

# The relationship between information and communication technologies adoption and management

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## Abstract

This paper examines the impact of information and communication technologies (ICT) adoption on management praxis. The study, building on the theoretical framework developed by Scott Morton and his colleagues, attempts to identify the dynamic relationships between ICT adoption and management efforts towards modernization and reorganization. Using data from leading Greek firms, we report evidence as to how changes in strategy, organizational structure, management systems, and human skills link with the current and prospective level of use of various types of advanced ICT. Findings generally appear to suggest that Greek firms are in a process of recognizing the potential of ICT to enable and support changes that are necessary for successfully competing in a hyper-competitive environment. In particular, ICT adoption is shown to affect strategy by supporting long-term strategic objectives and the quest for profitability. Indirectly, it also links to strategic planning systems. ICT is found to be related to an internal environment characterized by open organization and flexibility. Finally, the results show that the sample firms recognize the need for multi-skilled personnel to exploit the advantages stemming from ICT adoption. © 2002 Elsevier Science B.V. All rights reserved.

**Keywords:** Information and communications technologies; Impact; Strategy; Structure; Management systems; Human resources skills; Partial correlation analysis

## 1. Introduction

It is now widely accepted that globalization, deregulation, and innovation, propelled by information and communication technologies (ICT) are the key forces shaping the economic landscape. ICT has come to constitute the basis of economic development both at the macro and micro levels, and hence those actors that fail to participate in such developments risk increasing marginalization. It is, therefore, no surprise that the impact of ICT adoption and use on the management of

the firm has received considerable attention from researchers and practitioners alike.

For the greatest part, empirical research on the subject has been conducted in the US and other large economies (e.g. UK, Canada, and Australia). It could be argued, however, that even as ICT in business organizations around the world converge, the impact of their use may well depend on national culture [27] and in the specific idiosyncrasies of the economic environment in which they are embedded. It thus remains unclear if, and to what extent, relevant findings are applicable to other countries, and especially those that can be called “advancing” or “emerging”, such as Greece. Generalizations about the outcomes related to ICT adoption cannot be made until research

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accumulates evidence of similar effects across different economic environments.

After having made remarkable progress in terms of macroeconomic convergence, Greece has recently joined the Economic Monetary Union. Greek firms now face the challenge of continuously advancing their competitiveness in order to survive within the context of an increasingly hostile environment. On this account, they need to reorganize their structures, modernize their managerial practices and adopt new strategies for growth. These challenges are also indicative of the efforts needing to be undertaken by firms in other countries preparing to join the European Union, such as those of Eastern Europe (i.e. Hungary and Poland).

The role of ICT in the success of these efforts may be decisive. Unfortunately, there is a relative lack of empirical research regarding the impact of advanced ICT on Greek management. This lack of attention is surprising, since it is often argued that ICT fundamentally challenges the traditional ways by which firms operate, as it enables, and in many cases drives dramatic changes in the structure and operation of organizations. On the other hand, to be able to respond to today's ever changing competitive dynamics requires firms to adopt new ways of addressing market needs (e.g. innovation) as well as transforming the internal

organization (i.e. reducing managerial layers, increasing flexibility, using team-based work, etc.); such changes may also affect the extent of ICT adoption. Hence, the relationship between ICT adoption and management praxis is one of mutual influence and impact.

This study, building on the analytical framework developed by Scott Morton and his colleagues at MIT, attempts to identify the dynamic relationships involved between ICT adoption and management efforts. Using data from leading Greek firms we report evidence of recent changes in strategy, organizational structure, management systems, and human skills and their link to the current and prospective level of use of various types of advanced ICT.

## 2. Theoretical background

The theoretical model underlying this study is shown in Fig. 1, and is adopted and modified from the general framework developed by Scott Morton [49]. According to this framework, an organization is basically shaped by five forces (technology, strategy, structure, management systems, and people), which operate together in the context of a competitive environment. These forces collectively define a firm's

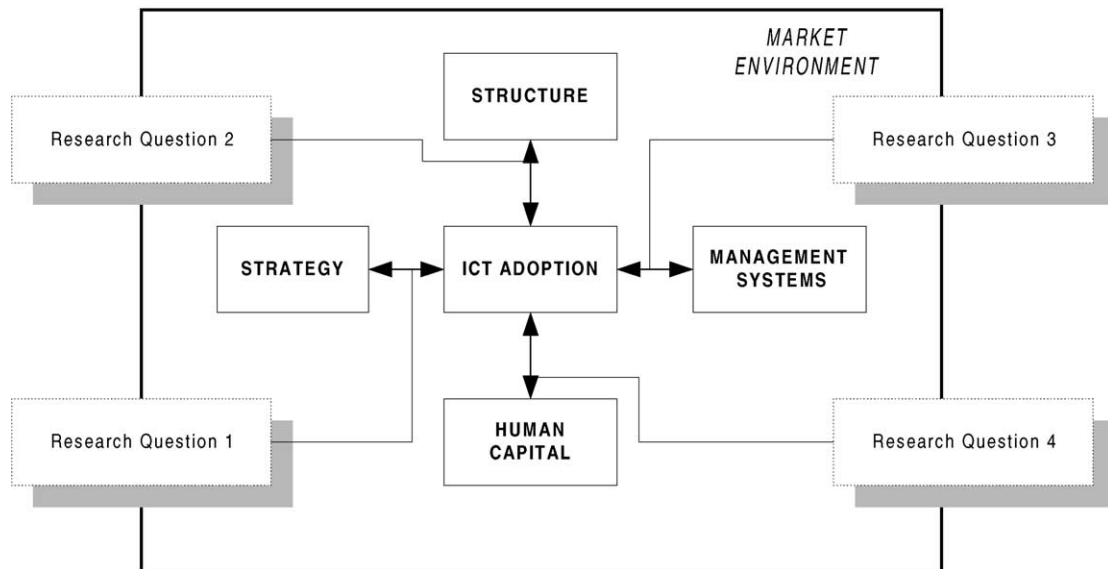


Fig. 1. Theoretical model.

fundamental *modus operandi* and are in dynamic equilibrium, leading to the accomplishment of the firm's objectives.

The model is particularly relevant, since it provides a structured way of exploring four broad research questions pertaining to the linkages between ICT adoption and recent changes in firms' strategy, structure, management systems, and human capital.

### 2.1. Information and communication technologies: types and impact on management

The shape of ICT utilization in today's organization is characterized by an explosion of products and services available not merely for the automation of basic transaction processing, but to systems that support the execution, co-ordination, control, and evaluation of entire business processes [56]. The multi-faceted nature of these technologies implies the need to study the impact of different types of technologies on management praxis. Dutta and Manzoni [14], for example, argue that ICT adoption corresponds to an incremental process of organizational capability development and strategic impact. Based on this, they differentiate among infrastructure, service, and value ICT.

The introductory ICT layer contains technologies that form part of the basic firm infrastructure providing the backbone for further information systems implementation. Far from exhausting them, in our study we covered infrastructure by focusing on *communication* technologies, comprising employee access to Internet, e-mail, and Intranets. Technology utilization at this level influences managerial action through automated communication and collaboration (e-mail, Intranets) often crossing organizational boundaries (Internet).

Further capability through ICT is achieved through technologies in the service layer, where emphasis has been given to the improvement of efficiency and effectiveness. The technologies provide *Process Support and Improvement* (PSI) to guide improvements in the content and context of the business processes in which they are embedded (in logistics, production, quality control, sales and distribution, and customer service). *Enterprise Resource Planning* (ERP), on the other hand, is a technology that has the potential of covering the entire value chain of activities under a unified technological platform.

Finally, current understanding seems to converge on the view that the value layer of ICT comprises technologies that:

- (i) enables the integration of, and access to, what has been called "organizational memory" [57];
- (ii) supports managerial decision making.

*Data Access and Analysis* (DAA) technologies, consisting of Data Warehouses that provide easy access to company data, Database Marketing, Data Mining, OLAP, and Statistical Sales Analysis tools, permit analysis and identification of relations "hidden" in large volumes of data to make information available to a wide set of actors across functional boundaries and hierarchical levels.

*Management Decision Support* (MDS) systems, on the other hand, provide, through DAA technologies, support to managers concerning decisions on scenario evaluation, monitoring of strategy implementation, etc. by handling largely unstructured, open-ended questions about unpredictable future events.

### 2.2. The relationship between strategy and ICT adoption

Strategy refers to the fundamental direction a firm pursues in its quest to adopt to industry environment. It is reflected both in the nature of goals set, and the array of activities undertaken to create a specific form of competitive advantage. According to Porter [38,39], there are two fundamental types of competitive advantage: differentiation and low cost.

The extant literature has from the outset advocated tight ICT-strategy linkages based on the assertion that technology affects strategy, that strategy has implications for new technology adoption, and that firms need somehow to integrate strategic thrusts with ICT capabilities [5,45]. The importance of ICT as a source of sustainable competitive advantage stems primarily from its potential to enable the transformation of a firm's value chain [40]. Since every value activity creates and uses information, ICT can be profitably exploited not only for the automation, but also integration and even transformation of activities that aim towards differentiation or low cost.

Porter and Millar [42] state that ICT offers organizations the opportunity either to enhance differentiation or to lower costs. For example, investments in ICT

may allow a firm to achieve a differentiation advantage by securing relationships with customers through improved product/service quality and by enhancing its ability to quickly respond to market changes. ICT can enable cost advantages by playing a direct or indirect role in the cost of various activities in the value chain. Wal-Mart provides a good example of how extensive use of ICT can provide a competitive edge. In this particular case, the integration of the retailer's supply-chain software with DAA technologies ensures on-time and efficient delivery of products to stores [43].

Beyond differentiation and cost advantages, ICT may also provide firms with unprecedented opportunities to expand to new markets and new types of activities. As new technology becomes embedded within the organization, gradual learning occurs that creates an awareness of different opportunities for action, which in turn could translate into changes in strategic goals [61].

Based on the above brief discussion, the following research question will be examined:

Research question 1: *Are changes in competitive strategy and strategic goals related to ICT adoption? If yes, with which types of ICT?*

### 2.3. The relationship between organizational structure and ICT adoption

Organizational structure provides the context for strategic choices to be formulated and it also provides the vehicle through which these choices are effectively implemented. In general, structure can be defined in the classical terms used by Burns and Stalker [7] when they distinguished between mechanistic and organic organizations. The former is characterized by a combination of a tall vertical hierarchy and high degrees of formalization and centralization. In contrast, organic firms have fewer managerial layers and tend to be less formalized and decentralized.

According to Miller [33], there is a relationship between the type of structure organizations espouse and their use of ICT. It is generally accepted that ICT may be an enabling mechanism (albeit not the sole one) for changes in organizational design. The extant literature generally predicts a flattening of the organizational chart because of changes in information technology [15,16,29]. Huber [20], for example, describes a flattening of managerial hierarchy because

the need for information intermediaries is reduced. According to him the role of middle managers as information supervisors tends to become obsolete, since ICT permits top management to communicate desired information without middle management. The decision-making process will, therefore, involve fewer levels of the organization because access to information is greater with ICT. Others, however, object to this line of reasoning. Zuboff [62], for example, argued that the role of ICT is not to replace middle-level professionals, but instead, to leverage their work.

As regards the concentration of decision-making authority and the formalization of rules and procedures, the findings of much of the innovation literature suggest that these factors inhibit innovation [9,10] and, hence, ICT exploitation.

Thus,

Research question 2: *Are changes in organizational structure related to ICT adoption? If yes, with which types of ICT?*

### 2.4. The relationship between management systems and ICT adoption

If structure provides the skeleton, management systems clearly correspond to the nervous system whereby coordination and control is effected throughout the organization. Prominent among these are the strategic planning, financial control, and Human Resource Management (HRM) systems.

ICT may dramatically enhance the coordination and control capacity of the firm [18], and hence, can stimulate increased use of management systems. ICT removes distance and time constraints in accessing required information flows and hence improves the coordination of activities within organizational boundaries. Moreover, ICT enables diffusion of organizational and market data that can be a crucial input for effective decision-making and control at all levels. ICT affects planning systems by improving organizational communication and by enhancing organizational flexibility [3]. Tallon et al. [52], found that operations-focused firms tend to use ICT to improve planning and management support, and to increase the efficiency and effectiveness of core processes in finance and human resources, among others.

Thus:

Research question 3: *Is increased emphasis on management systems related to ICT adoption? If yes, with which types of ICT?*

### 2.5. The relationship between human capital skills and ICT adoption

In a dynamic and hyper-competitive environment, ICT can be used as an enabler to turn data into information. However, it is only through people that information is interpreted and turned into knowledge. In fact, it is the interaction between people, technology, and culture, referred to as the “collective mind of the organization” [58], which allows the firm to address unexpected and novel problems [21].

In the ICT literature, a number of studies have prescribed complementing investments in information technology with employee participation, empowerment and cultural openness (e.g. [11,37]). It appears, however, that the human capital skills required to make effective use of ICT are the least tangible and perhaps, the most difficult complementary resources for the firm to develop.

ICT exploitation presupposes a culture that promotes continuous learning and employee empowerment, i.e. motivation, creativity and networking, among others. It is essential that employees are “multi-skilled” and “multi-functional” to take full advantage of the opportunities stemming by ICT adoption. They need to be equipped with appropriate analytical abilities and knowledge, and to be capable of efficiently organizing activities within a fluid and flexible environment. Further, they need to assume initiatives and exercise leadership for exploring innovative uses of new technologies. Finally, employees need to feel comfortable in an environment characterized by the need for extensive teamwork and horizontal communication [44].

Thus:

Research question 4: *Is increased emphasis on employee skills related to ICT adoption? If yes, with which types of ICT?*

### 2.6. The role of competitive environment and firm size

Two important contextual factors may condition the aforementioned relationships, namely market

dynamism and firm size. Market dynamism is of crucial importance to management in general, and management of technology, in particular. Technology policy regarding the adoption of new technologies is subject to managers’ perceptions regarding the direction and pace of market change. Irrespective of how accurately these perceptions reflect objective reality, the fact remains that decision to adopt or not new technologies is moderated by the particular understanding the firm develops of its market domain.

The influence of firm size in the adoption of new technologies, despite controversial empirical evidence, is postulated on the ground that large firms are in a better position to appropriate the returns of new technologies [35]. Moreover, large firms by definition own considerably more resources to allocate on new technologies in comparison to small firms. Finally, size is commonly used as a control variable in strategy and management related research.

## 3. Methodology

### 3.1. Sample and data collection

The study is based on a survey that was conducted between May and June 1999, just before Greece’s official accession to the EMU. It is part of a larger research project that sought to investigate the ways by which Greek firms are preparing for competing in the EMU. The data were solicited via mailed questionnaires from a population that included 500 leading Greek companies from all sectors of economic activity. They were selected from a database compiled by ICAP, based on 1996 financial figures.

The population, thus, drawn is clearly not representative of the general population. It was selected, however, on the premise that since it comprises market leaders, it represents the *avant grade* of Greek firms. Hence, conclusions based on this population should be indicative of subsequent developments in the Greek market as competing in the EMU will become a definitive reality.

To ensure data quality and to enhance response, the research instrument was pre-tested in three firms before mailing. Considerable efforts were given to ensure content validity by establishing relevance with practice and the elimination of wording problems

(such as biased, ambiguous, and inappropriate or double meaning items). Following some modifications, the final questionnaire was mailed to senior managers together with a letter explaining the purpose of the study and assuring anonymity. Four weeks after the initial mailing a follow-up was sent, providing the same material as the first.

A total of 91 managers provided complete answers to the questionnaire, giving an effective response rate of 18.2%. All respondents held senior managerial positions (i.e. CEOs or top managers directly reporting to the CEO). An additional number of 15 telephone and personal interviews was conducted to complement survey data with qualitative responses.

The sectoral distribution of the sample is as follows: manufacturing: 38.5%, commerce: 24.2%, financial services: 15.4%, construction: 4.4% and other services 17.6%. The average firm size is 515 employees (median 210). To test whether the sample firms are different from the population, we examined whether there are any differences in the means of all variables used in this study between early and late respondents. The rationale behind such an analysis is that late respondents (i.e. sample firms in the second mailing) are more similar to the population from which they are drawn than early respondents [2]. No statistically significant differences were found, thus, suggesting that non-response bias is not a serious issue in the study.

### 3.2. Measures

The research instrument contained questions in connection to ICT adoption and changes in competitive strategy, organizational structure, management systems, and employee skills. We established a common frame of reference by asking respondents to indicate changes relative to their firms' situation three years ago. All variables used in the study, with the exception of ICT adoption, were operationalized using self-typing *perceptual* measures, a well-accepted practice in this type of research.

Based on the rationale explained in Section 2.1, we measured ICT adoption with respect to the following technology types:

- (i) *Management Decision Support* (MDS) systems.
- (ii) *Enterprise Resource Planning* (ERP).

- (iii) *Data Access and Analysis* (DAA) technologies (i.e. Data Warehouse, Statistical Sales analysis, Database Marketing, Data Mining and OLAP).
- (iv) *Technologies for Process Support and Improvement* (PSI) (i.e. in logistics, production, Statistical Quality Control, sales and distribution, and customer service).
- (v) *Communication technologies* (i.e. employee access to Internet, e-mail, and Intranet).

We computed two composite indices that reflect the *current* and *prospective* use for *each* of these ICT types. Current use refers to the total number of applications currently utilized by a firm. Prospective use refers to the total number of technologies that are *either currently used or are currently developed for use* in the immediate future.

Change in competitive strategy orientation was measured along three key dimensions, namely, *quality*, *innovation*, and *low cost*, using three five-point Likert questions. Strategic goals were similarly operationalized using two items measuring change in emphasis on: (i) market share versus profitability, and (ii) long-term versus short-term objectives.

Change in organizational structure was measured with respect to the number of hierarchical levels and middle-level management positions, formalization, and centralization of authority. More specifically: change in the number of hierarchical levels was measured with one three-point item question (i.e. decreased, unchanged, increased). Respondents were also asked to indicate their plans for change in the near future. Change in the number of middle-management positions was identically measured.

Formalization refers to the degree of job codification and rule observation within an organization [24]. The operationalization of this construct was derived and adapted from Lefebvre et al.'s [25] study, using a three-item five-point Likert scale. The scale measures change in emphasis on complete job descriptions and compliance to company rules, and also, if there is less job overlap among managers. Centralization of authority concerns the distribution of power for the administration of operational activities. It was operationalized using one five-point Likert question, measuring the extent to which there is increased emphasis on centralization of operational budget formulation.

Change in emphasis on management systems was operationalized using four dummy variables indicating increased (or not) use of formal systems pertaining to: strategic planning, financial control, personnel evaluation, and personnel recruitment.

Employee skills refer to the personnel traits and qualities most favored by the firm's management. These skills include: communication, teamwork, analytical, leadership, the ability to organize, innovative thinking, and specialized knowledge. Respondents were asked to indicate in seven five-point Likert questions whether increased emphasis is given to each of these skills for the evaluation of current or prospective managerial personnel.

Finally, two control variables were utilized in the study, namely market dynamism and firm size. Dynamism refers to the amount and unpredictability of change taking place in the market environment. The operationalization of this construct was adapted from the scale developed by Miller [34], using four five-point Likert items. The scale asks questions about the degree of change in marketing policies, production technologies, rivals' moves, and customer tastes. Firm size was measured using the natural logarithm of the number of employees. Reliability coefficients for the formalization, employee skills, and market dynamism scales are 0.67, 0.72 and 0.70, respectively. Because all other variables are single item measures, alpha coefficients for these are meaningless.

## 4. Results and discussion

The descriptive statistics of all variables used in the study are presented in the Appendix A. We examined the four broad research questions using partial correlation analysis. This technique allows the computation of correlation coefficients that describe the linear relationship between two variables while controlling (i.e. removing or, adjusting) for the effects of one or more control variables. As indicated earlier, we control for market dynamism and firm size. Tables 1–4 report the partial correlation results regarding the relationship between ICT adoption and change in strategy, structure, management systems, and employee skills, respectively. In each Table, two sets of results are presented; one for *current*, and one for *prospective* use of the different ICT types.

### 4.1. ICT adoption and change in strategy

Table 1 reveals a negative association between current use of MDS systems and strategic change towards *low costs*. This is surprising, because lowering costs requires much effort to be devoted to cost control, which in turn requires extensive and disciplined quantification of enterprise cost parameters. A low cost strategy can be implemented using formal and analytical management practices that could potentially be supported by MDS systems, which allow the visualization, simulation, and forecasting of cost

Table 1  
ICT adoption and change in strategy

	MDS systems		ERP		DAA		PSI		Communication	
	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use
Change in competitive strategy orientation towards										
Low cost	–0.21**	–0.13	–0.01	0.05	0.10	0.13	0.04	0.07	–0.11	–0.11
Quality	–0.12	–0.07	0.06	0.12	0.06	0.00	0.12	0.10	–0.10	–0.22**
Innovation	–0.07	0.04	0.10	0.14	0.17	0.20*	0.01	–0.07	0.07	–0.02
Strategic aims										
Market share (vs. profits)	–0.03	–0.02	–0.19*	–0.19*	0.12	0.10	0.01	0.13	–0.06	0.07
Long-term targets (vs. short-term)	0.21*	0.20*	0.01	–0.14	0.02	–0.03	0.02	0.02	–0.12	–0.01

\*  $P < 0.10$ .

\*\*  $P < 0.05$ .

Table 2  
ICT adoption and change in organizational structure

	MDS systems		ERP		DAA		PSI		Communication	
	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use
Hierarchical levels										
Change in hierarchical levels	−0.25**	−0.09	0.04	−0.06	−0.18	−0.21*	−0.04	0.03	−0.26**	−0.19*
Future change in hierarchical levels	−0.22*	−0.02	−0.08	−0.07	−0.17	−0.20*	−0.15	−0.01	−0.23**	−0.32***
Extensiveness of middle line management										
Change in middle line management positions	0.06	−0.14	0.07	−0.17	−0.01	0.00	−0.04	0.05	0.12	0.10
Future change in middle line management positions	−0.04	−0.13	−0.03	−0.12	−0.09	0.07	−0.19	−0.07	0.07	0.15
Formalization										
Detailed job descriptions	−0.03	0.11	−0.19*	0.06	0.04	0.05	−0.05	0.01	−0.04	−0.16
Conformance to company rules	0.15	0.05	0.09	0.17	0.10	0.00	0.02	0.01	0.03	−0.02
Less job overlap	0.09	0.06	0.26**	0.22*	0.19*	0.15	0.16	0.13	0.16	0.05
Centralization										
Centralization of operational budgeting	0.05	−0.11	−0.02	0.02	−0.17	−0.22**	−0.13	−0.09	−0.06	−0.01

\*  $P < 0.10$ .

\*\*  $P < 0.05$ .

\*\*\*  $P < 0.01$ .



Table 3  
ICT adoption and change in the use of management systems

	MDS systems		ERP		DAA		PSI		Communication	
	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use
Increased emphasis on										
Strategic planning	0.24**	0.30***	0.16	0.08	0.35**	0.22**	0.04	0.09	−0.02	−0.09
Budgetary control	0.14	0.20*	0.18*	0.09	0.13	0.06	0.08	0.12	0.03	−0.08
Personnel control and evaluation	−0.07	0.06	0.13	0.11	0.17	0.17	0.10	0.06	0.17	0.04
Personnel recruitment	0.07	0.25**	0.00	−0.02	0.01	0.05	−0.06	−0.11	−0.02	0.05

\*  $P < 0.10$ .

\*\*  $P < 0.05$ .

\*\*\*  $P < 0.01$ .

Table 4  
ICT adoption and employee skills

	MDS systems		ERP		DAA		PSI		Communication	
	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use	Current use	Prospective use
Increased emphasis on										
Communication skills	0.02	0.04	−0.03	−0.01	0.05	0.12	0.05	0.00	0.16	0.17
Teamwork skills	0.09	0.08	0.02	−0.04	0.14	0.14	0.16	0.19*	0.00	−0.01
Analytical skills	0.29***	0.14	0.22**	0.20*	0.21*	0.00	0.16	0.22**	0.04	0.03
Leadership	−0.01	0.07	0.07	0.10	0.12	0.19*	0.05	0.08	0.04	0.03
Organizational abilities	0.10	0.10	0.01	0.01	0.15	0.12	0.15	0.18*	0.03	0.05
Innovative thinking	0.07	0.22**	0.12	0.04	0.11	0.08	0.06	0.14	−0.10	−0.12
Specialized knowledge	0.02	0.10	−0.11	0.00	−0.03	−0.05	−0.06	0.12	−0.05	−0.06

\*  $P < 0.10$ .

\*\*  $P < 0.05$ .

\*\*\*  $P < 0.01$ .

related performance indicators [55]. Our findings, however, indicate a negative relationship.

In contrast, the results show that both current and prospective users of MDS systems opt for strategic planning over a long-term horizon. The pursuit of *long-term strategic goals* reflects allocation of organizational resources directed towards strategic, as opposed to operational level activities. Strategic decisions, such as those involving new product introduction, entering into new market(s), and diversification of activities are by definition complex and relatively unstructured. Systems that support such decisions must supply information that is often multivariate and qualitative in nature [50], going beyond the realm of strict quantification of performance in financial terms. MDS systems could play such a role, since

they enable managers to focus more on in-depth analysis rather than data collection, to speed action [46], and to improve decision-making [6]. Our results appear to confirm the notion that MDS systems provide firms the capability to draw, combine and analyze information that embodies a variety of perspectives on organizational operations, and thus, to engage in long-term strategy formulation.

Current and prospective ERP use is found positively related to increased emphasis on *profitability* (as opposed to emphasis on market share). This finding is in line with market analyses that position ERP in the realm of technologies used “to improve productivity or achieve cost advantages” [13]. Table 1 also shows that strategic change towards *innovation* is associated with the prospective, but not current, use of DAA

technologies. This finding suggests that the sample firms are beginning to follow the international trend of turning to information access and analysis tools as they are orientating their strategy towards innovation. Apparently, our survey has ‘caught’ firms at the stage where they are preparing for implementing DAA applications for extracting potentially useful information that would otherwise remain “hidden” in large amounts of company data. Enhancing access to, and extraction of, information is considered as a mode of ICT adoption directly linked to securing a strategic advantage. Moreover, the critical role of information and knowledge in the process of building innovative capabilities has been firmly established in the innovation literature (see, for example [26]).

Our results indicate that the prospective use of *communication technologies* is negatively associated with increased emphasis on *quality*. This is surprising, since the potential of communication technologies to influence a strategy of quality can be important, as manifested in a number of success stories. For example, it was recently reported [47] that Bell Atlantic is making practical use of the Internet and Intranets to bring consistency to disjointed practices across the company. A “Project Management Center of Excellence” web page was created to communicate standard processes and recognize outstanding performance among project teams, with particular success. Another example is General Electric who recently developed an Intranet tool called “customer dashboard”, which is used to invite more than a thousand key customers to identify the most critical-to-quality aspects of the company’s products and then to define good performance and proper limits on defects [32]. Admittedly, the firms in our sample lack the size, and, perhaps more important, the management culture and sophistication to delve into such advanced uses of communication technologies. The negative, rather than positive association between the strategy of quality and the use of communication technologies warrants further exploration. Further, it is worth noting that increased emphasis on quality is not found to be associated with the use of any other ICT type. A central element of Total Quality management has been the recognition that providing regular, even real time, performance feedback to employees permits them to take responsibility for quality control, thus reducing the need for supervisors and quality

controllers. Computer-based applications, such as DAA, MDS, ERP, and PSI, could play such a role in providing information feedback regarding the critical factors for achieving and sustaining high quality. Our results, however, suggest that the sample firms have not reached the stage where ICT could be exploited in this direction.

#### 4.2. *ICT adoption and change in organizational structure*

The data in Table 2 show that the use of *MDS systems*, *DAA*, and *communication technologies* is linked to a decrease in the *number of hierarchical levels*, both relative to the past and with respect to expectations for decrease in the near future. More specifically, the results indicate that MDS and communication technologies are adopted to support information provision and person-to-person communication in the flat organization. Decrease in the number of hierarchical levels involves abandoning traditional hierarchical control over complex activities and processes. As such, managers must feel comfortable with a wide and volatile span of responsibilities, and this, in turn, results in an increased decisional and information-processing load. MDS tools support this need. Moreover, managers need to communicate intensively both vertically and horizontally, since coordination and control are substituted for cooperation in today’s organizations. Our results suggest that communication technologies play a vital role to this end.

The findings also reveal a positive association between current and future reduction in hierarchical levels, and the prospective use of *DAA technologies*. As noted earlier, the prospective use of these tools is positively linked to increased emphasis on innovation. Taken together, these findings suggest that the tendency towards innovation in flat organizations creates demand for managerial work that exhibits a fusion of working and learning [54]. In other words, DAA technologies are intended to ‘informatize down’, that is, to empower personnel to undertake open-ended decisional work.

Interestingly and in contrast to results concerning change in hierarchical levels, our findings show no significant association between ICT adoption and change in the number of middle-level management positions. As noted earlier, there are arguments both in

favor and against a positive impact of ICT on middle-level management. Our results support neither argument. Instead, it appears that middle-line management positions will slightly increase in the near future (see Appendix A), *independently* of any relationship to ICT adoption. This may be a result of the more general tendency of Greek firms to abandon the currently prevailing family-ownership model of management, in favor of a more professional one [51].

Turning to the issue of change in formalization, Table 2 indicates that current ERP adoption is the one and only technology found to have an association, indeed a negative one, with increased emphasis on detailed *job descriptions*. This finding is in accordance with the very nature of that technology, which aims at integrating all facets of business operations and management into a single architecture [12]. Because different work procedures are ‘melted down’, through the use of ERP, into integrated business processes [28], complicated interfaces among managers become unnecessary. The coherence of workflow thus, achieved may also explain why current and prospective ERP use is positively related to the “*less job overlap*” variable. In addition, the positive correlation of “*less job overlap*” with the current use of DAA applications suggests that the use of such technologies results in increased information availability, which, in turn, enables a clearer delineation of managerial roles.

Finally, the prospective use of DAA is found negatively linked to increased *centralization* of operational budgeting. It appears that firms having promoted delegation of operational decision-making also recognize the need to provide the technological means for extracting information necessary for effectively executing the task.

#### 4.3. ICT adoption and change in the use of management systems

Table 3 shows that increased emphasis on *strategic planning* systems is positively related to both the current and prospective use of MDS and DAA technologies. Both are appropriate technological means for extensive data monitoring, analysis, and modeling [31]; hence, they provide the basis for systematic exploration and evaluation of alternative courses of strategic action. This suggests a formal, control-oriented and benefits-monitoring driven approach to management [1].

*Financial control*, as shown in Table 3, is positively linked to the prospective use of MDS systems and the current use of ERP. With respect to the former, the results suggest that firms emphasizing financial control have only recently begun to recognize the capacity of MDS systems needed to provide direct access to timely, accurate, and actionable information about aspects relevant to financial planning and controlling. The positive association with ERP is explained by its capacity to integrate activity-based costing, operational-control, and financial reporting within the context of a single unified technological platform.

Increased use of *personnel recruitment* systems is found associated with ICT, and particularly with the prospective use of MDS systems. MDS systems are also found to link to strategic planning and financial control. By enabling thorough evaluation of alternative strategic actions, MDS systems appear to support a wide range of decisions that extend from the realm of financial controlling to that of human capital planning. Increased emphasis on HRM systems does not appear to be associated with the use of any other type of ICT. This is surprising, but it could be explained if one takes into account the idiosyncrasies of the Greek environment. Formal HRM systems are a relatively recent phenomenon in Greece; they are mostly utilized by foreign subsidiaries of multi-national firms and large Greek enterprises. It could be argued, therefore, that the use of these management systems is not yet mature enough to attract interest for extensive ICT support.

#### 4.4. ICT adoption and emphasis on employee skills

The final set of associations explored in the study concern the relationship between ICT use and emphasis on employee skills.

The results shown in Table 4 indicate that *analytical skills* are those most strongly associated with ICT use, and, more specifically, with MDS systems, ERP, DAA and PSI technologies. This finding, admittedly self-explanatory, implies that firms with such technologies in place require personnel that can understand and exploit them. ERP in particular, is well known for the exceptional capacities it incorporates for data reporting and manipulation; this can easily become overwhelming for users not accustomed to dealing with decisions relying on such a rich information basis.

The prospective use of PSI technologies appears to be strongly associated with increased emphasis on employee skills (i.e. *analytical skills, ability to organize, and teamwork*). PSI technologies often constitute the vehicle for changes in the division of labor from a functional decomposition to procedure and process integration. This is achieved through horizontal as well as vertical task integration. Horizontal task integration requires organizational actors to be able to organize a relatively diverse array of activities and to execute tasks effectively within cross-functional teams. Vertical task integration, on the other hand, requires that employees possess the analytical skills to combine, link, and exploit information at multiple levels of detail.

Table 4 reveals two additional associations. The first concerns the positive relationship between the prospective use of DAA technologies and increased emphasis on *leadership skills*. This finding suggests a tendency towards more demanding work arrangements, in the sense that employees are expected to exercise leadership and to undertake initiatives to exploit information uncovered with the use of such tools. The second finding, concerns the positive relationship between increased emphasis on *innovative thinking* and the prospective use of MDS systems. As noted earlier, this technology is also associated with increased emphasis on long-term strategic goals and strategic planning systems. It appears that the sample firms perceive MDS systems not only as providing the potential to support strategy formulation on a long-term horizon, but also, as providing opportunities for innovative solutions based on employees' creative thinking.

## 5. Implications and conclusions

Greece's recent accession to the EMU has generated formidable challenges for Greek firms. Within this context, the primary aim of our study was to investigate the relationship between ICT adoption and Greek firms' efforts towards modernization and reorganization. The findings indicate that current and prospective use of ICT is significantly associated with some important changes in strategy, organizational structure, management systems and human capital skills.

These results, however, should be interpreted against the economic background within which they were obtained. In terms of ICT awareness and penetration, Greece lags behind countries like the US and other advanced economies in the EU [22]. Given this "immaturity" of the Greek environment, our finding of a generally weak direct relationship between strategy and ICT use may not be overtly surprising. Further, ICT may influence competitive strategy *indirectly* rather than directly. As revealed in many of the personal interviews that complemented survey data, even though ICT use does not influence the *content* of strategy per se, it does result in increased availability and enhanced quality of information on which strategic decision-making is based. This reflects a particular management perspective on ICT termed "informing up". According to Schein [48], the diffusion of information supplied by ICT can be used to tighten, consolidate, and perhaps expand the power and scope of strategic control over enterprise activities.

This line of reasoning is compatible with the recent resource-based theorizing [4,59] and the 'strategic necessity hypothesis' [17,23]. The major premise is that ICT advantage depends heavily on "fitting the pieces together", that is, on exploiting relationships among complementary organizational resources. The significant relationship between ICT use and long-term objectives as well as the positive impact on the use of formal planning systems seem to point to this direction as a fruitful venue for future empirical research.

With respect to the relationship between ICT and organizational structure, the results reveal a rich set of significant direct associations. Overall, our findings imply that ICT is linked to a structural environment characterized by *open organization* and *flexibility*. It appears that Greek firms have begun to recognize the ability of ICT to release information throughout a lean hierarchical structure, while at the same time supporting managers' decisional capacity. Through informing down, managerial work shows signs of becoming better delineated, less formalized, and more decentralized. These results could also be interpreted as a sign of recognition of the fact that ICT-related benefits may be negated by structural constrictions.

It is important to emphasize, however, that the results indicate a noticeable lack of association

between certain types of ICT (i.e. PSI and communication technologies) and structural elements, such as formalization and centralization. Moreover, some of the significant associations found concern prospective, but not current use of ICT. This leads us to suspect that the observed transformation of organizational structure represents first-order change (i.e. incremental modification of existing arrangements), which is perhaps inadequate [41]. As Orlikowski and Gash [36] have argued, the exploitation of ICT typically necessitates second-order change, that is, radically different internal frames and processes that replace the existing *status quo*. In the long run, ICT exploitation may even require the creation of the very capacity to change (i.e. third-order change). Personal interviews with a number of respondents have confirmed that the pattern of observed structural changes is incremental rather than radical in nature. The interviews permit some optimism for the future, since they also confirm an awareness of the need for continuous implementation of structural changes.

Turning to the relationship between ICT adoption and the use of management systems, the results show a strong association between ICT and strategic planning; this suggests an indirect rather than a direct relationship with the firms' strategic behavior. This result is in line with academic and practice-oriented literature that strongly argues the need to integrate ICT with overall strategic planning efforts (e.g. [8,19]).

Finally, as regards employee skills, the results show that ICT adoption is related to a job enlargement effect [60] of managerial work, a trend that is similar to wisdom worldwide. Admittedly, our results do not and

can not indicate *how far* the sample firms are willing to go in providing employees access to information and autonomy to explore the possibilities offered by ICT. Maybe the management culture in Greece is changing; from the traditional command and control style characterizing until recent times many firms [30], to one embracing a more open philosophy with respect to human capital.

These results shed some light on the relationships between ICT adoption and change in the management of leading Greek firms. A limitation concerns the measurement of management practices, which was not exhaustive. Because of the exploratory nature of the research, it was thought best to begin with broad elements within each of the management dimensions examined. Our use of perceptual measures need not be considered a weakness, but does suggest that the respondents' perceptions as to the magnitude of change might not necessarily coincide exactly with reality.

Future research could examine the complementarities between ICT and organizational factors, particularly the firm's dynamic capabilities [53], which, from a resource-based perspective, constitute the fundamental basis for creating and sustaining competitive advantage. Moreover, it would be useful to see if similar studies, using data from other small economies—perhaps those preparing for joining the EU (e.g. Hungary, Poland, etc.), provide comparable results. Accumulating a body of research with findings extended to contexts other than large economies would hopefully provide a more global view of the relationship between ICT and management.

## Appendix A. Descriptive statistics

	Mean	S.D.
Change in strategy		
Competitive strategy		
Increased emphasis, relative to the past, on... (1: strongly disagree, ..., 5: strongly agree)		
Low cost	4.30	0.99
Quality	4.31	0.89
Innovation	4.01	0.99
Strategic goals		
Increased emphasis, relative to the past, on...		
Profits vs. market share (1: on profits, ..., 5: on market share)	3.14	1.16
Short-term vs. long-term targets (1: on short-term, ..., 5: on long-term objectives)	2.16	1.13

**Appendix A. (Continued)**


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Change in organizational structure		
Hierarchical levels (–1: decrease; 0: no change; 1: increase)		
Change in the number of levels, relative to the past	–0.04	0.72
Future plans for change in the number of levels	–0.08	0.75
Middle-level management positions (–1: decrease; 0: no change; 1: increase)		
Change in the number of positions, relative to the past	0.02	0.85
Future plans for change in the number of positions	0.17	0.85
Formalization and centralization		
Increased emphasis, relative to the past, on... (1: strongly disagree, ..., 5: strongly agree)		
Detailed job descriptions	3.78	1.22
Conformance to company rules	4.01	1.08
Relative to the past, we experience less job overlap	3.40	1.11
Centralization of operational budgeting	2.55	1.20
Change in management systems		
Increased emphasis, relative to the past, on... (0: No, 1: Yes)		
Strategic planning systems	0.70	0.46
Financial control systems	0.77	0.42
Personnel control and evaluation systems	0.74	0.44
Personnel recruitment systems	0.53	0.50
Change in employee skills		
Increased emphasis, relative to the past, on... (1: strongly disagree, ..., 5: strongly agree)		
Communication skills	4.73	0.52
Teamwork skills	4.69	0.49
Analytical skills	4.48	0.62
Leadership	4.30	0.76
Organizational abilities	4.57	0.62
Innovative thinking	4.28	0.76
Specialized knowledge	4.07	0.92
ICT adoption		
MDS systems (current use) (min: 0, ..., max: 1)	0.30	0.46
MDS systems (prospective use) (min: 0, ..., max: 1)	0.56	0.50
ERP (current use) (min: 0, ..., max: 1)	0.31	0.47
ERP (prospective use) (min: 0, ..., max: 1)	0.54	0.50
Data Access and Analysis (current use) (min: 0, ..., max: 5)	1.64	1.27
Data Access and Analysis (prospective use) (min: 0, ..., max: 5)	2.41	1.61
Process Support and Improvement (current use) (min: 0, ..., max: 5)	2.80	1.59
Process Support and Improvement (prospective use) (min: 0, ..., max: 5)	3.59	1.34
Communication technologies (current use) (min: 0, ..., max: 3)	2.42	0.91
Communication technologies (prospective use) (min: 0, ..., max: 3)	2.71	0.65

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