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Maximizing the positive influence of IT for improving organizational performance

Jacques Bulchand-Gidumal *, Santiago Melián-González [1]

University of Las Palmas de Gran Canaria, Faculty of Economics, Business and Tourism, Campus Universitario de Tafira, 35017 Las Palmas de G.C., Spain

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ABSTRACT

In the analysis of whether information technology (IT) has an impact on organizational performance, focus is usually placed on the relationship between an organization's investments in IT and that organization's performance. Therefore, it is standard to devote special attention to the size and complexity of the organization, to the investments in other organizational resources that may affect the performance of IT, and to the manner in which the two variables are measured. However, one area that has not been well explored is the manner in which the relationship between investments in IT and organizational performance develops. In this article, we show empirically that the planning and management of IT influence the organization's endowment of resources (physical and human), which consequently has positive effects on each of the IT-related areas usually found in organizations (applications, reliable and secure systems and communications, and training and support). In turn, the functioning of these areas influences the impact of IT on the organization, which then has positive effects on organizational performance. We have used data corresponding to IT management in Spanish universities, as well as independent rankings that are useful for evaluating their performance.

1. Introduction

The academic body that studies information technology (IT) has spent years debating the so-called "productivity paradox", that is, whether investment in IT corresponds to an adequate improvement in organizational performance. Since Solow (1987) stated that "we see computers everywhere except in the productivity statistics", a statement that came to be called the productivity paradox, a significant number of articles have attempted to explain the reasons behind this paradox. These explanations can be divided into two broad groups. On the one hand, some studies refer to methodological issues, such as the manner in which investment in IT, productivity, and even organizational performance are measured (Griliches, 1995; Hitt and Brynjolfsson, 1996; Brynjolfsson, 1998; Schreyer, 1998; Kholi and Devaraj, 2003). This type of reasoning fits perfectly in today's world, which faces a change of paradigm with few antecedents in the history of mankind (Castells, 2010) that necessitates methodological adaptation.

On the other hand, there are explanations regarding contextual variables that may act as moderators of the relationship between investment in IT and organizational performance. These include firm size (e.g., the larger the organization, the higher the performance that IT can offer: Kobelsky et al., 2008); the complexity of the firm (e.g., the greater the complexity, the higher the performance that IT can offer: Kobelsky et al., 2008; Fernández Menéndez et al., 2009); and investments in complementary assets that enable organizations to take maximum advantage of IT (Brynjolfsson, 2003).

* Corresponding author. Tel.: +34 928458958; fax: +34 928451022.
E-mail addresses: jbulchand@dede.ulpgc.es (J. Bulchand-Gidumal), smelian@dede.ulpgc.es (S. Melián-González).
[1] Tel.: +34 928451784; fax: +34 928451022.

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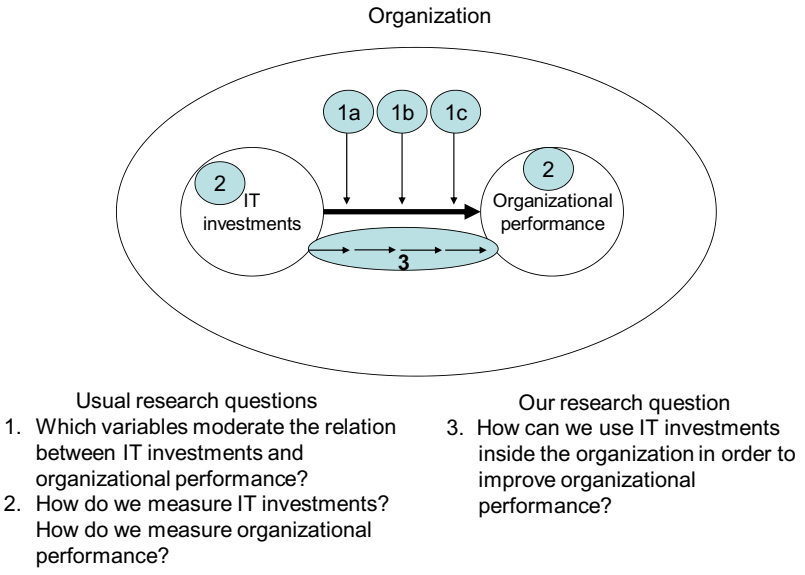


Source: The authors

Fig. 1. Research question.

However, in our opinion, the literature seems to have paid little attention to the ways in which investment in IT can lead to improved organizational performance (see Fig. 1).

Like Bharadwaj (2000) and Melville et al. (2004), we believe that knowing how IT adds value is one of the knowledge requirements that must be satisfied in order to continue making progress in this field. Since there are not many existing empirical studies that address this aspect, this article aims to help clarify the issue by providing data to support the validity of the proposals. In the literature, we find various studies (e.g., Powell and Dent-Micallef, 1997; Francalanci and Galal, 1998; Bresnahan et al., 2002) that, under the umbrella of the resource-based view of the firm (Barney, 1991) and also taking into account aspects other than IT, obtain positive results with regard to business performance from IT investments. The additional factors evaluated mainly relate to human resources and organizational issues.

However, none of the previous studies specify a detailed path that allows IT investments to improve organizational performance. This is the objective of this article. In pursuit of this objective, we first present the results of existing studies that we found useful for our study. We then present our model and its theoretical bases and explain the methodology followed, the results obtained, the final conclusions and their implications for managers, as well as the limitations of the work.

2. Literature review

Various studies have explored the space between investment in IT and organizational performance. In the context of process theories, Soh and Markus (1995) propose a theoretical model of how IT creates value. To that end, they review previous models on the same subject; more specifically, they analyze the proposals of Lucas (1993), Grabowski and Lee (1993), Markus and Soh (1993), Beath et al. (1994) and Sambamurthy and Zmud (1994). Since the model of Soh and Markus (1995) includes the models mentioned above, it is the model on which we will comment (Fig. 2).

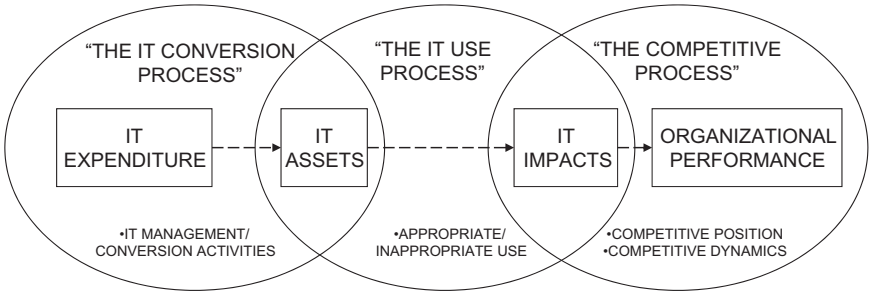
Due to the lack of definitive relationships among the elements that may be involved in the process of value creation by IT, these authors propose to begin at the end of the chain—in other words, the improvement in organizational performance due to investments in IT. As a result of this inverse strategy, three processes emerge in the creation of value.

The first process combines organizational performance with what Sambamurthy and Zmud (1994) label "IT impact". More specifically, for organizational performance to improve, the organization must have achieved a state in which one or more of the following IT contributions occur: the incorporation of IT in products and services that lead to better organizational performance; the effective redesign of business processes by means of IT, which also leads to improvements in organizational performance; the improvement, via IT, of the managers' capability to make decisions on aspects relevant to performance; and the contribution of IT to the creation of flexible organizational structures that are beneficial to the organization, customers, and suppliers.

The second process links IT impact with the quality of IT assets, which comprise: the portfolio of applications, IT infrastructure (hardware, operating systems, shared services such as network services, and the expertise of IT personnel), and user skills.

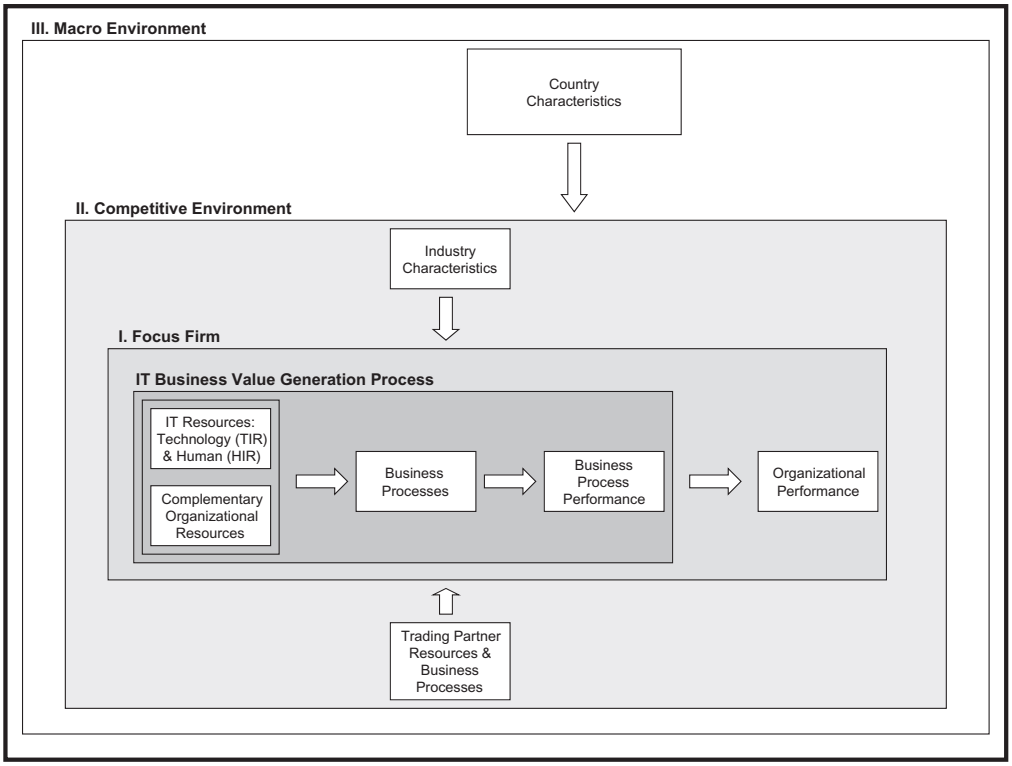
Finally, the third process combines IT assets with IT expenditure, highlighting that this process may be described as IT management, which, according to Markus and Soh (1993), comprises the formulation of the IT strategy, selection of the appropriate organizational structures for the IT strategy to be executed, selection of the suitable IT projects, and efficient management of the IT projects. Following the suppositions of the process theories, these three processes are necessary but insufficient conditions; thus Soh and Markus (1995) cite different contingencies (e.g., the firm's competitive position and political influences on decisions) that may explain why, given these circumstances, the desired relationships are not produced.

We also consider it interesting to analyze the model proposed by Melville et al. (2004) with the aim of developing a process through which IT can influence organizational performance. These authors propose the Integrative Model of IT Business Value in what they call IT Business Value Research. The theoretical model proposed by Melville et al. (2004) is very ambitious since it not only addresses technological, human, and organizational resources in the process of value creation in the firm, but other aspects as well. The aspects that stand out are macro-variables, such as the educational level of the country in



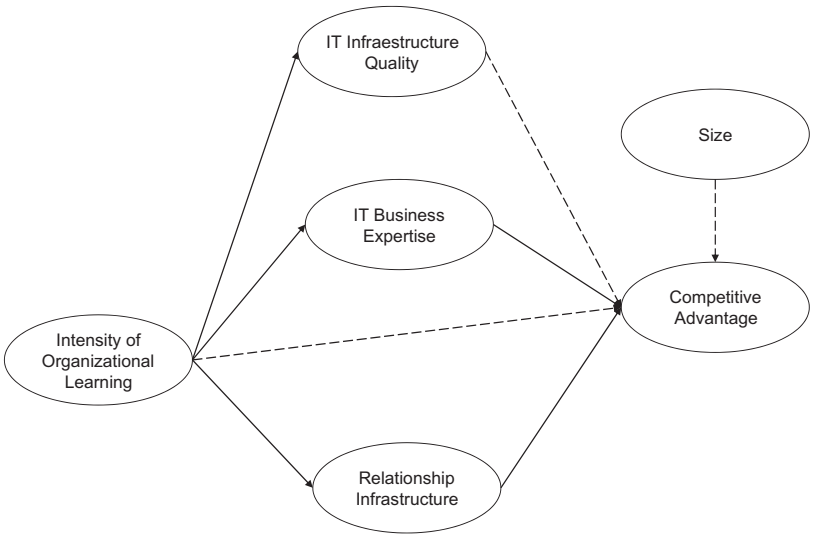
Source: Soh and Markus (1995:37)

Fig. 2. Soh and Markus' model.



Source: Melville et al. (2004:293)

Fig. 3. Melville et al.'s model.



Source: Bhatt and Grover (2005:269)

Fig. 4. Bhatt and Grover's model.

which the organization is located, and environment variables, such as the characteristics of the sector, and the resources and processes of the organization's partners. The model (Fig. 3) shows how the influence of the resources under consideration is channeled through the business processes within the firm (i.e., the different activities involved in the transformation of inputs into outputs: manufacturing, sales, distribution, customer service, etc.). Thus, the performance associated with these activities (i.e., business process performance) is influenced, which impacts organizational performance.

The two previous models have been developed only at a theoretical level with no empirical tests to support them. Now, we briefly discuss the two proposals that have been analyzed empirically.

First, there is the work of Bhatt and Grover (2005), which contains more specific elements than the previous models and focuses exclusively on the firm. These authors propose a model (Fig. 4) in which the intensity of organizational learning determines the quality of the IT infrastructure, business experience and knowledge of the IT personnel, and relationships between IT personnel and other business units. All these aspects influence the competitive advantage that the firm may possess (in this model neither the relationship between organizational learning and competitive advantage nor that between IT infrastructure quality and competitive advantage were confirmed).

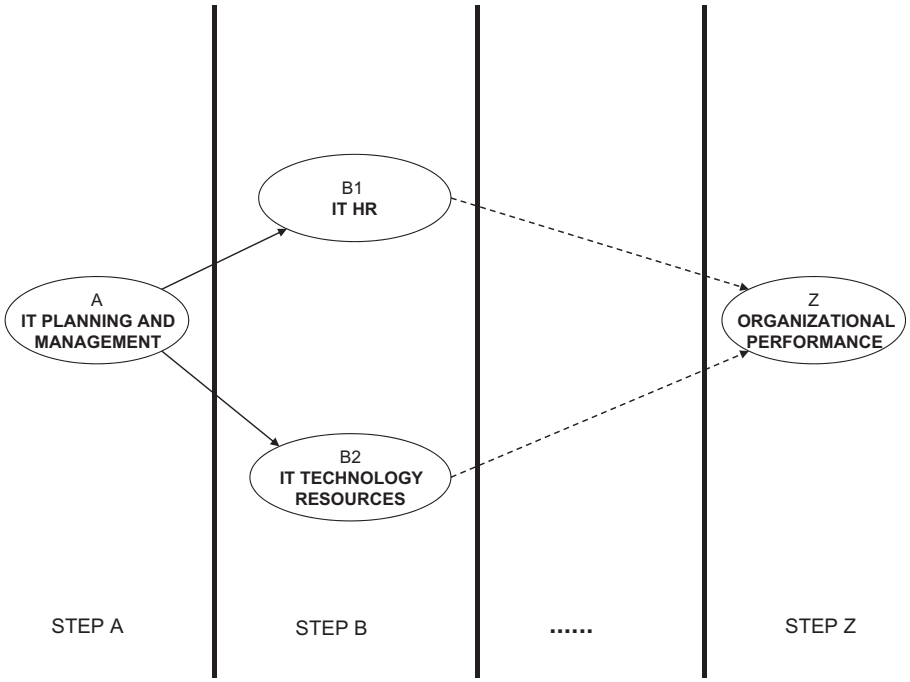
For her part, Bharadwaj (2000, p. 176) begins from the notion of organizational capability and defines IT capability in the following manner: "A firm's IT infrastructure, its human skills, and its ability to leverage IT for intangible benefits serve as firm-specific resources, which in combination create a firm-wide IT capability". She provides several examples of how this combination can be effective, including: a flexible infrastructure with strong IT skills, or the use of technology and skills to develop intangible IT-based assets, such as customer orientation and synergies. Although Bharadwaj (2000) confirms that firms with higher IT capability have better results, she provides no specific information on how such firms combine the previously mentioned resource, or others.

Finally, we must mention a series of studies that, under the umbrella of the resource-based view of the firm (Barney, 1991), find that IT resources together with human and other organizational resources have a positive influence on organizational performance. Thus, Powell and Dent-Micallef (1997) demonstrate that there is a positive influence on organizational performance when IT is exploited jointly with human and business resources. Moreover, Francalanci and Galal (1998), Bresnahan et al. (2002), and Galve Gorriz and Gargallo Castel (2005) consider human resources and investment in IT simultaneously and confirm improvements in business performance. Brynjolfsson and Hitt (1998) show how the combination of IT and organizational design has a positive effect on the firm's productivity. Although the objectives and results of these studies do not include a description of the value creation of IT, they provide valuable information on the elements that may play a role in value creation.

In light of the above discussion, we believe that it is possible to define a path at an organizational level that connects the IT investments of an organization and the performance of that organization. In the following section, we describe our model and its theoretical bases.

3. Elaboration of our model and work hypotheses

The review of the existing literature provides sufficient information to prepare, at a theoretical level, a stepwise model that combines the IT area of an organization and its performance. However, it must be stated that some of the models



Source: The authors

Fig. 5. Graph sent to IT experts.

discussed in the previous section are process models (Soh and Markus, 1995; Melville et al., 2004) while others are variance models (Bhatt and Grover, 2005; Bharadwaj, 2000). We are going to develop a variance model, although we will be using some of the constructs and ideas found in the process models that have been reviewed.

Thus, following the design suggestion of Soh and Markus (1995), we consider it appropriate to begin at the end of the sequence. The models with more specific elements regarding value creation activities are those of Soh and Markus (1995) and Melville et al. (2004). Both these models reflect that in order to improve organizational performance through IT, IT must have previously influenced the organization's production activity. In turn, penetration in the production processes is determined by IT resources or assets. In the previous section, there is consensus between the models regarding two specific IT assets: IT technology resources and IT human resources. These resources also appear in the studies that confirm the positive influence of IT on business performance. The model of Melville et al. (2004) explicitly ends at this point, while Soh and Markus (1995), Bhatt and Grover (2005), and Bharadwaj (2000) add an initiating element that refers to the planning or management of IT.

In order to define the content of the model that we wanted to develop, we sent a questionnaire to ten IT experts[2] for them to propose elements and specific routes between the links in the model that we had already constructed (Fig. 5). In order to provide them with a basic framework, we used Fig. 5, telling them that, from our perspective, the model begins with IT Planning and Management (step A) and involves the establishment of the necessary IT Human Resources and IT Technology Resources (step B). Then, we asked their opinions regarding the number and content of steps between B and Z, where step Z corresponds to Organizational Performance, and indicated to them that, if they considered it appropriate, they could also start from scratch.

Apart from emphasizing the importance of formal and planned IT management, all the experts agreed on the beginning of the process (steps A and B) with very slight variations (Table 1). Some experts suggested including specific elements related to working with IT governance methodology or having a strategic plan for IT; however, both these suggestions were considered to be part of the construct of IT Planning and Management. There was also a suggestion (Expert 3) of including a step between A and B in order to decide which applications were needed by the organization. However, this is an activity that, at a more general level, is also developed during the development of the strategic plan. Other suggestions were also made but were not included in the model since they were mentioned by just one expert (i.e. business process reengineering). Lastly, some experts renamed some of the elements that we had proposed (i.e., Expert 8 renamed IT Technology Resources as Equipment Purchasing Management).

A majority of the experts also agreed on the need to add a series of elements in the intermediate steps between B and Z (Table 1). These elements were: development of applications for improving management (mentioned by eight out of the ten

[2] Greater details on these experts will be provided in the methodology section.

Table 1
Answers received from IT experts.

Expert	Years of experience[a]	New or modified suggested elements and steps
1: University	5–10	IT Governance (A) IT Strategic Planning (A) Development of applications (C) Training and support (C) Reliable and secure systems and communications (C)
2: University	5–10	Training and support (C) Application outsourcing decisions (C) Secure systems and communications (C)
3: University	>10	Applications needed (B) Human resources (C) External human resources (C) Physical resources (C) Application development (D) Application support (D) Training (E) Support (E)
4: University	>10	Application outsourcing decisions (C) Reliable and secure systems and communications (C)
5: University	>10	Development of applications (C) Systems (C) Communications (C)
6: Industry	5–10	Development of applications (C) Systems and communications (B)
7: Industry	5–10	IT Governance (A) Development of applications (C) Systems and communications (C)
8: Industry	5–10	Equipment purchasing management (B) Development of applications (C) Training (C) Support (C)
9: Industry	5–10	Training and support (C) Reliable systems and communications (C) Secure systems and communications (C)
10: Industry	>10	Business process reengineering (A) Systems and communications (C) Equipment purchasing management (C) Service level agreement (D) Application development (D)

[a] Experience in IT management related posts. Not all experts mentioned items using the same terminology; we have reformulated some of the answers in order to use a common terminology for all of them.

experts with different names and in some cases with a focus on just one aspect of the activity, for example, outsourcing), training and support for users who are not IT personnel (mentioned by six out of the ten experts), and achieving systems and communications that are stable and secure (mentioned by seven out of the ten experts).

The three elements cited by the majority of the experts (applications, training and support, and stability and security of the equipment and communications) fall within the phase that Melville et al. (2004) place immediately after IT resources; this phase refers to the work done by organizations to incorporate IT into business activities. Hence, the aim of these actions is for IT to be used in the activities conducted by the organization. Moreover, these three elements coincide with the three areas present in the IT departments of most organizations (Baschab and Piot, 2007).

Furthermore, the link between these functions and the proposed resources is logical since IT human resources and IT technology resources permit the development of the three abovementioned activities. Without these resources, an organization cannot develop applications or control their development; secure and reliable functioning of its systems and communications cannot be guaranteed; and training and support cannot be provided to users. These resources must be managed and planned through IT planning actions, which is the variable that initiates the entire sequence. This is why we decided to place the three elements in step C, although some of the experts suggested creating another step or divided some of these activities in two or more (Expert 9 proposed separating Systems and Communications and Security; Expert 3 splitting Training and Support).

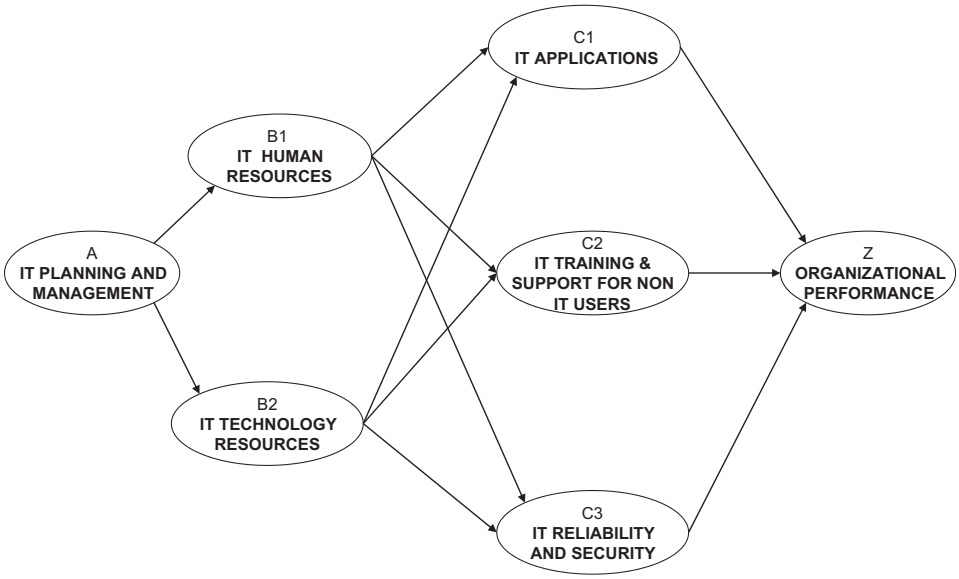
Thus, after the survey to the IT experts, we had a further-developed stepwise model that is shown Fig. 6.

Lastly, and with regard to the final portion of the sequence, Sambamurthy and Zmud (1994), Soh and Markus (1995), and Melville et al. (2004) emphasize that, before influencing organizational performance, IT must effectively be present in the organization's activities. In other words, the presence of IT must generate positive outcomes in these activities. We believe that Sambamurthy and Zmud's (1994) description and naming of the construct as IT impact is correct and includes a wide

range of options. Thus, we added a step before organizational performance to our model using this name and definition. This element will allow an increase in the information on how IT influences organizational performance.

In light of the above discussion, our final model is presented in Fig. 7.

The model functions in the following manner: organizations plan and manage the use of IT (IT Planning and Management), and, such planning and management establishes the need for basic IT infrastructure (IT Physical Resources) and the necessary IT human resources (IT Human Resources), which subsequently facilitates the process of acquiring these resources. These technological resources are necessary to be able to develop or acquire technological solutions (IT



Source: The authors

Fig. 6. Resultant model after the survey of IT experts.

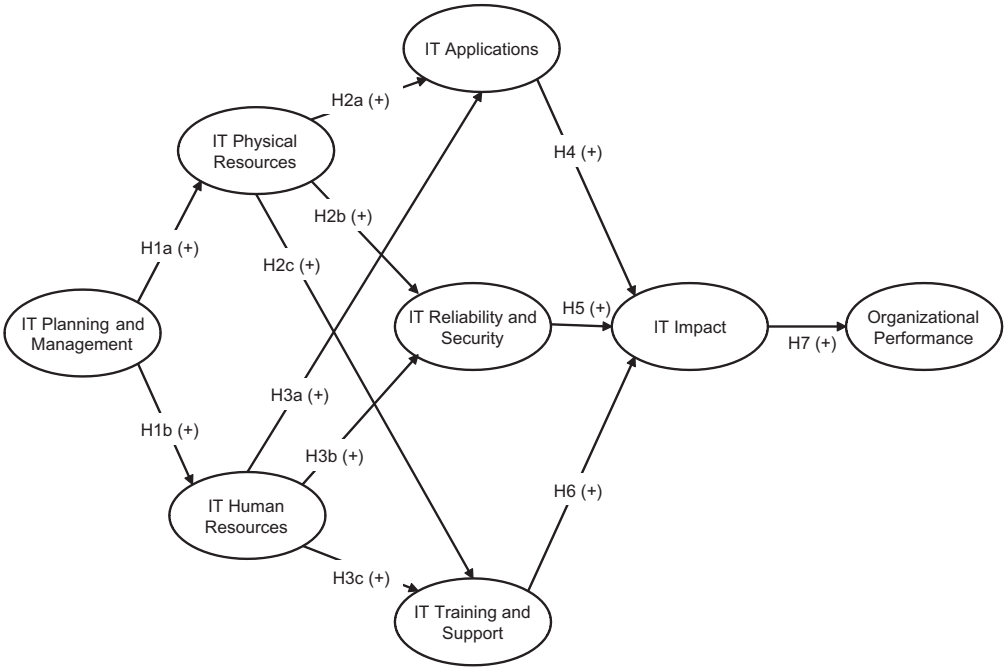


Fig. 7. The final model.

Table 2
Definition of the variables.

Item	Description	References	Examples from literature
IT planning and management	Strategic IT and information systems (IS) planning and management activities	Ward and Griffiths (1996), Cassidy (1998) and Boar (2001)	IS/IT management strategies, IT strategy (equipment, software development, etc.), feasibility studies, risk analysis
IT physical resources	Physical IT assets that form the IT infrastructure of the firm	Ross et al. (1996), Broadbent et al. (1999), Bharadwaj (2000) and Bhatt and Grover (2005)	Personal computers, databases, systems, networks, IT components
IT human resources	Human resources dedicated to the management and operation of IT in the firm	Powell and Dent-Micallef (1997), Francalanci and Galal (1998), Bharadwaj (2000), Bresnahan et al. (2002) and Galve Gorriz and Gargallo Castel (2005)	IT employees, qualified human resources
IT applications	IT application portfolio to automate management available in the firm	Whiting (1999), Cooper et al. (2000), Heun (2000), Levinson (2000) and Ranjan and Khalil (2008)	Data warehouses, software products, workflow applications, content manager applications
IT reliability and security	Existence of secure and reliable IT systems and communications	Broadbent and Weill (1992), Saunders and Jones (1992), Teo and Ang (1999) and Baschab and Piot (2007)	High availability, fault- tolerant servers, reliability, downtime
IT training and support	Existence of IT training procedures for non-IT users and a helpdesk	Baschab and Piot (2007)	Courses, help desk, customer satisfaction
IT Impact	Level of penetration of IT into the activities of the organization	Sambamurthy and Zmud (1994)	New and improved products and services, transformed business processes, better decision making, improved coordination facilities
Organizational performance	Overall firm performance, measured through several possible dimensions: productivity, efficiency, profitability, market value, etc.	Melville et al. (2004)	Productivity, efficiency, profitability, market value, etc.

Applications); construct reliable and secure systems and communications (IT Reliability and Security); and allow users to utilize IT, which subsequently requires an increase in the necessary training and support in their use of IT (IT Training and Support). With regard to IT personnel, their efforts manifest in proposing solutions to improve management (IT Applications), creating secure systems and communications (IT Reliability and Security), and developing IT training plans and providing support for non-IT personnel (IT Training and Support). Consequently, the above actions influence IT impact (IT Impact), which, in turn, influences organizational performance (Organizational Performance).

The definition of the variables is presented in Table 2; the indicators used for each item can be found in Appendix B. Items in the second (IT Physical Resources and IT Human Resources) and third (IT Applications, IT Reliability and Security and IT Training and Support) steps and their indicators are considered from the viewpoint of being organizational assets. However, in the third step, construct and indicators have been defined by considering their potential contribution to the development of organizational activities. Hence, for example, in IT Applications we measure the application portfolio as defined by Soh and Markus (1995); however, not only existing applications, but also those under development are considered as part of the construct; thus, we consider the activities that are being developed to provide applications for supporting organizational activities.

Now, we present the breakdown of the model in the hypotheses.

Many authors indicate the need to plan the development of IT (Ward and Griffiths, 1996; Cassidy, 1998; Boar, 2001). According to Ward and Griffiths (1996:96), it "[...] is taken to mean planning for the effective long-term management and optimal impact of information – in all its forms – information systems (IS) and information technology (IT)". For these authors, IT planning is of utmost importance as it allows the alignment of strategies; guarantees the existence of the resources necessary for the IT function to be able to respond to turbulent environments; helps determine an efficient, effective and feasible organizational structure: and improves communication between top management and IT technicians. In light of this, our first hypothesis is stated in the following manner:

H1(+). The intensity of IT planning and management activities has a positive influence on the level of (a) IT physical resources and (b) IT human resources.

The importance of basic IT resources for effective performance of IT is evident. Moreover, although its direct impact on business performance may be debatable, IT resources are undoubtedly a source of value for organizations (Ross et al., 1996; Broadbent et al., 1999; Bharadwaj, 2000; Bhatt and Grover, 2005). Thus, it is necessary to have basic IT resources in order to be able to develop the subsequent steps that lead to improving organizational performance. Therefore, we propose that the greater the deployment of IT resources, the higher the performance in the IT areas identified:

H2(+). IT physical resources in organizations have a positive influence on (a) IT applications that support the organization's activity, (b) the reliability and security of IT systems and communications, and (c) IT training and support for users.

The importance of human resources in improving IT performance has been confirmed in various studies (Powell and Dent-Micallef, 1997; Francalanci and Galal, 1998; Bharadwaj, 2000; Bresnahan et al., 2002; Galve Gorriz and Gargallo Castel, 2005). Bharadwaj (2000) proposes that organizations with a strong deployment of IT human resources can develop reliable applications to support their needs and communicate and work more efficiently with other units. As in the case of physical resources, we consider that IT human resources exercise a positive influence on the established IT areas.

H3(+). IT human resources have a positive influence on (a) IT applications to support the organization's activity, (b) the reliability and security of IT systems and communications, and (c) the IT training and support of users.

The three specific IT areas identified above should have a direct effect on the IT impact in an organization, since, as defined by Sambamurthy and Zmud (1994) this impact summarizes the penetration of IT in the activities, processes and/or structure of the organization. This influence constitutes hypotheses H4(+), H5(+) and H6(+). We now analyze these three hypotheses in greater detail.

First, different authors (Whiting, 1999; Cooper et al., 2000; Heun, 2000; Levinson, 2000; Ranjan and Khalil, 2008) recognize that the presence of certain management applications (e.g., data warehouses, work flows, content and news managers) in organizations favors organizational performance by sustaining corporate strategy, permitting improved decision making, and helping reduce costs and create better products and services. Therefore, we propose the following hypothesis:

H4(+). IT applications for the automation of management have a positive influence on IT impact.

Second, authors such as Teo and Ang (1999) and Baschab and Piot (2007) indicate that efficient and reliable IT services is critical to the alignment of IT. In turn, Broadbent and Weill (1992) indicate that one of the functions of the IT area of an organization is to provide reliable common infrastructures on which business processes can be developed. Similarly, Saunders and Jones (1992) find that issues related to IT reliability constitute one of the three most cited aspects in their literature review on the performance of the IT function. Thus, we propose the following hypothesis in this regard:

H5(+). The reliability and security of IT systems and communications in organizations have a positive influence on IT impact.

Baschab and Piot (2007) state that IT training and support for users is a positive value that helps to improve the technological performance of an organization. Thus, we establish the following hypothesis:

H6(+). IT training and support in organizations have a positive influence on IT impact.

Finally, and as we have stated previously, IT impact—as defined by Sambamurthy and Zmud (1994), that is, the presence of IT in business processes—has a positive influence on organizational performance (Soh and Markus, 1995; Melville et al., 2004). Thus, the seventh and last hypothesis is stated in the following manner:

H7(+). IT impact has a positive influence on organizational performance.

4. Methodology

In order to achieve our objective of empirically describing a stepwise model of the creation of value by IT in an organization, we chose the population of the 73 Spanish universities, 50 of which are state universities and 23 are private. Spanish universities are integrated into an institutional group called CRUE-TIC, a group that has the objective of analyzing and studying the use of IT in the entire Spanish university sector. In 2004, CRUE-TIC created a subgroup comprising 10 individuals from various universities to work on the IT data and indicators pertaining to the university sector. The initial objective of this subgroup was to create a set of indicators that would permit the technological classification of the universities. To that end, a database was created with the aim of obtaining homogeneous indicators that facilitate the understanding and study of the state of IT throughout Spanish universities.

In our study, the sample is formed by the universities that participated in the information collection activity conducted by the CRUE-TIC group in 2007, in which data for the universities for the period 2005–2006 was obtained. The data, which were regarding the characteristics of IT and IT management at each university, were obtained by means of a questionnaire that was completed by the chief information officer (CIO), the vice-rector responsible for the area, or his/her delegate. A total of 59 completed questionnaires were received, thereby yielding a response rate of 80.8%; three questionnaires were eliminated because they were not complete, thereby yielding a final response rate of 76.7%.

However, 8 of the 73 universities were significantly smaller than the other universities (fewer than 4000 students compared with an average of 20,000 students), and no answers were received from this group. Therefore, the sample used in this study is still more representative of the population than is reflected by the above response rate since the response rate was 86.2% for the 65 universities with over 4000 students.

Moreover, as described in the previous section and in order to define the theoretical model, we asked for the support of 18 IT managers, from both universities in the population of the study (8) and firms with workforces larger than 500 (10). We chose these experts according to their expertise, selecting those with over 5 years experience in management activities in the IT field. From among the 18 experts that were approached, 10 responded—5 IT managers of universities and 5 from other organizations. Through a written questionnaire, all these experts were asked to indicate their opinions of the elements of the stepwise model of IT and possible routes toward organizational performance.

Now, we describe the content and structure of the database employed in this study. It contains a vast amount of information related to IT in university institutions and has a total of 118 indicators. Table 3 presents examples of data for each of the six strategic axes on which the workgroup organized the information. It also includes a seventh block with context data regarding each institution.

In turn, each of these six axes comprises up to a total of 28 objectives. These objectives and the axes to which they belong are shown in Appendix A, together with how many of the previous 118 indicators belong to each objective and axis.

The data are in two different formats: categorical scales with three levels of response (e.g., "there is a datawarehouse", with three possible responses, namely, yes, no, or under development) and absolute quantities, either with low values (e.g., number of software products used for teaching) or with very high values (e.g., number of visits to the institutional website).

Given the quantity and variety of information, the database was revised, refined, and organized in accordance with the aim of this research. Thus, an exhaustive study process led to the elimination of variables with a very low response rate and/or those that contained information incoherent with the content of the indicator, probably due to the fact that different respondents understood the questions that were proposed differently. The remaining data were also treated to work with variables from the context of the size of the institution. To that end, logical ratios were created by dividing the absolute data by the number of faculty staff, number of administration personnel, number of students, total members of the university community (considered as the sum of the three previous groups), number of classrooms, and other factors. At the end of this process, there were 21 indicators remaining; their description and form of calculation are presented in Appendix B.

Of the constructs shown in Appendix B, we would like to specifically address the case of two of them: IT impact and organizational performance. As stated previously, IT impact follows the definition of Sambamurthy and Zmud (1994). These authors identified four areas in which the presence of IT in business processes can be identified: the incorporation of IT into new products or services, improvement through redesign of business processes, improvement of decision-making processes, and creation of flexible and adaptable organizational structures.

In our case, we identified three indicators that would allow us to measure IT impact. First, the number of solved incidents by the IT service is a proxy for increased productivity and non-IT employee satisfaction. Second, the percentage of faculty staff that use virtual training facilities is an indicator of business processes that have been redesigned and made more efficient or effective, and also of flexible and adaptive organizational structures. Third, the percentage of processes that have been automated or are in the process of being automated is an indicator of two of the areas previously named: business processes that have been redesigned and improvement of decision making.

With regard to organizational performance, since the database contained no information on it, we opted to measure it using university rankings conducted by magazines, newspapers, government bodies, and analysis units at universities. These rankings usually classify universities according to their teaching or research performance, which are the two main functions generally pursued by higher education institutions in Spain. There are many rankings of this type, the majority of which concentrate on only one of the two mentioned aspects. Therefore, we decided to use the only ranking that considers both

Table 3
Structure and content of the database.

Axes	Indicators	Examples of data
1. Teaching–learning	16	Number of students per computer in classrooms, classrooms with Wi-Fi coverage, existence of an institutional plan for the development of online teaching
2. Research	19	Scientific calculation capability, existence of an application for research management, research groups that have an institutional web page
3. Management processes	12	Computerized management processes, existence of a backup system to activate the services that suffer availability problems, typical e-administration technologies that are being exploited
4. Management of institutional information	21	Procedures available in the records management, departments that use the content manager to publish on the web, existence of a contingency plan in case of emergencies
5. IT training and culture	21	Individuals on the management staff who have received training in IT competencies, average budget for specialized training of IT personnel, users who access the intranet through a VPN
6. Organization of IT	16	Existence of a strategic plan for IT, IT personnel in relation to number of students, incidents successfully resolved by the IT department in relation to number of users
Context data	13	Number of administrative personnel, number of faculty staff, number of classrooms, number of research groups, number of subjects, total budget, total staff budget

variables simultaneously—the ranking prepared by the Institute of Industrial and Financial Analysis at the Complutense University of Madrid. More specifically, this article uses the values of that ranking for 2009, based on the data for the universities for the 2006–2007 period, which is 1 year later than the year that IT data was collected for. Measuring organizational performance for a year later than that in which the IT variables were measured avoids a possible inverse causality effect (i.e., the performance is actually what causes greater value in the IT antecedents considered) and provides a certain amount of time for the investments in IT to have an effect on the organization's performance. In this respect, a longitudinal study would probably help improve the quality of the results, and this is addressed in the limitations section.

The previously mentioned ranking analyzes the areas of teaching and research separately, assigning a score of between 0 and 100 to each university for each of these two aspects. The data are normalized by assigning the value of 100 to the leading university, which implies that the indices of the other universities represent their quality as a percentage of the leading university.

The ranking uses 32 variables that reflect different aspects of teaching and research, and those 32 variables are integrated into 10 factors, five corresponding to teaching and five to research. More specifically, 18 variables are grouped into five sub-indices of teaching quality: relative size of the university, human resources, computer resources and support availability, academic performance of students and the university's bibliographic availability, and doctorate results. In the case of research, 14 variables are grouped into five sub-indices: financial resources per researcher, obtaining of funds by means of competitive R&D projects and level of success among doctoral students, performance in the form of patents and doctoral theses, performance in the form of publications, and the academic level of the researchers. With the aim of including organizational performance in our model, we use the two final rankings—those for teaching and research.

The data was analyzed with structural equations using the partial least squares technique (PLS) (Fornell and Cha, 1994). This technique uses the ordinary least squares (OLS) algorithm and is designed to reflect the theoretical and empirical qualities of social sciences and behavior, in which we frequently find theories with insufficient support and little information available (Wold, 1979). More specifically, we use SmartPLS 3.0 build M3 (Ringle et al., 2005). Although we have already commented on the similarity between the sample and the population of this study, there are two ways that are frequently used in the PLS technique to determine the appropriate sample size. On the one hand, there is the controversial rule of thumb (Chin, 1998), which results in a sample of 30 cases in our study (i.e., the maximum number of indicators in any construct in our model is 3; 10 times this amount is 30). On the other hand, for a more precise evaluation, Chin and Newsted (1999) propose considering the question of the statistical power and the size effect, using Cohen's (1988) power tables. In our study, on the basis of the tables published by Cohen (1992), for a power = 0.80, an alpha = 0.05, and a large size effect ($r2 = 0.30$; $f2 = 0.42$), we would need a sample of 45 cases. In our study, we assume a large size effect because our model includes relationships that have already been confirmed in the literature and because of what we believe to be the underlying logic of the model. Both of these constitute reasons for predicting a significant impact on the dependent variables being studied. Moreover, we have followed the recommendations of Marcoulides and Saunders (2006) regarding the use of PLS, referring to the theoretical support for the model, data screening, and the analysis of the psychometric properties of all the variables of the model.

As stated previously, our model has eight constructs that were all considered to be reflective, that is, their indicators present a great level of correlation between them (as will be checked subsequently in the statistical analysis) and variation in one of them will normally lead to variation in the rest in the same construct. Appendix B presents these eight constructs, their descriptions, and the indicators that form them.

5. Data analysis

Two steps must be taken for ensuring the validity of the PLS technique (Barclay et al., 1995). First, the measurement and structural models are evaluated. The evaluation of the measurement model is conducted by ensuring the reliability of each item, reliability of the construct, average variance extracted (AVE), and discriminant validity of the indicators that are a measurement of the latent variables. Second, the structural model is validated in order to confirm the point up to which the causal relationships are consistent with the available data (Real et al., 2006).

With regard to the measurement model (Appendix C), all the indicators meet the individual reliability criterion of exceeding the threshold of 0.707 (Carmines and Zeller, 1979), except for the variable related to the existence of a backup plan, which obtained a reliability value of 0.65. However, since it exceeded the threshold of 0.60, we decided to retain it in the model. Similarly, all the constructs are reliable since their values for composite reliability (ρ_c) are higher than, or very close to, 0.8 (Nunnally, 1978). Moreover, all the constructs satisfy the condition of having an AVE above 0.5 (Fornell and Larcker, 1981). The discriminant validity is also guaranteed since the square root of the AVE of each construct is greater than the correlation of each construct with the other constructs (Table 4).

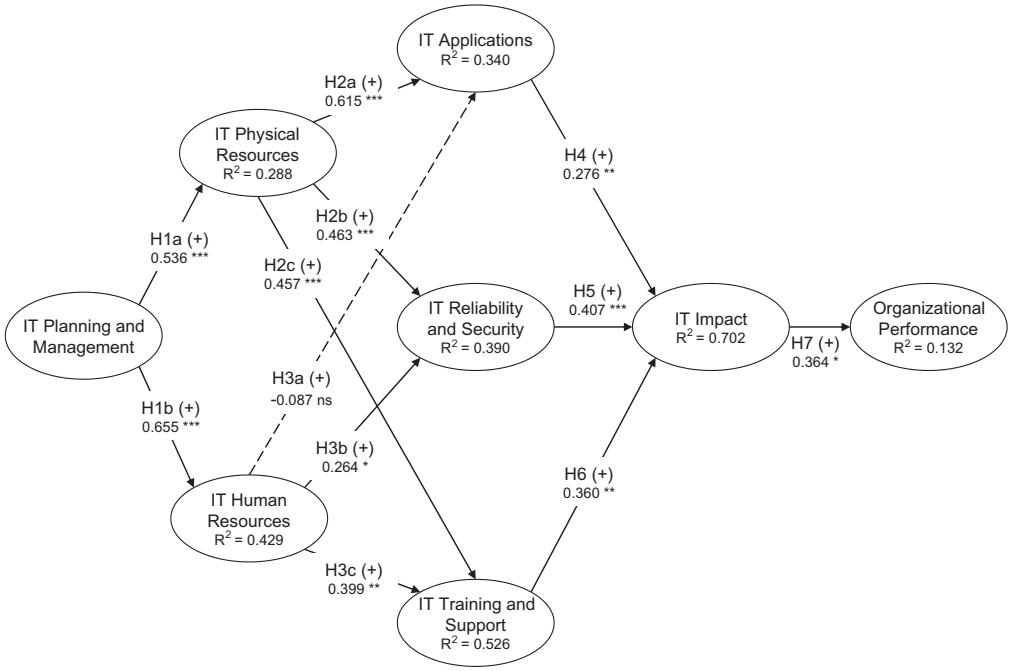
Now, we analyze the structural model, which is illustrated in Fig. 8, including the explained variance of the constructs (R^2) and the standardized coefficients (β).

In PLS, the structural model is evaluated by examining the values of R^2, Q^2 test for predictive relevance, size of the coefficients of the routes (i.e., the *paths*), and the stability of the estimations by means of the *t*-statistics obtained in the *bootstrap* with 500 samples. Table 5 presents the proposed hypotheses, path coefficients, and t values observed with the level of significance obtained in the *bootstrap* test. The table also presents the direct effects and the proportion of explained variance as well as the Q^2 of the constructs.

Table 4
The AVEs and the correlations between the first-order constructs.

Construct	1	2	3	4	5	6	7	8
1. IT planning and management	*0.826*							
2. IT physical resources	0.536	*0.887*						
3. IT human resources	0.655	0.431	*0.860*					
4. IT applications	0.231	0.178	0.577	*0.746*				
5. IT reliability and security	0.724	0.464	0.577	0.388	*0.771*			
6. IT training and support	0.731	0.596	0.629	0.221	0.683	*0.776*		
7. IT impact	0.629	0.424	0.725	0.513	0.760	0.699	*0.779*	
8. Organizational performance	0.170	0.093	0.306	0.307	0.273	0.191	0.364	*0.833*

Notes: (1) All the correlations are significant at the $p < 0.01$ level. (2) The square roots of the AVEs are displayed on the diagonal.



*** indicates p <0.001; ** indicates p <0.01; * indicates p <0.05
Note: the dotted lines indicate non-significant paths

Fig. 8. Estimated causal relationships in the structural model.

Now, we discuss whether the work hypotheses were proved. Hypothesis H1, with its sub-hypotheses H1a and H1b referring to the positive influence that IT planning and management activities have on the endowment of IT human resources and on the infrastructure or basic IT physical resources, respectively, is proved.

Hypotheses H2 and H3—referring to the influence that IT physical resources and IT human resources exercise on the existence of IT applications to improve management, the development of secure and reliable IT systems and communications, and IT training and support—are confirmed; the only exception is H3a, which relates IT human resources with IT applications to improve management. We understand that this could be due to the fact that only the human resources working in the organization (internal or external) are considered as part of the variable IT human resources, while outsourcing is not accounted for. Thus the existence of organizations with high levels of outsourcing could explain why this hypothesis was not confirmed.

Hypotheses H4, H5, and H6 regarding the influence of IT applications, IT reliability and security, and IT training and support on the IT impact of the organization's activity are accepted.

Finally, hypothesis H7, which relates the IT impact of the organization's activity with organizational performance, is also accepted.

With regard to the explained variance (R^2) of the constructs (Table 5), the structural model displays adequate predictive power. All the constructs, except organizational performance, obtain R^2 values of above 0.28, with 70.2% of the variance of the construct IT impact on the organization's activity being explained. In the case of the variable organizational performance,

Table 5
Direct, indirect, and total effects; explained variance; and the Q^2 test for endogenous variables.

Effect on the endogenous variable	*Paths*/value (*bootstrap*)	Explained variance (R^2) and direct effects	Q^2
Effects on IT physical resources		0.288	0.195
H1a: IT Planning and Management	0.536*** (5.273)	0.288	
Effects on IT human resources		0.429	0.261
H1b: IT planning and management	0.655*** (6.845)	0.429	
Effects on IT applications		0.340	0.143
H2a: IT physical resources	0.616*** (6.129)	0.355	
H3a: IT human resources	−0.087ns (0.718)	−0.015	
Effects on IT reliability and SECURITY		0.390	0.045
H2b: IT physical resources	0.463*** (4.237)	0.267	
H3b: IT human resources	0.264* (1.832)	0.123	
Effects on IT training and support		0.526	0.249
H2c: IT physical resources	0.457*** (3.712)	0.288	
H3c: IT human resources	0.399** (2.982)	0.238	
Effects on IT impact		0.702	0.321
H4: IT applications	0.276** (3.039)	0.142	
H5: IT reliability and security	0.407** (2.817)	0.309	
H6: IT training and support	0.360** (2.974)	0.251	
Effects on organizational performance		0.132	0.101
H7: IT impact	0.364* (2.186)	0.132	

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

13.2% of its variance is explained, which is lower than the threshold of 20–30% that is usually employed. In our opinion, the interpretation of the proposed model allows an understanding that this percentage of 13.2 is reasonable and indicates that the model is consistent. In effect, in our model we aimed to explain organizational performance via the presence of technology in the organization's activity. What our model shows is that the penetration of technology has a significant impact on organizational performance since it is able to explain part of its variance. However, expecting technology to explain a greater amount of organizational performance than what is achieved with this model is probably somewhat unreasonable given the large number of factors that can potentially influence it.

Apart from examining the R^2, the model is evaluated by observing the predictive relevance Q^2 of the constructs (Geisser, 1974; Stone, 1974), which, as Table 5 shows, is always above 0. This confirms that the structural model has satisfactory predictive relevance.

Finally, the *GoF* (Goodness-of-Fit) test (Tenenhaus et al., 2005; Wetzels et al., 2009) has recently been developed in order to guarantee the quality of the PLS models. In this study, we obtain a *GoF* value of 0.510, which significantly exceeds the value of 0.36 proposed by Wetzels et al. (2009) for the most unfavorable situation for this test, which is that of samples with great effects.

6. Conclusions and implications

The main objective of this study was to expand knowledge regarding the sequence through which IT can contribute toward improving organizational performance; in other words, how to orient investments in IT in order to maximize the outcomes. To the best of our knowledge, most previous studies on this subject have focused on other aspects. One group of studies has examined those characteristics of an organization that may have potential influence on the organization's ability to extract value from IT. Another group of studies have analyzed the manner in which the variables of IT investment and organizational performance are measured since it is obvious that there are many ways to measure variables related to both.

The principal result of this study is that we have been able to show a path, founded on the results and reasoning found in the literature, for how IT function to penetrate the activities developed by an organization and influence its performance. Moreover, the elements of that path are specific links that generate less ambiguity than expressions like *a suitable combination of technological human resources,* or *organizational structure that supports the IT tasks.* In this respect, except for the work of Bhatt and Grover (2005), other previous studies do not generate and test specific hypotheses regarding the relationship between IT and organizational performance. However, it would be ingenuous to aim for great precision in determining how all the elements of the path are managed, since that would be too specific to be generalized and applied in different activities.

Therefore, an overall analysis of the model shown in this study could enable managers to extract many interesting conclusions regarding how to orient IT management policies in their organizations. In this respect, on the one hand, the importance of planning and management in the context of technology has been shown. It is the variable that organizes and directs all IT activity and directly influences the two types of resources most studied in the literature on IT performance. Hence, IT human resources and basic IT assets constitute the basis for developing the three types of IT functions usually found in organizations: the development and acquisition of applications, guaranteeing the reliability and security of IT systems and communications, and user support. All three are important for ensuring the impact of technology in the

organization since they explain almost 70% of that impact, although achieving reliability and security in IT systems and communications and developing user support actions have greater importance than application development. The sequence of previous steps has resulted in defining a path that finally contributes to the improvement of organizational performance.

It should also be highlighted that we have shown that the presence and adequate management of technology in the organization's activities plays a role in organizational performance, with our model explaining 13% of its variance, which, in our opinion, is a significant figure considering that the model uses only IT-related variables. In this respect, it is logical to think that organizational performance is also explained by other factors (e.g., financial, sales and marketing management, etc.) that have nothing to do with IT and also by other organizational resources that are complementary to IT, such as organizational structure, policies and rules, workplace practices, culture, etc. (Melville et al., 2004). In fact, our model is focused on IT and has only considered the aspects of these complementary resources related to IT that are present in the construct of IT Planning and Management. We understand that taking these issues into consideration should cause the explained variance to be much higher.

That is, our model has shown that IT can be managed in organizations in a manner that improves organizational performance. In this sense, and as many previous studies have highlighted, IT investments in isolation are not sufficient to impact organizational performance. However, when IT is taken into consideration with other resources (human and organizational), this impact is possible, as this article confirms. In addition, our model shows the precise sequence of steps that must be paid attention to in order to achieve an impact on organizational performance.

In light of what this article shows, managers should stop considering the IT area as merely a cost-consuming department; instead, it should be viewed as a potential source of competitive advantage. In order to achieve this, the management must be involved in the processes of strategically planning and managing the IT area, which will allow appropriate resources to be established and utilized, as stated by Ward and Griffiths (1996). If managers additionally pay attention to complementary resources to IT (business model, organizational culture, etc.), the improvement in organizational performance will be even higher than the 13% found in this paper, as has already been proven by previous authors (Brynjolfsson, 2003; Melville et al., 2004; and others).

Finally, returning to the well-known "productivity paradox", some authors, including Huan et al. (2006), indicate that one of its explanations is the existence of intermediate variables between investments in IT and organizational performance. These intermediate variables that moderate the influence have been globally termed *IT capability*. In the case of Huan et al. (2006) and Bharadwaj (2000), the intermediate variables are IT infrastructure, human IT resources, and IT-enabled intangibles; IT capability is said to consist of the combination and assembly of these variables in a manner that they function well together. However, in these models, there are no further specifications regarding how these combinations may be created. In the case of Bharadwaj (2000), the author offers different examples of possible interactions among the key resources, but does not model or contrast them. In this study, we have broken down the IT capability concept into several constructs, thereby making it more concrete, and we have measured all the necessary elements in order to provide guidance on how to deal with IT investments.

More precisely, we have shown that IT capability can be broken down into two steps. First, the necessary IT resources (human and physical) are acquired. Second, these basic resources are combined and organized in a manner that generates impact in the organization by developing IT applications, providing IT training and support to users, and guaranteeing the existence of secure and reliable IT systems and communications. This sequence can allow managers to understand that failures in areas found at the end of our stepwise model can be due to lack of resources in previous steps (IT human resources or IT physical resources) or a lack of planning and management in the IT area.

7. Limitations and suggestions for future research

This study has developed a technological path for organizations on the basis of a review of the literature, results of a survey of IT managers or those holding equivalent positions in universities, and the use of a large database with data on the use of IT in universities and other data on organizations. The process that has been developed has five limitations that indicate future areas of research.

First, universities are a very particular type of organization. Apart from the high segmentation of the profiles of workers that perform their tasks within the university, the fact that the customer (the student) is permanently within the organization presupposes a series of considerations (e.g., the need for computer labs and wireless networks) that do not occur in other organizations (e.g., an automobile manufacturer, or an automobile sales concessionaire) or occur to a very low extent (e.g., a bank or a public administration).

Second, the survey only asked questions of a quantitative nature in order to obtain objective data. It would be interesting to know the respondents' opinions regarding whether they consider the endowments of human resources and technology to be adequate.

Third, we believe that it would be of interest to know the opinion not only of the manager of an organization's IT area, but also of the general manager, since that individual can provide a less biased vision of IT than can be found within the IT area itself. However, this limitation has been partially addressed by using organizational performance indexes that are not related to IT.

Fourth, our model does not include complementary assets that are not part of IT, thereby explaining a limited amount of variance in organizational performance. However, we understand that taking these resources into consideration also would allow for establishing a model that is able to explain a larger amount of this variance.

Finally, this study has compared the IT management in universities for the period 2005–2006 with the organizational performance obtained in the period 2006–2007. It would be interesting to undertake a longitudinal study or repeat this study after 2 or 3 years in order to confirm whether the relationships have been maintained. Thus, while this is an area that we have not explored in this study, it would be logical to think that the IT needs of organizations in a particular sector would evolve over time and require, in one particular period, greater efforts in the area of IT human resources and, in another, greater emphasis on physical infrastructure. It would also be desirable to study longitudinal information pertaining to each of the constructs that appear in the proposed chain, beginning with IT planning and management and ending at IT impact.

Acknowledgements

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Appendix A

See Table A1.

Table A1
Definition of objectives and axes.

Objective	Name	Indicators
Axis 1. Teaching–learning (16 indicators)		
1.1	To incorporate IT in classrooms (computer and non-computer)	9
1.2	To provide shared technological infrastructure (IT rooms, Wi-Fi, laptops, etc.)	2
1.3	To facilitate virtual teaching by means of initiatives for training and implementation of computer platforms	5
Axis 2. Research (19 indicators)		
2.1	To make available for the personal use of researchers the technical means to conduct their work (computer, Internet connection, e-mail, tools, etc.)	3
2.2	To make bibliographical means as accessible as possible	3
2.3	To provide centralized technical media to support research	6
2.4	To promote the expansion of research activity by means of IT tools	4
Axis 3. University management processes (12 indicators)		
3.1	To have computer applications for the university management processes (academic, economic, research and human resources management)	3
3.2	To streamline and modernize user attention with e-administration technologies	6
3.3	To make available to administration personnel the IT they need (computer, Internet access, e-mail, tools for collaborative work, etc.)	3
Axis 4. Information management in the institution (21 indicators)		
4.1	To have institutional information available on electronic support in order to facilitate its collection, organization, storage and diffusion	4
4.2	To be prepared to manage institutional knowledge on the basis of statistics, indicators, balanced scorecards and data analysis	2
4.3	To have policies of information communication and publication (information sources, flows, managers, etc.)	4
4.4	To guarantee the integration of information	1
4.5	To make IT (web, e-mail, bulletins, SMS, etc.) the main form of communication	5
4.6	To guarantee the security of information and compliance with the legal requirements related to the use of personal information	5
Axis 5. IT training and culture (21 indicators)		
5.1	To achieve extensive adequate levels of IT competence for administration personnel, faculty staff, and students	5
5.2	To ensure specific training for IT personnel	3
5.3	The transfer of IT experiences to society	2
5.4	To facilitate access to free and open code software	3
5.5	To facilitate access to IT for personal use (laptops, broadband at home, etc.)	2
5.6	To promote the appropriate, ethical, and supportive use of IT	6
Axis 6. Organization of IT (16 indicators)		
6.1	To conduct strategic IT planning	3
6.2	Adequate distribution of IT human resources	4
6.3	To establish sufficient, stable and own funding for IT	3
6.4	To promote the quality of IT services and implement plans for improvement	4
6.5	To increase the satisfaction of IT services users	1
6.6	To collaborate and share IT experiences with other organizations	1
Context data (13 indicators)		

Appendix B

See Table A2.

Table A2
Measurements.

Constructs/Indicators	Definition
IT planning and management (three indicators)	*Strategic IT and IS planning and management activities*
IT plans	Percentage of the following plans already functioning or in the development stage: strategic IT plan, equipment renewal plan, obsolete equipment donation plan, and HR deployment plan
Good practices	Percentage of good practices from the following 24 that are functioning or in the development stage: formal decision-making flow chart; definition of IT personnel functions; management by processes in the area; viability studies; acquisition and maintenance procedures; IT management processes; levels of provision of services (definition and management); risk management methodology; software development methodology; management of security, incidents, problems, settings, changes and versions; independent financial management; management of availability, capacity and continuity; webpage accessibility and availability in various languages
Virtual training initiatives	Percentage of initiatives from a total of 15 proposals related to virtual teaching planning that are functioning or are under development: existence of a special unit for virtual teaching and endowment of human resources; whether that unit has personnel and whether there is a training plan for students, administrative staff, faculty staff and technicians; initiatives to virtualize regulated and non-regulated teaching; existence of quality criteria; production of multimedia content; initiatives for subject sharing; incentives for faculty staff; creation of faculty staff networks; promotion of participation in specific congresses
IT physical resources (three indicators)	*Physical IT assets that form the IT infrastructure of the organization*
Video conferencing rooms	Number of classrooms with videoconferencing facilities in relation to the university community
Faculty and administrative staff—e-mail	Percentage of faculty and administration staff who have email addresses
Faculty and administrative staff—computers	Percentage of faculty and administration staff who have computers
IT human resources (three indicators)	*Human resources dedicated to the management and operation of IT in the organization*
IT technicians	Number of centralized, full-time technicians devoted to IT in relation to the total number of technicians devoted to IT
IT external	Number of full-time, external IT technicians (i.e., firms, student cooperatives) in relation to the university community
IT interns	Number of centralized, full-time IT interns in relation to the total number of technicians devoted to IT
IT applications (three indicators)	*IT application portfolio to automate management available in the firm*
Applications	Percentage of the following applications that are functioning or in the development stage: user directory, single login, data warehouse, document manager, workflow manager
Faculty staff collaborative tools	Percentage of faculty staff with access to collaborative tools
Research software	Research software products available in relation to the entire university community
IT reliability and security (three indicators)	*Existence of secure and reliable IT systems and communications*
High availability	The number of identified services among 21 such services that have high availability already or are in the process of being implemented
Backup systems	Existence of a backup system to activate services that experience availability problems
Backup plan	Existence of a plan and equipment to make backup copies.
IT training and support (three indicators)	*Existence of IT training procedures for non-IT users and of a helpdesk*
Norms	Existence of norms for the appropriate use of e-mail and distribution lists, appropriate use of computer classrooms, appropriate use of the Internet in free access labs, promotion of respect for personal information and intellectual property
IT training	Ratio of IT courses to the total number of courses for administrative and faculty staff
User satisfaction	Measurement of user satisfaction with IT services, particularly with helpdesk and training
IT impact (three indicators)	*Level of penetration of IT into the activities of the organization*
Solved incidents	Number of incidents successfully resolved by IT services in relation to the administration personnel and to the faculty staff
Virtual training faculty	Number of faculty staff who use the institutional virtual teaching platform in relation to the total number of faculty staff
Automated processes	The number identified management processes that have been automated or are in the process of being automated from among 45 such processes, including every functional area of universities: human resources, financing, payroll, library, student recruitment, Ph.D. candidate management, scholarships, etc.
Organizational performance (two indicators)	*Overall firm performance, measured through several possible dimensions: productivity, efficiency, profitability, market value, etc.*
Academic performance	Academic performance (as measured by a ranking developed at the Complutense University of Madrid)
Research performance	Research performance (as measured by a ranking developed at the Complutense University of Madrid)

Appendix C

See Table A3.

Table A3
Individual and composed reliability and average variance extracted.

Construct/dimension and indicators	Loading	Composed reliability	AVE
IT planning and management		.865	.682
IT plans	.749		
Good practices	.848		
Virtual training Initiatives	.875		
IT physical resources		.917	.787
Video Conference Rooms	.859		
Faculty and administrative staff email	.884		
Faculty and administrative staff computers	.917		
IT human resources		.895	.739
IT technicians	.857		
IT external	.861		
IT interns	.861		
IT applications		.790	.557
Applications	.741		
Faculty collaborative tools	.726		
Research software	.771		
IT reliability and security		.813	.595
High availability	.844		
Backup systems	.809		
Backup plan	.648		
IT training and support		.819	.602
Norms	.735		
IT training	.721		
User satisfaction	.864		
IT impact		.771	.532
Solved incidents	.716		
Virtual training staff	.773		
Automated processes	.786		
Organizational performance		.818	.693
Academic performance	.886		
Research performance	.775		

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