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IT/IS implementation risks and their impact on firm performance

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ABSTRACT

There has been considerable theoretical work on the role of information systems (IS) in creating competitive advantage and enhancing organizational performance. The literature identifies a consistent lack of success by organizations in achieving business benefits from their IS investments and in particular their difficulties in obtaining a sustainable competitive advantage. A great deal of debate appears to exist nowadays related to the participation of information technology (IT) risks to organizational performance. Previous research has dealt with the examination of the existing relationships between the implemented information technology and firm's performance variables. This research focuses on the IT impact on firm's non-financial IT risk. The research was conducted using questionnaires that were sent to world's five hundred largest corporations as they were published in the fortune magazine (European edition, No. 14, 2003) and to Greek companies. The results indicate that IT risk factors affect mainly coordination and partially information ability but not productivity. Furthermore, the most significant risk factors affecting business performance are management ability, information integrity, controllability and exclusivity.

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1. Introduction

Business investments may contain business risks that threaten firm's abilities to implement business processes effectively (Bell, Marrs, Solomon, & Thomas, 1997). Thus it is not surprising that a large number of CEOs feel that the use of a "robust" program for managing business risks ensures an essential basis for maintaining competitive advantage (Economist Intelligence Unit, 2001). It becomes clear though, that firms that wish to manage risk on a firm-wide basis, have to "stretch" their focus beyond classic types of risk and to include economic risk types together with risks related to reputation and data integrity (Pricewaterhouse Coopers, 2002). This is also supported by CAS (2003) that points out that firms have to identify the importance of all types of risks and not only the familiar ones.

Enterprise risk management (ERM) refers to a continuous firm-based process that focuses on business risk definition, anticipation and management (CAS, 2003). ERM deals with fundamental factors that firms try to manage in order to identify possible risks. Hence ERM provides a holistic basis for firm-wide risk assessment and analysis. Generally firms are threatened by four types of risks: hazard risks, financial risks, strategic risks and operational risks and ERM covers all four risk types including their "sub-risks". For example, operational type risks contain risks derived from business operations, empowerment and information technology (CAS, 2003). This research is specialized to a specific part of ERM process, and in particular examines the impact of information technology risks on firm performance.

During the last three decades the use of information technology/systems (IT/IS) has been increased significantly. Many organizations invested a considerable amount of money in various types of information systems in order to improve their organizational performance and competitiveness (Clemons & Row, 1991; Porter, 1985; Powel, 1996; Powel & Dent-Micallef, 1997).

The adoption, implementation and expansion of an information system have an important impact on the way business functions are organized within a firm. This impact can be divided into two major categories: financial and non-financial impacts. Financial impacts can be expressed in monetary terms such as profitability and cost, while non-financial impacts in terms such as labour's conduciveness and teamwork. According to Wijnhoven and Wassenaar (1990), the real value of an information system can be estimated by taking into account both forms of impacts. Hence, the evaluation of an information system is a critical decision when an organization plans to adopt an information system.

This research refers to the non-financial impact of information systems implementation on a firm's performance examining IT/IS implementation risks. It focuses on giving a better insight of the variables that consist and determine both IT implementation risk and the three fundamental measurements of a firm's performance. More specifically, IT risk are decomposed into six measured risk

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variables: (i) exclusivity, (ii) information integrity, (iii) controllability, (iv) user operations, (v) continuity, and (vi) management ability and firm performance is measured by productivity, coordination and information ability. Then an attempt is made to examine the relationship between each risk variable with each of the three different performance variables. The main objective is not only to explore which risks affect what type pf performance, but also the magnitude of their relationships.

2. Literature review

2.1. Information technology costs and risks

The implementation of an information system by an organization is not a harmless and risk-free procedure. As Irani (1999) stated, there are not only the benefits and gains that come with information technology implementation, but there are also a number of non-financial tangible and intangible costs and risks which are related to this implementation. Hallikainen, Kivijarvi, and Nurmimaki (2002) suggests that the use of the information technology encapsulates both systematic and unsystematic risk. Further they argued that the risk perspective of IT implementation can be divided into five basic categories: (i) the application complexity, which refers to the number of links to other existing other systems, (ii) the application size, which focuses on the number of users needed to use and develop the information system, (iii) the organizational environment, which is related to intensity of conflicts between the IS team members and users, (iv) the team expertise, which refers to user experience and team's expertise in system's development, and finally (v) the technological novelty, which focuses on the information system's update needs and the number of hardware and software suppliers (Hallikainen et al., 2002).

According to Netherlands National Bank's Risk Analysis Manual (De Nederlandsche Bank, 2001), information technology risk is the predictable or possible risk that comes up because of insufficient processing of the existing information system, and can be defined using the terms of, exclusivity, integrity, controlability, user operations, continuity and manageability. The first term (exclusivity) refers to information system's level of inappropriate authorization and unauthorized access. For example, in a high-risk ranked IS a user has the ability to change static and confidential data and the IS is very vulnerable to unauthorized users. Also, the term integrity risk refers to the volume of incorrect and irregular used and processed data. Moreover, the level of an IS controlability can be determined using the degree by which functioning of IS has been tested and by assessing the quality of documentation that follows the information system's control procedures. Likewise, a firm may notice an inadequate use of information technology which can result from users not being supported adequately by the IS structural organization and the lack of skill and experience applied to the information system (user operations risk). Additionally, an IS is exposed to continuity risk when there is not a high level of data and information availability and there is a high volume of system failures and disruptions. Finally, the term manageability describes the organization's exposition to risk because of the low degree of IS adjustment to new updates, which reflects the low degree of information system's flexibility and maintainability (De Nederlandsche Bank, 2001).

2.2. Financial and non-financial impact

Firms are investing in information systems to capture and exploit the benefits from information technology implementation. Many researchers (Cox & Clark, 1984; Duchessi, Scaninger, & Hobbs, 1989; Mcallister & Carlisle, 1993) focused their researches on the economic and financial impact of Information technology on firm's operations. Further, Irani (1999) stated that technological changes induce a firm's operations continuously and transform the way that firms use and exploit information technology. Moreover Irani (2002) identified two types of IT impact: (i) financial and (ii) non-financial impacts. The term financial can be defined as "the consequences that can be explained in monetary terms" while, in contrast, non-financial impact can be defined as "the consequences, which cannot be explained in monetary terms" (Renkema & Berghout, 1997). Also, Escobar-Pérez (1998) argues that the information technology impacts can be further divided into managerial and development impact. The first type includes attributes like: probability to achieve business benefits, support of management decision making, response to competitive systems, while the second type of impact refers to the introduction and adaptation of the information system and the system's requirements and needs.

Furthermore, Irani (2002) argued that the benefits and costs of information technology investments can also be classified as tangible and intangible. The term "tangible" can be defined as something that can be visible and sensible, and the term "intangible" can be described as something that can be invisible and indefinable (e.g. knowledge, information mentality, culture) (Brynjolfsson & Yang, 1998).

3. Research modeling

3.1. The impact of IT/IS implementation on a firm's performance

The implementation of an information system is not only a beneficial action for an organization, but there are several risks and costs that the organization has to consider. According to Irani (1999) new direct and indirect costs arise after the implementation of an information system that can be classified into human and organizational costs. The category of human costs refers to: (i) the needed employee training for the handling of the new information system, (ii) the employee's motivation and interest in the new computerized technology which is reduced as time goes by, (iii) the needed changes in the employee's salaries which increase as time goes by, (iv) the required staff turnover for skilled employees, (v) the cost of ownership and the level of vendor's support, (vi) the needed staff resource for the integration of computerized environment into work practices and (vii) the management effort and dedication for linking and combining different information systems. Further, the category of organizational costs refers to: (i) the needed organizational restructuring because of IS investment, (ii) productivity losses till the complete adaptation of the new information system, (iii) the required business process re-engineering and redesign of a firm's processes and functions, (iv) the needed software updating and protection from viruses and hacking, and (v) security breaches that cause a great loss of time and productivity, and reduce the firm's trust and image (Irani, 2002).

Moreover, Cline and Guynes (2001) supported the fact that firms that are leaders in IT investments are more profitable and productive, in contrast with other firms within the same industry which spend less on information technology. Furthermore, Kivijärvi and Saarinen (1995) argued that there is a connection between the impacts caused by IS implementation and firm's performance and firms need to use their knowledge mechanisms in order to identify any risks and to achieve improved firm performance. Additionally, Heo and Han (2003) reported that organizations should develop evaluation mechanisms, so that measuring performance variables will determine three factors: (i) the organizational impact, (ii) the relationships between the affected business functions and IT costs, and (iii) the firm's performance.

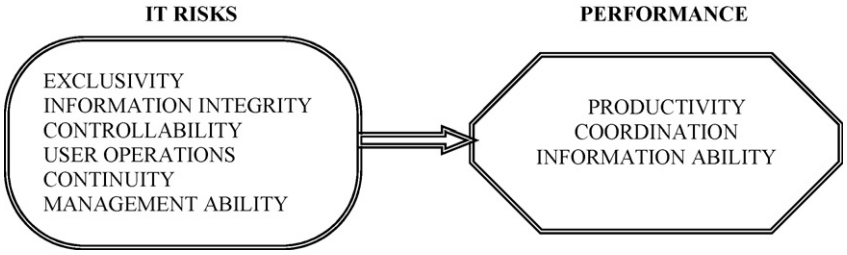


Fig. 1. IT implementation risks impact on performance.

Further, researchers (Brynjolfsson & Hitt, 1993; Mahmood & Mann, 2000; Sircar, Turnbow, & Bordoloi, 2000) found that IT/IS implementation is related with the firm's revenues and improves firm's reliability, flexibility and performance. In addition, Cline and Guynes (2001) found that firms invest in information technology to create value through the expected impact on their business functions and costs, resulting in the improvement of their performance parameters such as profitability, flexibility, and competitiveness level. Finally, Rakesh (1996) stated that the nature of IT impact on business processes can be productive, coordinative and informative.

3.2. IT risks and performance

This paper is part of a broader research that attempted to examine how IT implementation affected a firm's business processes and functions as well as the risks and costs involved, and then, to link them with the overall firm performance. In this paper, an attempt is made to examine how the risks involved in the implementation of information technology affect a firm's performance (Fig. 1). The investment in information systems does not only benefit firms, but also involves new types of risks and costs. According to Alter (2002), serious problems and drawbacks in a firm's performance are caused by eight categories of IT risks which are: (i) operator errors, which refer to the misconduct of the system operator, (ii) hardware malfunctions, which refer to errors made because of wrong hardware design, (iii) software bugs, which refers to a flaw in the used programme that leads to incorrect results, (iv) data errors, which stands for invalid data, (v) accidental disclosure of information, which describes user's carelessness, (vi) damage to physical facilities, which refers to inadequate protection against failure of system's components, (vii) inadequate system performance, which stands for system's failure to meet the designed expectations and (viii) liability, which refers to system's level of responsibility (Alter, 2002).

The research model (Fig. 1) is mainly based on the Netherlands National Bank's Risk Analysis Manual (De Nederlandsche Bank, 2001). According to this Risk Analysis Manual, information technology risks appear from an insufficient followed strategy and policy and from inefficient manipulation of the implemented information technology, both of which can decelerate an organization's performance improvement. In specific, six out of seven risk items proposed from the Netherlands National Bank's Risk Analysis Manual are incorporated into the research model in an attempt to both confirm the validity of the model (using our research sample) but also to explore the magnitude of the effect for each of the individual items on business performance. An analysis of the six IT risks can give a better insight into the IT risks and costs under investigation. These are (Table 1):

(i) information integrity risk, which refers to the incorrect, incomplete or untimely input of data and information,

Table 1
Core IT risks attributes.

IT risks	Measured attributes	Variables
Exclusivity	User authorization Unauthorized access	Static data Access data
Information integrity	Information is correct Information is compliant	Readable data Response to firm needs Meeting requirements
Controllability	IT/IS functions have been tested	System development Problem development Configuration development Performance management
User operations	IT/IS is user friendly	(User friendliness for skilled) (User friendliness for unskilled)
Continuity	Information availability	Frequency of disruptions
Management ability	IT/IS is maintainable IT/IS is extendable IT/IS is flexible IT/IS is adaptable	IT maintainability IT expandability Reorganize data Acquire data Divest data Time-to-market of updates cost/future technologies Time-to-market of updates cost/new OS Time-to-market of updates cost/new hardware Time-to-market of updates cost/new versions

Adapted from: De Nederlandsche Bank, June 2001, Risk Analysis Manual.

(ii) management ability risk, which reflects the level of information system's flexibility, maintainability, extendibility and adaptability,
(iii) controllability risk, which stands for the inadequate documentation and number of control points provided by the used information technology,
(iv) user operation risk, which describes the deficient and insufficient handling of the implemented information system,
(v) exclusivity risk, which refers to system's security, meaning the level of inappropriate and unauthorized accesses and
(vi) continuity risk, which outlines the level of system's information availability and restorability.

All the above six analyzed types of information technology risks are critical for the expected accomplishments of IT implementation and organization's performance (De Nederlandsche Bank, 2001).

Moreover, Jordan and Silcock (2005) expressed that faulty and risky use of the IT may have a serious impact on productivity and performance. Several researches (NIST, 2002; O'Donnell, 2005)

point to the fact that a mixture of the above six risk types may affect firm's performance. In specific, exclusivity and information integrity risk result to inaccurate, erroneous data leading to false decisions and low information ability. Also, data continuity problems cause low firm performance as well as controllability, user operations and insufficient manageability (Jordan & Silcock, 2005).

Further, performance is measured using three different parameters: (i) productivity, (ii) coordination and (iii) information ability (Table 2). According to Shao and Lin (2001) investments in information technology have an efficient impact on a firm's production process, where, in contrast, Ko and Bryson (2002) found IT implementation has not improved a firm's productivity as it was designed and expected to do, but still a connection between IT impacts on firm's functions and costs and firm's performance exists. Moreover, Hitt and Brynjolfsson (1996) found evidence that spending in information technology may lead a firm's productivity to a higher level. Furthermore, Kling et al. (2001) stated that information technology investments directly improve a firm's performance by giving solutions to critical coordination problems as they become more complex and interdependent. Also, Gurbaxani and Shi (1992) stated that information systems might simplify firm's functions, improving a firm's coordination ability. Additionally, Bruque-Camara, Moyano-Fuentes, Hernandez-Ortiz, and Vargas-Sanchez (2003) argued that a firm's information ability improves by IT implementation and can lead the organization to higher levels of performance, as Poston & Grabski, (2000) also stated.

3.3. Research methodology

The main objectives of this research are to examine the way information technology is used and its impacts on the firms' non-financial performance. A structured questionnaire was designed and used to collect the data. The purpose of the questionnaire was to investigate those factors within a firm that are affected by IT/IS implementation. This questionnaire was distributed via electronic mail (e-mail) to six hundred major firms in Greece that have implement and use IT/IS systems. Additionally, the questionnaire was sent via electronic mail (e-mail) to the world's five hundred largest corporations as they are published in the "Fortune" magazine (European edition, No. 14, 2003).

The head of the IT department of each firm was contacted (by telephone or personally), in order to provide them with explanations regarding different aspects of the particular research. One hundred and fifty four completed questionnaires were received. From them, ten were discarded, because they were not considered valid. Finally, 144 questionnaires are included in the data set; 102 from Greek companies and 42 from foreign companies.

The questionnaire consists of fifty nine multiple questions and is divided into five sections.

Each section consists of several questions which are measured using 5-point Likert type scales ranging from 1 (very high) to 5 (very low). The first section refers to the general characteristics of the firm, such as the industry it belongs to, and the size of the firm (sales, market share, number of employees). The second section contains questions concerning firm's productivity gathering data about firm's business planning, inventory and supply chain, product quality and employee skills and abilities. The next section measures firm's coordination as far as data and process management and employees are concerned. Further, section four deals with firm's information ability, measuring items such as Internet usage, data capturing and flow and the provision of customer information. Finally, the last section is about firm's information technology risks. In this section there are questions measuring the six risk types: exclusivity, information integrity, controllability, user operations, continuity and management ability.

Table 2
Variables measuring firm's performance.

Factor	Attribute	Variable
Productivity	Inventory and supply chain	Supply communication
		Delivery time
		Inventory
		Manufacturing cost
		Labor cost
		Produced output
		Manufacturing ability
	Business planning	Sales
		Intensity of rivalry
		Privileged information
		Bargaining power with suppliers
		Bargaining power with buyers
		ROI
		Total output
	Human resources	Improved employees' computer skills
		Increased staff needs
		Employees' adoption of new technology
		Employees' ability to solving problem
		Team skills
	Customer support	Product quality
		Customer returns
		Defected rates
Coordination	Data and process management	IS openness
		IS reliability
		IS scalability
		Data reusability
		Data portability
		Data updating
		Data management
		Security breaches
		Data availability
		On-line ordering
		IT integration
		Data processing
		Program processing
		Security costs
	Human resources	Team scheduling
		Team support
		Employees' respect for the company
		Employees' trust for the company
		Employee needs satisfaction
		Employee opportunities enhancement
		Employee interest for their job
Informative ability	Customer support	Question reply
		Complaints response
		Helpful information
	Data and process management	IT equipment reduction
		Data capturing time reduction
		Data flood reduction
		Data report submission
		Internet use
		Filtering data
		Capturing data
		Useful information
		New data flow
		New computerized production

4. Data analysis and interpretation of results

4.1. Descriptive statistics

Table 3a presents the profile of the questionnaire participants. The proportions of the firms that participated are 72.9% Greek firms and 27.1% foreign firms. These firms are mainly from the

Table 3a
Descriptive statistics of research sample.

Variable	Statistics			
Origin	Greek firms:	72.9%	Foreign companies:	27.1%
Industry	Manufacturing:	47.9%	Financial:	10.4%
	Services:	22.9%	IT/Telecommunications:	18.8%
Size (employee based)	Small (<250):	33.3%	Medium (251–1000):	15.6%
	Large (1001–50,000):	28.9%	Very large (>50,000):	22.2%
Ownership	Single firms:	47.9%	Corporations:	52.1%
Market share	<10%:	29.7%	10.01%–25%:	32.5%
	25.01%–50%:	21.6%	>50%:	16.2%
Sales	Small (<€100 millions):	47.2%	Medium (€100 m–1 billion):	8.4%
	Large (€1–50 billions):	21.2%	Very large (>€50 billions):	22.2%

manufacturing industry (47.9%) but also form the services (22.9%), IT/telecommunications (18.8%) and financial (10,4%) industry. It is also a balanced sample as far as the size (based on their employee number) and market share are concerned.

Table 3b presents the impact of IT/IS implementation on different types of risks involved. In detail, the mean values for all attributes are between "high" and "satisfactory", except for the attributes concerning exclusivity and continuity which are between "satisfactory" and "low".

These results reflect the improvement of information systems capabilities in minimizing data's corruptions (information integrity). Further, the level of data readability and data requirements indicates a quality evolution of end-user software design. In addition, the level of data response is "high", reflecting the better architecture of computer networks and process software.

Additionally, as far as controllability is concerned, only "IS development" is closer to "high" than the remaining three variables which are closer to "satisfactory" level, indicating that although the advances in IT/IS has enabled companies to control their functions properly, there are still some problems with running these systems. Another explanation is that IS performance, project and configuration management, is only at "satisfactory" level, because of a well recognized problem, this of management's tendency to fund failing projects, as Kumar (2002) stated.

Moreover, the values of the attributes that define firms' exclusivity risk are closely to "satisfactory" as is continuity risk as well. It can be assumed that there is a difficulty in determining the boundaries between data manipulation and data access authorization. In other words, it is difficult for organizations to set the right data access limits for their employees without putting in danger their used data's exclusivity and continuity. "Access confidential data" is close to "satisfactory", because of the fact that security policy generally focuses on specific technical threats and vulnerabilities of the IS and not on vital threats as Coles and Moulton (2003) implied. Also, "change static data" is at the same level, because of the users' need of users to change static data in order that new information is "born" using the specific IT/IS. Further, the continuity risk is at a fair level because security policy often focuses on specific infrastructure platforms and systems and not on business processes, as Coles and Moulton (2003) stated.

Considering information system's friendliness, the lower user operation risk exists for the skilled users, while there is a fair level of risk for the unskilled users. It can be argued that information systems are usable and friendly even for the unskilled employees; otherwise their level of friendliness would have been low.

Examining management ability risk, can be noticed that again, all the measured variables are between "high" (future cost) and "satisfactory" (data divesting). It can be extracted that IT implementation has affected mainly information systems' maintainability and expendability, but not its costs Meaning that, it is difficult and expensive for firms' to replace the information systems they are currently using with other new IT/IS. These results (Table 3b) also display the difficulty that exists in divesting useful data, causing a fair management risk for the organization. Further, IS maintainability and extendability levels are close to "high" because of the reduction of hardware prices which gives the ability to firm's to extend their networks and maintain them easily. Moreover, data acquisition and reorganization variables are close to "high", because of the improvement of software's ability to manage inputted data.

Regarding the participants' origin it can be noticed that Greek firms reported higher information integrity controllability and user operations risks that foreign firms. On the other hand foreign firms reported higher exclusivity, continuity and management ability risks. It can also be noticed that on the part of information integrity risk Greek firms are far for foreign firms risk position.

Taking a closer look to Table 3b, it can be seen that large firms occupy more "risk-secured" position than the other firms except for exclusivity and management ability risks. Furthermore, large firms hold a relatively better "risk-secured" position than medium and very large firms (as the large firms' risk means are higher than medium and very large firms' risk means). In addition, small firms reported higher information integrity risk and medium firms higher user operations risk relatively to other firms. Also, it can be noticed that the services industry reported the higher information integrity risk and the financial industry reported the lowest continuity risk.

It must be stressed here that the mean value of all the variables presented in Table 3b were tested and found to be significantly different to zero. Furthermore, no significant difference was found in the mean value of the variables concerning information integrity, controllability and exclusivity, when they were compared to the other variables within the same factor.

To summarize, IT/IS implementation is associated mainly with "information integrity" which is close to "high". Moreover, all variables are placed between "high" and "satisfactory" apart from "exclusivity" and "continuity" which are between "satisfactory" and "low".

4.2. Factor and correlation analysis

Confirmatory factor analysis (with Varimax Rotation) was, performed to examine whether the initial classification of the variables into the specific factors was valid or not (Table 4). Cronbach's alpha was used to measure the internal consistency while KMO (Kaiser–Mayer–Oltin) was used to measure the sampling adequacy. A weak threshold (0.5) is accepted for both measures (Malhotra, 1999). The results of the factor analysis indicated that although

Table 3b
Impact of IT/IS implementation on risks.

IT risk	Variables	Variable mean[a,b]	S.D.	Factor mean[b]	Origin[b]		Size[b]				Industry[b]			
					Greek	Foreign	Small	Medium	Large	Very large	Manufacturing	Financial	Services	IT/telecommunications
Exclusivity	Change static data	3.23	0.95	3.24	3.29	3.12	3.33	3.12	3.25	3.10	3.50	3.80	2.82	2.78
	Access confidential data	3.25	0.97											
Information integrity	Data readability	2.25	0.63	2.27	2.18	2.51	2.05	2.19	2.46	2.43	2.35	2..27	1.94	2.48
	Data response	2.29	0.65											
	Data requirements	2.27	0.67											
Controllability	IS development	2.52	0.54	2.64	2.62	2.69	2.68	2.50	2.69	2.43	2.70	2.60	2.55	2.64
	IS project management	2.73	0.70											
	IS configuration management	2.67	0.66											
	IS performance management	2.65	0.69											
User operation (IS friendliness)	Skilled users	2.17	0.77	2.47	2.40	2.65	2.33	2.00	2.85	2.45	2.48	2.30	2.55	2.44
	Unskilled users	2.77	0.80											
Continuity	Continuity	3.31	0.65	3.31	3.37	3.15	3.20	3.29	3.62	3.20	3.35	4.00	3.09	3.11
Management ability	IS maintainability	2.40	0.73	2.45	2.47	2.40	2.63	2.24	2.42	2.37	2.50	2.42	2.52	2.27
	IS extendability	2.31	0.71											
	Data reorganization	2.40	0.70											
	Data acquisition	2.27	0.64											
	Data divesting	2.83	0.97											
	Future cost	2.13	0.53											
	New OS cost	2.42	0.70											
	Hardware cost	2.73	0.57											
	New version cost	2.58	0.73											

[a] 1: Very high, 2: high, 3: satisfactory, 4: low, 5: very low.
[b] All mean scores are significantly different to zero.

Table 4
IT risks factor analysis.

IT risks	KMO	Bartlett's sig.	Total variance explained (TVE)	Cronbach a	Loadings
Exclusivity	0.500	0.000	71.380	0.598	0.845 0.845
Information integrity	0.662	0.000	70.669	0.792	0.861 0.891 0.765
Controllability	0.668	0.000	50.689	0.665	0.540 0.838 0.827 0.591
User operation (IS friendliness)	0.500	0.000	68.325	0.536	0.827 0.827
Management ability	0.561	0.000	56.783	0.742	0.756 0.829 0.663 0.757

"Exclusivity" and "User Operation" risk factors have a rather low Cronbach alpha (0.598 and 0.536) and "Controllability" and "Management Ability" risk factors have a relatively weak TVE indicator (50.689 and 56.783) risk factors are created those that initially was decided to be examined. The sixth factor is "Continuity" that is measured by a simple variable.

Table 5 demonstrates the relationships between the IT risks and firm's productivity, coordination and Information ability.

From this analysis it is extracted that all IT risk factors (except "continuity") affect coordination and information ability. Furthermore, only exclusivity is related to Productivity. To conclude, it is obvious that only coordination and information ability are affected by all IT risk factors, while Productivity is affected by only one factor. All relationships are statistically significant and negative as they should be according to theory.

In an attempt to interpret these results, some interesting points can be presented:

- Concerning *exclusivity risk*: if a large proportion of a firm's employees are authorized to change or access confidential data (high risk), then there is a negative impact on firm's performance, because of crucial data losses and delays, which, in turn, delay firm's productivity (productivity decreases), confuse employees (low coordination) and slows down firm's "informing up" process, as the quality of firm's information becomes "questionable" (low information ability).
- Concerning *information integrity risk*: if a firm's used information is at a high degree readable, correct and complete (low information integrity risk), then employees do not waste time searching for additional data or clarifying the information they receive in order to accomplish their tasks (high coordination), and the quality of a firm's "generated" information increases (high information ability).
- Concerning *controllability risk*: if there is adequate documentation concerning the use of IT and the functioning of the IT has been and can be well sampled (low controllability risk), then IT users can easily deal with many problems that appear at different departments and/or branches (high coordination), and the information derived from these departments is consistent (high informative ability).
- Concerning *user operations risk*: if firm's IT system is user friendly (low user operations risk), then the IT users can straightforwardly solve coordination problems without the assistance of IT specialists (high coordination), but also IT users may provide their departments with high quality data and timely information (high information ability).
- Concerning *management ability risk*: if a firm's IT is highly maintainable, flexible and adaptable (low management ability risk), then IT users may easily update and maintain their information systems and improve their collaboration (high coordination), and also, the integrity and the quality of the firm's generated data and information may not be affected by IT hardware changes (high informative ability).

4.3. Regression analysis

Table 6 demonstrates the results of the regression analysis between the IT risks and firm's performance factors. Three lin-

Table 5
The correlations between the IT risks and firm's productivity, coordination and information ability.

Correlations	Exclusivity	Information integrity	Controllability	User operations	Continuity	Management ability
Productivity						
Pearson's *r*	−.231*	.019	−.149	−.138	.051	−.056
Sig. (2-tailed)	.006	.828	.082	.107	.556	.516
Coordination						
Pearson's *r*	−.327**	−.453**	−.371**	−.496**	−.087	−.455**
Sig. (2-tailed)	.000	.000	.000	.000	.301	.000
Information ability						
Pearson's *r*	−.203*	−.212*	−.277**	−.287**	−.118	−.244**
Sig. (2-tailed)	.014	.011	.001	.001	.161	.003

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 6
The regression analysis between the IT risks and firm's performance factors.

Dependent variable Productivity	Independent variables −.186 exclusivity				
(*t*) (Sig.)	(−2.769) (.006)				
Adj. R^2 Sig. *F* Sig. *F* Durbin Watson VIF	0.046 .006 7.666 .006 1.577 1.000				
Dependent variable	Independent variables				
Coordination	−.137 exclusivity	−.199 info. integrity		−.127 controllability	−.186 manag. ability
(t) (sig)	(−3.803) (.000)	(−5.494) (.000)		(−3.473) (.001)	(−5.096) (.000)
Adj. R^2 Sig. *F* Sig. *F* Durbin Watson VIF			4.52 .000 30.494 .000 2.091 <1.074		
Dependent variable	Independent variables				
Information ability	−.096 exclusivity	−.098 info. integrity		−.135 controllability	−.111 manag. ability
(t) (sig)	(−1.822) (.071)	(−1.837) (.068)		(−2.500) (.014)	(−2.063) (.041)
Adj. R^2 Sig. *F* Sig. *F* Durbin Watson VIF			.133 .000 6.472 .000 1.829 <1.074		

ear regression models were tested having as dependent variables the performance factors (productivity, coordination, information ability) and as independent variables, the IT risks factors (exclusivity, information integrity, controllability, user operations, continuity, management ability).

The first equation indicates a negative relationship between productivity and exclusivity risk, however, its predictive power (adjusted R^2) is small (0.046). This outcome supports Solow's saying that "We see computers everywhere, except in the productivity statistics" (Solow, 1987) and several researches that found no correlation of IT implementation with firm's productivity (Brynjolfsson, 2003; Hitt & Brynjolfsson, 1996; Strassmann, 1990; Strassmann, 1997; Strassmann, 2002; Yosri, 1992).

The second equation presents a negative relationship between coordination and (i) exclusivity, (ii) information integrity, (iii) controllability and (iv) management ability risks. The predictive power of this model is 45% ($R^2 = 0.452$) and the model is theoretically valid. According to Dhillon and Backhouse (1996), firms should maintain a high information integrity level in order to minimize IT risks. Also Kling et al. (2001) imply that firms may improve their coordination if they identify, tighten, and consolidate their IT risks.

The third equation suggests a negative relationships between information ability and (i) exclusivity, (ii) information integrity, (iii) controllability and (iv) management ability risks. However, once again the level of adjusted R^2 is low (0.133). If employees can change fundamental firm data than the level of firm's information integrity declines making difficult to manage. Additionally, Dhillon and Backhouse (1996) imply that low information integrity leads to information mismanagement and, finally, to information losses (low information ability).

In summary, the results indicate that mainly coordination and partially information ability can be explained by taking into consideration various IT risk factors (adjusted $R^2 = 0.452$ and 0.133 respectively). In other words four types of risk (exclusivity, information integrity, controllability and management ability) appear to affect firm's coordination and informative ability.

5. Conclusions

According to several researchers (Brynjolfsson, 1993; Mahmood & Mann, 2000, etc.), the mystery of "productivity paradox" enabled many researchers to examine and investigate the connection between information technology implementation and a firm's productivity. This paper reflects on a study of the IT impact on a firm's general performance measuring performance variables such as: (i) productivity, (ii) coordination, (iii) information ability and (iv) IT risks. The research was conducted using questionnaires that were sent to the world's five hundred largest corporations, as they are published in the "Fortune" magazine (European edition, No. 14), and to a few hundred Greek companies. The results imply that information technology implementation may have an impact on a firm's performance but this impact does not affect firm's productivity as it was expected to do. Probably, this fact supports the theory of "productivity paradox". On the other hand, it is found that IT risk factors affect mainly coordination and partially information ability.

From a managerial perspective, it would be meaningful to understand the way that information technology implementation affects a firm's performance variables. The results of this research showed that IT affects non-financial IT risk variables at a "satisfactory" level. Hence, it is possible for a developing organization that IT implemen-

tation may slightly empower its development process and secure its competitiveness in its industry. Also, it can be assumed that an already developed organization may implement an IS, in order to catch up with any antagonistic market actions from its competitors that may cost it market share. Further the research found evidence that IT mostly affects a firm's coordination, thus it can be suggested that, on average, organizations may gain a sufficient competitive advantage regarding their coordination ability. In other words, it can be assumed that organizations that wish to achieve lower IT risk levels may not fully achieve their goal, simply by implementing or improving their information technology. According to these results, the key for a successful and low-risk IT implementation may not lie on pursuing productivity benefits and gains, but it probably lie on combining IT gains, risks and costs, with a in press opportunity within market sector.

Moreover, from a research perspective, it is hoped that this analysis concerning non-financial IT risks across a firm's performance levels, may provide future researchers with an essential framework for investigating and evaluating IT impact. Also, future research may go even further by determining the IT impact using variables that this research has not used at all, and evaluating IT effects not only in a static but also in a dynamic way, in order to give managers premium information to achieve better exploitation of IT benefits.

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