, 827–843.
Oakland, J.S., 1993. Total Quality Management. The Route for Improving Performance. Butterworth-Heinemann, Oxford.
Palvia, P., Kuma, A., Kumar, N., Hendon, R., 1996. Information requirements of a global EIS: an exploratory macro assessment. Decis. Support Syst. 16 (2), 169–248.
Pavlou, P.A., El Sawy, O.A., 2006. From IT leveraging competence to competitive advantage in turbulent environments: the case of new product development. Inform. Syst. Res. 17 (3), 198–227.
Pearson, J.M., McCahon, C.S., Hightower, R.T., 1995. Total quality management: are information systems managers ready? Inform. Manage. 29, 163–252.
Perez-Arostegui, M.N., Benitez-Amado, J., Tamayo-Torres, J., 2012. Information technology-enabled quality performance: an exploratory study. Ind. Manage. Data Syst. 112 (3), 1–25.
Pinsonneault, A., Kraemer, K.I., 1997. Middle management downsizing: an empirical investigation of the impact of information technology. Manage. Sci. 43 (5), 659–738.
Podsakoff, P., Mackenzie, S., Lee, J., Podsakoff, N., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J. Appl. Psychol. 88 (5), 879–903.
Powell, T.C., Dent-Micallef, A., 1997. Information technology as competitive advantage: the role of human, business, and technology resources. Strat. Manage. J. 18 (5), 375–405.
Prajogo, D.I., Sohal, A.S., 2003. The multidimensionality of TQM practices in determining quality and innovation performance, an empirical examination. Technovation 24 (6), 443–515.
Prajogo, D.L., Sohal, A.S., 2006. The integration of TQM and technology/R&D management in determining quality and innovation performance. Int. J. Manage. Sci. 34 (1), 296–312.
Raisinghani, M.S., Ette, H., Pierce, R., Cannon, G., Daripaly, P., 2005. Six Sigma: concepts, tools, and applications. Ind. Manage. Data Syst. 105 (3–4), 491–505.
Rathnam, S., Mahajan, V., Whinston, A.B., 1995. Faciliting coordination in customer support teams: a framework and its implications for the design of information technology. Manage. Sci. 41 (12), 1900–1921.
Ravichandran, T., Rai, A., 2000. Total quality management in information systems development: key constructs and relationships. JMIS 16 (3), 119–155.
Ravichandran, T., Lertwongsatien, C., 2005. Effect of information systems resources and capabilities on firm performance: A resource-based perspective. JMIS 21 (4), 237–276.
Ray, G., Muhanna, W.A., Barney, J.B., 2005. Information technology and the performance of the customer service process: A resource-based analysis. MIS Quarterly 29 (4), 625–652.
Reed, R., Lemak, D.J., Mero, N.P., 2000. Total Quality Management and sustainable competitive advantage. J. Qual. Manage. 5 (1), 5–26.
Rockart, J., Short, J., 1989. IT in the 1990's: managing organizational independence. Sloan Manage. Rev. Winter, 7–17.
Ross, J.W., Beath, C.M., Goodhue, D.L., 1996. Develop long-term competitiveness through IT assets. Sloan Manage. Rev. 38 (1), 31–42.
Samson, S., Terziovski, M., 1999. The relationship between total quality management practices and operational performance. J. Oper. Manage. 17, 393–409.
Sanchez-Rodriguez, C., Martinez-Lorente, A.R., 2011. Effect of IT and quality management on performance. Ind. Manage. Data Syst. 111 (6), 830–848.
Saraph, J.V., Benson, G.P., Schroeder, R.G., 1989. An instrument for measuring the critical factors of quality management. Decis. Sci. 20, 810–829.
Sila, I., 2007. Examining the effects of contextual factors on TQM and performance through the lens of organizational theories: an empirical study. J. Oper. Manage. 25 (1), 83–109.

Sousa, R., Voss, C.A., 2002. Quality management re-visited: a reflective review and agenda for future research. J. Oper. Manage. 20 (1), 91–109.

Stocker, G.D., 1990. Reducing variability – the key to continuous quality improvement. Manufacturing Systems 8 (3), 32–36.

Stone, M., Woodcock, N., Wilson, M., 1996. Managing the change from marketing planning to customer relationship management. Long Range Plann. 29 (5), 675–758.

Stump, R.L., Sriram, V., 1997. Employing information technology in purchasing buyer-supplier relationships and size of the supplier base. Ind. Market. Manage. 26 (2), 127–163.

Teo, T.S.H., Ranganathan, C., 2003. Leveraging IT resources and capabilities at the housing and development board. J. Strat. Inform. Syst. 12 (3), 229–249.

Tippins, M.J., Sohi, R.S., 2003. IT competency and firm performance: is organizational learning a missing link? Strat. Manage. J. 24 (8), 745–761.

Thiagarajan, T., Zairi, M., 1997a. A review of total quality management in practice: understanding the fundamentals through examples of best practice applications. TQM Mag. 9 (6), 414–428.

Thiagarajan, T., Zairi, M., 1997b. A review of total quality management in practice: understanding the fundamentals through examples of best practice applications-Part I. TQM Mag. 9 (6), 270–286.

Thompson, K.R., 1998. Confronting the paradox in a total quality environment. Organ. Dyn. 26, 62–74.

Wade, M., Hulland, J., 2004. Review: the resource-based view and information systems research: review, extension, and suggestions for future research. MIS Quart. 23 (1), 107–142.

Wilson, F.A., (PhD, UMIST) 1994. Perspectives on computer-based systems and management. The University of Manchester.

Zadrozny, M.A., Ferrazzi, K.E., 1992. Building a technology base for TQM. Chief Inf. Off. J. 5 (2), 16–37.

Zahedi, F., 1998. Quality information systems: a unifying framework. Int. J. Technol. Manage. 16, 446–465.

Zhang, Z., 2000. Developing a model of quality management methods and evaluating their effects on business performance. Total Qual. Manage. 11 (1), 129–137.