INNOVATION, INFORMATION SYSTEMS STRATEGIC ALIGNMENT AND BUSINESS VALUE[1]

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Abstract

For long time the strategic alignment of information systems (IS) has been one of the most important issues that IS and business managers face and at the same time a major research topic in the IS domain. In this paper is presented an empirical study of the business value of IS strategic alignment, which examines IS strategic alignment both at the strategy formulation and implementation level; also, we investigate the effect of adopting an innovation strategy on IS strategic alignment. The study is based on firm-level data from Greek companies, which are used for estimating econometric models of firm output based on the Cobb-Douglas production function. It is concluded that IS strategic alignment both at the strategy formulation and implementation level generates significant business value, increasing considerably the contribution of ICT investment to firm output. Also, the adoption of an innovation strategy has a positive effect on the strategic alignment of IS both at the strategy formulation and implementation level, as it puts pressure on firms to direct their IS investment towards the support of their new innovative products/services, and also to increase the involvement of organizational units responsible for these innovations in the projects implementing the required IS and applications.

Keywords: information systems (or information and communication technologies) investment, information systems (or information and communication technologies) strategic alignment, information systems (or information and communication technologies) business value, innovation, Cobb-Douglas production function.

INTRODUCTION

As information systems (IS) strategic alignment is defined the extent to which business strategies are enabled, supported and stimulated by IS strategies (Broadbent & Weil, 1993). Luftman (2000) provides a 'bilateral' definition stating that business-information technology (IT) alignment concerns applying IT in an appropriate and timely way, in harmony with business strategies, goals and needs, and refers to both how IT is aligned with the business and also how the business should or could be aligned with IT. In the same direction Yala and Hu (2009) define IT-business strategic alignment as the fit between IT strategy and business in organizations. The above representative definitions show that the essence of strategic alignment of IS consists in the establishment of a bilateral relationship

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between the IS planning process and the business/strategy planning processes, which allows a) the mission, goals, competitive strategy, future directions and action plan of the firm, and also the analysis of both its external environment (e.g. competition, opportunities, threats) and its internal environment (e.g. resources, capabilities, strengths, weaknesses), which are basic elements of its business/strategy plan, to be taken into account for the formulation of its IS plan, and b) the capabilities, strengths and weaknesses of both the existing IS and the planned ones, the forms and the extent of information and communication technologies (ICT) usage in the industry and the capabilities offered by existing and emerging ICT that may interest and influence the enterprise, which are basic elements of the IS plan, to be taken into account for the formulation of the business/strategy plan.

For more than two decades IS strategic alignment has been one of the most important issues that IS and business managers face and at the same time a major research topic in the IS domain (Chan & Reich, 2007; Earl, 1989; Forrester, 2007; Luftman & McLean, 2004; Luftman, 2005; Yala & Hu, 2009); critical reviews of this research are provided by Loukis et al (2008a) and Chan & Reich (2007). One of its main topics has been the investigation of the 'business value' that IS strategic alignment generates, with this term denoting its impact on various aspects of business activity and performance. However, as explained in more detail in the following 'Background' section, this research has been focused mainly on IS strategic alignment at the strategy formulation level, but has ignored the strategy implementation level, though the strategic management literature (e.g. Johnson et al, 2008; Wheelen & Hunger, 2004;) has repeatedly stressed that good strategies sometimes are not implemented properly, so the outcomes are finally much lower than the expectations, recommending that more attention should be paid to strategy implementation. Also, recent literature has underlined that IS strategic alignment should be applied and researched not only at the highest hierarchical levels, in which strategy is formulated, but also in the middle and lower ones, in which strategy is implemented (Bartenschlager & Goeken, 2009; Chan & Reich, 2007; Tarafdar & Qrunfleh, 2009). Another weakness of this research has been the lack of a sound theoretical background (e.g. from management science or economics) in most studies, and also the use of subjective measures of business performance and ICT contribution to it (usually firms' management perceptions). Finally, the effect of strategy on IS strategic alignment has not been investigated; however, it would be interesting for IS and business managers and researchers to examine whether and to what extent various strategies put pressure on firms to direct their IS investment towards the support of the strategy.

This paper contributes to addressing these research gaps by presenting an empirical study of the business value of IS strategic alignment, which examines IS strategic alignment both at the strategy formulation and implementation level; also, it investigates the effect of adopting an innovation strategy on IS strategic alignment. Our study is theoretically founded on the well-established and validated Cobb-Douglas production function and is based on objective measures of business performance and ICT contribution to it; using firm-level data from 231 Greek firms from the 27 most important sectors of the Greek economy, which have been collected in a survey conducted in cooperation with ICAP, one of the largest business information and consulting companies of Greece, econometric models of firm output (value added) are estimated, having as independent variables the employed non-ICT capital, ICT capital and labor, and also the extent of ICT strategic alignment in the firm. These models allow the estimation of the contribution of ICT strategic alignment at various levels to firm output, and compare it to the contribution of the basic inputs (non-ICT capital, ICT capital and labor); in this way we can examine whether and to what extent ICT strategic alignment at various levels increases the contribution of ICT capital to firm output.

The paper is divided in five sections. The following section presents briefly the background of our study (discussing the strategic potential of ICT, the previous empirical research on the business value of IS strategic alignment and the association between ICT and innovation). In the third section the research hypotheses, the method and the data of this study are described, while in the fourth section the results are presented. In the final section the conclusions and limitation of this study are outlined.

BACKGROUND

The Strategic Potential of ICT

For long time there has been a high level of interest of both researchers and practitioners in the IS and management domains in the alignment between IS and business strategy (Chan & Reich, 2007; Earl, 1989; Forrester, 2007; Luftman & McLean, 2004; Luftman, 2005; Yala & Hu, 2009), which is founded on the recognition that ICT have a significant strategic potential, and if properly exploited they can have a significant strategic impact on the firm and provide valuable competitive advantages. The initial research on this strategic potential of ICT has been based on the work of M. Porter (1980) on competitive strategy, which identifies three generic business strategies: differentiation, cost leadership and focus; furthermore, it concludes that organizations use these generic strategies in order to control five basic industry forces, which determine their competitive position and profitability: rivalry among existing competitors, bargaining power of suppliers, bargaining power of buyers, threat of substitute products/services and threat of new entrants. Parsons (1983) applied the above work of M. Porter to the ICT and reached the conclusion that IS can have a significant strategic impact if the are used to change the products, services, markets or production economics of an industry, to affect the buyers and suppliers of the firm, to prevent customers from buying products and services from competitors, to preclude new competitors, to alter the degree of rivalry, or to support one of the abovementioned M. Porter's generic strategies. McFarlan (1984) also applied the above work of M. Porter to the ICT and concluded that they can have a strategic impact, if they are used in order to build barriers against new entrants, build switching costs, change the basis of the competition, generate new products and services and change the balance of power in supplier relationships. Building on these conclusions Benjamin et al (1984) enriched the perspective of the strategic potential of ICT by concluding that it is not only IS affecting customers or supporting new products and services that can have a strategic impact, but also IS affecting internal operations and supporting traditional products and services can be of high strategic importance as well and provide competitive advantages. Ives and Learnmonth (1984) applied the concept of value chain to the interaction of a customer with a firm and concluded that an IS that fits into customer lifecycle and differentiates products or services from those of the competitors can be of high strategic importance. Wiseman (1985) concludes that IS supporting the internal operations or the traditional products and services of a firm can have strategic impact if they support its 'strategic thrusts', such as M. Porter's generic strategies, innovation, growth or alliances, in a manner that influences relationships with customers, suppliers or competitors. Important in this vein is the contribution of Porter & Millar (1985), who identify three basic ways that ICT can affect competition: by altering industry structures, by supporting differentiation and cost leadership strategies, and also by spawning entirely new businesses; they also argue that ICT have strategic potential if they can add value to a product or service in at least one of the primary activities (inbound logistics, operations, outbound logistics, marketing and sales, after-sales support and services) or one of the support activities (human resources management, technology development, infrastructure management, procurement) of the value chain. Scott Morton (1990), describing the results of research conducted in the MIT in cooperation with ten large USA firms, concludes that ICT changes dramatically the ways we communicate, we do business and live, so they can offer very high rewards as long as ICT is connected with firm strategy, management processes, structure and individuals' roles. At the same time many case studies have been published on this topic describing and analyzing 'real-life' IS that have provided competitive advantage (e.g. Chan & Reich, 2007; Earl, 1989; Hopper, 1990; Robson, 1997; Pemberton et al, 2001; Picolli & Applegate, 2003), which validate and prove the practical applicability of the above arguments. Recently, Fink & Neumann (2009) from a quantitative study based on data collected from 293 IT managers concluded that IT can provide significant competitive advantages (by supporting innovation, widening array of products without increasing costs and enabling favorable IT-induced market position), which are higher in firms having effective IT management capabilities and knowledgeable personnel.

Subsequent research on this topic has emphasized the need for combining ICT with other resources of the firm in order to have a strategic impact. In this direction Carr (2003) argues that a narrow and exclusively technological focus cannot result in competitive advantages ('IT Doesn't Matter'). Powell and Dent-Micallef (1997) from an empirical study in the retail industry found that ICT alone cannot

produce sustainable performance advantages, and such advantages can be gained only by using ICT in order to leverage intangible, complementary human and business resources. Miller (2003) found that sometimes these complimentary resources can be of low value, or even considered as liabilities, until they are they are incorporated in a new ICT-based 'engine of value creation'; therefore ICT can be instrumental in leveraging existing resources of low value, or even liabilities, into valuable resources that offer (possibly in combination with other resources and ICT) competitive advantage. Another important dimension of the strategic potential of ICT as enablers of 'strategic agility' is proposed by Sambamurthy et al (2003), who argue that the capabilities of ICT can create new strategic 'digital options' for the firm and enable it to launch new competitive initiatives and respond quickly and effectively to changes in its environment.

Also, research has been conducted concerning the sustainability of the competitive advantages provided by ICT. Mata et al (1995), based on a resource-based view of the firm, conclude that 'managerial ICT skills' (defined as the ability of ICT management to understand the business needs of other functional units, customers and suppliers, and in cooperation with them to develop IS that cover these needs) is the only ICT attribute of a firm that can provide a sustainable competitive advantage. Bharadwaj (2000) adopting also a resource-based perspective and using a matched-sample comparison group methodology found that superior firm-specific ICT resources (ICT infrastructure, human ICT resources and ICT-enabled intangibles) result in superior financial performance. Picolli & Ives (2005) from an extensive literature review identified four basic barriers to the erosion of the competitive advantages provided by 'IT-dependent strategic initiatives': IT resources barrier, complementary resources barrier, IT project barrier and preemption barrier; they conclude that the existence of one or more of these barriers can make the competitive advantages offered by 'IT-dependent strategic initiatives' sustainable for long time.

From the above research considerable theoretical support and empirical evidence has been produced concerning the potential of ICT to support business strategies and provide (usually in combination with other resources of the firm) significant competitive advantages, which under specific conditions can be sustainable; it has also been concluded that the realization of this strategic potential is not an easy task and necessitates the establishment of a connection between ICT and the overall strategy of the firm.

The Business Value of IS Strategic Alignment

One of the main streams of the IS strategic alignment research has been the investigation of its business value; it is dealing mainly with the impact of IS strategic alignment on business performance or on the contribution that IS make to business performance. In the following we review the most important empirical studies that have been conducted in this research stream. King and Teo (King & Teo, 2000; Teo & King, 1996) examined empirically the impact of four types of integration between the business plan (BP) and the information systems plan (ISP) (administrative, sequential, reciprocal and full integration) on the perceived contribution of IS to various measures of organizational performance and on the perceived extent of various types of IS problems (organization problems, implementation problems, database problems, hardware problems and cost problems); using data from 157 large USA firms from the Corporate 1000 Book and performing independent sample t-tests and calculating correlations they found that the extent of the above BP-ISP integration and also its proactive orientation has a statistically significant positive relation with the perceived IS contribution to organizational performance, and also a statistically significant negative relation with the perceived extent of IS problems. Chan et al (1997) investigated empirically the impact of IS strategic alignment on perceived IS effectiveness and perceived business performance; using data from 164 North-American financial services and manufacturing firms (from USA and Canada) with more than 100 employees from the Dun and Bradstreet directories they constructed a structural equations model (SEM), from which it was concluded that IS strategic alignment has statistically significant positive contributions to both perceived IS effectiveness and perceived business performance. Using the same data Sabherwal and Chan (2001) addressed the same research question, but in regard to the business strategy the enterprise has adopted; considering three different business strategies (based on the

strategies typology proposed by Miles and Snow (1978): 'defenders', 'prospectors' and 'analyzers', they found that the strategic alignment of IS affects perceived business performance only in enterprises following a 'prospector' or 'analyzer' business strategy, but not in the ones following a 'defender' business strategy. Cragg et al (2002) examined the link between IS strategic alignment and four measures of perceived firm performance (long term profitability, sales growth, financial resources availability and public image & customer loyalty) in the context of small firms; using data from 250 small UK manufacturing firms and performing analysis of variance (ANOVA) they found that the subgroup of firms having higher levels of alignment had also higher levels of all these four measures of perceived firm performance than the ones with lower levels of alignment. Bergeron et al (2003), based on data collected through a mail survey from 110 Canadian small and medium firms, and using cluster analysis found that firms exhibiting a 'conflictual coalignment pattern' of business strategy, business structure, IT strategy and IT structure had lower performance (measured through subjective perceptions of management as to firm's performance relative to competition in terms of sales growth rate, market share gains, net profit, return on investment, return on sales and financial liquidity) in comparison with the other firms. Kearns and Sabherwal (2006), using data collected through a survey of 274 senior information officers of medium to large USA corporations, concluded that organizational emphasis on knowledge management and centralization of ICT decisions have a positive effect of top managers' knowledge on ICT, which in turn have both a positive effect on business-ICT strategic alignment; the latter has a positive effect on ICT business impact through an increase of the quality of ICT projects' planning and a decrease of their implementation problems. Yayla & Hu (2009), using data from a survey of 169 Turkish firms in the area of Istanbul, found that strategic alignment of IS has a positive impact on organizational performance only in high uncertainty environments, while in low uncertainty environments organizations may not need high degrees of IS alignment to achieve high performance.

It should be mentioned that all the above empirical studies have used subjective (perceived) measures of business performance and/or enterprise systems contribution to business performance. The only empirical investigation of the impact of IS strategic alignment on business performance that uses objective measures of business performance has been the one conducted by Byrd et al (2005); based on data from 275 fabricated metal products manufacturing companies from South-eastern USA they constructed econometric models having sales revenue per employee and profit per employee as dependent variables, while as independent variables they used the IT expenditure per employee, a measure of IS strategic alignment and an interaction term equal to the product of the above two independent variables. In these econometric models the coefficient of this interaction term was found to be positive and statistically significant, so it is concluded that there is a synergistic coupling (positive interaction) between IT strategic alignment and IT investment with respect to both these measures of firm performance. However, the econometric models constructed in this study did not include some fundamental independent variables, such as non-IT capital and labour, which constitute basic determinants of firm output according to production economics (Nicholson & Snyder, 2008).

In conclusion, this research stream has produced some evidence of positive contribution of IS strategic alignment to business performance, based mainly on data from large and economically developed countries (such as USA or UK). However, it has focused on IS strategic alignment at the strategy formulation level, but has ignored the strategy implementation level, though the strategic management literature (e.g. Johnson et al, 2008; Wheelen and Hunger, 2004) has emphasized the importance of strategy implementation, since often good strategies sometimes are not implemented properly. Furthermore, recent literature has underlined that IS strategic alignment should be applied and researched at various hierarchical levels, and not only at the highest ones, in which strategy is formulated (Bartenschlager & Goeken, 2009; Chan & Reich, 2007; Tarafdar & Qrunfleh, 2009); for instance Tarafdar & Qrunfleh (2009) argue that 'For business and IT to work to reach a common goal, there needs to be alignment at both the planning and execution levels' (p. 338) therefore 'in order to benefit from the use of IT in areas critical to the business, organizations need to achieve both Strategic and Tactical IT alignment' (p. 346). Also, this research stream lacks a sound theoretical background (e.g. from management science or economics), and uses mainly subjective measures of business performance and ICT contribution to it (usually perceptions of firms' management). Therefore further research is required in order to understand better the contribution of IS strategic alignment, both at

strategy formulation and implementation level, on various dimensions of business performance, in various types and sizes of enterprises and various sectoral, national and cultural contexts, based on sound theoretical foundations and objective measures.

ICT and Innovation

There has been considerable literature analyzing the potential of ICT to enable and support important innovations (e.g. Bresnahan et al, 2002; Bresnahan, 2003; Brynjolfsson & Hill 2000; Davenport, 1993; Hammer, 1990; Hammer & Champy, 1993; Tapscott & Caston, 1993; Porter & Millar, 1985). Their basic argument is that ICT are 'general purpose technologies' with high levels of flexibility and adaptability, so they can be used in numerous different ways and for many purposes and therefore enable and support important innovations. ICT can change the way that human work is performed, measured, controlled and reported, enabling and supporting significant restructuring of the work, allocating well-defined routine tasks to computers and redesigning/improving tasks that require human skills. Moreover, they enable individual workers to have more information and complete bigger parts of the processes they are dealing with, so the existing historically fragmentation of many processes can be dramatically reduced. Also, ICT facilitate the flow of information between geographically remote locations, enabling thus and supporting radical innovations in products, services and processes. Davenport (1993) identified nine particular modes of using ICT for innovation: automational, informational, sequential, tracking, analytical, geographical, integrative, intellectual and disintermediating. For the above reasons modern ICTs can enable and support new enhanced business processes and work practices, which lead to big productivity increases, initially by reducing costs and increasing output quality, and subsequently by designing new products and improving important intangible aspects of existing products, such as convenience, timeliness, quality, etc.

However, the above arguments concerning the association between ICT and innovation have been empirically investigated only to a limited extent. Most of the empirical research in this area has examined the effect of innovation on the productive impact of ICT (Hempell, 2005; Licht & Moch, 1997; Loukis et al, 2008b); their basic conclusion is that the combination of ICT investment with innovation increases the contribution of the former to various measures of business productivity and performance. On the contrary there are few empirical investigations dealing with the effect of ICT on innovation. Kafouros (2006) based on data from 89 UK firms over a 14 years period found that two features of the Internet ('search' and 'communication') improve three critical dimensions of R&D efficiency (cost, time and quality) and firms' absorptive capacity; also, by using the Cobb-Douglas framework, he provides econometric evidence indicating that the Internet improves R&D efficiency. Bartel et al (2007) using data from valve manufacturing plants came to the conclusion that plants adopting IT-enhanced equipment tend to shift their products range towards more customized valve products. Koellinger (2008) using data from 7302 European enterprises collected through the e-Business Market Watch Survey of the European Commission reached the conclusion both innovation and ICT usage have a positive impact on profitability and increase of sales and employment; another conclusion of this study is that 41% of the enterprises having reported product/service innovation and 48% of the enterprises having reported process innovation have used Internet technologies for enabling it. Finally, there is some literature analyzing the potential of e-business to enable and support innovation in the way firms do business and establishment of new business models (Afuah & Tucci, 2001; Tavlaki & Loukis, 2005; Timmers, 1998; Wu & Hisa, 2008); however, there is a lack of empirical investigations of these arguments and expectations as well.

In conclusion, the above research has provided useful theoretical arguments concerning the relationship between ICT and innovation and the high potential of the former to enable and support the latter. However, are missing empirical investigations of this relation; furthermore, the relationship between ICT alignment and innovation has not been investigated.

HYPOTHESES, METHOD AND DATA

In order to contribute to filling the above research gaps the present study investigates empirically the effect of IS strategic alignment at the strategy formulation and implementation level on the contribution of ICT to business performance. Our first research hypothesis concerns the bilateral relationship between the ICT plan and the business/strategy plan. Establishing a link between these two plans results in the selection of the most appropriate IS investments, which support to the highest possible extent the selected business strategy and the action plans of the firm. The business/strategy plan includes an analysis of firm's internal environment (having as final outcome the strengths and weaknesses), which constitutes a very good foundation for determining the most appropriate internal IS that should be developed, in order to support internal business functions, reinforce strengths and reduce weaknesses; also it provides a basis for using ICT in combination with unique resources of the company in order to provide sustainable competitive advantage. Also, the business/strategy plan includes an analysis of the external environment of the company (having as final outcome the opportunities and threats), which constitutes a very good foundation for determining the most appropriate inter-organizational and 'outward-looking' (e.g. Internet-based) IS that should be developed for connecting the company with customers, suppliers and business partners. Furthermore, the whole process followed for achieving a bilateral relationship between the ICT plan and the business/strategy plan increases IS managers' business awareness and knowledge, and executives' awareness and knowledge about the capabilities and opportunities offered by ICT. In general, the exploitation of the great strategic potential of ICT, which has been analysed briefly in the previous section, necessitates a close and bilateral interaction between ICT strategy and business strategy. For the above reasons we expect that higher level of bilateral relationship between the ICT plan and the business/strategy plan will increase the contribution of ICT to business performance. Therefore our first research hypothesis H1 is:

H1: The extent of bilateral relationship between the ICT plan and the business/strategy plan affects positively the contribution of ICT to business performance.

However, it is not sufficient to establish links between ICT and business only at the strategy formulation level. The strategic management literature (e.g. Johnson et al, 2008; Wheelen & Hunger, 2004) has repeatedly stressed that good strategies sometimes are not implemented properly, so their outcomes are finally much lower than the expectations; for this reason it recommends that more attention should be paid to strategy implementation. Also, recent literature has underlined that IS strategic alignment should be applied and researched not only at the strategy formulation level, but also at the strategy implementation level as well (Bartenschlager & Goeken, 2009; Chan & Reich, 2007; Tarafdar & Qrunfleh, 2009). Business strategy/plans are implemented by the organizational units of the firm (e.g. directorates, departments), while the IS strategy/plans are implemented through IS and applications development projects; therefore is useful to establish a link between the IS and applications development projects on one hand and the organizational units of the firm that will use these new IS/applications on the other. The involvement of the organizational units in IS and applications development projects aligns the latter with the processes and work practices of the former, which implement and reflect the business strategies (e.g. Avison & Fitzgerald, 2006; Bleistein et al, 2006a; Bleistein et al, 2006b). We expect that the contribution of the organizational units who will be the future users is going to improve substantially these new IS and applications (e.g. by defining appropriate requirements so that the implementation of the business strategy is supported to the highest possible extent, by testing them and identifying problems that may prevent or decrease the support they offer to business strategies, etc.), and finally increase the contribution of ICT to business performance. Thus, our second research hypothesis H2 is:

H2: The extent of involvement of the organizational units of the firm (e.g. directorates, departments) in IS and applications development projects affects positively the contribution of ICT to business performance.

Our third and fourth research hypotheses concern the effect of adopting innovation strategy on IS strategic alignment at the strategy formulation and implementation level respectively. As explained in the previous section ICT are 'general purpose technologies' with high levels of flexibility and adaptability, so they have high potential to enable and support important innovations. For this reason firms adopting strategy of frequent introduction of new products/services with significant innovations

will have i) to take into account seriously the capabilities offered by ICT in order to define and design these innovative products/services, and ii) to plan and develop appropriate new IS and applications in order to support their production and distribution; this will result in a higher degree of bilateral relationship between the ICT plan and the business/strategy plan. Furthermore, in the projects that will develop these new IS and applications it becomes necessary to involve the organizational units of the firm who are responsible for these innovative products/services. For these reasons we expect that higher extent of adopting innovation strategy will result in higher extent of IS strategic alignment at the strategy formulation and implementation level. Therefore our third and fourth research hypotheses H3 and H4 are:

H3: The extent of adopting innovation strategy affects positively the extent of bilateral relationship between the ICT plan and the business/strategy plan.

H4: The extent of adopting innovation strategy affects positively extent of involvement of the organizational units of the firm (e.g. directorates, departments) in IS and applications development projects.

As our basic foundation for testing the above hypotheses we have used the Cobb-Douglas production function (Nicholson & Snyder, 2008), which associates the output of a firm with the inputs it employs. In particular, it posits that firm output, measured by the value added (VA) during a given time period (=sales revenue minus expenses for buying materials and services), is an exponential function of the basic inputs it has used in this period, capital (K) and labour (L), while it is also affected by various parameters of the management and the processes of the firm that determine how efficiently the inputs are used and combined. The Cobb-Douglas production function has been successfully used in the past for estimating the contribution of various firm inputs, including ICT investment, to firm output (e.g. Brynjolfsson & Hitt, 1996; OECD, 2003; OECD, 2004; Stolarick, 1999). In this study we have used the following extended form of the Cobb-Douglas production function, in which the capital is divided into ICT capital (K) and non-ICT capital (CK):

$$VA = e^{\beta_0} L^{\beta_1} K^{\beta_2} ICK^{\beta_3} \qquad (1)$$

where $\beta_1 - \beta_3$ are the output elasticities of L, K and CK respectively. By log-transforming the above equation (1) we obtain the following linear form of it:

$$\ln VA = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(ICK) \qquad (2)$$

In order to investigate the effect of IS strategic alignment on firm value added we included in the right hand side the additional variable STR_AL, which measures the extent of IS strategic alignment in the firm:

$$\ln VA = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(ICK) + \beta_4 STR\_AL \qquad (3)$$

In particular, in order to test hypotheses 1 and 2 we estimated two regression models of this form, a first one with STR_AL equal to the degree of IS strategic alignment at the strategy formulation level STR_AL_S (= degree of bilateral relationship between the ICT Plan and the Overall Business/Strategy Plan), and then a second one with STR_AL equal to the degree of IS strategic alignment at the strategy implementation level STR_AL_I (= degree of organizational units' (e.g. directorates, departments) involvement in IS and applications development projects). In each of these models, if the estimated coefficient of STR_AL is positive and statistically significant, then we can conclude that IS strategic alignment (at the strategy formulation or implementation level respectively) makes an additional contribution to firm value added, beyond the one made by the 'hard' ICT capital, resulting in an increase of the total contribution of ICT to firm value added (and finally providing support to hypothesis 1 or 2 respectvely). Furthermore, in order to test hypotheses 3 and 4 we estimated the correlation coefficients of the above two IS strategic alignment variables STR_AL_S and STR_AL_I with a variable INNOV measuring the extent of adopting innovation strategy.

For estimating the above regression models and correlations we used data that have been collected through a survey among Greek companies, which has been conducted in cooperation with ICAP, one

of the largest business information and consulting companies of Greece. This survey was based on a structured questionnaire, which included questions about the basic financial data of the company (yearly sales revenue, expenses for materials and services, labour expenses, value of capital, value of ICT capital, etc.), the extent of IS strategic alignment at strategy formulation and implementation level and also the extent of adopting innovation strategy; the questions we used for this study are given in Appendix A. We finally received questionnaires from 281 companies (99 small, 98 medium and 84 large ones) from the 27 most important sectors of the Greek economy; 231 of them were complete and were used in our study. Their average number of employees was 492 and the median number of employees 84, while their average and median yearly sales revenue was 183.7 and 9.5 million Euro respectively.

RESULTS

Initially for the value added (VA) we estimated the regression model of the above equations (3), for STR_AL = STR_AL_S (IS strategic alignment at the strategy formulation level) and then for STR_AL = STR_AL_I (IS strategic alignment at the strategy implementation level), using the SPSS 13.0 statistical software; the results are shown in Tables 1 and 2 respectively. From the first estimated model shown in Table 1 initially we can see that the coefficients of labour, non-ICT capital and ICT capital are all positive and statistically significant. This indicates that both the 'traditional' inputs (labour and non-ICT capital) and the 'new economy' input (computer capital) make a positive contribution to firm value added; therefore there is no evidence of 'ICT Productivity Paradox' in the Greek firms. Also, we remark that from the three standardised coefficients the one of the labour is the highest (0.541), so we can conclude that the labour makes the largest contribution to value added; this conclusion is probably associated with the labour intensive nature of the Greek economy. From the other two inputs we can see that the standardised coefficient of the ICT capital (0.245) is higher than the one of the non-ICT capital (0.102), so we can conclude that the ICT capital contributes to firm value added more than the 'traditional capital'.

Dependent variable : ln (VA)			
Independent variable	Coefficient	Standardized Coefficient	Significance
constant	3.186		0.000
ln (L)	0.541	0.518	0.000
ln (K)	0.102	0.130	0.002
ln (ICK)	0.245	0.271	0.000
STR_AL_S	0.108	0.120	0.001
R-squared : 0.758			

Table 1. Regression model for the impact of labour, non-ICT capital, ICT capital and IS strategic alignment at the strategy formulation level (bilateral relationship between the ICT Plan and the Overall Business/Strategy Plan) on firm value added

With respect to the IS strategic alignment at the strategy formulation level, which is a major topic of this study, we remark that the coefficient of the corresponding independent variable is positive and statistically significant. Therefore it can be concluded that the establishment of bilateral relationship between the ICT plan and the overall business/strategy plan makes an additional contribution to firm value added, beyond the one made by the 'hard' ICT capital, resulting in an increase of the total contribution of ICT to firm value added. It is also interesting to compare the effect of this 'soft' action of IS strategic alignment at the strategy formulation level with the effect of the 'hard' ICT investment, based on the corresponding standardized coefficients. We remark that the effect of establishing a bilateral relationship between the ICT plan and the overall business/strategy plan (standardized coefficient 0.120) is lower than the effect of the ICT capital (standardized coefficient 0.271), however

it has a considerable size of 0.120/0.271 = 44% of the effect of the ICT capital. This indicates that the 'soft' action of IS strategic alignment at the strategy formulation level generates significant business value, as it can increase by 44% on average the contribution of the ICT capital to firm value added. This conclusion can be interpreted taking into account that the link between the business/strategy and the ICT plans allows the selection of the most appropriate IS investments, which support to the highest possible extent the selected business strategy and the action plans of the firm, finally resulting in the generation of higher business value from ICT. Also, the analysis of firm's internal and external environment that the business/strategy plan includes allows the definition of the most appropriate internal and external ('outward-looking') IS respectively to be developed, resulting thus in higher ICT business value. The whole process of establishing a bilateral relationship between the ICT plan and the business/strategy plan increases IS managers' business awareness and knowledge, and at the same time executives' awareness and knowledge about the capabilities and opportunities offered by ICT, resulting in a higher exploitation of the strategic potential of ICT .

From the second estimated model, which concerns IS strategic alignment at strategy implementation level and is shown in Table 2, initially we remark that again the coefficients of labour, non-ICT capital and ICT capital are all positive and statistically significant, confirming the conclusion drawn from the first model that both the 'traditional' inputs (labour and non-ICT capital) and the 'new economy' input (computer capital) make a positive contribution to firm value added. Also, by comparing the corresponding three standardized coefficients it is confirmed that labour makes the largest contribution to firm value added (standardized coefficient 0.550), followed by the computer capital (standardized coefficient 0.252) and finally the non-computer capital (standardized coefficient 0.113).

Dependent variable : ln (VA)			
Independent variable	Coefficient	Standardized Coefficient	Significance
constant	2.547		0.000
ln (L)	0.550	0.526	0.000
ln (K)	0.113	0.143	0.001
ln (ICK)	0.252	0.279	0.000
STR_AL_I	0.165	0.117	0.001
R-squared : 0.760			

Table 2. Regression model for the impact of labour, non-ICT capital, ICT capital and IS strategic alignment at the strategy implementation level (organizational units' involvement in IS and applications development projects) on firm value added

Concerning the IS strategic alignment at the strategy implementation level, which constitutes another major topic of this study, we can see that the coefficient of the corresponding independent variable is positive and statistically significant. Therefore it can be concluded that the involvement of firms' organizational units in IS and applications development projects makes an additional contribution to firm value added, beyond the one of the 'hard' ICT capital, resulting in an increase of the total contribution of ICT to firm value added. Its effect on value added (standardized coefficient 0.117) is lower than the effect of the 'hard' ICT capital (standardized coefficient 0.279), however it has a considerable size of 0.117/0.279 = 42% of the effect of the ICT capital. This indicates that IS strategic alignment at the strategy implementation level through the involvement of firms' organizational units (who implement business/strategy plan) in IS and applications development projects (through which the IS plan is implemented) generates significant business value, as it can increase by 42% on average the contribution of the ICT capital to firm value added. This conclusion can be interpreted taking into account that the involvement of the organizational units in IS and applications development projects aligns the latter with the processes and work practices of the former, which reflect and implement the business strategies. Also, the participation and contribution of the organizational units improves substantially these new IS and applications and finally increases the contribution of ICT to business performance. The definition of appropriate requirements by the organizational units ensures that the

implementation of the business strategy is supported to the highest possible extent; moreover, the testing of the new IS and applications by the organizational units who will use them results in the early identification of problems, which would decrease the support provided to business strategies.

Finally, the estimated correlation coefficients of the above two IS strategic alignment variables, STR_AL_S (at the strategy formulation level) and STR_AL_I (at the strategy implementation level), with the INNOV variable measuring the extent of adopting innovation strategy, are shown in Table 3. We remark that innovation has a positive and statistically significant correlation with both IS strategic alignment at the strategy formulation and the strategy implementation level (we can see that the corresponding two correlation coefficients are of similar magnitude). This indicates that adopting a strategy of frequent introduction of new products/services with significant innovations puts pressure on firms to take into account seriously the capabilities offered by ICT in order to define and design these innovative products/services; also, innovation strategy puts intensive pressure to plan and develop appropriate new IS and applications for supporting the production and distribution of the innovative products/services. These result in a higher degree of bilateral relationship between the ICT plan and the business/strategy plan. Furthermore, in the projects that develop these new IS and applications it becomes increasingly necessary to involve the organizational units of the firm who are responsible for these innovative products/services, so the IS strategic alignment at this strategy implementation level increases.

IS Strategic alignment variable	Correlation Coeff. with Innovation variable
STR_AL_S	0.200**
STR_AL_I	0.195**

*Table 3. Correlation coefficients between two IS strategic alignment variables STR_AL_S and STR_AL_I and the innovation variable INNOV (** denotes statistical significance at the 1% level)*

CONCLUSIONS - LIMITATIONS

In the previous sections has been presented an empirical study of the business value of IS strategic alignment, which examined IS strategic alignment, not only at the strategy formulation level, but also at the strategy implementation level as well, which has not investigated in the previous literature; also, the effect of adopting an innovation strategy on IS strategic alignment at both these levels has been investigated. This study has been theoretically founded on the well-established and validated Cobb-Douglas production function and used on objective measures of business performance and ICT contribution to it; it has been based on the estimation of econometric models of firm output (value added), which have as independent variables the employed non-ICT capital, ICT capital and labor, and also the extent of ICT strategic alignment in the firm. It has been concluded that the 'soft' action of IS strategic alignment both at the strategy formulation and the strategy implementation level generates significant business value, as it can increase by 44% and 42% respectively on average the contribution of the ICT capital to firm value added. Also, he have found that the adoption of innovation strategy has a positive effect on the strategic alignment of IS both at the strategy formulation and implementation level, as it puts pressure on firms to direct their IS investment towards the support of their new innovative products/services, and to increase the involvement of organizational units responsible for these innovations in the corresponding IS and application development projects.

The results of this study have interesting implications for firms' management. Firms should lay more emphasis on increasing the 'quality' of their ICT investment, by establishing stronger links and aligning of them to their business/strategy plans, instead of focusing exclusively on increasing the 'quantity' (magnitude) of ICT investment. They should adopt a more 'holistic' approach to IS strategic alignment, which should not be made only at the 'higher' strategy formulation level, but also at the 'lower' strategy implementation levels as well. The former should focus on the establishment of a

bilateral relationship between the ICT plan and the overall business/strategy plan, which will allow the selection of the most appropriate IS investments that the highest possible extent the selected business strategy and the action plans of the firm, resulting in a higher exploitation of the strategic potential of ICT. The latter should focus on achieving a high level of participation and involvement of firm's organizational units in IS and applications development projects (e.g. in requirements definition, testing, etc.), which will result in 'better' IS and applications, having more complete, appropriate and usable functionality, which supports business strategy to the highest possible extent. Moreover, firms adopting an innovation strategy (frequent introduction of new highly innovative products/services) should lay special emphasis on strategic alignment both at the strategy formulation and implementation level, so that they can plan and develop appropriate IS and applications for supporting the definition, design, production and distribution of their new innovative products/services. Furthermore, the findings of this study have interesting implications for research in this area. They indicate that IS strategic alignment research (e.g. aiming to identify antecedents and impact on business performance or various organizational characteristics) should deal not only with the strategy formulation at the highest hierarchical levels, but also with the strategy implementation at the middle and lower hierarchical levels as well. Also, this study has developed a sound framework, theoretically founded on the well-established and validated Cobb-Douglas production function from the microeconomics domain, for conducting empirical research of the effects of various mechanisms of IS strategic alignment, and also other 'soft' ICT actions (e.g. establishment of ICT processes, ICT training, etc.), on business performance.

A limitation of this study is that it has been based on a sample of Greek firms. Therefore the findings may have been influenced to some extent by the economic, cultural, social, etc. characteristics of the Greek national context. Greece has a small size of internal market and also small average firm size, which make economies of scale (of particular importance for ICT investment and exploitation, and also for innovation) more difficult than in bigger countries. Also, Greece is characterised by lower ICT usage and investment than most European countries (European Commission 2008), and also a lack of tradition in the area of adoption and usage of advanced and sophisticated technologies, and also technological innovation. Another limitation of this study is that it has examined only one mechanism of IS strategic alignment at the strategy implementation level. Further research is in progress by the authors for investigating the impact of various types and mechanisms of IS strategic alignment at different hierarchical levels on business performance, and also on its dependence from various external and internal environment factors.

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Appendix:

Survey questions (used in this study)

- Yearly total sales revenue (without VAT) : _____ Euro
- Yearly total expenses for buying materials and services (without VAT) : _____ Euro
- Yearly total labour (personnel) expenses (without VAT) : _____ Euro
- Value of assets at the end of the year (without VAT) : _____Euro
- Value of computer equipment (hardware, software and networks) at the end of the year (without VAT): _____ Euro

- To what degree there is bilateral relationship between the ICT Plan and the Overall Business/Strategy Plan of your firm?

not at all	to a small degree	to a moderate degree	to a high degree	to a very high degree
□	□	□	□	□

- To what degree the organizational units of various levels (e.g. directorates, departments) are involved in IS and applications development projects

not at all	to a small degree	to a moderate degree	to a high degree	to a very high degree
□	□	□	□	□

- To what degree you adopt a strategy of frequent introduction of new products/services with significant innovations

not at all	to a small degree	to a moderate degree	to a high degree	to a very high degree
□	□	□	□	□

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