

IS/IT AND ITS RELATIONSHIP WITH UNIVERSITY PERFORMANCE IN THE TEACHING AREA: A RESOURCE AND CAPABILITY THEORY APPROACH.

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Abstract

The relationships among Information Systems and Technologies (IS/IT), and organizational performance has been commonly analyzed in the context of for-profit organizations. This research, which is part of a more extensive investigation, offers insights on such relations in the university domain. We approach our analysis from a Resource and Capability Theory perspective. In such context, focus on what we call “resources and capabilities associated to IS/IT” and their potential relations with organizational performance, which we view as composed of the functional performance in the teaching, research and institutional management areas. This paper, however, only presents our results in the teaching area.

Keywords: *Resources and Capabilities, Information Systems and Technologies, Universities’ performance.*

1 INTRODUCTION

Improved performance has become a permanent goal for every organization, especially for higher education institutions, which face an increasingly demanding and competitive. Existing research have demonstrated that there might exist some relations among organizational Information Systems and Technologies (IS/IT) and performance levels achieved. However, such studies have mainly focused on for-profit organizations.

This research analyzes the existing relationships between IS/IT and the performance of higher education institutions through the perspective of the Resource and Capability Theory. We have focused on what we call “resources and capabilities associated to IS/IT” and their potential relations with the performance of these organizations, which we view as composed of the particular performance in the teaching, research and institutional management areas. This paper, however, only presents our results in the teaching area. Therefore, the objective of this investigation is to analyze whether the capabilities associated to IS/IT exercise a positive influence in the performance of universities in the teaching area.

The research in this paper is part of a more extensive investigation, which we define as an exploratory study, given the topic it investigates and the approach we apply. This paper begins with an explanation of the research methodology. It continues by describing our theoretical framework, hypothesis formulation and the empirical work we performed. It finishes by concluding on our results.

2 WORKING METHODOLOGY

- Review of the state-of-the-art on the relevant topics.
- Identification and analysis of concepts, characteristics, and type of resources and capabilities associated to IS/IT that enable our conceptualization and classification.
- Identification and analysis of university performance concepts and characteristics, which allow a conceptualization development and its evaluation.
- Hypothesis formulation and research model construction.
- Measurement items definition (accomplished through literature review and expert interviews).
- Population definition, and design, validation and application of data collection instruments.
- Data analysis and results.
- Conclusions

3 PERFORMANCE OF UNIVERSITIES

According to King (2000), the increased interest in the performance level of higher education during the last years is due to two main reasons. Specifically, higher education systems have become massive and public budget for education have shrunk. Thus, the topic has attracted growing interest in many countries, where concerns for evaluation have been promoted with the central purpose of improving the quality level of higher education. Regarding institutional evaluation, the application of performance indicators have been highlighted (where qualitative and quantitative indicators are generally used, which operational information on institutional functioning). There exists a huge variety of indicators depending on the area or aspect of the system being analyzed or the purpose of its utilization.

Based on our study on the topics mentioned above, this research has considered that the performance of universities is connected with the efforts of these organizations to achieve their objectives. Within this objectives efforts are mainly oriented to processes that contribute to the activities in the Teaching, Research, Technical Assistance, University Extension (relationships with external environment), and Institutional Management. Objectives are oriented towards goal accomplishment, results or product performance. It is possible to state, then, that the performance of a university is composed of the individual performance in a number of areas, each of which is associated to particular processes developed by the organization. Regarding the distinctive case of Teaching, we have identified —through literature review— three aspects of major interest: inputs (factors or elements utilized in teaching execution), processes (actions performed to utilize inputs in order to obtain desired outputs), and outputs (products or results attained by the organization through the teaching process).

4 IS/IT RESOURCES AND CAPABILITIES

As pointed out by Navas and Guerras (1998), the purpose of analysing organizational resources and capabilities is “to assess organizational potentialities to generate competitive advantages through identifying and valuing the resources and abilities it possess or has access to”. Within the group of resources and capabilities that an organization possesses, we can find those resources and capabilities that are related to Information Systems and Technologies (IS/IT). Earlier research underlines that, in order to accomplish and sustain increased performance, resources and capabilities related to IS/IT must be combined with other kinds of resources and capabilities (Bharadwaj, 2000; Teo and Ranganathan, 2003), specifically, organizational, human and business resources. Therefore, we argue that resources and capabilities directly related to IS/IT must be

backed by other organizational resources and capabilities if superior performance is to be attained. This second group of resources and capabilities becomes, then, what we have termed resources and capabilities indirectly related to IS/IT.

Consequently, resources and capabilities directly related to IS/IT along with resources and capabilities indirectly related to IS/IT, conform what we have called in this research resources and capabilities associated with IS/IT. In order to identify and eventually classify these resources and capabilities, we have reviewed the notions proposed by a number of authors such as: Dehning and Stratopoulos (2003), Mata, Fuerst and Barney (1995), Teo and Ranganathan (2003), Bharadwaj (2000), Wade and Hulland (2004), Melville, Kraemer and Gurbaxani (2004), among others. Therefore we state that:

- **Resources directly related to IS/IT:** are an array of available tangible and intangible elements or factors directly related to the acquisition, processing, distribution and utilization of information. These elements may be utilized in accordance with the capabilities associated to IS/IT the entity possesses. These resources are those located at IS/IT organizational area. This array comprises: (i) physical IS/IT infrastructure (computers, communications technology, technical platforms, networks); (ii) IS/IT financial resources; proprietary IS/IT technology (patent and copyright protected); (iii) IS/IT application and utilization experience; (iv) organizational resources in IS/IT area that may facilitate the design, development and exploitation of IS/IT (some examples of these resources are a culture that understands technology as a supportive factor of business; fluent relations with users; close relations with external agents related to IS/IT; a flexible organizational structure; a good reputation of IS/IT department within the organization); (v) IS/IT human resources, which include IS/IT managerial staff (this incorporates both IS/IT and business knowledge and experience) and (vi) IS/IT personnel (this consists of IS/IT knowledge, experience, training, specialized skills).
- **Capabilities directly related to IS/IT:** are an array of available intangible elements or factors directly related to the acquisition, processing, distribution and utilization of information. These elements enable an adequate development, deployment and utilization of resources directly related to IS/IT to achieve the desired results. These capabilities are those of the IS/IT area and comprise: (i) technical abilities to develop and utilize IS/IT; (ii) abilities to identify available opportunities for technology application; (iii) skills necessary to understand the business and to visualize the way it can be supported through IS/IT; (iv) IS/IT managerial abilities to conceive, develop and exploit IS/IT to support organizational activities and operations; (v) ability to develop, within the IS/IT area, organizational resources that may facilitate the conception, development and utilization of IS/IT within the organization (these are described under resources directly related to IS/IT)
- **Resources indirectly related to IS/IT:** are an array of available tangible and intangible elements or factors that support adequate development, deployment and utilization of resources and capabilities directly related IS/IT. These elements may be utilized in accordance with the capabilities associated to IS/IT the entity possesses. These resources are those located outside IS/IT organizational area. This array comprises: (i) financial resources allocated to functional areas —different from IS/IT— so that they provide support to IS/IT utilization (for instance, IS/IT personnel training budget); (ii) organizational resources outside IS/IT area, which may facilitate the conception, development and exploitation of IS/IT within the organization (these factors include an IS/IT friendly culture; close relations with external agents related to IS/IT; a flexible organizational structure, among others); (iii) human resources outside IS/IT area, which include managerial staff (this incorporates both IS/IT experience and level of support towards

IS/IT) and organizational personnel (this consists of IS/IT knowledge, experience, training and skills).

- **Capabilities indirectly related to IS/IT:** are an array of available intangible elements or factors that support adequate development, deployment and utilization of resources and capabilities directly related to IS/IT as well as resources indirectly related to IS/IT. All of these elements enable the achievement of the desired results. Capabilities indirectly related to IS/IT are located outside IS/IT organizational area. This array comprises: (i) technical abilities to utilize IS/IT (those of IS/IT users); (ii) abilities to identify available opportunities for technology application; (iii) skills necessary to understand the business and to visualize the way it can be supported through IS/IT; (iv) managerial abilities outside IS/IT area to conceive, develop and exploit IS/IT to support organizational activities and operations; (v) Ability to develop, outside the IS/IT area, organizational resources that may facilitate the conception, development and utilization of IS/IT within the organization.
- **Resources associated to IS/IT:** are an array of resources directly related to IS/IT and resources indirectly related to IS/IT.
- **Capabilities associated to IS/IT:** are an array of capabilities directly related to IS/IT as well as capabilities indirectly related to IS/IT.

Consequently, we argue that resources and capabilities associated to IS/IT are those that enable efficient development, deployment and utilization of organizational IS/IT, which, in turn, should become a supporting tool to accomplish and sustain improved organizational performance.

Consensus exists on the fact that organizational resources, though being important, do not produce any effect by themselves (Grant, 1996). They alone cannot explain organizational potentialities (Ventura, 1996); enable specific activity execution (Navas and Guerras, 1998); or justify competitive advantage development (Benavides, 1998). Therefore it is necessary to apply a “capability” that allows adequate combination, exploitation and management of such resources, so that they deliver value (Ventura, 1996; Navas and Guerras, 1998; Benavides, 1998). Accordingly, this research has focused more on capabilities than on resources.

Regarding resource classification, we have identified the following categories: technological, organizational, financial and human resources. Capabilities, on the other hand, have been classified as pertaining three different domains: technical domain, managerial domain and organizational domain. However, in this paper we do not show the classification for resources since —as we have pointed out— we have concentrated on capabilities associated to IS/IT. These capabilities have been classified as follows:

- **Technical capabilities associated to IS/IT:** they include organizational technical abilities to successfully develop IS/IT (organizational unit responsible for IS/IT) and utilize IS/IT (the whole organization).
- **Managerial capabilities associated to IS/IT:** This category comprises organizational managerial abilities (within and outside IS/IT area; but most importantly within it) to conceive, develop and exploit IS/IT functions that successfully support organizational activities and operations.
- **Organizational capabilities associated to IS/IT:** This category refers to the firm’s abilities to develop (within and outside IS/IT area) organizational aspects that facilitate successful conception, development, and exploitation of IS/IT.

5 RESEARCH HYPOTHESIS FORMULATION

For our hypothesis formulation we have devised two models:

Direct Model. Relates all three types of capabilities associated to IS/IT (technical, managerial and organizational) with Teaching performance directly. This engenders hypothesis H1, H2, and H3 (figure 1).

Model of Relation among capabilities associated to IS/IT (integrated by technical, managerial and organizational capabilities) and Teaching performance, which gives rise to hypothesis H4 (figure 2).

- Hypothesis H1: Technical capabilities associated to IS/IT (TC) have a positive relation with university performance in the Teaching domain (TP).
- Hypothesis H2: Managerial capabilities associated to IS/IT (MC) have a positive relation with university performance in the Teaching domain (TP).
- Hypothesis H3: Organizational capabilities associated to IS/IT (OC) have a positive relation with university performance in the Teaching domain (TP).
- Hypothesis H4: Capabilities associated to IS/IT (composed of technical capabilities associated to IS/IT, managerial capabilities associated to IS/IT and organizational capabilities associated to IS/IT), have a positive relation with university performance in the Teaching domain (TP).

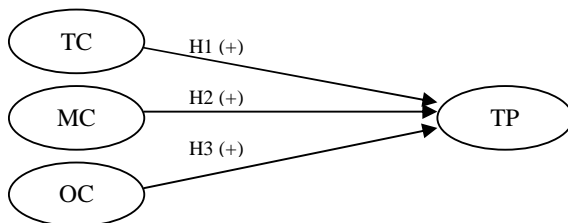


Figure 1. *Direct Model: Individual capabilities-Teaching performance*

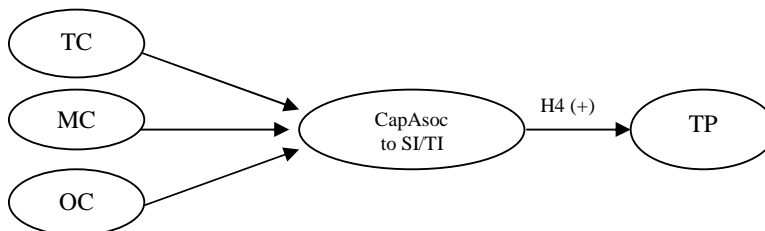


Figure 2. *Model of relation among capabilities associated to IS/IT and Teaching performance*

6 EMPIRICAL WORK

Data was collected through questionnaires (see technical details in table 1)

Geographical area	Spain
Observed units (and universe)	Public Universities (50 Universities)
Sample size	41 Universities
Response rate	27 Universities (65,85% of the studied units)
Respondents	Vice-rector
Measurement type (objective or subjective)	Subjective
Questionnaire response period	March thru July 2006
Questionnaire distribution means (and response collection)	Via email
Number of acceptable responses	52

Table 1. Technical record of empirical study (Source: Authors)

The statistical technique applied to analyze the data is a structural equations model. Specifically, we used the Partial Least Square technique (PLS), mainly for the following reasons: (i) PLS is recommended for predictive research models (Barclay et al., 1995; Chin et al., 2003); (ii) PLS better supports exploratory studies; (iii) PLS is especially adequate for statistical analysis of small samples and for data sets that do not necessarily exhibit a multivariate normal distribution (Chin, 1998). We used PLS-Graph software package, version 3.11.

Cepeda and Roldan (2004) specify that using PLS means to perform a model estimate, utilizing the corresponding criterions (see table 2) in two stages: (i) measurement model evaluation (analyzes whether the theoretical concepts are being adequately measured through the observed variables) and (ii) structural model evaluation (the weight and magnitude of variable relations are evaluated). However, these authors highlight that validity and reliability evaluations are only applied to “reflective” indicators and to “formative” indicators. In our model both types of indicators are represented (Reflective indicators for constructs of capabilities associated to IS/IT and formative indicators for the Teaching performance construct).

MODEL EVALUATION CRITERIONS
MEASUREMENT MODEL EVALUATION
Item individual reliability: Loadings are examined. The most diffused threshold to accept an indicator as part of a construct is that its loading value should be equal or greater than 0.707. However, it is recognized that in cases when scales are fairly new (like it is the case in this research) this threshold should be relaxed to accept loading values of 0.65.
Construct reliability. Proves internal consistency of the indicators when the concept is measured, that is, whether the indicators are measuring the same latent variable. It is measured through the “composite reliability” value (ρ_c). Values over 0.7 are acceptable.
Convergent Validity. Proves whether the items used to measure a construct actually measure the same thing. It is valued through the average variance extracted (AVE). Values greater than 0.5 are acceptable.
Discriminant Validity. It indicates to which extent a given construct is different from other constructs. Average variance extracted (AVE) for its valuation. AVE should be greater than the variance shared between the analyzed construct and the other constructs of the model.
STRUCTURAL MODEL EVALUATION
This analysis is performed based on three indicators: path coefficients (β) (Values associated to the arrows that link the model constructs, acceptable value of 0.2 and ideal value of 0.3), t-values and explained variance (R^2) of the construct that is explicated by the model (values equal or greater than 0.1).

Table 2: Model evaluation criterions (Source: Cepeda and Roldan, 2004)

Our **evaluation of the Direct Model** shows that all three capacity constructs are first order constructs and have reflective indicators; the Teaching Performance (TP) construct, on the other hand, is a second order construct and is formed by Teaching Performance Input (TPI), Teaching Performance Process (TPP) and Teaching Performance Output (TPO). This evaluation has enabled us to assess the fulfillment of the required conditions to evaluate the Measurement Model. The results of the Structural Model evaluation are shown in figure 3.

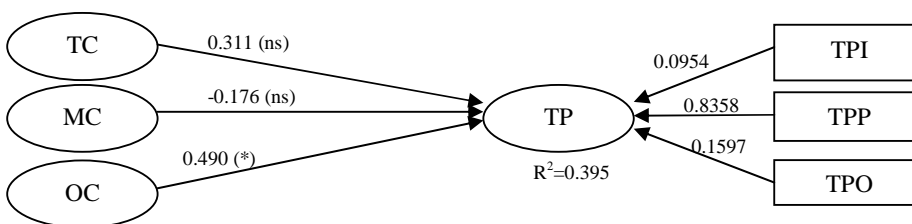


Figure 3: Direct model: Individual capabilities-Teaching Performance (Structural model and associated data)) (Source: Authors)

Our **evaluation of the Model of Relation** shows that both constructs involved are second order constructs. Besides the construct Capabilities associated to IS/IT is formed by Technical Capabilities (TC), Managerial Capabilities (MC) and Organizational Capabilities (OC) associated to IS/IT, Teaching Performance is formed by Teaching Performance Input (TPI), Teaching Performance Process (TPP) and Teaching Performance Output (TPO). The results of the Structural Model evaluation are shown in figure 4.

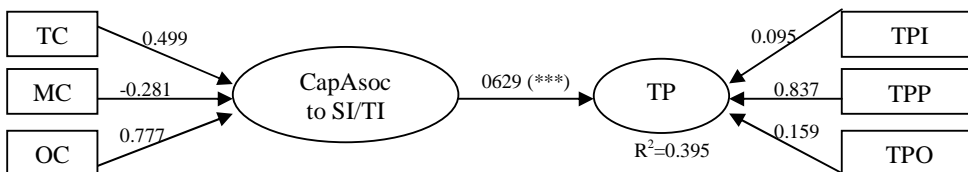


Figure 4: Model of relation between Capabilities associated to IS/IT and Teaching Performance (Structural model and associated data) (Source: Authors)

7 DISCUSSION AND CONCLUSIONS

Observing our results of the evaluation of both the Direct Model (figure 3) and the Model of Relation (figure 4), we can state that: the individual effect each capability on Teaching Performance is low or non existent. Therefore, it is necessary to merge these capabilities into one construct (Capabilities associated to IS/IT) in order for them to have a joint strong positive relation with Teaching Performance. This demonstrates that hypothesis H1 and H2 are not supported, whilst the model does support hypothesis H3 and H4. This last hypothesis (H4) shows the higher positive and statistically significant value.

It is interesting to observe that Managerial Capabilities associated to IS/IT do not show influence in any case, that is, no effects (Direct Model) and no participation (Model of Relation). In this vein, CRUE (2004) argue that Spanish university directives have a rather low awareness of impact of effective IT usage in activities such as research, teaching and management. They also point out that if this organizations do not reap value from IT, they will operate inefficiently and will loose competitive edge with respect to other European universities. Specifically, Bricall (2000) and CRUE (2004) have pointed out that one of the most relevant IT-related drawbacks in universities is the lack or faulty planning, since these tools have been developed and implemented according to observed specific needs. We can also add that there is no regulation regarding IT application for universities (CRUE, 2004). All three shortcoming we have mentioned (low awareness of IT impact, scarce planning and lack of regulation) point toward low attention to the development of managerial aspects of IS/IT in universities. This could be the reason why we have obtained the results above regarding Managerial Capabilities associated to IS/IT.

With respect to the higher participation of the Technical Capabilities and Organizational Capabilities associated to IS/IT (Model of Relation, figure 4), we can argue that in either in the formation of Capabilities associated to IS/IT or in the relation of these capabilities with Teaching Performance, elements such as the following have a greater impact: (i) aspects related to the capabilities of members of the organization to utilize IS/IT to develop adequate communications and coordination, both inside and outside the organization; (ii) aspects related to the capabilities of the IS/IT area to expand its technical knowledge and experience for an adequate IS/IT development and exploitation. We also include in this category the capabilities of the whole group of institutional members to develop their technical knowledge and experience to adequately utilize IS/IT. We close this category with the capabilities of the IS/IT area to develop adequate IS.

In this regard, we argue that the progressive development and implementation of IS/IT in universities (CRUE, 2004) would not have been possible if organizations lacked technical capabilities to complete it, even if technology was available. Besides, if we think of the great amount of information that is managed and shared within universities; the need for permanent internal communication; and the increased number of meetings that take place in this organizations (in all levels), it is possible to infer that , in order to develop, streamline and control all these

activities requires an adequate IS/IT support. We argue that within such support, the most relevant contribution should be that of the capabilities of the people who participate in these activities, those who utilize IS/IT, which should enable the accomplishment of adequate levels of communication and coordination.

Finally, we observe that: (i) given the increasing relevance recognized to IS/IT utilization in universities, it is interesting to develop studies that enable the evaluation of the effects of these tools on the activities and results of this type of organizations. Moreover, if studies like this have found positive effects of IS/IT on the performance of organizations in general, it is attractive, then, to study what happens in the very particular case of universities. (ii) The exploratory character of this investigation enables us to show results and draw conclusions on the behavior of the investigated topics in universities. However, we believe it is necessary to keep researching on the topic in order to gather more data to validate, modify or reject what we have found, which would enrich both IS/IT knowledge and higher education organizations' behavior. In this regard, the most salient limitations of this research are: (i) we researched only one university activity area (Teaching); (ii) we only included public institutions in Spain, which narrows organizations type (private universities were excluded) and geographical scope; (iii) we obtained less valid cases than we desired. Therefore, future research on this topic should point to reduce these limitations.

References

- Barclay D., Higgins C. and Thomson, R. 1995. 'The Partial Least Squares (PLS) approach to causal modeling, personal computer adoption and use as an illustration'. *Technology Studies*, Special Issue on Research Metodology, Vol. 2, Nº 2, pp. 285-309.
- Benavides C. 1998. *Tecnología, innovación y empresa*. Ediciones Pirámide, S.A., Madrid, España.
- Bharadwaj A. 2000. 'A resource-based perspective on information technology capability and firm performance: an empirical investigation'. *MIS Quaterly*, 24(1) 169-196.
- Cepeda G. and Roldán J. 2004. 'Aplicando en la práctica la Técnica PLS en la Administración de Empresas'; XIV Congreso de la Asociación Científica de Economía y Dirección de Empresas (ACEDE).
- Chin W., Marcolin B. and Newsted, P. 2003. 'A Partial Least Squares variable modelling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic mail emotion/adoption study'. *Information Systems Research*, 14(2), pp. 189-217.
- Chin, W. 1998. 'The Partial Least Squares Approach to Structural Equation Modelling', in Marcoulides G. A. (ed.) *Modern Methods for Business Research*. Mahwah, NJ: Lawrence Erlbaum Associates, Publisher.
- CRUE. 2004. *Las TIC en el Sistema Universitario Español*. Conferencia de Rectores de las Universidades Españolas (retrieved from www.crue.org on december of 2006)
- Dehning, B. and Stratopoulos, T. 2003. 'Determinants of a sustainable competitive advantage due to an IT-enabled strategy'. *The Journal of Strategic Information Systems*, Volume 12, Issue 1, pp.7-28.
- Grant R. 1996. *Dirección Estratégica. Conceptos, Técnicas y Aplicaciones*, (first ed. by Civitas in 1996), Civitas, Madrid (original edition Publisher in 1995 by Blackwell Publishers, Cambridge, Massachussets, USA, under the title *Contemporary strategy analysis: concepts, techniques, applications*. Spanish translation by Zulima Fernández, José Daniel Lorenzo Gómez y José Ruis Navarro).
- King F. 2000. 'The changing face of accountability: monitoring and assessing institutional performance in higher education'. *The Journal of Higher Education*, vol. 71(4): 411-431.
- Mata F., Fuerst W. and Barney J. 1995. 'Information Technology and sustained competitive advantage: a resource-based analysis'. *MIS Quarterly*, 19,(4): 487-505.
- Melville N., Kraemer K. and Gurbaxani V. 2004. 'Review: information technology and organizational performance: an integrate model of IT business value'. *MIS Quarterly*, 28(2): 283-322.
- Navas J. and Guerras L. 1998. *La dirección estratégica de la empresa. Teoría y Aplicaciones*. Editorial Civitas, second ed., Madrid.
- Teo T. and Ranganathan C. 2003. 'Leveraging IT resources and capabilities at the housing and development board'. *The Journal of Strategic Information Systems*, 12(3): 229-249.
- Ventura J. 1996. *Análisis dinámico de la estrategia empresarial: un ensayo interdisciplinar*, Servicio de Publicaciones, Universidad de Oviedo.

Wade M. and Hulland J. 2004. 'The resource-based view and information systems research: review, extension, and suggestions for future research'. *MIS Quarterly*, 28(1): 107-142.