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Technological distinctive competencies and organizational learning: Effects on organizational innovation to improve firm performance

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ABSTRACT

This paper analyzes how top management support of technology influences the generation of technological skills, technological distinctive competencies and organizational learning. The research also examines the effects of technological distinctive competencies and organizational learning on organizational innovation and reflects how all of these variables impact organizational performance. The results of our empirical analysis, based on a sample of 201 Spanish technological firms, suggest that: (1) top management support positively influences the generation of technological skills, technological distinctive competencies and organizational learning; (2) technological distinctive competencies and organizational learning positively affect organizational performance, directly and indirectly through organizational innovation.

Introduction

Recently, firms have been operating in business environments characterized by rapid change and increasing competitiveness (Hitt et al., 2000). In this context, technology and technology relationships to organizational structures, processes and results have been conceived as an important subject of interest for organizational researchers (Orlikowski, 2000), since they enable organizations to develop

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products or delivery of services more quickly in highly competitive situations on a global level, as well as continuous technological change and ever shorter product life cycles (García Morales et al., 2007b).

When faced with such scenarios, firms must innovate continuously to guarantee their organizational survival (Hurley and Hult, 1998). Innovation must be driven by the capability to exploit organizational competencies, technologies and knowledge in order to stimulate competitive advantages (DeCarolis, 2003). Firms are under increasing pressure to foster "organizational learning" and develop, strengthen and renew "technological competencies." These competencies enable firms to adapt, integrate and reconfigure their skills, knowledge and capabilities. In doing so, they adapt to the changing business environment and deliver value to the customer in the appropriate form, responsibly and continuously (Wang et al., 2004; García Morales et al., 2007b).

This research presents a model to analyze the importance of top management support in the effective adoption and implementation of new technologies in organizations and, more specifically, in the generation of technological distinctive competencies, technological skills and organizational learning. This study will also contribute empirical evidence of the effects of technological distinctive competencies and organizational learning on organizational innovation and demonstrate how all of the foregoing influence organizational performance. Prior studies have analyzed the relation between some of the foregoing constructs; for example, support from management and effective implementation of specific technologies, such as information systems (Young and Jordan, 2008) and the influence of technological distinctive competencies on organizational performance (Lee et al., 2001; Wang et al., 2004). There is, however, no integrated model of all of these systems in the literature, nor is there a model that focuses on the broad concept of technology. We would also point out that the analysis proposed does not only explain how to achieve improvement in organizational performance through direct relationships with strategic variables such as technological distinctive competencies and organizational learning. This analysis also introduces indirect relationships, in this case through innovation, which can achieve the same goal. We therefore find an innovative model with great potential that enables organizations not only to survive in turbulent and changing environments but also to improve their competitive position. We will perform this analysis within the framework of technology firms. We choose this type of firm because of the current importance of technology firms in modern economies, due to the contribution of technology firms to economic growth, increase in productivity and creation of new, innovative industries, products and processes (Grinstein and Goldman, 2006).

This study provides an explanation of the crucial role that top management support of technology plays in the process of stimulating technological skills, technological distinctive competencies and organizational learning. Top management includes the "CEO and its direct subordinates responsible for corporate policy" (Green, 1995, p. 223). Different studies have shown that, when top management's level of support and commitment is perceived as high, it is logical to expect the success of the system (Ifinedo, 2008). Managers must be willing to allocate adequate capital and human resources (Carbonell and Rodríguez Escudero, 2009). Although some authors have shown that this support is essential for the successful implementation of specific technology, such as information systems (Dong, 2008), few studies in the existing literature analyze how this support affects the process of technology implementation in general. We must therefore take into account a much wider concept of technology: a body of knowledge, tools, and techniques derived from science and practical experience and used in the development and application of products, processes, systems, and services (Steensma, 1996).

The influence of top management support on technological distinctive competencies may also be stimulated by the development of technological skills, which in a technological context refer to both firm-specific techniques and scientific understanding (Leonard-Barton, 1992). These skills provide the basis for a firm's competitive competencies (Teece, 1986). The "myth of deskilling" wrongly encourages managers to expect that new equipment will enable a reduction of required skills. This myth is one of the greatest obstacles to the effective implementation of new technologies (Swamidass and Nair, 2004). The generation of required skills is thus a crucial question, since the generation of skills can also have repercussions for the generation of competencies, as competencies reflect a set of skills and technologies (Peppard and Ward, 2004). Another important issue is determining how the top management support can foster organizational learning. The promotion of continuity, commitment, capability, contribution, collaboration and consciousness of organizational learning is in the hands of top management (García Morales et al., 2007b). It is top management's task to stimulate the creation of organizations that adopt a learning culture (Real et al., 2006). The literature has shown that this result can be achieved through the creation of a shared vision, team learning, personal mastery and mental models (Senge, 1990). Our study also treats how organizational learning can be encouraged by involving top management in the processes supporting new technologies (Robey et al., 2000). This research therefore shows how top management support affects organizational learning (Andrawina, 2009).

The literature on organizational learning has grown exponentially in recent years (Bontis et al., 2002; Nonaka and Takeuchi, 1995; Real et al., 2006). Organizational learning has been defined as a collective capability based on experiential and cognitive processes and involving knowledge acquisition, knowledge sharing, and knowledge utilization (Aragón Correa et al., 2007; Zollo and Winter, 2002). More synthetically, organizational learning has been catalogued as a complex process related to the development of new knowledge (Huber, 1991; Slater and Narver, 1995). Learning processes are intrinsically social and collective phenomena (Carayannis et al., 2006). Thus, a culture of learning in which people work together enables organizations to establish themselves by fostering and maintaining a system of knowledge creation (Wang et al., 2007). Various authors have proposed that, to maintain their competitive advantages, organizations should strive to develop continuous learning (Jiménez Jiménez and Sanz Valle, 2011; Senge, 1990; Zott, 2003). The concepts of learning and knowledge creation have also acquired special relevance because they are often used to describe the innovation process (Nonaka and Takeuchi, 1995). More than ever, organizational learning is a need rather than a choice (Senge et al., 1994).

In recent years, there has been marked interest in the idea that competencies constitute the foundation for obtaining sustainable competitive advantages over time (Wu, 2009). Competencies are conceptualized as "measurable patterns of knowledge, skills, abilities, behaviors, and other characteristics that differentiate high from average performance" (Wu, 2009, p. 9575). Following this concept, technological distinctive competencies can be defined as "the organization's expertise in mobilizing various scientific and technical resources through a series of routines and procedures which allow new products and production processes to be developed and designed" (Real et al., 2006, p. 508; Martín Rojas et al., 2011). Although various authors use the terms "technological capabilities" (Lall, 1992; Figueiredo, 2002; Silvestre and Dalcol, 2009) rather than "technological distinctive competencies" (Real et al., 2006; Martín Rojas et al., 2011), our study uses the concept of "technological distinctive competencies," since this concept fits better with our research goals. The term capability has been defined as "the firm's ability to perform repeatedly a productive task which relates either directly or indirectly to a firm's capacity for creating value through effecting the transformation of inputs into outputs" (Grant, 1996, p. 377). As Marino states (1996, p. 41), "competencies have a technology or knowledge-based component. In particular, competencies often result from a blending of technology and production skills. Capabilities, on the other hand, are rooted more in processes and business routines." For this reason, we focus on technological distinctive competencies in the framework of our research. These include, among others, the competencies to obtain information on the state and progress of the relevant science and technologies, to generate advanced technological processes, to update and introduce new innovations based on technologies, to attract and retain qualified technical personnel, to achieve the technological differentiation of products and to assimilate new technologies (Real et al., 2006). Some authors have stressed that technological distinctive competencies drive the development of organizational learning (Prencipe, 1997), since the competencies require change over time to maintain their value, a quality that emphasizes the processes of developing knowledge and learning (McEvily et al., 2004). There is, then, a relationship between technological distinctive competencies and organizational learning (Tippins and Sohi, 2003).

In analyzing the influence of technological distinctive competencies and organizational learning on organizational innovation, this research focuses on innovation at the organizational level, which has been defined as "the development and/or use of new ideas or behaviors. A new idea can pertain to a new product, service, market, operational and administrative structures, processes and systems" (Damanpour et al., 2009; p. 652). Following most of the studies of the adoption of innovation at the firm level, we thus define innovation as "new to the adopting organization" (Damanpour et al., 2009; p. 652). Such is the importance of innovation that it has been generally considered one of the key factors leading to corporate success, as innovation enables firms to negotiate the turbulence of the external environment in especially dynamic markets (Jiménez Jiménez and Sanz Valle, 2011). Despite the clear and evident advantages derived from innovation, innovation is not a problem-free process. Innovations are increasingly complex, costly and risky due to changes in consumer preferences, pressure from competitors, and rapid and radical technological changes (Griffin, 1997). Although this difficulty is recognized, promoting innovation is the basis for achieving both sustainable competitive advantages (Chen and Jaw, 2009) and organizational survival (Damanpour and Evan, 1984; Hurley and Hult, 1998).

Finally, we will also deepen understanding of the effects of technological distinctive competencies, organizational learning and organizational innovation on organizational performance. We use organizational performance to refer to both strategic market performance – which includes market share and sales growth rate – and financial market performance – which involves return on sales, return on investment and return on equity (Murray and Kotabe, 1999). Prior studies state that firms possessing technological distinctive competencies (such as the competence to apply scientific and technological knowledge to develop and improve products and processes) tend to be more innovative and thus usually to obtain much better performance (McEvily et al., 2004). Also, organizational learning is a determinant of improvement in organizational results (e.g., Carayannis et al., 2006; Leonard-Barton, 1992). To this we must add the crucial importance of organizational innovation, which is necessary for firms to acquire better organizational performance (Thornhill, 2006; Weerawardena et al., 2006). In sum, we will indicate how to improve organizational performance through all of the strategic variables presented above.

To achieve these objectives, this study is structured as follows. Section 'Hypotheses', based on prior research, proposes a series of hypotheses. Section 'Methodology' presents the data and the research methodology used in this empirical analysis to test the hypotheses developed in Section 'Hypotheses'. Section 'Results' shows the results obtained. In Section 'Discussion and implications', we present the discussion and implications of this research. Section 'Conclusions' explains the conclusions of this study. Finally, Section 'Limitations and future research' establishes some limitations and lines for future research.

Hypotheses

The influence of top management support on technological skills

Nowadays, organizations must both acquire and maintain access to new technologies and be able to make effective use of them to maintain and improve their competitive advantages (Weigelt, 2009). In order to best utilize the technology available, firms are placing more emphasis on obtaining higher technological skill levels (Campbell and Warner, 1992). The use of technologies may lead to higher-quality products. The utilization of computer-integrated manufacturing may improve the speed of production as well as product flexibility. The adoption of e-business tools may enhance the worker's productivity in sectors such as electronics and general machine sector. However, to achieve these goals, organizations must invest in technological skills and knowledge upgrading (Oyelaran-Oyeyinka and Lal, 2006). In such scenarios, support from management is crucial, as management is responsible for orchestrating and optimizing the use of technology and human resources (Pinheiro, 2010).

Some authors have demonstrated a relationship between top management support and the development of technological skills (Cyert and Mowery, 1987; Greenan, 2003; Dong, 2008; Mahmood, 2003; Štemberger et al., 2011). Climbing the technological ladder requires updating of skills by learning new technologies (Oyelaran-Oyeyinka and Lal, 2006). Top management can support technology training programs, whose main purpose is to produce users with practical technological skills that enable them to use technology applications. Such programs also seek, however, to create motivated users able to apply learned technological skills to their jobs, users who can continue to learn as skill and technology requirements change (Sein et al., 1999; Mahmood, 2003). Thus, top management support enables the creation of more stimulating work environments for technical subordinates, which offer greater opportunities for learning, growth and the development of technological skills (Cordero et al., 2004). This aspect becomes essential when considering the positive impact that the accumulation of technological skills may have on important variables such as productivity, quality of products (Oyelaran-Oyeyinka and Lal, 2006), potential to absorb external knowledge (Lin, 2007), education of employees (Sein et al., 1999), growth and profitability (Swamidass and Nair, 2004).

Top management support and participation reflect the importance that top management executives place on technology (Byrd and Davidson, 2003). Beath (1991) found top managers to be the most important antecedent to successful implementation of technology because they are able to bring about organizational change. The increasing level of technological skills in the workforce complements the change that comes with the decision to support new technologies, computerization and the adoption of internal electronic tools within firms (Goldin and Katz, 1998; Greenan, 2003). When top management supports the decision to develop new technologies, organizations expand their existing knowledge or experience (Schilling and Hill, 1998). Through these organizational changes and facilitation of the learning curve on new technologies (Greenan, 2003), one can expect that employees' technological skills will increase (Peterson and Van Fleet, 2004). These arguments lead to the following hypothesis:

Hypothesis 1. Top management support will be positively related to technological skills.

The influence of top management support and technological skills on technological distinctive competencies

Business environments and society in general have been undergoing constant transformation in recent years by a series of factors, among which are globalization, the knowledge revolution and the rapid dissemination of new technologies (Ireland and Hitt, 1999). So great is the importance of this last factor that different authors have shown how firms should adopt and assimilate these technologies if they wish to maintain and improve their competitive advantage (Lee and Grewal, 2004). In this context, the modernization of firms to adapt to new technologies involves a series of changes that refer, in terms of the factor of capital, to replacing old equipment with new (often introducing greater communications technologies) and, in terms of work, to investment in new skills and competencies to face new needs (Greenan, 2003). Along these lines and given their importance, the literature on management has focused recently on how organizations can develop and exploit critical competencies on the global market (Steensma, 1996; Wu, 2009), such as technological distinctive competencies (Teece et al., 1994). Management plays a decisive role in developing these competencies, which we will analyze in what follows.

Thanks to the support of top management executives—reflected among other issues in the financing dedicated to technologies and to the role these executives play in the implementation, use and success of technologies in organizations (Byrd and Davidson, 2003), firms can foster technological distinctive competencies such as the competency to assimilate new technologies, to maintain their position on the technological vanguard in their sector, or to remain up to date and introduce innovations based on information technologies (Real et al., 2006). Without top management support, this technological assimilation would not occur (Armstrong and Sambamurthy, 1999). This phenomenon accentuates the important role that managers perform in obtaining the maximum potential from the technology (Booth and Philip, 1998). According to the foregoing, top management support may, through the identification of technological projects (Melville et al., 2004), be related to the generation of sources of technological distinctive competencies, which involves both exploration and exploitation of technological opportunities (Huang, 2011). As March (1991) pointed out, both exploration and exploitation are essential and must be balanced within firms. Exploration involves actions captured by terms such as search, risk taking, experimentation or discovery. Exploitation includes such actions as refinement, selection, efficiency, implementation and execution. Effective selection among routines or practices is crucial to survival, but so is the generation of new alternative practices, especially in a changing environment.

The promotion and securing of resources devoted to R&D in technology, as well as the measure of support from management (Byrd and Davidson, 2003), stimulates organizations' technological distinctive competencies. These affect the work climate of R&D (itself a source of technological competencies), the capability to link the R&D plan to the competitive strategy, the capability of achieving effective collaboration with other organizations in R&D, and effective installation of programs oriented to the development of technological competencies (Huang, 2011; Real et al., 2006). Such effects also occur when management takes charge of facilitating technology transfer throughout the firm – which has different levels of the transfer of expertise or know-how, since much knowledge is incrusted in technology (Malik, 2002) – and promotes the creation of technological distinctive competencies, such as the capability to develop knowledge management programs, that guarantee the competency to generate technology or to absorb technology from other organizations (Real et al., 2006).

Technological changes altering the market recently show the need for firms to possess competencies to maintain themselves strategically (Drejer, 2001). Through top management support, fostering technology (Schepers et al., 2005) can develop technological distinctive competencies that make key contributions to increase the firm's competitive advantage (Irwin et al., 1998; Peteraf and Bergen, 2003). Managers must be responsible for examining the threats that new technologies present and the need to maintain the organization's capabilities (Smith and Sharif, 2007). These arguments lead to the following hypothesis:

Hypothesis 2. Top management support will be positively related to technological distinctive competencies.

The disposition to acquire technology has been conceived as characteristic of the most successful organizations (Kim and Pae, 2007). Making the right decision about opportunities for technology investment can provide organizations with considerable operating and competitive benefits (Torkkeli and Tuominen, 2002). These characteristics should be reinforced by sufficient preparation at the organizational level. Organizations must not only be willing to adopt new technologies but also to use them to the best advantage in order to obtain the benefits indicated above. Because this preparation reflects the firm's capability to adopt and use new technological resources (Parasuraman, 2000), appropriate technological preparation is required. In such scenarios, technological skills are strategic, as they can achieve effective implementation of new technological processes (Swamidass and Nair, 2004).

Various studies indicate the existence of a relationship between technology skills and technological distinctive competencies. Some authors argue that the concept of competency reflects a set of skills and technologies (Peppard and Ward, 2004). One key to developing organizational competencies is the possession of technical skills, as well as organizational processes to exploit those skills (Caldeira and Ward, 2003). To obtain business benefits derived from investments in technology, organizations should develop competencies that exploit these technologies, competencies that involve a series of individual skills (Wu, 2009). We can define the competency as an underlying element that projects itself as skilled behavior. This definition is based on the very concept of competency as involving a series of skills related, among other things, to the effective performance of management functions and personnel behavior that enables employees to perform their functions satisfactorily and permits differentiation of employees with superior performance (Rajadhyaksha, 2005).

Competencies involve a series of models of behavior required to achieve effective organizational performance. They imply not only skills, but also how to apply these skills effectively in a specific area to achieve successful performance (Sgobbi, 2002). In the area of technology, increase in the personnel's technological skills will facilitate the development of technological distinctive competencies (Caldeira and Ward, 2003; Real et al., 2006). We can thus show the interconnection between technological skills and technological distinctive competencies, which is consistent with studies that indicate that organizational competency emerges from the understanding of business processes and of individual skills (McGrath et al., 1995).

Ultimately, the implementation of technologies is often accompanied by the development of new skills and knowledge. The latter are necessary for professionals to be able both to manage increasingly complex systems (Schramm, 2006) and to avoid the failure of technologies due to the scarcity of technological skills (Booth and Philip, 1998). The incorporation of new technological skills is related to the generation of technological distinctive competencies, since technological distinctive competencies involve the implementation and extension of the reach and consequences of different organizational capabilities. These in turn require the mastery of technological skills (Miyazaki, 1999). These arguments lead to the following hypothesis:

Hypothesis 3. Technological skills will be positively related to technological distinctive competencies.

The influence of top management support and technological distinctive competencies on organizational learning

Because scientific and technological advances occur constantly and because market needs change continuously, organizations must learn to respond increasingly quickly and satisfactorily to turbulent and uncertain environments (Lynn et al., 2003). The greater the commitment from the organization's management to implement new technologies and the more resources top management devotes to this end, the more processes top management will encourage that integrate organizational learning. Support for the introduction of new technologies provides a clear example. At the organizational level, such introduction incorporates an important factor for the design of learning organizations in providing an infrastructure to store, access and review some of the elements that make up organizational memory (Robey et al., 2000). There is, then, a positive relation between the incorporation of information technologies and organizational learning, a relationship established when the right culture exists (Real et al., 2006).Top management executives' support of the implementation, use and success of technologies is key for their firms' assimilation of these technologies at the organizational level (Armstrong and Sambamurthy, 1999). Such support will lead, further, to obtaining higher levels of organizational learning, as Ruiz Mercader et al. (2006) have shown for the case of small firms that make greater use of individual and collaborative technologies. Along the lines described above, management's stimulation of projects in which e-learning technologies and techniques are used also helps to facilitate organizational learning through the transformation of tacit knowledge into explicit, knowledge that can be disseminated at the organizational level (Falconer, 2006).

Management can support another series of actions to facilitate organizational learning, such as the promotion of technology transmission projects. Such projects foster and affect the creation, acquisition and retention of knowledge (Gupta and Govindarajan, 2000), that is, the processes that integrate organizational learning. When firms make a commitment to carry out processes by developing new technologies, they are really fostering learning processes based on the creation of new knowledge (Manaikkamäkl, 2007).

Finally, top management support has the potential to influence organizational knowledge and learning in a significant way (Andrawina, 2009) through the promotion of technology. Firms that stand out as being technologically proactive and thus promote their own technological development will generate greater organizational learning (García Morales et al., 2007b). Top management performs a crucial role, not only because top management is responsible for securing the financial and personnel resources necessary (Thong et al., 1996) but also because it is critical in promoting changes at the organizational level (Dong, 2008). These arguments lead to the following proposition:

Hypothesis 4. Top management support will be positively related to organizational learning.

Nowadays, firms face a situation of intense competitiveness, in which the key factor for competitive success lies in the capability constantly to develop new products, processes or services. Given this scenario, various studies have stressed the need for organizations to include technology in their corporate agendas (Kim and Pae, 2007) and to develop technological distinctive competencies that enable them to obtain benefits from the use of new technologies (Leonard-Barton, 1992).

Technological distinctive competencies are positively related to organizational learning (Tippins and Sohi, 2003). Organizations that develop technological distinctive competencies usually possess high potential to absorb technology, which enables them to understand others' technological mental models and ways of acting more easily, thereby achieving a shared vision of key technological assumptions and existing relationships and improving the capability to learn at the organizational level (García Morales et al., 2007b; Senge et al., 1994). The development of central competencies in the organization, as in the case of technological distinctive competencies, encourages processes of organizational learning (Andreu and Ciborra, 1996) and stimulates organizational performance (DeCarolis, 2003).

Firm-specific technological distinctive competencies help to explain why firms are different, how they change over time, and whether or not they are able of remaining competitive (Patel and Pavitt, 1997). Technological distinctive competencies may become institutionalized over a long period of time and form part of the company's knowledge creation system (Leonard-Barton, 1992), which in turn affects the development of organizational learning (Huber, 1991). Organizational learning is a change in the organization that occurs as it acquires experience, and that routines and beliefs change in response to direct organizational experience through trial-and-error experimentation and organizational search (Levitt and March, 1988). In this sense, the acquisition of technological distinctive competencies (the process by which organizations develop new technological competencies and renew existing ones) will foster the ability of the organizations to learn from experience. This is the case because the acquisition of technological distinctive competencies involves the assimilation or absorption of technological knowledge from other organizations and the creation of technological competence through processes such as search or experimentation (McEvily et al., 2004; Ahuja and Katila, 2001).

Thus, technological distinctive competencies increase the potential to absorb and manage technological knowledge and the capability to innovate, producing improvements in organizational performance (Wang et al., 2004). Employees with technological distinctive competencies can use information technologies more easily, facilitating organizational learning (Kautz and Thaysen, 2001). These arguments lead to the following hypothesis:

Hypothesis 5. Technological distinctive competencies will be positively related to organizational learning.

The influence of technological distinctive competencies and organizational learning on organizational innovation

In recent years, various studies have shown that organizational innovation is essential for both organizational survival (Cavusgil et al., 2003; Han et al., 1998; Hurley and Hult, 1998) and organizational performance (Brett and Okumura, 1998; Smith et al., 2005). The set of competencies that each organization possesses plays a key role in the development of organizational innovation, since without these competencies the organization could not innovate in response to the rapid technological changes (Ahuja, 2000). In this context, and among these competencies, technological distinctive competencies merit special attention (Ritter and Gemünden, 2004).

Diverse studies stress the existence of a positive relationship between technological distinctive competencies and organizational innovation. DeCarolis (2003) argues that one of the basic functions of technological distinctive competencies is the exploitation of technological knowledge to develop organizational innovations satisfactorily. In analyzing exploiting competencies, Nerkar and Roberts (2004) emphasize that the ultimate reason that firms develop technological distinctive competencies has to do with the satisfactory development of new products. Firms deeply implicated in technological distinctive competencies in the long term increase their organizational innovation (Huang, 2011). Autio and Yli-Renko (1998) show that new technology firms enjoy a series of strengths that cannot be easily replicated by large companies, as is the case of technological distinctive competencies in highly specialized fields, which foster and contribute to high innovative efficiency.

We can conclude by stressing, as do Cantwell and Fai (1999, p. 333), that "while on the surface innovation is commonly observed through the market phenomena of the emergence of new products and the diversification of existing products, the underlying capability to change what markets receive is provided by the corporate capability to create and refine to a viable point new products and processes, which rests on the cumulative generation of technological competence in firms." By means of technological distinctive competencies, organizations can become pioneers in the market by developing new products and new production processes (Ritter and Gemünden, 2004). Thus, technological distinctive competencies have a positive influence on innovative organizational performance (Huang, 2011). These arguments lead to the following hypothesis:

Hypothesis 6. Technological distinctive competencies will be positively related to organizational innovation.

We are witnessing increasingly dynamic and competitive environments, in which organizational innovation constitutes the basis for sustaining competitive advantages (Nonaka, 2007), as well as the key to organizational survival (Damanpour and Evan, 1984; Hurley and Hult, 1998). Such organizational innovation depends on the knowledge base that the organization possesses, generated by organizational learning (Cohen and Levinthal, 1990; Nonaka and Takeuchi, 1995). Knowledge is a strategic variable not only in new firms that introduce new products or create new markets but also in already established firms that must innovate continuously to face the threat caused by the disruption, for example, of new technologies (Cefis and Marsili, 2005). It is necessary to stimulate the development of factors that drive innovation and enable the constant search for and introduction of new ideas, products, services, systems, policies, programs and processes before other firms in the environment do so (Llorens Montes et al., 2005).

Diverse recent studies have shown the existence of a positive relationship between organizational learning and organizational innovation (e.g., Aragón Correa et al., 2007; Calantone et al., 2002). Organizational innovation usually begins with the construction of a new kind of knowledge within the firm (Demarest, 1997). Organizational learning, a process related to the development of new knowledge (Huber, 1991), therefore affects organizational innovation, since knowledge creation enhances the introduction of new products and services (Smith et al., 2005).

Organizational learning ''supports creativity, inspires new knowledge and ideas and increases the potential to understand and apply them, favours organizational intelligence and (with the culture) forms a background for orientation to organizational innovation'' (García Morales et al., 2007b, p. 535). Such learning facilitates the introduction of new products and services, the establishment of new markets and technologies, and firms' capability to adapt and change to respond to new market demands (Smith et al., 2005). Organizational learning can be market focused, internally focused and/or relationally focused, but it must influence organizational innovation (Weerawardena et al., 2006).

Along these lines, we can observe, on the one hand, that learning is an antecedent of innovation (Hurley and Hult, 1998) and, on the other, firms that create and use knowledge continuously and effectively are those most able to innovate rapidly and satisfactorily (Cavusgil et al., 2003). It is essential for organizations to possess the capabilities necessary for a learning organization or for evolving with the goal of acquiring these capabilities (Gilbert and Cordey Hayes, 1996). Organizations with high levels of commitment to learning tend to achieve much greater innovative orientation and activity (Ussahawanitchakit, 2008). For innovation to become a top priority in firms oriented to new technologies, organizations must have a high degree of effective organizational learning (García Morales et al., 2007b).

In sum, organizational learning involves a commitment to learning in itself, an open mind and exchange of knowledge. These qualities promote a set of knowledge-questioning and knowledge-enhancing values that lead to the development of innovative products, services and technologies, as well as the exploration of new markets (Keskin, 2006; Slater and Narver, 1995). These arguments lead to the following hypothesis:

Hypothesis 7. Organizational learning will be positively related to organizational innovation.

The influence of technological distinctive competencies, organizational learning and organizational innovation on organizational performance

Technological distinctive competencies have been linked to obtaining competitive advantage (Coombs and Bierly, 2006; Tyler, 2001). In this context, studies have demonstrated that, in turbulent environments, firms that define their business area based on their technological distinctive competencies achieve better organizational performance (DeCarolis, 2003). Malerba and Marengo (1995) prove that the level of technical competencies affects performance positively in Italian high technology firms. Lee et al. (2001) found a positive relationship between technological distinctive competencies and financial performance in new Korean technology firms. Lokshin et al. (2009) stress the crucial role that technological distinctive competencies play in the innovative performance of organizations, with the consequent positive effect that this has on organizational performance.

Technological distinctive competencies stimulate organizational capability to recognize and apply new external knowledge, which is necessary to continue the development of competencies that generate higher organizational performance (Wang et al., 2004).

Technological distinctive competencies can provide firms with competitive advantages, not only in their current product lines but also in future business they have not yet conceived (Steensma, 1996). When firms "learn" and improve their technical and organizational skills, they not only manage to act more competently in their current activities but also acquire more capability to find other new activities in the process of expansion, generally in technology-related activities (Bachmann, 1998). Organizations that possess better technological distinctive competencies tend to be more innovative, which leads to obtaining higher organizational performance (McEvily et al., 2004). These arguments lead to the following hypothesis:

Hypothesis 8. Technological distinctive competencies will be positively related to organizational performance.

Organizational learning has been considered a strategic variable for obtaining competitive advantages that are sustainable over time and for improving performance in organizations (Garvin, 1993; Jiménez Jiménez and Sanz Valle, 2011). Some studies show that organizational learning has a direct and positive influence on organizational performance (Carayannis et al., 2006; Senge et al., 1994); others stress that, due to their influence on innovation, this learning affects organizational performance indirectly (Nonaka and Takeuchi, 1995; Senge et al., 1994).

It would be wrong to state that an increase in organizational learning always leads to an increase in organizational performance, since this does not occur in all cases (Hoopes and Postrel, 1999). Understanding how organizational learning affects organizational performance, whether directly or indirectly, is quite complex, since we have little knowledge of the mechanisms through which organizational learning is transformed into improvements in performance (Snyder and Cummings, 1998).

Knowledge management and organizational learning attempt to drive the increase in the quantity and quality of performance, enabling firms to improve their sales, achieve more support and create, maintain and improve their customer base (García Morales et al., 2007a). Organizations that have developed a strong culture of learning are good at the creation, acquisition and transfer of knowledge, as well as at the modification of behavior to reflect new knowledge and perspectives (Huber, 1991; Garvin, 1993; Škerlavaj et al., 2007). Since knowledge is a strategic resource for organizations to acquire competitive advantage (Hitt et al., 2000), learning that takes place on different organizational levels usually has a positive relation to organizational performance (Bontis et al., 2002). Firms oriented to learning benefit in specific areas that usually increase organizational performance, such as greater flexibility and rapidity of response, enabling them to face new challenges and act before their competitors do (Slater and Narver, 1995). Further, these firms usually possess specific competencies (Lei et al., 1996) that other organizations do not, competencies generated through learning.

The same is true of orientation to the market which, combined with organizational capabilities such as the capability to apply learning, increases organizational performance (Day, 1994; Hurley and Hult, 1998). Only through organizational learning is possible to anticipate and understand customers' needs and thus to possess better state-of-the art technology and to acquire a much greater capability to understand rivals' strengths and weaknesses (Calantone et al., 2002).

In conclusion, the growing importance of the relationship between organizational learning and organizational performance has fostered recent analysis by various authors (e.g., García Morales et al., 2007b; Zahay and Handfield, 2004). In spite of the difficulties involved in determining the benefits generated by learning – difficulties that on occasion seem to be hidden for different reasons or time lags or simply not captured due to inadequate perceptions in the firm (Senge et al., 1994) – there is empirical evidence of the impact of organizational learning or orientation to learning on the area of financial and non-financial performance in the literatures on marketing (Baker and Sinkula, 1999) and strategic management (Tippins and Sohi, 2003). As projected above, firms that learn and learn quickly manage to obtain a much greater strategic capability that enables them both to maintain a position of competitive advantage and to improve their results (Senge et al., 1994). These arguments lead to the following hypothesis:

Hypothesis 9. Organizational learning will be positively related to organizational performance.

Many studies in the literature have shown the existence of a positive relationship between organizational innovation and organizational performance (Schulz and Jobe, 2001; Weerawardena et al., 2006) or between certain characteristics or aspects of innovation (e.g., design, speed, flexibility) and organizational performance (Danneels and Kleinschmidt, 2001; García Morales et al., 2007b). Other research has shown that not promoting innovative projects and activities influences both organizational productivity and performance negatively (Lööf and Heshmati, 2002). However, innovation is an expensive and risky activity. Although innovation usually influences the improvement of organizational performance, innovation may have drawbacks, such as greater exposure to market risks, increased costs, employee dissatisfaction and the generation of changes without guarantee (Simpson et al., 2006). In spite of these qualifications, the great majority of studies published on this issue agree that organizational innovation affects organizational performance positively (e.g., Bierly and Chakrabarti, 1996; Koc and Ceylan, 2007).

Taking into account the rapid market changes occurring constantly in consumers' preferences and demands, competitors and technology (Calantone et al., 2003), those firms that possess greater innovation capability will be able to respond better to the turbulence in the environment (Jiménez Jiménez and Sanz Valle, 2011). Such response will permit them to increase organizational performance and consolidate a competitive advantage sustainable in the long term (Calantone et al., 2002; Hurley and Hult, 1998).

In recent years, due to the great interest awakened in the relationship between organizational innovation and organizational performance, different studies have provided empirical evidence on the positive nature of this relationship. Irwin et al. (1998) use the perspective of resources and capabilities to show the positive influence of technological innovations on organizational performance, holding that the characteristics of rareness, value and inimitability moderate this relationship. Other authors have shown that firms that adopt innovative product portfolios obtain a positive impact on organizational performance (Cho and Pucik, 2005). García Morales et al. (2007a) stress that innovation and innovation capability to improve organizational performance influence not only large organizations but also small and medium-sized firms. In spite of having a smaller quantity of resources, these firms benefit from other aspects that stimulate innovation, such as greater flexibility, shorter decision chains, greater facility for detecting errors and learning from them, greater affinity with values and styles of leadership that facilitate communication and knowledge transfer, greater capability for customization, and higher employee motivation, among others (García Morales et al., 2007a).

Finally, we can conclude that organizations continuously subjected to dynamic and changing environments innovate with the intention of improving their performance and effectiveness at the entrepreneurial level, grounding this conclusion in the positive relationship between organizational innovation and organizational performance (Aragón Correa et al., 2007; Damanpour et al., 2009; Hurley and Hult, 1998; Thornhill, 2006). These arguments lead to the following hypothesis:

Hypothesis 10. Organizational innovation will be positively related to organizational performance.

Methodology

This section presents the research methodology employed in this study. We first describe the sample used and then discuss how each of the variables included in the study is operationalized. Finally, we present the statistical analysis.

Sample and procedure

The first necessary step in an empirical study is selecting the population to be analyzed. The population for this study consisted of the technological organizations possessing the greatest turnover in Spain. Technological organizations are firms that emphasize an orientation to R&D and innovativeness and entrepreneurship and that maintain a special pattern of work relations (a corporate culture of technology). These elements describe shared values, beliefs and symbols, as well as the way things are done in the firm (Grinstein and Goldman, 2006). The sample was selected by means of stratified sampling with proportional allocation (size and geographical location) from the Bradstreet (2003) database. Choosing a sample of firms located in a relatively homogeneous geographical, cultural, legal and political space enables us to minimize the impact of the variables that cannot be controlled in the empirical research (Hofstede, 1980). The Spanish market is relatively well developed and wholly integrated in the European Union. However, Spain is in a geographical area that has received relatively little attention from organizational researchers (Martín Rojas et al., 2011). When compared with the European Union, Spain has a low level of technological capital per employee. Empirical research on technology in Spain is necessary to enable the improvement of the level of technology in the Spanish economy and to drive a new model of production for Spain (Aragón Correa et al., 2007; Martín Rojas et al., 2011).

We developed a structured questionnaire to investigate how organizations face these issues. We then established a reliable list of the CEOs of the organizations, with the help of partial funding from the Spanish Ministry of Science and Research and the Council for Economics, Innovation and Science of the Andalusian Regional Government. We omitted the responses of the interviewees in this first stage from the subsequent analysis of the survey data.

We decided to use CEOs as our key informants, because they receive information from a wide range of departments and are therefore a very valuable source for evaluating the different variables of the organization. They also play a major role in informing and moulding the variables under study by determining the types of behavior that are expected and supported (Baer and Frese, 2003). Although numerous actors may be involved in the management process, the CEO is ultimately responsible for plotting the organization's direction and plans, as well as for guiding the actions carried out to achieve them (Westphal and Fredickson, 2001). The same types of informant were chosen, since this means that the level of influence among the organizations is constant, increasing the validity of the variables' measurements (Glick, 1985).

Surveys were mailed to the 1000 selected organizations along with a cover letter. We used this method because surveys enabled us to reach a greater number of organizations at a lower cost, to exert less pressure for immediate reply, and to provide the interviewees with a greater sense of autonomy. The cover letter explained the goal of the study and offered recipients the option of receiving the results once the study was completed. To reduce possible desirability bias, we promised to keep all individual responses completely confidential and confirmed that our analysis would be restricted to an aggregate level that would prevent the identification of any organization. We told interviewees that they would soon receive the questionnaire and reiterated the necessity that the person chosen answer the questionnaire, even at the cost of receiving fewer responses.

We mailed each manager who had not yet responded two reminders. 226 valid questionnaires were returned, but because of missing values only 201 questionnaires were included in the research. The response rate was 20.1% (Table 1). The possibility of non-response bias was checked by comparing the characteristics of the responding businesses with those of the nonresponding businesses. This analysis indicated that respondents did not differ significantly from nonrespondents with respect to return on assets, return on equity, return on sales or number of employees. Nor did we find significant difference between early and late respondents (Armstrong and Overton, 1977). Likewise, a series of Chi-square and *t*-tests revealed no significant differences due to geographical location or size in the variables studied. Since all measures were collected with the same survey instrument, the possibility of common method bias was tested using Harman's one-factor test (see Konrad and Linnehan, 1995; Scott and Bruce, 1994). A principal components factor analysis of the questionnaire measurement items yielded five factors with eigenvalues greater than 1.0, which accounted for 72 percent of the total variance. Since several factors, not just one single factor, were identified and since the first factor did not account for the majority of the variance, a substantial amount of common method variance does not appear to be present (Podsakoff and Organ, 1986).

Table 1
Technical details of the research.

Sectors/size	1–49	50–250	+250	Total
High-tech services				
Computer science activities, research and development services	4	15	16	35
Postal and telecommunications services	4	19	11	34
High-tech manufacturing				
Chemical industry	0	19	6	25
Aerospace construction	4	18	3	25
Radio, television and communication manufacture	2	17	9	28
Office machinery and computer science equipment	3	18	4	25
Medical instruments, precision optics and watches	1	19	9	29
Geographical location	Spain			
Methodology	Structured questionnaire			
Procedure	Stratified sample with proportional allocation (size)			
Universe of population	50,000 firms			
Sample (response) size	1000 (201) firms			
Sample error	6.9%			
Confidence level	95%, $p-q=0.50$; $Z=1.96$			
Period of data collection	From April 2010 to May 2010			

Measures

The use of constructs has played an important role in designing a survey instrument in management research. In any research concerning behavioral elements, no device using a single metric unit can measure precisely, and researchers usually employ two or more measures to gauge a construct or scale. Since developing new constructs or scales of measurement is a complex task, wherever possible we use pre-tested constructs from past empirical studies to ensure their validity and reliability.

Top management support

Using scales established by Byrd and Davidson (2003) and Ray et al. (2005), we drew up a four-item scale (Appendix A) to reflect top management support. A confirmatory factor analysis was developed to validate our scales ($\chi^2_2 = 11.42$; NFI = .99; NNFI = .98; GFI = .99; CFI = .99). The scale was unidimensional and showed high reliability (α = .926).

Technological skills

This research used the scales designed by Ray et al. (2005), Byrd and Davidson (2003) and García Morales et al. (2007b) and established a scale of four items (Appendix A) to reflect technological skills. Using a confirmatory factor analysis ($\chi^2_2 = 9.04$; Normed Fit Index, NFI = .99; Non-Normed Fit Index, NNFI = .97; Goodness of Fit Index, GFI = .99; Comparative Fit Index, CFI = .99), we validated our scales and then verified each scale's unidimensionality and its high validity and reliability (α = .879).

Technological distinctive competencies

Using scales established by Real et al. (2006), we drew up a four-item scale (Appendix A) to reflect technological distinctive competencies in the organization. A confirmatory factor analysis was developed to validate our scales ($\chi^2_5 = 16.86$; NFI = .99; NNFI = .99; GFI = .99; CFI = .99). The scale was unidimensional and showed high reliability (α = .923).

Organizational learning

This research used the scale of four items developed by Aragón Correa et al. (2007) and García Morales et al. (2008) to measure organizational learning (Appendix A). These items have been duly adapted to the present study. A confirmatory factor analysis was developed to validate the scales

($\chi^2_2 = 5.74$, NFI = .99, NNFI = .99, GFI = .99, CFI = .99) and showed that the scale was unidimensional and had adequate validity and reliability (α = .908).

Organizational innovation

We used the scale of four items developed by Zahra (1993) to measure organizational innovation (Appendix A). These items have been duly adapted to the present study. A confirmatory factor analysis was developed to validate the scales ($\chi^2_9 = 19.47$, NFI = .98, NNFI = .99, GFI = .99, CFI = .99) and showed that the scale was unidimensional and had adequate validity and reliability (α = .915). A 7-point Likert scale (1 '*totally disagree*', 7 '*totally agree*') for this and all prior variables allowed managers to express agreement or disagreement.

Organizational performance

Having reviewed how performance is measured in different works of strategic research, this research used the scale of five items developed by Murray and Kotabe (1999). The use of scales for evaluating performance relative to the main competitors is one of the most widely used practices in recent studies (Choi et al., 2008). Many researchers have used managers' subjective perceptions to measure beneficial outcomes for firms. Others have preferred objective data, such as return on assets. The literature has established widely that there is a high correlation and concurrent validity between objective and subjective data on performance, which implies that both are valid when calculating a firm's performance (Dess and Robinson, 1984; Homburg et al., 1999). This research included questions involving both types of assessment in the interviews, but the CEOs were more open to offering their general views than to offering precise quantitative data. Subjective, self-reported performance measures such as those used in this study have been found to correlate highly with objective measures of firm performance (Venkatraman and Ramanujan, 1987). When possible, the correlations between objective and subjective data were calculated, and these were high and significant (0.762, $p < .001$, for return on assets; 0.785, $p < .001$, for return on equity; 0.822, $p < .001$ for return on sales; and 0.819, $p < .001$ for market share). A confirmatory factor analysis was developed to validate the scales ($\chi^2_5 = 34.92$, NFI = .97, NNFI = .95, GFI = .98, CFI = .97) and showed that the scale was unidimensional and had high reliability (α = .867). This research used a Likert-type 7-point scale (1 "*Much worse than my competitors*," 7 "*Much better than my competitors*") to ask about the organization's performance as compared with that of its most direct competitors. All the scales provide adequate levels of validity, reliability and unidemensionality (Hair et al., 2004).

Model and analysis

The data were analyzed through a structural equations model (LISREL 8.30 program), since there was an exogenous latent variable (top management support [ξ_1]), a first-grade endogenous latent variable (technological skills [η_1]) and second-grade endogenous latent variables (technological distinctive competencies [η_2], organizational learning [η_3], organizational innovation [η_4] and organizational performance [η_5]). This procedure enables us to translate the theoretical constructs into mathematical models so that the latter can in turn be estimated and evaluated empirically (Jöreskog and Sörbom, 1996). The hypotheses are given concrete graphic form in the theoretical model presented in Fig. 1. We used a recursive non-saturated model. Structural equation modeling takes into account errors in measurement, variables with multiple indicators and multiple-group comparisons (Koufteros et al., 2009).

Results

In this section we present the main research results. First, Table 2 shows the means and standard deviations as well as the inter-factor correlation matrix for the study variables. There are significant and positive correlations among top management support, technological skills, technological distinctive competencies, organizational learning, organizational innovation and organizational performance. Second, structural equations modeling was performed to estimate direct and indirect effects using LISREL with the correlation matrix as input. This type of analysis has the advantage of correcting for unreliability of measures and also provides information on the direct and indirect paths

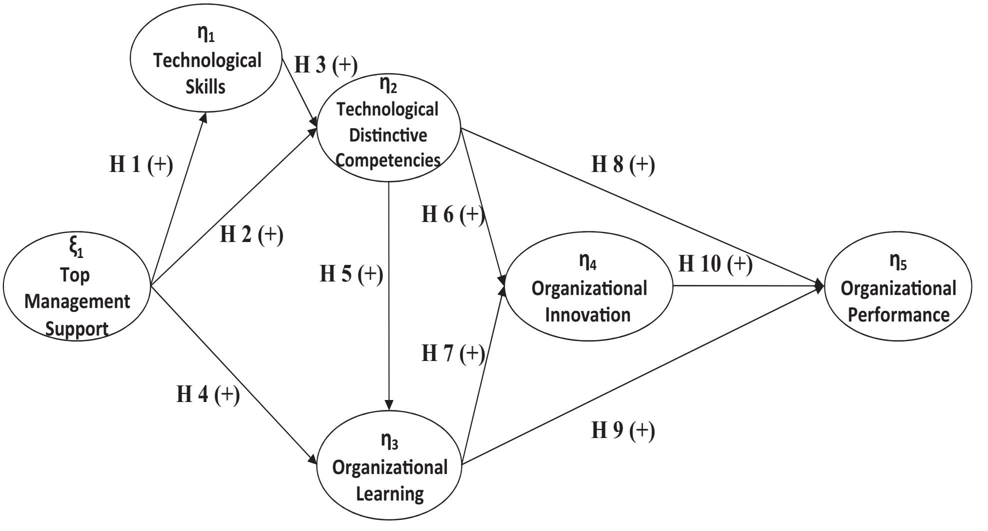

Fig. 1. Hypothesized model.

Table 2
Means, standard deviations and correlations.

Variable	Mean	S.D.	1	2	3	4	5	6
1. Top management support	4.706	1.438	1.000					
2. Technological skills	4.891	1.280	.448***	1.000				
3. Technological dist. competencies	4.742	1.302	.622***	.557***	1.000			
4. Organizational learning	4.791	1.404	.570***	.415***	.569***	1.000		
5. Organizational innovation	4.171	1.367	.557***	.376***	.487***	.493***	1.000	
6. Organizational performance	4.477	0.987	.390***	.353***	.438***	.464***	.413***	1.000

* $p<.05$ (two-tailed). $n=201$.
** $p<.01$ (two-tailed). $n=201$.
*** $p<.001$ (two-tailed). $n=201$.

between multiple constructs after controlling for potentially confounding variables. Fig. 2 shows the standardized structural coefficients. The relative importance of the variables is reflected by the magnitude of the coefficients.

In terms of the quality of the measurement model for the sample, the constructs display satisfactory levels of reliability, as indicated by composite reliabilities ranging from 0.87 to 0.92 and shared variance coefficients ranging from 0.57 to 0.75 (Table 3). Convergent validity can be judged by looking at both the significance of the factor loadings and the shared variance. The amount of variance shared or captured by a construct should be greater than the amount of measurement error (shared variance >0.50). All the multi-item constructs meet this criterion, each loading (λ) being significantly related to its underlying factor (t-values > 15.98) in support of convergent validity. To assess discriminate validity, this research performed a series of chi-square difference tests on the factor correlations among all of the constructs (Anderson and Gerbin, 1988). The research performed these on each pair of latent variables by constraining the estimated correlation parameter between them to 1.0 and then performing a Chi-square difference test on the values obtained for the constrained and unconstrained models (Anderson and Gerbin, 1988). The resulting significant differences in Chi-square indicate that the constructs are not perfectly correlated and that discriminant validity is achieved.

The overall fit measures, multiple squared correlation coefficients of the variables (R^2s), and signs and significance levels of the path coefficients all indicate that the model fits the data well ($\chi^2_{340} = 713.79$, $p > .001$; $\chi^2_{ratio} = 2.09$; NFI = .98; NNFI = .99; GFI = .99, CFI = .99, IFI = .99, PGFI = .83). The

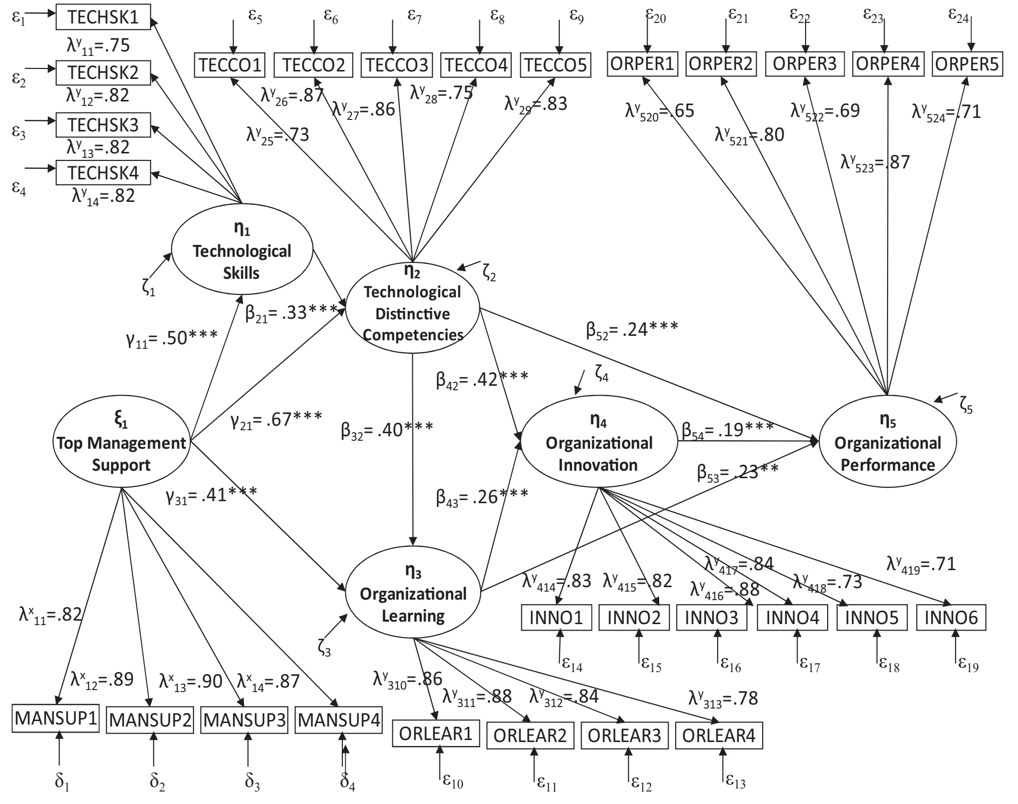

Fig. 2. Results of structural equation model.

hypothesized model was a significantly better fit than the null model ($\chi^2_{378} = 14,242.41$, $p > .001$; $\Delta\chi^2_{38} = 13,528.62$, $p > .001$). All of the modification indices for the beta pathways between major variables were small, suggesting that adding additional paths would not significantly improve the fit. The residuals of the covariances were also small and centred around zero.

Looking at the standardized parameter estimates (Table 4), the findings show that top management support is closely related and affects technological skills (γ_{11} = .50, $p < .001$, R^2 = .25), as was predicted in Hypothesis 1. The technological distinctive competencies are influenced by top management support (γ_{21} = .67, $p < .001$) and technological skills (β_{21} = .33, $p < .001$), supporting Hypotheses 2 and 3, respectively. Furthermore, we have shown an indirect effect (.16, $p < .01$) of top management support on technological distinctive competencies by technological skills (.50 × .33; see, for instance, Bollen (1989) for calculation rules). The global influence of top management support on technological distinctive competencies is thus 0.83 ($p < .001$). Comparing the magnitudes of these effects indicates that the effect of top management support on technological distinctive competencies is larger than the total effect of technological skills on technological distinctive competencies. Globally, technological distinctive competencies are explained well by the model (R^2 = .78).

Organizational learning is directly influenced by top management support (γ_{31} = .41, $p < .001$). Furthermore, this research has shown an indirect effect (.33, $p < .01$) of top management support on organizational learning by technological distinctive competencies (.67 × .40) and technological skills – technological distinctive competencies (.50 × .33 × .40). The global influence of top management support on organizational learning is thus 0.43 ($p < .001$), supporting Hypothesis 4. Organizational leaning is also influenced by technological distinctive competencies (β_{32} = .40, $p < .001$), supporting Hypothesis 5. Comparing the magnitudes of these total effects indicates that the effect of top management support on organizational learning is larger than the effect of technological distinctive

Table 3
Validity, reliability and internal consistency.

Variable	Item	Parameter	Validity, reliability and internal consistency		
			λ^*	R^2	A. M.
Top management support	MANSUP1	λ^x_{11}	0.82*** (f.p.)	0.67	
	MANSUP2	λ^x_{12}	0.89*** (23.39)	0.80	α = 0.926
	MANSUP3	λ^x_{13}	0.90*** (23.41)	0.81	C.R. = 0.926
	MANSUP4	λ^x_{14}	0.87*** (23.10)	0.76	S.V. = 0.759
Technological skills	TECHSK1	λ^y_{11}	0.75*** (f.p.)	0.57	
	TECHSK2	λ^y_{12}	0.82*** (18.01)	0.68	α = 0.879
	TECHSK3	λ^y_{13}	0.82*** (18.02)	0.67	C.R. = 0.879
	TECHSK4	λ^y_{14}	0.82*** (17.92)	0.67	S.V. = 0.646
Technological distinctive competencies	TECCO1	λ^y_{25}	0.73*** (f.p.)	0.53	
	TECCO2	λ^y_{26}	0.87*** (23.95)	0.76	α = 0.923
	TECCO3	λ^y_{27}	0.86*** (23.96)	0.74	C.R. = 0.904
	TECCO4	λ^y_{28}	0.75*** (22.74)	0.56	S.V. = 0.656
	TECCO5	λ^y_{29}	0.83*** (23.67)	0.69	
Organizational learning	ORLEAR1	λ^y_{310}	0.86*** (f.p.)	0.74	α = 0.908
	ORLEAR2	λ^y_{311}	0.88*** (23.77)	0.77	C.R. = 0.906
	ORLEAR3	λ^y_{312}	0.84*** (23.38)	0.71	S.V. = 0.707
	ORLEAR4	λ^y_{313}	0.78*** (22.83)	0.61	
Organizational innovation	INNO1	λ^y_{414}	0.83*** (f.p.)	0.69	
	INNO2	λ^y_{415}	0.82*** (20.54)	0.68	
	INNO3	λ^y_{416}	0.88*** (20.98)	0.78	α = 0.915
	INNO4	λ^y_{417}	0.84*** (20.67)	0.70	C.R. = 0.916
	INNO5	λ^y_{418}	0.73*** (19.55)	0.53	S.V. = 0.647
	INNO6	λ^y_{419}	0.71*** (19.16)	0.51	
Organizational performance	ORPER1	λ^y_{520}	0.65*** (f.p.)	0.53	
	ORPER2	λ^y_{521}	0.80*** (16.86)	0.65	α = 0.867
	ORPER3	λ^y_{522}	0.69*** (16.06)	0.51	C.R. = 0.870
	ORPER4	λ^y_{523}	0.87*** (16.97)	0.75	S.V. = 0.577
	ORPER5	λ^y_{524}	0.71*** (15.98)	0.51	

Notes: λ^* = standardized structural coefficient; R^2 = reliability; α = alpha Cronbach; C. R. = compound reliability; S. V. = shared variance; f. p. = fixed parameter; A. M. = adjustment measurement.

* $p < .05$ (two-tailed).

** $p < .01$ (two-tailed).

*** $p < .001$ (two-tailed).

competencies on organizational learning. Globally, organizational learning is explained well by the model ($R^2 = .60$).

Organizational innovation is influenced by technological distinctive competencies ($\beta_{42} = .42$, $p < .001$) and organizational learning ($\beta_{43} = .26$, $p < .001$), supporting Hypotheses 6 and 7, respectively. Furthermore, we have shown an indirect effect (.10, $p < .01$) of technological distinctive competencies on organizational innovation by organizational learning ($.40 \times .26$). The global influence of top management support on technological distinctive competencies is thus 0.83 ($p < .001$). Comparing the magnitudes of these effects indicates that the total effect of technological distinctive competencies on organizational innovation is larger than the total effect of organizational learning on organizational innovation. Globally, organizational innovation is explained well by the model ($R^2 = .40$).

Finally, for organizational performance, we find a significant relationship with technological distinctive competencies ($\beta_{52} = .24$, $p < .001$), organizational learning ($\beta_{53} = .23$, $p < .01$) and organizational innovation ($\beta_{54} = .19$, $p < .001$), supporting Hypotheses 8, 9 and 10, respectively. Furthermore, we have shown an indirect effect (.19, $p < .01$) of technological distinctive competencies on organizational performance by organizational innovation ($.42 \times .19$), organizational learning ($.40 \times .23$), and organizational learning – organizational innovation ($.40 \times .26 \times .19$). The global influence of technological distinctive competencies on organizational performance is thus 0.43 ($p < .001$). There is also an indirect

Table 4
Structural model result (direct, indirect and total effects).

Effect from		To	Direct effects[a]	T	Indirect effects[a]	t	Total effects[a]	t
Top management support	→	Technological skills	0.50***	12.75			0.50***	12.75
Top management support	→	Technological dist. comp.	0.67***	12.10	0.16***	8.37	0.83***	16.14
Top management support	→	Organizational learning	0.41***	3.46	0.33***	3.69	0.74***	15.68
Top management support	→	Organizational innovation			0.54***	16.06	0.54***	16.06
Top management support	→	Organizational performance			0.47***	14.01	0.47***	14.01
Technological skills	→	Technological dist. comp.	0.33***	7.12			0.33***	7.12
Technological skills	→	Organizational learning			0.13**	3.28	0.13**	3.28
Technological skills	→	Organizational innovation			0.17***	5.89	0.17***	5.89
Technological skills	→	Organizational performance			0.14***	5.56	0.14***	5.56
Technological dist. comp.	→	Organizational learning	0.40***	3.65			0.40***	3.65
Technological dist. comp.	→	Organizational innovation	0.42***	5.80	0.10**	3.24	0.52***	8.39
Technological dist. comp.	→	Organizational performance	0.24***	4.68	0.19***	3.98	0.43***	7.86
Organizational learning	→	Organizational innovation	0.26***	3.33			0.26***	3.33
Organizational learning	→	Organizational performance	0.23***	3.05	0.05***	2.89	0.28***	3.71
Organizational innovation	→	Organizational performance	0.19***	4.68			0.19***	4.68
Goodness of fit statistics	$\chi^2_{340} = 713.79$ ($p > .01$) GFI = 0.99 AGFI = 0.98 ECVI = 4.23 AIC = 845.79 CAIC = 1129.81 NFI = 0.98 NNFI = 0.99 IFI = 0.99 PGFI = 0.83 NCP = 373.79 RFI = 0.98 CFI = 0.99 RMSEA = 0.074							

[a] Standardized structural coefficients.
† $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 5
Model statistics against theoretical model.

Model	Description	χ^2	*df*	$\Delta\ \chi^2$	RMSEA	ECVI	AIC	NCP	CAIC
1	Theoretical	713.79	340		0.074	4.23	845.79	373.79	1129.81
2	W.R. Top Manag. Support → Tech. Dist. Comp.	956.55	341	242.76	0.095	5.43	1086.55	615.55	1366.26
3	W.R. Top Manag. Support → Org. Learning	753.44	341	39.65	0.078	4.42	883.44	412.44	1163.15
4	W.R. Tech. Skills → Tech. Dist. Comp.	772.20	341	58.41	0.080	4.51	902.20	431.20	1181.91
5	W.R. Tech. Dist. Comp. → Org. Learning	731.27	341	17.48	0.076	4.31	861.27	390.27	1140.99
6	W.R. Tech. Dist. Comp. → Org. Innovation	726.51	341	12.72	0.075	4.28	856.51	385.51	1136.23
7	W.R. Tech. Dist. Comp. → Org. Performance	723.54	341	9.75	0.075	4.27	853.54	382.54	1133.25
8	W.R. Org. Learning → Org. Innovation	738.39	341	24.06	0.076	4.34	868.34	397.39	1148.10

Notes: W.R. = without relationship; $n = 201$.

effect (.05, $p < .01$) of organizational learning on organizational performance by organizational innovation (.26 × .19). The global influence of organizational learning on organizational performance is thus 0.28 ($p < .001$). Comparing the magnitudes of these effects indicates that the effect of technological distinctive competencies on organizational performance is larger than the total effect of organizational learning or innovation on organizational performance. Globally, organizational performance is explained well by the model ($R^2 = .33$). In addition to these effects, we have shown other indirect effects (Table 4) of top management support on organizational innovation (.54, $p < .001$) and performance (.47, $p < .001$), and of technological skills on organizational learning (.13, $p < .01$), innovation (.17, $p < .001$) and performance (.14, $p < .001$).

In testing the theoretical framework, we fit several nested models, each incorporating different assumptions about parameters. Comparisons with reasonable alternative models are recommended as a means of showing that a hypothesized model is the best representation of the data. Comparison is considered to be an important part of assessing model fit (Bollen and Long, 1993). The summary statistics in Table 5 indicate that Model 1 was preferred to the others, supporting the inclusion of a model with these relationships among the analyzed constructs. For example, if we compare the theoretical model (Model 1) with a model that does not consider the relationship between technological skills and technological distinctive competencies (Model 4), we can see that the latter has a worse Root Mean Square Error of Approximation (>RMSEA = .006), Expected Cross-Validation Index (>ECVI = .28), Akaike Information Criterion (>AIC = 56.41), Consistent Akaike Information Criterion (>CAIC = 52.1) and Estimated Non-Centrality Parameter (>NCP = 57.41). Hence, results show that technological skills affect technological distinctive competencies and that Model 1 was preferred to Model 4 ($\Delta\chi^2 = 58.41$, Δdf = 1). Likewise, the theoretical model is preferable to other models formulated (Table 5). Length restrictions prevent a detailed discussion of each model and of other models (a full report is available from the authors). In sum, the proposed theoretical model represents (Fig. 2) the preferred, i.e., the most acceptable and parsimonious, model.

Discussion and implications

Taking previous studies into account, this article provides a global model that determines the theoretical and empirical effects of the top management's support of technology on the generation of technological skills, technological distinctive competencies and organizational learning. This research also examines the effects that technological distinctive competencies and organizational learning have on organizational performance directly and indirectly through organizational innovation. The results of this analysis offer important theoretical and managerial implications for both researchers and business practitioners.

Along the lines of previous theoretical studies, this paper provides theoretical evidence that top management support of technology positively influences the generation of technological skills, technological distinctive competencies and organizational learning. However, our study goes further and also shows, first, how top management support of technology indirectly affects technological distinctive competencies through the development of technological skills; and, second, how organizational learning improves with the development of technological distinctive competencies generated as a result of top management support of technology. These results reveal the importance of promoting implementation of new technologies in organizations, a well-accepted principle for sustaining or advancing competitive advantages in the marketplace (Kim and Pae, 2007). Some studies argue that firms that utilize the most recent advances in technology face better chances of survival than those that do not (Levitas et al., 2006). Our research shows, however, that firms wishing to achieve this goal must update their technological skills, which can be improved through top management support (Cordero et al., 2004). Such updating in turn affects the generation of technological distinctive competencies (Caldeira and Ward, 2003) and facilitates effective use of technology. Effective use is not possible otherwise, as some technology may be especially foreign and unfamiliar to a firms' technological competency base (Steensma, 1996). Further, generation of these technological distinctive competencies, which form part of the company's knowledge creation system (Leonard-Barton, 1992), fosters organizational learning processes (Andreu and Ciborra, 1996) that provide a foundation for organizations to gain sustainable competitive advantages (Jiménez Jiménez and Sanz Valle, 2011).

Another theoretical contribution of this study is that technological distinctive competencies and organizational learning affect organizational performance positively, directly and indirectly through organizational innovation. Our research supports the theoretical arguments of previous studies on the positive relationship of technological distinctive competencies (e.g., DeCarolis, 2003; Lokshin et al., 2009), organizational learning (e.g., Carayannis et al., 2006; Garvin, 1993) and organizational innovation (e.g., Aragón Correa et al., 2007; Thornhill, 2006) to organizational performance. However, we also verify that technological distinctive competencies and organizational learning affect organizational performance positively and indirectly through organizational innovation. Organizational innovation is a strategic factor to enable growth and the creation of wealth (Damanpour et al., 2009; Hurley and Hult, 1998). To improve their organizational innovation levels, firms create contexts that facilitate innovation, dedicating resources to this goal and assuming a structure and culture that stimulate the development and implementation of innovations (Senge et al., 1994; Van de Ven, 1986). Organizational innovation becomes essential, because innovation enables their renewal over time, firms' adaptation and change to meet new market demands (Smith et al., 2005). Organizational innovation also helps organizations to achieve a better response from the environment (García Morales et al., 2007b). This study shows the indirect effect of technological distinctive competencies and organizational learning on performance through organizational innovation to be especially appealing. On the one hand, we find that organizations that foster technological distinctive competencies stimulate the recognition and application of new knowledge in firms, which helps them to create and distribute innovative products or services that consumers will value and that will thus have positive repercussions for organizational performance (Wang et al., 2004). On the other hand, these results show that cultures of learning within organizations facilitate the search for and development of new knowledge, which leads to an increase in organizational innovations that will in turn improve organizational performance (Aragón Correa et al., 2007; Real et al., 2006).Our research also has implications for business practitioners. First, the presence of top managers who support the implementation of new technologies and encourage a technologically proactive attitude in organizations has become a key factor. This attitude helps firms to adopt technologically advanced stances and to exploit new opportunities that emerge continuously in environments subject to intense technological change (García Morales et al., 2007b).

Second, the acquisition of new technological distinctive competencies can be stimulated through the development of technological skills, which can be encouraged with the support of top management through a new and broader type of training (Swamidass and Nair, 2004). Competency-building is a complex, long-term process that must take place hand-in-hand with a long-term corporate strategy (Miyazaki, 1999). Involving management through the design of the entrepreneurial strategy is thus also a fundamental issue.

Third, organizations that place managers with a predisposition to learning in decisive positions and that promote top management's stimulation of a shared vision (Senge et al., 1994) facilitate the development of organizational learning. When top management supports investments in learning, public talks on learning and the elimination of negative group dynamics that might impede learning, organizational learning is fostered within the firm (García Morales et al., 2007b).

Conclusions

To synthesize and conclude, we should point out that the sources of sustainable competitive advantage in technology firms are based on a set of technological distinctive competencies and other capabilities present in these organizations (García Morales et al., 2007b). Thus, managers should stress the fostering of technological distinctive competencies, organizational learning and organizational innovation, as all of these competencies and strategic capabilities can have positive effects on improving organizational performance (Hurley and Hult, 1998; Real et al., 2006). In this way, organizations will find themselves in a better position to respond to turbulence in the environment and to take advantage of the technological opportunities that are generated continuously. These activities will contribute to improving their competitive position.

Limitations and future research

The investigation presented here exhibits several limitations that should be considered. First, survey data based on self-reports may be subject to social desirability bias (Podsakoff and Organ, 1986). However, an assurance of anonymity can reduce such bias even when responses are related to sensitive topics (Konrad and Linnehan, 1995). The low risk of social desirability bias in this study was indicated by several managers who commented that it made no sense at all for their companies to go beyond regulatory compliance. In the absence of published data, our investigation follows the methods used in previous studies (e.g., Bueno Campos et al., 2010; Llorens Montes et al., 2004). We thus compared the model obtained to the model in which the objective values for performance available to us were used. We found no significant differences between the two models. Further, the results from the correlation analysis between objective and subjective performance data show close relationships.

Second, although Harman's one-factor test and other method test did not identify common method variance as a problem, it still may have been (Podsakoff and Organ, 1986; Konrad and Linnehan, 1995). Although Spector (2006) has argued it is incorrect to assume that the use of a single method automatically introduces systematic bias, we recommend that future research gather measures of independent and dependent variables from different data sources to minimize the effects of any response bias (Podsakoff et al., 2003).

Third, our data are cross-sectional, which makes difficult to examine the evolution of the different variables in our study. This issue is of particular interest, considering the dynamic nature of some of our variables. Although we tested the most plausible directions for the pathways in our model, longitudinal research is needed to assess the direction of the relationship and to detect possible reciprocal processes. We have tried to temper this limitation through attention to theoretical arguments that rationalize the relationships analyzed and integration of temporal considerations into measurement of the variables (Hair et al., 2004). Fourth, futures studies should be based on a larger sample, preferably in more than one country and in other sectors.

Finally, the model only analyzes the relation of top management support and technological skills to organizational performance through technological distinctive competencies, organizational learning and organizational innovation. It should be noted that the variables selected explain an acceptable amount of variance of organizational performance. Other intermediate constructs could be analyzed, such as corporate entrepreneurship or knowledge management (e.g., Nonaka and Takeuchi, 1995). We might also examine other consequences of introducing learning and innovation processes in organizations (e.g., quality improvement, staff satisfaction, improvements in relational capability). The homogeneous geographical context examined here limits the influence of external factors, but future research might well explicitly integrate the influences of external factors (Aragón Correa and Sharma, 2003). More empirical papers supporting (or rejecting) our results in different contexts would be welcomed (especially longitudinal studies).

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Appendix A

Top management support: Indicate the degree to which you agree or disagree with the following statements about top management support: (1) top management cultivates technology project champions, (2) top management ensures adequate funding of technology research and development, (3) top management restructures work processes to leverage technology opportunities in the organization, and (4) top management facilitates technology transfer throughout the organization.

Technological skills: Indicate the degree to which you agree or disagree with the following statements about the technological skills. The skills of the people in the organization: (1) are very superior to closest competitors in hardware and operating systems performance, (2) are very superior to closest competitors in business applications software performance, (3) are very superior to closest competitors in communications services efficiency, and (4) are very superior to closest competitors in implementing new acquired technological knowledge and technologies.

Technological distinctive competencies: Indicate the degree to which you agree or disagree with the following statements about whether the organization has: (1) competence to obtain information about the status and progress of science and relevant technologies, (2) competence to generate advanced technological processes, (3) competence to assimilate new technologies and useful innovations, (4) competence to attract and retain qualified scientific-technical staff, and (5) competence to dominate, generate or absorb basic and key business technologies.

Organizational innovation: The organization has increased significantly: (1) the emphasis on developing new products/services, (2) the rate of introduction of new products/services on the market, (3) spending on new product/service development activities, (4) the number of products/services added by the organization and already existing on the market, (5) the number of new products/services introduced by the organization for first time on the market, and (6) percentage of revenue generated from new businesses/services that did not exist three years ago.

Organizational learning: In the last three years: (1) the organization has acquired and shared much new and relevant knowledge that provided competitive advantage, (2) the organization's members have acquired some critical skills that provided competitive advantage, (3) organizational improvements have been influenced fundamentally by new knowledge entering the organization (knowledge used), and (4) the organization is a learning organization.

Organizational performance: Relative to your main competitors, what is your firm's performance in the last three years in the following areas? (1) Organizational performance measured by return on assets (economic profitability or ROA), (2) organizational performance measured by return on equity (financial profitability or ROE), (3) organizational performance measured by return on sales (percentage of profits over billing volume), (4) organization's market share in its main products and markets, and (5) growth of sales in its main products and markets.

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