

The Impact of Information Technology Infrastructure Flexibility on Firm Performance: An Empirical Study of Jordanian Public Shareholding Firms

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ABSTRACT

Most of the Information Systems (IS) research considered Information Technology (IT) as infrastructure flexibility construct in terms of connectivity, compatibility, modularity, and IT personnel competency. Chanopas *et al.* (2006) expanded the construct by adding other five elements; namely scalability, continuity, rapidity, facility, and modernity. Indeed, since no research validates Chanopas *et al.*'s (2006) study, which was the first describing a new framework represents IT infrastructure flexibility. The current research aims at examining their investigation on the nine variables that reflect the construct. In addition, as research has neglected the association between IT infrastructure flexibility and firm performance besides some researchers calls (e.g. Chanopas *et al.*, 2006; Tanriverdi, 2006; Fink and Neumann, 2009; Zhang *et al.*, 2009; Bhatt *et al.*, 2010) who emphasised that very little theoretical and practical research occurs on studying the relationships among IT infrastructure flexibility, IT-based competitive advantage, and firm performance. This paper is the first that empirically tested the associations among them. Several statistical techniques were conducted on data collected from a sample of 98 firms. Empirical results did not find a direct relationship between IT infrastructure flexibility and firm performance. However, causal links were founded between IT infrastructure flexibility and IT-based competitive advantage; and IT-based competitive advantage and firm performance. The conclusions of the current study are provided, and areas for further research are also addressed.

Keywords: IT Infrastructure Flexibility, IT-based Competitive Advantage, Firm Performance.

INTRODUCTION

Since firms do encounter changing environment, rivalry competition, and rapid technological advancements; how to survive in these challenges is a crucial question. Certainly, for small and medium enterprises (SMEs) and large firms, responding to change and exploiting market opportunities are key survival and success capability. Therefore, firms should use their resources in innovative ways for creating competitive advantage. Resources contain all assets,

capabilities, organizational processes, firm attributes, information, and knowledge controlled by a firm that allow the firm to perceive and implement strategies that advance its efficiency and effectiveness (Barney, 1991). Indeed, IT infrastructure considered to be an important part of a firm's resources and capabilities, and in supporting operational and strategic activities.

However, some researchers (e.g. Bhatt and Grover, 2005; Bhatt *et al.*, 2010) did not find a direct relationship between IT infrastructure and a firm's competitive advantage. Therefore, a flexible IT infrastructure is a key for firms to survive. In this regard, it has been confirmed that IT infrastructure flexibility is an enabler to competitive advantage since the sharing of information and knowledge is vital (Fink and Neumann, 2009; Zhang

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et al., 2009; Bhatt *et al.*, 2010). Initially, Byrd (2001) defined IT infrastructure flexibility as the capability of the infrastructure to support a wide variation of hardware, software and other technologies which can be easily diffused into the overall technological platforms, to allocate any type of information to anywhere inside and outside the firm, and to support the design, development and implementation of a heterogeneity of business applications. This paper empirically examines the impact of IT infrastructure flexibility on firm performance through IT-based competitive advantage. It validates nine dimensions of IT infrastructure flexibility including connectivity, compatibility, modularity, IT personnel competency, scalability, continuity, rapidity, facility, and modernity.

The rest of this paper is organized as follows. It commences with the literature review regarding IT infrastructure, IT infrastructure flexibility, IT-based competitive advantage, and firm performance. Then, the research model and hypotheses development are described. It then presents the methodology used for the study followed by its analysis and findings. The discussion and conclusion are then provided and areas for future research are also addressed.

Theoretical Background

Reviewing the literature that relates to IT infrastructure, IT infrastructure flexibility, IT-based competitive advantage, and firm performance offers the conceptual bases for this research.

Information Technology Infrastructure

IT infrastructure consists of IT architecture, processes and skills (Papp, 1995). IT architecture entails software, hardware, networks, data, applications and data management that a firm uses to sustain its IT and business strategies. The second parts of IT infrastructure are the processes which refer to the enhancement of specific IT practices and activities that employees may

do to manage, develop and maintain IT applications and, in turn, improve IT infrastructure. The last component is IT skills, which is related to the human resource activities to enhance IT. This includes hiring and training practices, employee competencies and salaries, and the IT culture and its connected norms.

Byrd and Turner (2000, p. 172) defined IT infrastructure, composed of two major components – technical and human infrastructure – as follows: ‘The shared IT resources, consisting of a technical physical base of hardware, software, communication technologies, data, and core applications and a human component of skills, expertise, competencies, commitments, values, norms, and knowledge that combine to create IT services, provide a foundation for communication interchange across the entire organization and for the development of present and future business applications’. While the technical infrastructure is composed of the applications, data, and technology, the human IT infrastructure consists of the knowledge and capacity to manage IT resources. Research identified IT infrastructure and processes as one of four variables necessary to achieve IT-business partnership (Henderson and Venkatraman, 1993). Further, they defined three components for IT infrastructure and processes: architecture, processes, and skills. Architecture refers to technology priorities, and choices that allow applications, software, networks, hardware and data management to be integrated into a cohesive platform. Processes relate to the practices and activities carried out to develop and maintain applications and manage IT infrastructure. Skills refer to IT human resource considerations, such as how to hire/fire, motivate, train/educate, as well as culture.

Croteau *et al.* (2001) measured technological infrastructure by embodying five components: user involvement in IS (personal commitment in the organization and cooperation of users in all features of IT); connectivity (configuration of networks which

combines systems and applications, and allow accesses from different locations); distributed computing (issuing information and processing power to users); flexibility (business communication commitments, and shared data and application elements); and technology awareness (a common interest to gain IT knowledge and to adopt new technology in firms). Bergeron *et al.* (2004) captured IT structure construct by using two dimensions of "IT planning and control" relates to how well firms manage their IT function, resources, and infrastructure related to their competitors, and "IT acquisition and implementation" represents the extent to which firms manage the selection and introduction of new IT applications. However, researchers (e.g. Byrd and Turner, 2000; 2001) emphasized that flexible IT infrastructure should be considered as a source of sustainable competitive advantage.

To sum up, researchers in the area of IS have used the construct of IT infrastructure to study its effect on organizations. Also, knowing how to measure IT infrastructure is precious to IT managers and executives for managing IT resources in the firms they work for. This is to say that with a high degree of IT infrastructure occurrence, firms could be able to accommodate unpredictability of business environment.

Information Technology Infrastructure Flexibility

Apart from an organization's core competency, IT infrastructure flexibility is vital if organizations are to survive in the increasingly competitive global environment. Many have called for more research on the relationship between IT infrastructure and organizational flexibility in order to respond to external events (Tallon and Kraemer,

2003). Earlier research by Weill (1992) argued that IT infrastructure should be flexible in order to manage increasing customer demands without further costs. Duncan (1995) argued that infrastructure flexibility could improve the ability of system developers to design and build systems to meet business objectives.

Therefore, a flexible IT infrastructure is able to react to changing business environments. Duncan (1995) illustrated IT infrastructure flexibility in terms of connectivity, compatibility, and modularity. Connectivity and compatibility are linked to the idea of reach and range, which are concerned with the sharing of a common set of IT resources among internal and external users. Byrd and Turner (2000) statistically proofed that IT infrastructure flexibility consist of four variables namely connectivity, compatibility, modularity, and IT personnel competency.

Byrd and Turner (2000) defined connectivity as the ability of any technology component to attach to any of the other components inside and outside the organizational environment; compatibility as the ability to share any type of information across any technology component; modularity as the ability to add, modify and remove any software, hardware or data components of the infrastructure with ease and with no major overall effect; and IT personnel competency contains both skills and experience required of IT personnel to perform IT activities. In addition, Chanopas *et al.* (2006) expanded the four components of IT infrastructure flexibility (i.e. connectivity, compatibility, modularity, and IT personnel competency) by adding another five components namely scalability, continuity, rapidity, facility, and modernity. The following table states the nine components.

Table 1: Components and Definitions of IT Infrastructure Flexibility (Adapted from Chanopas *et al.*, 2006)

Components	Definition
IT personnel competency	The degree to which IT personnel possess relevant skills and experience to effectively perform IT activities.
Scalability	The degree to which hardware/software can be scaled and upgraded on existing infrastructure.
Continuity	The degree to which hardware/software/data/IT personnel can seamlessly serve the users in an organization without disruption.
Compatibility	The degree to which hardware/software can share any type of information both inside and outside the organization.
Connectivity	The degree to which hardware/software can connect to others both inside and outside the organization.
Rapidity	The degree to which hardware/software can deliver information whenever it is needed.
Modularity	The degree to which hardware/software/data can be separated and recombined to support new system development.
Facility	The degree to which hardware/software can be used with ease.
Modernity	The degree to which hardware/software are based on well-known products and technological trends.

IT-based Competitive Advantage and Firm Performance

Some researchers (e.g. Zhang *et al.*, 2009) argued that IT infrastructure flexibility increases the degree to which firms adapt to environmental changes (i.e. in terms of users' needs; business processes designs; and unplanned changes in IT-related requirements) which could in turn improve firms performance. Indeed, IT-based competitive advantage refers to the know-how of IT to meet the wants driven by the changes from inside and outside the firm. Also, the researchers emphasized that the lack of flexibility could cause rise in costs, delays in projects and new product launch, and increase in customer dissatisfaction; besides decreases in firm performance. Moreover, Tallon (2008) measured the flexibility construct in terms of the degree to which a firm can utilize IT in respond to changes in demand, reacting to new products and services in the market,

changes in pricing or product mix, moving into new markets, and customizing a product to a specific customer or market segment.

Adapted from Byrd and Turner (2001), Fink and Neumann (2009) measured IT-based competitive advantage in terms of innovativeness, market position, mass customization, and difficulty to duplicate. Innovativeness implied that firms often use IT as a component for an information-based innovation by generating and implementing new ideas, processes, products, and services. Market position was assessed by indicating a firm's position in which competitors are forced to adopt less favorable postures. Mass customization was measured by determining whether firms utilize IT to widen the array of products without increasing costs. Difficulty to duplicate was assessed by knowing if the IT infrastructure in the firms difficult and expensive for rivals to duplicate.

Using IT relatedness as a second-order construct (comprising IT infrastructure, IT strategy-making processes, IT vendor management processes, and IT-human resources management processes); Tanriverdi (2005) empirically tested its significance for firm performance. IT infrastructure components, applicable across most industries include hardware, software, and communications technologies. Once a strategic alignment is established as being important for firm performance (Henderson and Venkatraman, 1993; Sabherwal and Chan, 2001; Masa'deh and Kuk, 2009; Garg and Goyal, 2012), then corresponding business strategies are necessitated corresponding to IT strategies, thus, using a common IT strategy-making process offers a strategic direction for the IT decisions on the business units (Tanriverdi, 2005; 2006).

Moreover, the common IT strategy-making process uses procedures that reflect the earlier experience within firms and preferences about IT strategic concerns like alignment between IT and business strategies. The IT role initiates tasks for managing and developing IT vendor relationships (Brown and Ross, 2003). Even business units spend time and effort to determine strategic goals for relationships with multiple vendors, in which they expand agreements with the same IT vendors or get similar products from different vendors. The absence of common IT vendor management processes synergies results in the inability of firms to negotiate for lower costs and better quality of IT products and services. IT-human resources management processes could be achieved cross business units when IT employees understand the general needs, goals, share common values and incentives which results of synergies within the firm (Tanriverdi, 2006).

Furthermore, Tanriverdi (2005) tested 250 large multi-business firms by using a mail survey for both business and IT executives, in which 50 different

industries in both the service and manufacturing sectors were represented. He found out that IT-relatedness improved firm-level Knowledge Management (KM) capability, which itself enhanced corporate financial performance. Therefore, it was shown that IT relatedness had significant indirect effects on firm performance through the mediation of KM capability. Financial performance was gauged by using objective measures of accounting-based (ROA) and market-based performance (Tobin's Q). In addition, the study avoided the common method bias by collecting IT relatedness data from senior IT executives, the KM capability data from senior business executives, and the financial performance data from the COMPUSTAT database. However, a suggestion was made for additional research in small- and medium-sized firms to validate the results, which were based on large multi-business firms only. Hence, it can be seen that firms that incorporate IT relatedness into their IT strategies are more likely to increase their performance.

To summarize, a firm's infrastructure could make tactical innovations in business process feasible, and the characteristics of competitors' infrastructures may likewise cause their inability to imitate the innovation rapidly enough to mitigate the first mover's advantage. Consequently, since a flexible IT infrastructure is not easily imitated, innovations are coring which assist management control over the uncertainty environment.

Research Model and Hypotheses Development

The focus of this research was to investigate how IT infrastructure flexibility impacted firm performance directly as well as indirectly through IT-based competitive advantage. Figure 1 displays the research's proposed framework.

Indeed, some research focused on the relationship between IT infrastructure and some organizational

enablers such as strategic alignment between IT and business strategies. For instance, a recent study by Chung *et al.* (2003) tested the impact of IT infrastructure flexibility on strategic alignment and applications implementation by using data from 200 US and Canadian medium and large companies. They asked IT personnel to complete a questionnaire relating to compatibility, connectivity, and modularity on a 7-point Likert scale ranging from 1, ('not at all') to 7 ('to a great extent'). They found that all three components of

IT infrastructure flexibility correlated positively with strategic alignment and on the applications implementation (e.g. management information systems; decision support systems; data warehouse; and knowledge management). Thus, a flexible IT infrastructure is essential if firms are to maintain sustainable competitive advantage. The researchers suggested that their model should also be tested on responses from business and IT managers.

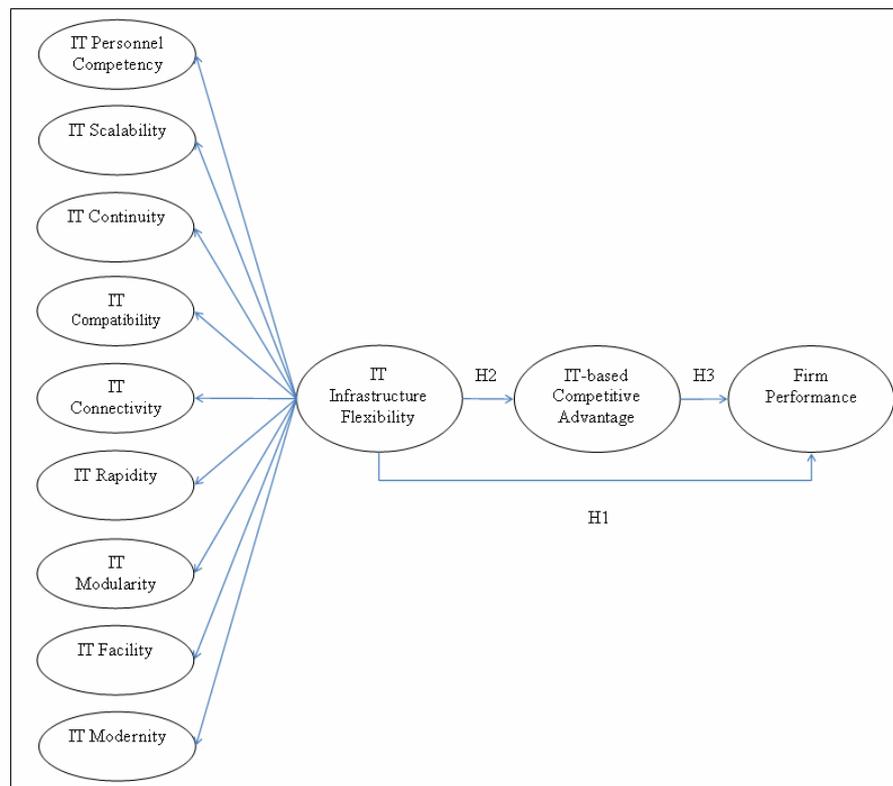


Figure 1. Research Framework

A more recent study conducted by Ness (2005) tested the relationship between IT flexibility, strategic alignment and IT effectiveness. Further, Ness (2005) used Tallon and Kraemer's (2003) model to represent IT flexibility, namely compatibility, connectivity, and

modularity. IT effectiveness measurements included user satisfaction, quality of service, and helpfulness of the IT staff. Ness (2005) distributed questionnaires to 3,080 CIOs and senior IT executives at large for-profit US firms but received only 81 responses, due mainly to the

size of the selected firms, the level of executive involvement, their availability to respond, and the fact that many firms had moved. The study provided empirical evidence, nonetheless, that IT flexibility, strategic alignment and IT effectiveness are positively associated, and that IT flexibility has a stronger positive correlation with IT effectiveness than with strategic alignment. Furthermore, IT effectiveness was found to be a moderating variable between strategic alignment and IT business value. Ness suggested further research to validate the findings in small and medium sized firms, and within diverse market sectors. However, few empirical studies tested whether IT infrastructure flexibility enabled firm performance (Bhatt *et al.*, 2010). This leads to the following hypothesis:

H1: Information technology infrastructure flexibility has a direct effect on firm performance.

Earlier research argued that IT units have to become facilitators to sustain competitive advantage (e.g. Allen and Boynton, 1991). However, Nemetz and Fry (1988) suggested that in order to achieve improved delivery capability, then flexibility should be undertaken to do so in which it deals with business demand changing and uncertainty. Davenport and Linder (1994) asserted that IT infrastructure flexibility should be seen as core competency of organizations. Thus, firms should utilize their IT units to respond very quickly to tactical moves by competitors; which in turn provide a higher competitive advantage over their competitors. Indeed, Byrd and Turner (2001) found a statistical support on the association between IT infrastructure flexibility (measured using three dimensions namely IT personnel flexibility, integration, and modularity) and competitive advantage.

In addition, Zhang *et al.* (2009) found that IT responsiveness mediated the impact of IT infrastructure flexibility (in terms of modularity and IT personnel

competency) and firm performance. They considered modularity and IT personnel competency as they are the least studied dimensions of IT infrastructure flexibility. Also, Bhatt *et al.* (2010) examined and found a positive impact of the association between IT infrastructure flexibility and organizational responsiveness in which the latter related to an organization's ability to response to environmental changes. They measured IT infrastructure flexibility in terms of IT scalability, compatibility, the ability to share information, modularity, and if the IS systems can handle multiple business applications.

Fink and Neumann (2009) tested the relationship between IT infrastructure flexibility (in terms of IT modularity, IT compatibility, and IT connectivity) and IT-based competitive advantage mediated by range of physical capabilities (in terms of whether the IT unit provides a wide range of channel management services, security and risk management services, communication services, data management services, application infrastructure services, and IT facilities management services). The researchers did not find a statistical support of the effect of IT modularity on range of physical capabilities; IT compatibility on range of physical capabilities; and range of physical capabilities on IT-based competitive advantage. Thus, Fink and Neumann called for further research to investigate the above associations. Based on the above discussion, the researcher formulates the following hypothesis:

H2: Performing information technology infrastructure flexibility is positively related to IT-based competitive advantage.

Moreover, although researchers (e.g. Fink and Neumann, 2007) found a relationship between IT infrastructure flexibility and organizational agility in terms of achieving innovation, there is a lack of

empirical research on the effect of IT-based innovations on firm performance (Fink and Neumann, 2009). However, some researchers (e.g. Bhatt *et al.*, 2010) found that firms which respond quickly to customer changes and competitors, and leverage their IT investments to innovate are better exploiting opportunities to gain long term performance benefits than those slow in responding. Therefore, this research formulates the following hypothesis:

H3: Performing IT-based competitive advantage is positively related to firm performance.

Research Methods

Measures

In this study, the researchers developed a field study for IT managers. That is as a basis for data collection and analysis, respondents answered all items on seven-point Likert-scales ranging from “1” meaning “strongly

disagree” to “7” meaning “strongly agree”. Further, elements used to consider each of the constructs were primarily obtained from prior research. These elements provided a valued source for data gathering and measurement as their reliability, and validity has been verified through previous research and peer review. IT infrastructure flexibility construct was measured using nine dimensions which were drawn from Chanopas *et al.* (2006); IT-based competitive advantage variable was measured using four items which were adapted from Byrd and Turner (2001) and Fink and Neumann (2009); and firm performance was measured using five items which were identified from Bhatt *et al.* (2010). Moreover, Table (2) shows the measured constructs and the items measuring each construct in which the nine dimensions collectively constitute the overall scoring of IT infrastructure flexibility.

Table 2: Constructs and Measurement Items

Construct	Measurement Items
IT Personnel Competency (PC)	PC1: IT personnel understand policies and goals of the organization. PC2: IT personnel are able to plan for future technological challenges. PC3: IT personnel are able to be IT project leaders. PC4: IT personnel are able to quickly learn and apply new technologies. PC5: IT personnel are eager to learn new technologies. PC6: IT personnel are able to interpret business problems and develop appropriate technical solutions. PC7: IT personnel are knowledgeable about environmental constraints within the industry. PC8: IT personnel are able to work cooperatively with users in a cross-functional team. PC9: IT personnel are skilled in multiple technologies and tools (e.g. programming languages, operating systems).

Construct	Measurement Items
<i>IT Scalability</i> (SC)	SC1: Hardware/software can be easily upgraded on existing IT infrastructure. SC2: Hardware/software can be easily scaled on existing IT infrastructure. SC3: Hardware/software can be easily and quickly adapted for changing needs and standards. SC4: Hardware/software can support business growth in the future. SC5: Hardware/software can be added to, modified or removed from existing IT infrastructure with no major overall effect.
<i>IT Continuity</i> (CT)	CT1: Disaster planning and recovery are ready to launch. CT2: Data backups are adequately kept. CT3: IT personnel in any positions can be easily replaced. CT4: Hardware/software can be concurrently used by a large number of users.
<i>IT Compatibility</i> (CM)	CM1: Applications can be used across multiple operating systems. CM2: Data can be shared across applications and operating systems. CM3: Data across applications and operating systems has consistency and integrity. CM4: The organization provides multiple data types (e.g. text, voice, multimedia) for data sharing. CM5: Data can be shared across departments and organizational boundaries. CM6: The organization provides multiple interfaces (e.g. website, call center) for data sharing.
<i>IT Connectivity</i> (CN)	CN1: Authorized data can be accessed by external parties through IT networks, regardless of location. CN2: Authorized data can be accessed by internal users through IT networks, regardless of location. CN3: All external parties (e.g. customers, suppliers) are electronically linked with the organization through IT networks. CN4: Conferences within the organization can be held through IT networks, regardless of location. CN5: All departments and branches are electronically linked together through IT networks.
<i>IT Rapidity</i> (RP)	RP1: IT components (e.g. hardware, software, database) are standardized throughout the organization. RP2: Speed of communication through IT networks is satisfactory for internal users. RP3: Compared to rivals within the industry, the organization has the foremost IT networks.
<i>IT Modularity</i> (MD)	MD1: Data is separated from applications. MD2: Legacy systems within the organization do not restrict the development of new applications. MD3: Reusable subsystems or modules are widely used in system development (e.g. login module is reused in many applications). MD4: Data captured in one part of the organization are immediately available to everyone in the organization.
<i>IT Facility</i> (FC)	FC1: Single terminal can be used to operate on different operating systems. FC2: Applications are user-friendly (e.g. web-based, menu-driven). FC3: Non-IT personnel can use applications without intensive training.
<i>IT Modernity</i> (MR)	MR1: Hardware/software are based on well-known products. MR2: Hardware/software are based on current technological trends.

Construct	Measurement Items
<i>IT-based Competitive Advantage (CA)</i>	CA1: The company often uses IT as a component for an information-based innovation. CA2: The company's IT-induced market position is such that competitors are forced to adopt less favourable competitive postures. CA3: The company utilizes IT to widen the array of products without increasing costs. CA4: The IT infrastructure in the company would be difficult and expensive for rivals to duplicate.
<i>Firm Performance (FP)</i>	FP1: Over the past three years, our firm's financial performance has been outstanding. FP2: Over the past three years, our firm's financial performance has exceeded the competitor's performance. FP3: Over the past three years, our firm's sales growth has been outstanding. FP4: Over the past three years, profitability of our firm has been higher than our competitor's profitability. FP5: Over the past three years, our firm's sales growth has exceeded the competitor's sales growth.

Sample and Data Collection

The initial instrument was pre-tested in three semi-structured interviews with IT managers and three MIS academic professors. This is to improve its understandability, relevance, completeness, length, and overall appearance of the survey. Changes and modifications were made to the final version of the questionnaire. In addition, to ensure adequacy of response, a cover letter was attached to each questionnaire elaborating the importance of participants' participation. Furthermore, this study has been applied in Jordan as scholars (e.g. Chanopas *et al.*, 2006; Fink and Neumann, 2009; Zhang *et al.*, 2009; Bhatt *et al.*, 2010) have called for such research in the context of developing countries. The research population consists of all Jordanian public shareholding firms (i.e. banks, insurance, services, and manufacturing companies) that engaged in business and IT processes. Also, surveys were distributed to 180 Jordanian IT managers in which 98 were returned resulted in a high response rate of 55%.

Empirical Analysis

Indeed, the total number of respondents was 98 IT managers, 80% were male and only 20% females. Also,

the age range of the IT managers was weighted towards the younger age clusters of 26-35 and 36-45, by 48% and 21% respectively. In addition, length of service was distributed highly for both clusters less than two years and 2-6 years, by 43% and 32% respectively. This is to say that the nature of Jordanian industries requires middle-aged managers, who react promptly to numerous situations of ambiguity, and are thus able to lead IT departments.

Also, given a model with multiple relationships, this study employed Structural Equation Modeling (SEM) techniques with Analysis of Moment Structures (AMOS) 6 software for data analysis. SEM can be divided into two sub-models: a measurement model and a structural model. Whereas the measurement model identifies relationships between the observed and unobserved variables, the structural model defines relationships among the unobserved (i.e. latent) variables by specifying which latent variables directly or indirectly influence (i.e. cause) changes in other latent variables in the model (Byrne, 2001). Further, the structural equation modeling process consists of two components: validating the measurement model and fitting the structural model. While the former is accomplished through confirmatory

factor analysis, the latter is accomplished by path analysis with latent variables (Kline, 2005).

Table 3 shows different types of goodness of fit indices in assessing this study initial specified model. It displays that the research constructs fits the data moderately according to the absolute, incremental, and parsimonious model fit measures, comprising chi-square per degree of freedom ratio (χ^2/df), Incremental Fit Index (IFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). Furthermore, the researchers examined the standardized regression weights for the research's indicators and found

that some indicators had a low loading towards the latent variables. In particular (CN4 = 0.482, FC3 = 0.427, FP5 = 0.431). Moreover, since all of these items did not meet the minimum recommended value of factor loadings of 0.50 (Newkirk and Lederer, 2006), and because the initial fit indices were moderately fit the sample data, then they were all removed and excluded from further analysis. Therefore, the measurement model was modified and showed a better fit to the data (as shown in Table 3). For instance, χ^2/df and RMSEA did change for the final model, the IFI = 0.75, TLI = 0.71, and CFI = 0.74 indicated better fit to the data after removing the low factor loading items.

Table 3. Measurement Model Fit Indices

Model	χ^2	df	p	χ^2/df	IFI	TLI	CFI	RMSEA
Initial Estimation	1641.191	743	0.00	2.209	0.72	0.69	0.72	0.101
Final Model	1451.479	666	0.00	2.179	0.75	0.71	0.74	0.099

Measurement Model

Once modifying the final measurement model for all constructs, the next phase is to evaluate them for unidimensionality, reliability, and validity. Indeed, the outcomes of the measurement model are presented in Table 4, encapsulates the standardized factor loadings, measures of reliabilities and validity for the final measurement model.

Unidimensionality

Unidimensionality states to the extent to which the study indicators form their latent variable. An examination of the unidimensionality of the research constructs is essential and an important prerequisite for establishing construct reliability and validity analysis (Chou *et al.*, 2007). Also, in line with Byrne (2001), this research assessed unidimensionality using the factor loading of items of their respected constructs. Table 4 shows solid evidence for the unidimensionality of all the

constructs that specified in the measurement model. All loadings (except CN4, FC3, and FP5) were above 0.50, the criterion value recommended by Newkirk and Lederer (2006). These loadings confirmed that 47 (out of 50) items were loaded satisfactory on their constructs.

Reliability

According to Hair *et al.* (1998), reliability refers to the extent to which a set of indicators measure an aggregate construct consistently. Cronbach alpha and composite reliability are seen as appropriate tests to measure construct reliability. Table 4 indicates that all cronbach alpha values for the eleven constructs exceeded the recommended value of 0.60 (Bagozzi and Yi, 1988) demonstrating that the instrument is reliable. In addition, as shown in Table 4, composite reliability values ranged from 0.87 to 0.97, and were all greater than the recommended value of more than 0.60 (Bagozzi and Yi, 1988) or greater than 0.70 as suggested by

Holmes-Smith (2001). Consequently, according to the above two tests, all the research constructs in this study are considered reliable.

Table 4. Properties of the Final Measurement Model

Constructs and Indicators	Standard Loading	Standard Error	Square Multiple Correlation	Error Variance	Cronbach Alpha	Composite Reliability	AVE
<i>IT Personnel Competency</i>					0.94	0.92	0.92
PC1	0.807	0.101	0.651	0.071			
PC2	0.890	0.109	0.792	0.053			
PC3	0.854	0.112	0.730	0.066			
PC4	0.885	0.106	0.783	0.052			
PC5	0.820	0.114	0.672	0.077			
PC6	0.744	0.115	0.553	0.094			
PC7	0.786	0.105	0.618	0.072			
PC8	0.731	0.122	0.535	0.109			
PC9	0.808	0.091	0.653	0.050			
<i>IT Scalability</i>					0.86	0.90	0.90
SC1	0.825	0.107	0.681	0.069			
SC2	0.884	0.109	0.781	0.065			
SC3	0.668	0.108	0.446	0.102			
SC4	0.779	0.104	0.606	0.079			
SC5	0.650	0.112	0.422	0.113			
<i>IT Continuity</i>					0.84	0.95	0.78
CT1	0.800	0.111	0.639	0.089			
CT2	0.750	0.126	0.563	0.115			
CT3	0.754	0.118	0.569	0.100			
CT4	0.736	0.127	0.541	0.120			
<i>IT Compatibility</i>					0.86	0.97	0.84
CM1	0.657	0.165	0.431	0.127			
CM2	0.788	0.160	0.621	0.075			
CM3	0.785	0.155	0.617	0.072			
CM4	0.650	0.172	0.423	0.132			
CM5	0.765	0.166	0.586	0.088			
CM6	0.708	0.163	0.501	0.102			

Constructs and Indicators	Standard Loading	Standard Error	Square Multiple Correlation	Error Variance	Cronbach Alpha	Composite Reliability	AVE
<i>IT Connectivity</i>					0.77	0.93	0.91
CN1	0.554	0.205	0.306	0.240			
CN2	0.705	0.180	0.498	0.134			
CN3	0.833	0.160	0.694	0.072			
CN5	0.682	0.171	0.466	0.106			
<i>IT Rapidity</i>					0.74	0.92	0.88
RP1	0.798	0.148	0.623	0.076			
RP2	0.684	0.174	0.468	0.131			
RP3	0.642	0.181	0.412	0.166			
<i>IT Modularity</i>					0.75	0.91	0.82
MD1	0.606	0.191	0.367	0.191			
MD2	0.558	0.164	0.311	0.152			
MD3	0.734	0.180	0.538	0.133			
MD4	0.687	0.170	0.472	0.118			
<i>IT Facility</i>					0.65	0.87	0.81
FC1	0.762	0.185	0.581	0.135			
FC2	0.636	0.191	0.404	0.159			
<i>IT Modernity</i>					0.62	0.88	0.96
MR1	0.499	0.117	0.220	0.129			
MR2	0.852	0.190	0.726	0.104			
<i>IT-based Competitive Advantage</i>					0.93	0.95	0.90
CA1	0.833	0.158	0.700	0.181			
CA2	0.791	0.172	0.623	0.125			
CA3	0.861	0.152	0.756	0.132			
CA4	0.882	0.150	0.782	0.129			
<i>Firm Performance</i>					0.96	0.94	0.93
FP1	0.870	0.184	0.735	0.127			
FP2	0.809	0.169	0.693	0.131			
FP3	0.656	0.163	0.556	0.125			
FP4	0.702	0.173	0.682	0.129			

Convergent and Discriminant Validity

Validity can be seen as the extent to which a set of

indicators measure an aggregate construct accurately (Hair *et al.*, 1998). Further, as convergent validity test is

necessary in the measurement model to determine if the indicators in a scale load together on a single construct; discriminant validity test is another main one to verify if the items that developed to measure different constructs are certainly evaluating different constructs.

As shown in Table 4, all items were significant and had loadings more than 0.50 on their underlying constructs. Moreover, the standard errors for the items ranged from 0.091 to 0.205 and all the item loadings were more than twice their standard error. In addition, discriminant validity was considered using several tests. First, it could be examined in the measurement model by investigating the shared average variance extracted (AVE) by the latent constructs. Also, the correlations among the research constructs could be used to assess discriminant validity by examining if there is any extreme large correlations among them which imply that

the model have a problem of discriminant validity. Also, if the AVE for each construct exceeds the square correlation between that construct and any other constructs then discriminant validity is occurred (Fronell and Larcker, 1981). As shown in Table 4, this study showed that the AVEs of all the constructs were above the suggested level of 0.50, implying that all the constructs that ranged from 0.87 to 0.96 were responsible for more than 50 percent of the variance in their respected measurement items, which met the recommendation that AVE values should be at least 0.50 for each construct (Bagozzi and Yi, 1988; Holmes-Smith, 2001). Moreover, as shown in Table 5, discriminant validity was confirmed as the AVE values were more than the squared correlations for each set of constructs. Thus, the measures significantly discriminate between the constructs.

Table 5. AVE and Square of Correlations between Constructs

Constructs	PC	SC	CT	CM	CN	RP	MD	FC	MR	CA	FP
IT Personnel Competency (PC)	0.92										
IT Scalability (SC)	0.82	0.90									
IT Continuity (CT)	0.71	0.82	0.78								
IT Compatibility (CM)	0.76	0.89	0.86	0.84							
IT Connectivity (CN)	0.59	0.87	0.86	0.76	0.91						
IT Rapidity (RP)	0.64	0.63	0.62	0.85	0.64	0.88					
IT Modularity (MD)	0.61	0.72	0.76	0.77	0.86	0.83	0.82				
IT Facility (FC)	0.76	0.82	0.73	0.82	0.76	0.77	0.69	0.81			
IT Modernity (MR)	0.65	0.84	0.77	0.85	0.89	0.62	0.81	0.74	0.96		
IT-based Competitive Advantage (CA)	0.61	0.63	0.67	0.76	0.81	0.63	0.71	0.81	0.76	0.90	
Firm Performance (FP)	0.72	0.62	0.62	0.71	0.83	0.61	0.79	0.83	0.82	0.77	0.93

Note: Diagonal elements are the average variance extracted for each of the twelve constructs. Off-diagonal elements are the squared correlations between constructs.

Structural Model

Following the two-phase SEM technique, the measurement model results were used to test the

structural model, including paths representing the proposed associations among research constructs. Furthermore, in order to examine the structural model it

is essential to investigate the statistical significance of the standardized regression weights (i.e. *t*-value) of the research hypotheses (i.e. the path estimations) at 0.10, 0.01, 0.05, and 0.001 levels (see Table 6); and the coefficient of determination (R^2) for the research

endogenous variables as well. Indeed, the coefficient of determination for IT-based competitive advantage and firm performance were 0.32 and 0.51 respectively, indicating that the model moderately accounts for the variation of the proposed model.

Table 6. Summary of Proposed Results for the Theoretical Model

Research Proposed Paths	Coefficient Value	t-value	p-value	Empirical Evidence
H1: IT Infrastructure Flexibility → Firm Performance	0.084	0.976	0.329	Not Supported
H2: IT Infrastructure Flexibility → IT-based Competitive Advantage	0.565	6.747	0.000	Supported
H3: IT-based Competitive Advantage → Firm Performance	0.665	7.741	0.000	Supported

Discussion and Conclusion

This paper contributes to the IT infrastructure literature by developing and empirically testing a causal chain model of IT infrastructure flexibility on firm performance mediated by IT-based competitive advantage. Further, this study has added to the body of knowledge by offering additional support to Chanopas *et al.* (2006) in which IT infrastructure flexibility could be occurred by the existence of connectivity, compatibility, modularity, IT personnel competency, scalability, continuity, rapidity, facility, and modernity. This is in line with Liden (2010) who stated that the difference between a flexible firm and an inflexible firm is its ability to make changes quickly. It's the difference between a process that takes several months or even years, and one that takes just a few weeks or months. Thus, a good infrastructure would enable a firm to implement changes in a step-by-step approach, delivering instant improvements; integrate seamlessly with all of a firm's existing legacy systems; and enable a firm to easily add new business logic besides providing a full business processes support.

Moreover, consistent with Byrd and Turner (2001),

Fink and Neumann (2009), Zhang *et al.* (2009), and Bhatt *et al.* (2010), IT infrastructure flexibility found to be positively and significantly correlated with IT-based competitive advantage. Also, firms which are exploiting their IT investments to innovation mechanisms are better gaining performance benefits. This supports the argument of Bhatt *et al.* (2010), on the relationship between IT-based competitive advantage and firm performance. Consequently, hypothesis 2 and hypothesis 3 were supported strongly. Surprisingly, although great attention was made by several researchers (Bhatt *et al.* 2010) regarding the correlation between IT infrastructure flexibility and firm performance, there was no relationship between them, indicating that hypothesis 1 was not empirically supported.

Furthermore, the current research failed to show that firms experiencing high level of IT infrastructure flexibility could impact their firm performance directly. Initially, the causal relationships between IT investments and firm performance were found to be elusive and mixed due to the exclusion of some organizational factors such as IT-business partnership, and IT innovations (Chan and Reich, 2007). This is in line with

Shannak *et al.* (2010) who frankly declared that the lack of the significant relation between IT infrastructure flexibility and firm performance could be due to the fact that managers, business executives, and decision makers do not recognise the importance and value of such association. Thus, more research is needed to clarify and explain the lack of support of this hypothesis bearing in mind that the research field based on the country of Jordan, thus, cultural context could be occurring.

Indeed, hypothesis 2 was supported in the structural model, underlying that managers should be aware that without improved IT infrastructure flexibility cannot effectively increase IT-based competitive advantage. This is to confirm that the more the IT managers know and ensure a high degree of IT infrastructure flexibility existence in terms of IT connectivity, IT compatibility, IT modularity, IT personnel competency, IT scalability, IT continuity, IT rapidity, IT facility, and IT modernity (see Tables 1 & 2); then the more they would engage in applying IT innovation initiatives. This hypothesis thus contributes and supports the arguments of Byrd and Turner (2001), Tallon (2008), Fink and Neumann (2009), Zhang *et al.* (2009), and Bhatt *et al.* (2010). This is by confirming that IT infrastructure should be flexible to generate competitive advantage.

In other words, if information needs regarding customers, competitors, and other expected and unexpected changes occur; then a firm with flexible IT infrastructure can adjust and reconfigure its IT infrastructure according to the information processing needs so quickly. Consequently, a firm could make quick adjustments to meet the customer's product and service needs; decide how to respond to its competitor's changes in the business environment; support new set of business requirements; and taking new initiatives on developing new products and services in the marketplace.

Largely consistent with Dans (2001) and Bhatt *et al.* (2010), IT-based competitive advantage was found to be positively and significantly correlated with firm performance. Further, once IT infrastructure is being flexible to generate competitive advantage, this directly impacted a firm's performance. This underlines the significance role of IT innovations in organizational exploitation and exploration activities. Therefore, hypothesis 3 was supported strongly. This finding appears to lend support to these made by Fink and Neumann (2009) who argued that a highly degree of concentration on IT-based competitive advantage processes, and adapting agile architectures and systems could lead to better investments, business value, and profitability.

Initially, Reich and Benbasat (1990) reported that firms in industries where environmental dynamism occur, which is related to the high level of products and services changes in the industry and the high unpredictability of the actions of competitors, then IT played a vital role to such firms by increasing their ability to process information. Thus, in such great changes of a firm's products, services, and technologies; IT managers' are more likely to exploit the IT applications effectively.

Tallon and Kraemer (2003) said that the more external environment change requires firms to exploit strategic IS applications in order to survive. Consequently, they confirmed that the greater the services and technologies changes, the more they engaged in exploitation activities by using their present skills, and in turn better performance. Furthermore, Desarbo *et al.* (2005) found that market environmental uncertainty (based on changes in customer preferences, customer price sensitivity, customer product needs, changing customer base, and ease of forecasting marketplace changes) existed more in defender firms

(i.e. engage more in exploitive works). This implies that the more level of knowledge of how to deal with dynamism environmental uncertainty, the higher managers' stick in their exploitative works, which then result in improved firm performance.

To sum, the motivation of this study was to determine the impact of several contextual variables (IT connectivity, IT compatibility, IT modularity, IT personnel competency, IT scalability, IT continuity, IT rapidity, IT facility, and IT modernity) on IT-based competitive advantage, and examine how the mediating roles of IT-based competitive advantage affect firm performances. A theoretical model was proposed and empirical testing was completed using a sample of 98 Jordanian public shareholding firms. The findings increase our understanding of the IT infrastructure flexibility mechanisms, and their firm performance association with the context of IT-based competitive advantage as a key mediating variable.

However, there are some limitations of the study. The first limitation is the use of the same informant for the independent, intermediary, and dependent variables. Even though the researcher tried to reduce data incorrectness by asking the best positioned to answer the questionnaire (IT manager), consequently, further research should consider both IT managers and business managers not only to avoid depending on a single source of information as a way of testing the research model from several perceptions, but also as an attempt to evidence the source of any differences between them. Another limitation is that the proposed conceptual model is based on the cross-sectional data from the Jordanian public shareholding firms.

REFERENCES

- Allen, B., and Boynton, A. 1991. "Information architecture: In search of efficient flexibility". *MIS Quarterly*, 15(4): 435-445.
- Bagozzi, R., and Yi, Y. 1988. "On the evaluation of

Therefore, longitudinal investigations are preferred for better implications of the IT infrastructure. In addition, although the response rate of this study was sufficient for the condition of statistical analysis, the percentage of those who did not respond was still observable. In other words, even though the research results could be representative, it is reasonable to be watchful in its generalization. Therefore, to increase statistical validity, then further research should consider higher response rates. Moreover, it might be possible that examining the main constructs in this study over a longer period yield more insights into the associations between the research variables on firm performance.

Also, the data and results reported in this paper were based on a single country, Jordan, and in turn are applicable specifically to the Jordanian context. Thus, this raises inquiries regarding the generalizability to other cultures and different contexts. Consequently, further research is needed with regards to several countries since this would help to advance understanding of the IT infrastructure flexibility issue and the conditions and outcomes of achieving it from different nationwide origins in different contexts. Indeed, although this paper investigated several hypotheses and offered empirical support for the acceptance and refusal of some of these hypotheses; more generalizations on the application of the theoretical premises that developed in building the research model will be needed. This is to say, a more generalized research model that compensate the current research limitations by adding further impacting variables to the model and obtain a more representative sample from different sectors will be required.

- structural evaluation models". **Journal of the Academy of Marketing Science**, 16(1): 74-94.
- Barney, J. 1991. "Firm resources and sustained competitive advantage". **Journal of Management**, 17(1): 99-120.
- Bergeron, F., Raymond, L., and Rivard, S. 2004. "Ideal patterns of strategic alignment and business performance". **Information & Management**, 41(8): 1003-1020.
- Bhatt, G., and Grover, V. 2005. "Types of information technology capabilities and their role in competitive advantage: An empirical study". **Journal of Management Information Systems**, 22 (2): 253-277.
- Bhatt, G., Emdad, A., Roberts, N., and Grover, V. 2010. "Building and leveraging information in dynamic environments: The role of IT infrastructure flexibility as enablers of organizational responsiveness and competitive advantage". **Information & Management**, 47: 341-349.
- Brown, C., and Ross, J. 2003. "Designing a process-based IT organization". **Information Strategy**, 19(4): 35-41.
- Byrd, T. 2001. "Information technology, core competencies and sustained competitive advantage". **Information Resources Management Journal**, 14(2): 27-36.
- Byrd, T., and Turner, D. 2000. "Measuring the flexibility of information infrastructure: Exploratory analysis of a construct". **Journal of Management Information Systems**, 17(1): 167-208.
- Byrd, T., and Turner, D. 2001. "An exploratory examination of the relationship between flexible IT infrastructure and competitive advantage". **Information & Management**, 39(1): 41-52.
- Byrne, B. 2001. **Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming**. Mahwah, New Jersey, London: Lawrence Erlbaum Associates.
- Chan, Y., and Reich, B. 2007. "IT alignment: What have we learned". **Journal of Information Technology**, 22(4): 297-315.
- Chanopas, A., Krairit, D., and Khang, D. 2006. "Managing information technology infrastructure: A new flexibility framework". **Management Research News**, 29(10): 632-651.
- Chou, T., Chang, P., Cheng, Y., and Tasi, C. 2007. "A path model linking organizational knowledge attributes, information processing capabilities, and perceived usability". **Information & Management**, 44: 408-417.
- Chung, S., Rainer, R., and Lewis, B. 2003. "The impact of information technology infrastructure flexibility on strategic alignment and applications implementation". **Communications of the Association for Information Systems**, 11: 191-206.
- Croteau, A., Bergeron, F., and Raymond, L. 2001. "Business strategy and technological deployment: fit and performance". **Information System and Management**, 6(4).
- Dans, E. 2001. **IT Responsiveness in Small and Medium Enterprises: It Pays to be on Top of IT**. In Proceedings of the 8th European Conference on Information Technology Evaluation.
- Davenport, T., and Linder, J. 1994. **Information Management Infrastructure: The New Competitive Weapon**. In Proceedings of the 27th Hawaii International Conference on System Sciences, IV, 885-896.
- Desarbo, W., Benedetto, C., Song, M., and Sinha, I. 2005. "Revisiting the Miles and Snow strategic framework: Uncovering interrelationships between strategic types, capabilities, environmental uncertainty, and firm performance". **Strategic Management Journal**, 26: 47-74.
- Duncan, N. 1995. "Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure". **Journal of Management Information Systems**, 12(2): 37-57.
- Fink, L., and Neumann, S. 2007. "Gaining agility through IT

- personnel capabilities: The mediating role of IT infrastructure capabilities". **Journal of the Association for Information Systems**, 8(8): 440-462.
- Fink, L., and Neumann, S. 2009. "Exploring the perceived business value of the flexibility enabled by information technology infrastructure". **Information & Management**, 46(2): 90-99.
- Fronell, C., and Larcker, D. 1981. "Evaluating structural equation models with unobservable variables and measurement error". **Journal of Marketing Research**, 18: 39-50.
- Garg, A., and Goyal, D. 2012. "Striving towards strategic alignment in SMEs: An empirical analysis". **Journal of Advances in Management Research**, 9(1): 77-95.
- Hair, J., Anderson, R., Tatham, R., and Black, W. 1998. **Multivariate Data Analysis**, 5th edition, New Jersey, Prentice-Hall International Inc.
- Henderson, J.C., and Venkatraman, N. 1993. "Strategic alignment: leveraging information technology for transforming organizations". **IBM Systems Journal**, 32(1): 4-16.
- Holmes-Smith, P. 2001. **Introduction to Structural Equation Modeling Using LISREL**. Perth, ACSPRI-Winter Training Program.
- Kline, R. 2005. **Principles and Practice of Structural Equation Modeling**, 2nd edition, New York: The Guilford Press.
- Liden, C. 2010. "Don't give up on IT: Technology can deliver business flexibility". **MHD Supply Chain Solutions**, 46.
- Masa'deh, R. and Kuk, G. 2009. **Antecedents and Intermediaries between Strategic Alignment and Firm Performance**. In Proceedings of the 2009 Conference of the Academy of Management Annual Meeting (AOM), Illinois, Chicago, U.S.A, 7-11 August.
- Nemetz, P., and Fry, L. 1988. "Flexible manufacturing organizations: Implications for strategy formulation and organization design". **Academy of Management Review**, 13(4): 627-638.
- Ness, L. 2005. "Assessing the relationships among IT flexibility, strategic alignment, and IT effectiveness: Study overview and findings". **Journal of Information Technology Management**, XVI(2): 1-17.
- Newkirk, H., and Lederer, A. 2006. "The effectiveness of strategic information systems planning under environmental uncertainty". **Information & Management**, 43: 481-501.
- Papp, R. 1995. **Determinants of Strategically Aligned Organizations: A Multi-Industry, Multi-Perspective Analysis**. Hoboken, New Jersey: Stevens Institute of Technology.
- Reich, B., and Benbasat, I. 1990. "An empirical investigation of factors influencing the success of customer-oriented strategic systems". **Information Systems Research**, 1(3): 325-347.
- Sabherwal, R., and Chan, Y. 2001. "Alignment between Business and IS Strategies: A Study of Prospectors, Analyzers, and Defenders". **Information Systems Research**, 12(1): 11-33.
- Shannak, R., Masa'deh, R., Obeidat, B., and Almajali, D. 2010. **Information Technology Investments: A Literature Review**. In Proceedings of the 14th IBIMA Conference on Global Business Transformation through Innovation and Knowledge Management: An Academic Perspective, Istanbul-Turkey, 23rd-24th June, 1356-1368.
- Tallon, P. 2008. "Inside the adaptive enterprise: An information technology capabilities perspective on business process agility". **Information Technology and Management**, 9: 21-36.
- Tallon, P., and Kramer, K. 2003. **Investigating the Relationship between Strategic Alignment and Business Value: The Discovery of a Paradox. Creating Business Value with Information Technology: Challenges and Solutions**. Idea Publishing Group.

- Tanriverdi, H. 2005. "Information technology relatedness, knowledge management capability and performance of multibusiness firms". **MIS Quarterly**, 29(2): 311-334.
- Tanriverdi, H. 2006. "Performance effects on information technology synergies in multibusiness firms". **MIS Quarterly**, 30(1): 57-77.
- Weill, P. 1992. "The relationship between investment in information technology and firm performance: A study of the valve manufacturing sector". **Information Systems Research**, 3(4): 307-333.
- Zhang, J., Li, H., and Ziegelmayr, J. 2009. "Resources or capability? A dissection of SMEs' infrastructure flexibility and its relationship with IT responsiveness". **Journal of Computer Information Systems**, 50(1): 46-53.

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(Chanopas *et al.*, 2006)

(Chanopas *et al.*, 2006)

Chanopas *et al.*, 2006; Tanriverdi, 2006; Fink and Neumann, 2009; Zhang *et al.*, 2009; Bhatt *et al.*,) (2010

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