Information & Management 46 (2009) 90–99

Contents lists available at ScienceDirect

Information & Management

journal homepage: www.elsevier.com/locate/im

Exploring the perceived business value of the flexibility enabled by information technology infrastructure

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ARTICLE INFO

Article history:
Received 28 September 2007
Received in revised form 1 April 2008
Accepted 17 November 2008
Available online 30 January 2009

Keywords:
IT infrastructure
Flexibility
Resource-based view
IT business value
Strategic alignment
IT-based competitive advantage

ABSTRACT

We developed a multidimensional definition of IT infrastructure (ITI) and applied it in exploring the perceived strategic payoffs of ITI-enabled flexibility. We began by developing a typology of theoretical approaches that can be used to organize the literature and then developed a multidimensional model by conceptualizing how flexibility can be enabled through technical, human, and process elements of ITI and how these are interrelated. We used a resource-based view of the firm and a dynamic capabilities perspective to account for competitive impacts of the flexibility. Finally, we hypothesized on the moderating effects of organizational size and reporting level of the top IT executive. Data collected from 293 IT managers showed that the range of managerial ITI capabilities, which were positively affected by all areas of IT personnel knowledge and skills, was responsible for the competitive impacts of the ITI-enabled flexibility. Multigroup analyses showed that large organizational size or reporting to the CEO reduced the positive effects of the range of managerial ITI capabilities on competitive impacts.

1. Introduction

Flexibility due to an IT infrastructure (ITI) is considered an important source of business value. Business, public, and governmental organizations confronted with time and other pressures must adjust their strategies, but frequent change cannot be accomplished unless the ITI is able to accommodate it in an efficient and effective manner. This issue, though extensively explored, continues to attract attention e.g., [23,26], but the approaches adopted to define and investigate ITI make it difficult to integrate the implications of the many research efforts. These range from narrow approaches that view ITI as an architecture of technical components to more comprehensive approaches that see it as a mix of components, knowledge and skills, and services. Because ITI investments are not always guided by current business needs, efforts to extend ITI should consider how flexibility is introduced into each of its elements and how they are interrelated. We therefore decided to identify the sources of flexibility and their interrelationships and find how they are related to perceived IT value.

2. A review of recent relevant literature

The importance of ITI-enabled flexibility has been recognized since the earliest days of automation. The primary objective of our study was to explore the business value of this flexibility. The main hurdle to overcome was the lack of a formal comprehensive model. Therefore, we addressed this objective first.

2.1. A typology of theoretical approaches to ITI

We identified three theoretical approaches to ITI in the literature. The *technical-oriented approach* employs a narrow definition that regards ITI as an architecture (arrangement) of technical components, shared across the organization. The researchers who have only used the technical domain to define ITI consistently used four categories: platforms, networks and telecommunications, data, and core applications. Whereas the technical-oriented approach focused on the tangible IT platform, the *component-oriented approach* adopted a broader perspective that viewed ITI as having two distinct elements—technical and human. The technical components were no different from those in the previous approach. The human components were typically defined in terms of the knowledge and skills possessed by the IT personnel in the organization. The various knowledge and skill areas were generally technical, behavioral, and business [3,17].

These two theoretical approaches focused on the structure of ITI (its components). The *process-oriented approach* takes a broader viewpoint, extending the domain to incorporate processes and activities that utilize the components e.g., [13]. The process element frequently corresponds to shared IT services provided by IT. Such services are considered part of ITI when they are available

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0378-7206/$ – see front matter
doi:10.1016/j.im.2008.11.007

to the whole enterprise. Weill et al. [31] identified 10 clusters of shared IT services that they classified as either physical capabilities (channel management, security and risk management, communication, data management, application infrastructure, and IT facilities management) or management-oriented capabilities (IT management, IT architecture and standards, IT education, and IT research and development).

2.2. A multidimensional definition of ITI

The various approaches collectively suggested that ITI encompassed technical, human, and process elements [21]. However, the studies have not formally described the interrelationships among these elements. Empirical studies have normally measured ITI only through the technical element e.g., [7,32]. Even studies that investigated the process element also e.g., [18] did not analyse how the elements were interrelated. Thus, empirical evidence of the interrelationships among ITI elements is lacking.

McKay and Brockway [20] saw ITI as a layer of physical IT components under a layer of shared IT services. They viewed human components as the "mortar" that bound the physical components into functional IT services. This implied a hierarchy of components and processes, where IT processes utilize components to support business processes. This hierarchy can be theoretically strengthened and extended by using strategic management's conceptualization of firm resources and capabilities. Resources are the basic units of analysis, while a capability is the capacity for resources to perform a task or activity together. Thus, resources represent the basic building blocks of capabilities. By viewing ITI components as firm resources and ITI processes as firm capabilities, we proposed a causal relationship between ITI resources (technical and human) and ITI capabilities. This was the conceptual basis upon which a formal model of ITI-enabled flexibility was developed. The hypothesized research model is presented in Fig. 1.

3. Model development

The multidimensional definition of ITI captures the well-known three stage model of ITI utilization: resource acquisition, capability development, and capability utilization. While the investment policy first identifies the required capability and then helps acquire the technical and human ITI resources for its development, strategic value might be gained by making additional ITI investments in anticipation of future business needs. These are investments in flexibility, because they provide degrees of freedom in responding to new business needs. ITI-enabled flexibility is defined here as the ability of ITI to adapt to new, different, or changing business requirements.

3.1. ITI-enabled flexibility: ITI elements

3.1.1. Technical ITI element

Sharability involves connectivity and compatibility. For the technical ITI element to support multiple business processes and applications, the technical components should be seamlessly deployed across the organization, allowing users to share information. Reusability can be achieved by implementing independent and standardized components, implying modularity. Loosely coupled components allow greater flexibility in end configurations. It has been well established that shared technical components enhance flexibility when they are connectable, compatible, and modular [9]. Thus, we saw IT connectivity, compatibility, and modularity as the flexibility-enabling dimensions of ITI.

3.1.2. Human ITI element

The ability of human ITI resources to enable flexibility is reflected in the depth and breadth of the knowledge and skills of the IT personnel [5]. Therefore, we considered the three domains of IT personnel knowledge and skills as the flexibility-enabling dimen-

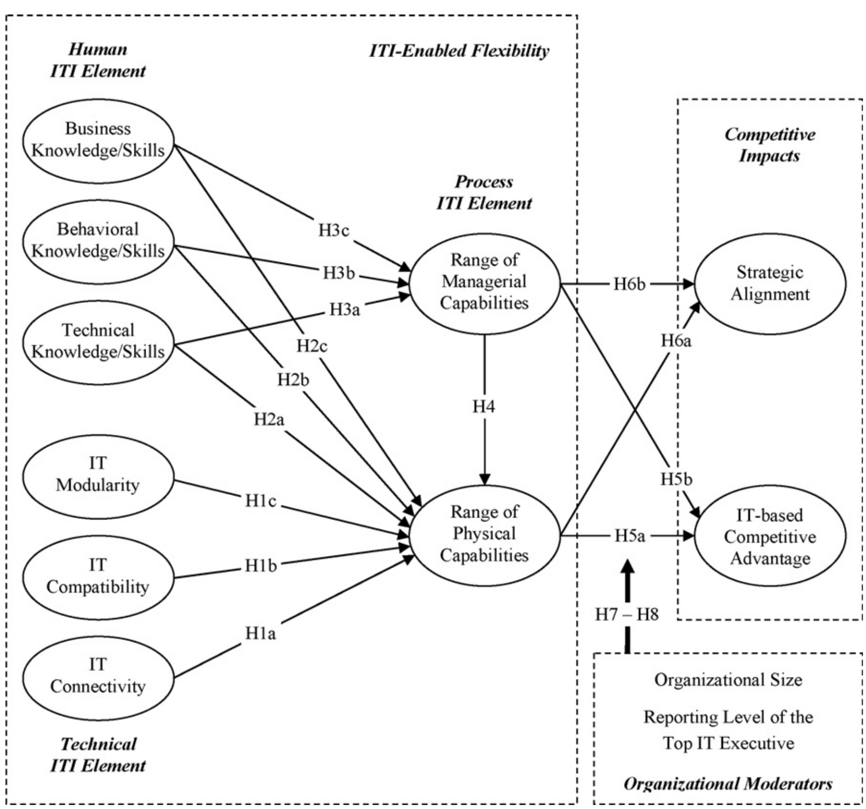

Fig. 1. Hypothesized research model.

sions of human ITI. Possessing the knowledge and skills puts an organization in a position to take advantage of new opportunities.

3.1.3. Process ITI element

The process ITI element provides flexibility when the range of capabilities is extended. Enterprises with high agility have more and broader ITI services. This view of flexibility has been adopted in other areas, such as manufacturing management. Technology diversification creates a potential for organizational growth. Because ITI capabilities can be either physical or managerial, we identified two flexibility-enabling dimensions for the process element: range of physical and managerial capabilities.

3.2. ITI-enabled flexibility: interrelationships among ITI elements

In the transition from resource acquisition to capability development, resource attributes should have an impact on the capabilities that use the resources. Building on the idea that flexibility should allow a wider range of constructions (ITI capabilities), we formulated a set of hypotheses that helped investigate the interrelationships among the flexibility-enabling dimensions of ITI elements.

3.2.1. Effects of technical dimensions on process dimensions

The flexibility afforded by technical ITI is positively associated with the way organizations implement their technologies and applications [10]. Therefore, we hypothesized that:

Hypothesis 1a. IT connectivity positively affects the range of physical capabilities.

Hypothesis 1b. IT compatibility positively affects the range of physical capabilities.

Hypothesis 1c. IT modularity positively affects the range of physical capabilities.

3.2.2. Effects of human dimensions on process dimensions

Human dimensions are also hypothesized to positively affect process dimensions. More varied and in-depth technical skills are needed due to the rapid rate of technological change. IT professionals must demonstrate a wider range of behavioral skills, specifically better coordination and boundary-spanning abilities [27]. An organization whose IT personnel possess broad technical, behavioral, and business knowledge and skills is better positioned to develop new physical services. Thus we hypothesized:

Hypothesis 2a. Technical knowledge and skills positively affect the range of physical capabilities.

Hypothesis 2b. Behavioral knowledge and skills positively affect the range of physical capabilities.

Hypothesis 2c. Business knowledge and skills positively affect the range of physical capabilities.

The development of managerial services should also be positively influenced by the existence of broad knowledge and skills. Managerial services involve such activities as identifying new technologies and evaluating their business applicability, defining investment priorities, and educating management on how to generate value from IT. Such capabilities require technical understanding, a business orientation, and an ability to form relationships. Thus

Hypothesis 3a. Technical knowledge and skills positively affect the range of managerial capabilities.

Hypothesis 3b. Behavioral knowledge and skills positively affect the range of managerial capabilities.

Hypothesis 3c. Business knowledge and skills positively affect the range of managerial capabilities.

3.2.3. Effect between process dimensions

The clustering of ITI capabilities into physical and managerial categories implies the existence of an interrelationship between them. Limited managerial capabilities would probably lead to inadequate physical capabilities. Broad managerial capabilities provide the potential to develop physical capabilities, because of their ability to reallocate resources. Thus

Hypothesis 4. The range of managerial capabilities positively affects the range of physical capabilities.

3.3. The business value of ITI-enabled flexibility

3.3.1. IT-based competitive advantage

The resource-based view (RBV) of the firm argues that heterogeneity and immobility of its resources result in superior performance [2]. The flexibility-enabling dimensions of ITI elements allow a firm to generate value. Broad ITI capabilities have strategic value, because they allow a firm to exploit its opportunities and neutralize environmental threats. As ITI dynamically evolves [16], the path dependency and irreversibility in its development make it difficult to imitate.

We drew on the dynamic capabilities perspective, an extension of the RBV, to define the flexibility-enabling dimensions of the process ITI element as a source of competitive advantage. Change-oriented capabilities allow firms to reconfigure and redeploy their resources to meet demands [30]. By ensuring the availability of a wide range of physical and managerial capabilities, a firm can reallocate its existing capabilities and underlying resources to support a new set of business requirements. Thus

Hypothesis 5a. The range of physical capabilities positively affects IT-based competitive advantage.

Hypothesis 5b. The range of managerial capabilities positively affects IT-based competitive advantage.

3.3.2. Strategic alignment

Strategic alignment is important in gaining business value from IT [14,28]. The strategic alignment model established the importance of ITI in aligning functional integration and strategic fit. Prahalad and Krishnan [25] noted that, in many companies, the ITI lacked flexibility, resulting in a gap between emerging strategic directions and the ability of IT to support them. A wide range of ITI capabilities should allow more degrees of freedom in providing technological response to change, thereby adding flexibility. Therefore

Hypothesis 6a. The range of physical capabilities positively affects strategic alignment.

Hypothesis 6b. The range of managerial capabilities positively affects strategic alignment.

3.4. Organizational moderators of business value

We hypothesized that ITI-enabled flexibility had business value because it positively affected an organization's competitive position. However, this may depend on organizational characteristics, such as its size. While larger size can positively affect innovation diffusion because of financial slack, marketing skills, and experience, it may also result in inertia [8]. Research has used these theoretical arguments to develop contradicting hypotheses about the relation between size and IT adoption [1,33]. We hypothesized that the negative moderating effect was stronger because of the forces inhibiting change in large organizations and their negative association with flexibility. Thus

Hypothesis 7. Organizational size negatively affects the relationships between ITI-enabled flexibility and competitive impacts.

It is believed that the reporting level of the top IT executive significantly influences his or her ability to interact intensively with the CEO and the top management team. Direct reporting to the CEO has been found to be a significant antecedent of IT effectiveness [19]. The two-way communication facilitated by direct reporting should increase the saliency of IT considerations in strategic decision-making and of identifying and capitalizing on opportunities from the use of IT. We therefore expected:

Hypothesis 8. The reporting level of the top IT executive positively affects the relationships between ITI-enabled flexibility and competitive impacts.

4. Methodology

A field study methodology was used to test the research model empirically. First, a questionnaire instrument was constructed to measure ITI-enabled flexibility, competitive impacts, and organizational moderators. Second, it was assessed in a pre-test and three pilots. Last, the main dataset was collected by conducting a cross-sectional survey of IT managers in Israel.

4.1. Instrument construction

The questionnaire was constructed to capture the perceptions of IT managers because of their combined managerial-professional perspective: ITI resources and capabilities are transparent to most organizational users and involve professional competencies that nonprofessionals may find difficult to assess. Thus IT managers were selected as the target population; our approach was consistent with previous studies e.g., [12].

The technical and human flexibility-enabling dimensions were operationalized by measures adapted from Byrd and Turner [6]. We adapted their 16 items for measuring technical flexibility by IT connectivity, compatibility, and modularity, and we adopted 17 items as measures for human flexibility, through technical, behavioral, and business knowledge and skills, based on content validity and item loading considerations. To measure the process flexibility-enabling dimensions, measures of the range of physical and managerial capabilities were developed based on the framework of Weill et al. Ten items were constructed to measure the range of ITI services in each capability cluster. These were *a priori* classified as measuring the range of either physical or managerial capabilities. The strategic alignment was operationalized using measures adapted from Mirani and Lederer [22]. Four items associated with innovativeness, market position, mass customization, and difficulty to duplicate measured IT-based competitive advantage. The approach of Tallon et al. [29] was used to measure the perceived business value of IT. Questionnaire items, listed in Appendix A, used seven-point Likert scales anchored with either "strongly disagree" and "strongly agree" or "not at all" and "very large extent". The questionnaire also included a section to obtain background information, which measured the moderating variables.

The initial instrument was pre-tested in nine semi-structured interviews with IT managers and academics as a way of improving its understandability, relevance, and completeness. Then the instrument was pilot-tested in three Web-based surveys of three convenience samples of IT managers. In total, 37 questionnaires were returned in the three pilot tests. Analysis of the reliability of the scales showed satisfactory Cronbach's α coefficients that ranged from 0.73 to 0.96.

4.2. Data collection

The final instrument was administered to IT managers in a large, cross-sectional, Web-based survey. An active database of IT professionals managed by the primary IT community provider in Israel was used to reach the target population of IT professionals in management positions. A cover letter with a link to the questionnaire Web page was e-mailed to the list of about 8000 IT managers. The links were personalized to minimize data integrity concerns. The e-mails provided means of communication with the research team to deal with any respondents' concerns of confidentiality, etc. The e-mails were distributed only once, with no reminders.

Overall, 361 questionnaires were returned; using the number of recipients who clicked on the questionnaire page link as the population (1311), we computed a response rate of 27.5%. The possibility of a nonresponse bias was rejected; we compared the functional role distribution (in the original database of IT professionals) with that of the returned questionnaires using a χ^2 test. This produced a χ^2 value of 3.65 with three degrees of freedom, indicating statistically insignificant difference between the two distributions ($p = 0.30$). Of the 361 returned questionnaires, 68 were dropped because of one or more of the following characteristics: non-management positions (34), small-sized organizations (less than 20 employees) (22), unfamiliarity with the organization (less than 2 months) (3), and a significant number of missing values (16). Table 1 shows the characteristics of the final sample of 293 responses, including the distribution for the moderating variables.

IT managers may rate the competitive impacts of ITI higher than do non-IT managers. Because the database used to recruit respondents included those who described themselves as IT professionals, the collected data did not allow direct comparison between the evaluations of IT and non-IT managers. Nevertheless, respondent bias could be partially assessed by comparing the evaluations of respondents in the "other" category with those of the rest of the respondents. The "other" category included managers in IT-related positions (such as CTOs) or in IT-related organizations (such as CEOs). While they described themselves as IT professionals, their perspective was generally different from that of IT unit managers. Student *t*-tests comparing "other" respondents with the rest of the sample found statistically significant mean differences only for 12 out of the 50 questionnaire items—four in one construct (behavioral knowledge and skills) and only one a competitive impact item (SA2). Therefore, the assumption that respondent position caused significant survey bias was rejected.

A series of one-way ANOVA tests were conducted to confirm that respondents' evaluations were not significantly affected by the moderating variables. The tests found a statistically significant effect of organizational size on only six items and a statistically significant effect of reporting level on only two of the 50 questionnaire items.

5. Empirical analysis

Data analysis used SEM techniques with EQS 6.1 software and maximum likelihood estimation (MLE). In line with a two-step approach, the measurement model was separately estimated and respecified prior to testing the structural model. Following the

Table 1
Sample characteristics.

Characteristic (valid N)	Frequency	Percent
Job title (290)		
CIO/manager of the IT unit	46	15.9%
Senior IT management	76	26.2%
Junior IT management	70	24.1%
Other management (e.g. CEOs, CTOs)	98	33.8%
Time with the company (290)		
2 months to a year	17	5.9%
1–5 years	112	38.6%
More than 5 years	161	55.5%
Industry (281)		
Banking/finance	20	7.1%
Business services	13	4.6%
Communications	47	16.7%
Defense	14	5.0%
Distribution/retail	13	4.7%
Education	9	3.2%
Government/municipalities	18	6.4%
Health services	14	5.0%
Insurance	8	2.8%
Logistics	3	1.1%
Manufacturing	17	6.0%
Real estate	2	0.7%
Technological development	38	13.5%
Transportation	7	2.5%
Utilities	5	1.8%
Other	53	18.9%
Organizational size (288)		
"Approximately how many employees work in the company?"		
20–50	30	10.4%
51–250	60	20.8%
251–500	38	13.2%
501–1000	39	13.5%
>1000	121	42.0%
Reporting level of the top IT executive (289)		
"To whom does the top IT executive in the company report?"		
Administrative vice president	19	6.6%
Operations vice president	60	20.8%
Controller/Finance vice president	24	8.3%
CEO/President/General manager	160	55.4%
Other	26	9.0%

standard method, the *a priori* measurement model was revised by iteratively dropping items (one at a time) that shared a high degree of residual variance with other items (based on reported standardized residuals). Descriptive statistics and inter-correlations for the constructs are shown in Table 2. Standardized item loadings for the *a priori* and revised measurement models are shown in Appendix A.

5.1. Measurement model

Prior to testing the hypothesized relationships, the 10 constructs in the model were tested for construct reliability, unidimensionality, convergent validity, and discriminant validity. All construct reliabilities, except that of IT connectivity, were above the commonly used threshold of 0.70, which is not an absolute standard and lower values had been deemed acceptable in exploratory research. In general, the construct reliabilities for the technical and human flexibility-enabling dimensions were above the values reported for the original scales. The unidimensionality of the constructs was established by separate confirmatory factor analyses that produced GFI and CFI values above the recommended 0.90 threshold. As shown in Appendix A, standardized item loadings for the revised measurement model were above 0.50 for all items (significant at the $p < 0.001$ level) and above 0.70 for most items, representing satisfactory convergent validity. Discriminant validity can be assessed by comparing two nested models for each pair of constructs in the measurement model: an unconstrained model that frees the correlation between the two constructs and a constrained model that sets the correlation between them to 1.0. A significantly lower χ^2 value for the unconstrained model indicated that the constructs were not perfectly correlated and provided evidence of discriminant validity. The χ^2 difference was significant ($p < 0.01$) in all possible paired comparisons of the constructs. Because some inter-correlations were relatively high, we also performed an alternative test of discriminant validity. It compared the χ^2 of the measurement model with its 10 constructs against a series of alternative measurement models with 9 constructs, where every possible pair of constructs was combined into a single construct. The χ^2 of the measurement model was significantly smaller ($p < 0.01$) than any alternative measurement model with combined constructs, providing additional evidence of discriminant validity.

5.2. Structural model

The results of a structural analysis of the hypothesized research model are presented in Fig. 2. Generally, model fit indices indicated that the research model was supported by the sample data. The adjusted χ^2 at 2.07, CFI at 0.920, adjusted GFI (AGFI) at 0.792, standardized root mean square residual (RMR) at 0.055, and root mean square error of approximation (RMSEA) at 0.060 were all within accepted levels [11]. Only the GFI at 0.819 was below the accepted threshold of 0.90. In light of the relative complexity of the research model with its 10 constructs, the model fit results were considered satisfactory.

Most hypotheses were supported by the sample data. Of the three technical flexibility-enabling dimensions, only IT connectiv-

Table 2
Construct descriptive statistics and inter-correlations.

Construct	Mean	S.D.	CR	Correlation matrix									
				CN	CM	MD	TC	BH	BS	PC	MC	SA	CA
IT connectivity (CN)	4.76	1.31	0.53	0.52									
IT compatibility (CM)	4.34	1.36	0.72	0.78	0.62								
IT modularity (MD)	4.37	1.53	0.77	0.67	0.80	0.64							
Technical know. (TC)	4.17	1.43	0.80	0.54	0.56	0.60	0.76						
Behavioral know (BH)	5.28	1.29	0.93	0.29	0.33	0.34	0.50	0.85					
Business know. (BS)	5.14	1.30	0.91	0.35	0.35	0.33	0.51	0.84	0.84				
Physical cap. (PC)	4.90	1.47	0.90	0.67	0.59	0.53	0.73	0.50	0.47	0.78			
Managerial cap. (MC)	5.27	1.56	0.88	0.53	0.52	0.51	0.68	0.71	0.67	0.83	0.80		
Strategic alignment (SA)	5.23	1.29	0.86	0.32	0.48	0.43	0.54	0.62	0.64	0.60	0.64	0.82	
Competitive adv. (CA)	5.19	1.56	0.81	0.53	0.62	0.49	0.53	0.49	0.53	0.62	0.67	0.68	0.73

S.D. = standard deviation; CR = composite reliability. Values on the diagonal are the square roots of AVE.

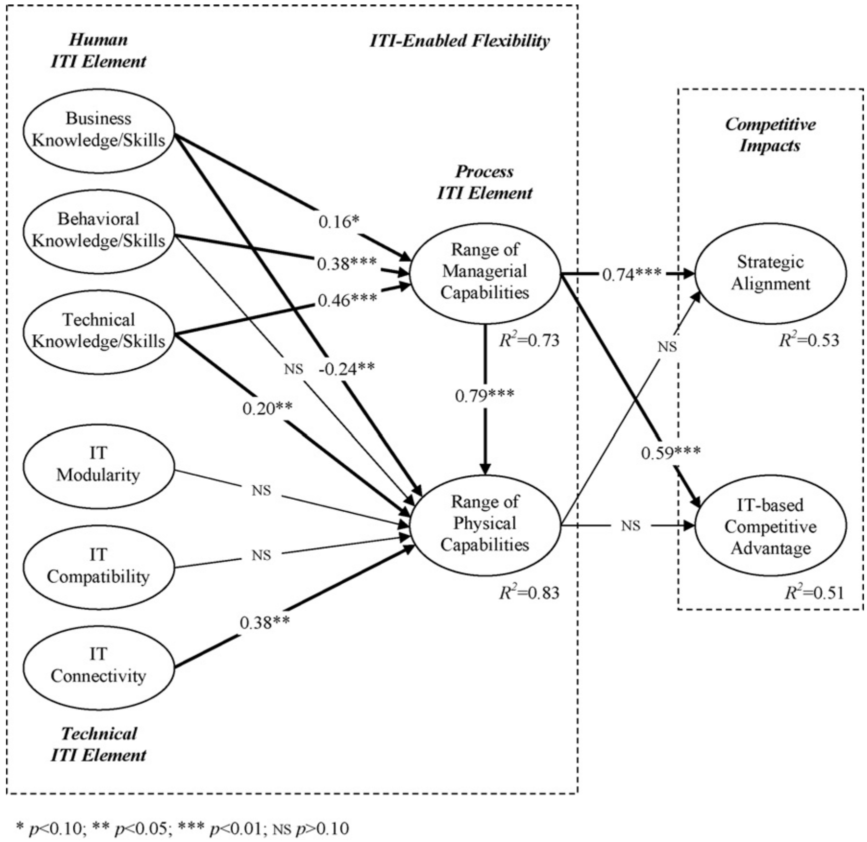

Fig. 2. Research model results.

ity significantly affected the range of physical capabilities (corroborating Hypothesis 1a). Of the three human flexibility-enabling dimensions, both technical and business knowledge and skills significantly affected the range of physical capabilities. However, whereas the effect of technical knowledge and skills was positive (corroborating Hypothesis 2a), the effect of business knowledge and skills was negative. All three human flexibility-enabling dimensions significantly affected the range of managerial capabilities (corroborating Hypotheses 3a–3c). The path from the range of managerial capabilities to that of physical capabilities was highly significant, corroborating Hypothesis 4. As for the competitive impacts of process flexibility-enabling dimensions, only the range of managerial capabilities significantly affected IT-based competitive advantage (corroborating Hypothesis 5b) and strategic alignment (corroborating Hypothesis 6b).

To confirm that the pattern of significant paths in the structural model was not extended by the respecification of the measurement model and dropping items, the structural model was retested, based on the *a priori* measurement model with all the items. Generally, this analysis resulted in the same significant paths at the same level of significance. The only differences were in the effects of business knowledge and skills—the negative effect on the range of physical capabilities became insignificant and the positive effect on the range of managerial capabilities became stronger ($\gamma = 0.30$, $p < 0.01$). To reject the possibility that the significant paths in the structural model were a consequence of common method bias, resulting from the use of a single instrument to measure all constructs, a stringent test suggested by Podsakoff et al. [24] was used. A common methods variance factor was added to the structural model, and all the items of the endogenous constructs were allowed to load on this factor also. Thus the variance of a specific item was partitioned into three components: trait, method, and random error. Retesting the structural model with the methods factor resulted in a very similar pattern of significant paths, ruling out a significant influence of common method bias.

5.3. Multigroup models

The moderating effects of organizational size and reporting level of the top IT executive on the competitive impacts of ITI-enabled flexibility were examined using a series of multi-sample analyses with EQS 6.1. This procedure enabled us to compare path coefficients between the subgroups of each moderator and to test for the statistical significance of differences. The organizational size subgroups were created by splitting the sample into large organizations (over 1000 employees) versus small-medium organizations (1000 employees or less), based on a split of the sample. The reporting level subgroups were created by splitting the sample into organizations where the top IT executive reported to the CEO versus those where this executive reported to others.

Differences in path coefficients between subgroups were analysed by estimating a series of nested multigroup models. First, the structural model was estimated by allowing all model parameters to be free across subgroups. Next, a particular path was constrained to be equal across subgroups. When the difference in χ^2 values between the constrained and unconstrained multigroup models (with one degree of freedom) was statistically significant, it indicated that the difference in path coefficients between subgroups was statistically significant and that the particular path was therefore affected by the moderator. This procedure was implemented systematically for the four paths between process flexibility-enabling dimensions and competitive impacts (Hypotheses 5a, 5b, 6a and 6b) for each moderator. The results were summarized in Tables 3 and 4, which showed the unconstrained

Table 3
Moderating effects of organizational size.

Path	Difference in χ^2 (1 df)	p	Small-medium organizations ($N = 167$)	Large organizations ($N = 121$)
Physical cap. → strategic alignment	0.014	0.906	0.04	0.09
Managerial cap. → strategic alignment	1.82	0.177	0.74***	0.55***
Physical cap. → competitive adv.	0.009	0.924	0.18	0.21
Managerial cap. → competitive adv.	0.369	0.544	0.56***	0.49***

*** $p < 0.01$.

Table 4
Moderating effects of reporting level of the top IT executive.

Path	Difference in χ^2 (1 df)	p	Reports to a VP or other ($N = 129$)	Reports to the CEO ($N = 160$)
Physical cap. → strategic alignment	0.322	0.570	0.05	−0.09
Managerial cap. → strategic alignment	0.023	0.880	0.71***	0.80***
Physical cap. → competitive adv.	2.479	0.115	−0.03	0.42**
Managerial cap. → competitive adv.	5.575	0.018	0.82***	0.28

** $p < 0.05$.
*** $p < 0.01$.

standardized path coefficients in each subgroup (as if each subgroup was estimated independently), the constrained–unconstrained χ^2 differences, and their statistical significance. The χ^2 differences for organizational size were not statistically significant and thus Hypothesis 7 (negative moderating effect of organizational size) was not supported.

This result notwithstanding, some of the differences in path coefficients between organizational size subgroups were in the hypothesized direction. In particular, the range of managerial capabilities had a smaller effect on strategic alignment in large organizations than in small-medium organizations. Such a comparison agreed with previous research, which had used straightforward comparisons of path coefficients across groups to establish moderation e.g., [15]. Hypothesis 8 (positive moderating effect of reporting level) was supported only for the relationship between the range of physical capabilities and competitive advantage. Reporting level had the opposite effect (negative moderating effect) on the relationship between the range of managerial capabilities and competitive advantage.

6. Discussion

The results of the empirical analysis show the interrelationships among the dimensions of ITI-enabled flexibility. They suggest that once connectivity is established, the range of physical capabilities does not depend on other technical flexibility-enabling dimensions. Our study viewed integration as biased toward technical aspects; it overlooked data management aspects which may offset the positive effects of connectivity. Within this view of integration, the results suggested that the range of physical capabilities depended on connectivity more than on compatibility and modularity.

The results also emphasize the important role of IT personnel knowledge and skills in determining the range of physical and managerial capabilities. However, apparently, the range of physical capabilities was not affected by behavioral skills and was negatively affected by business skills. A plausible explanation for this was the tradeoff that typically exists between the scope of technical and business skills in an IT unit due to resource constraints.

Our empirical analysis showed that strategic alignment and competitive advantage are contingent on the range of managerial capabilities but not physical ones. While this is inconsistent with our hypotheses, it is consistent with the view that physical capabilities are more easily acquired.

In general, the results do not support Hypothesis 7, which is less surprising when considered in conjunction with the contradicting effects of organizational size. Therefore, we concluded that organizational size did not influence the competitive impacts of ITI-enabled flexibility. The reporting level of the top IT executive apparently affected the way that competitive advantage was attributed; for the top IT manager reporting to the CEO, it was considered to be due to the range of physical capabilities, but when reporting elsewhere, it was seen as due to the range of managerial capabilities.

6.1. Contribution to research

Our study contributed by examining ITI using a multi-dimensional approach. Prior empirical research on ITI has typically defined it as either a resource base or a set of capabilities, and has not explored the relationships between its elements and how it creates business value. Although the specific pattern of interrelationships found applied only to their flexibility-enabling dimension, the general evidence of relationships between ITI resources and capabilities empirically supported ITI's multidimensionality: human resources are at least as important as technical ones in the deployment of ITI capabilities.

We also examined the effect of flexibility of IT on business value. We defined and operationalized the flexibility-enabling dimensions of ITI elements, identifying the key technical and human dimensions that influenced process dimensions, establishing process dimensions as sources of strategic alignment and competitive advantage, and identifying moderating effects on them.

6.2. Implications for practice

Senior IS executives in the past 20 years have shifted toward ITI issues by stressing the importance of building a responsive ITI [4]. Since then, given the increasing turbulence of business environments, the move toward IT centralization and growing interest in agile architectures and systems, this trend has continued. Our study offered a comprehensive view of ITI and the conditions under which it facilitates technological flexibility. This may lead to improved prioritization of ITI initiatives and investments and better understanding of their business value. Beyond the importance of technical knowledge and skills, our findings accentuated the contribution of behavioral and business knowledge and skills, indicating that the development of such competencies had positive influences on competitive impacts. This stressed the importance of building a human ITI that supports the objectives of the technical ITI. We identified ITI capabilities as potential sources of strategic alignment and competitive advantage and supported a less conservative approach to investments, encouraging broadened ITI capabilities, particularly managerial ones.

6.3. Limitations

The methodology of this study imposed limitations on its contribution. The methodology was designed to collect cross-sectional data from IT managers; as such, it had three limitations. First, such a research design only establishes associations between constructs, whereas causality then must rely on theoretical justification. Second, although organizational IT users may find the evaluation of ITI resources and capabilities difficult, their perspective is necessary to identify gaps in different perceptions of ITI. Third, the dynamics of longitudinal processes cannot be analysed using this methodology.

Acknowledgements

The authors are grateful to Professor Sibley and the three anonymous reviewers for their constructive comments and helpful suggestions throughout the review process.

Appendix A. Measures and standardized item loadings

Item	Wording	Loading (*a priori* model)	Loading (revised model)
IT connectivity			
CN1	All remote, branch, and mobile users are connected to the central office	0.54	0.55
CN2	The company utilizes open systems network mechanisms to boost connectivity	0.56	0.51
CN3	There are very few identifiable communications bottlenecks within the company	0.47	Dropped
CN4	The company utilizes a virtual network or VLAN to connect to end users	0.51	0.50
IT compatibility			
CM1	End users throughout the company utilize a common operating system	0.31	Dropped
CM2	Software applications can be easily transported and used across multiple platforms	0.57	0.57
CM3	The company offers a wide variety of types of information to end users	0.71	0.72
CM4	The user interfaces provide transparent access to all platforms and applications	0.65	0.64
CM5	The company provides multiple interfaces or entry points (for example, Web access) for external end users	0.55	0.55
IT modularity			
MD1	The company utilizes online analytical processing (OLAP)	0.47	Dropped
MD2	The corporate database is able to communicate through many different protocols (for example, ODBC, OLE-DB)	0.50	0.52
MD3	Mobile users have ready access to the same data used at desktops	0.59	0.61
MD4	The company easily adapts to various vendors' database management systems (DBMS) protocols and standards	0.67	0.68
MD5	Data captured in one part of the company are immediately available to everyone in the company	0.63	Dropped
MD6	Reusable software modules are widely used in new systems development	0.67	0.70
MD7	IT personnel utilize object-oriented technologies to minimize the development time for new applications	0.64	0.66
Technical knowledge and skills			
TC1	The IT personnel are skilled in multiple structured programming, CASE methods, or tools	0.77	Dropped
TC2	The IT personnel are skilled in distributed processing or distributed computing	0.79	0.72
TC3	The IT personnel are skilled in network management and maintenance	0.50	Dropped
TC4	The IT personnel are skilled in developing Web-based applications	0.75	0.77
TC5	The IT personnel are skilled in data warehousing, mining, or marts	0.73	0.78
Behavioral knowledge and skills			
BH1	The IT personnel are self-directed and proactive	0.82	0.82
BH2	The IT personnel have the ability to plan, organize, and lead projects	0.90	0.90
BH3	The IT personnel have the ability to plan and execute work in a collective environment	0.90	0.90
BH4	The IT personnel work well in cross-functional teams addressing business problems	0.83	0.83

Appendix A (*Continued*)

Item	Wording	Loading (*a priori* model)	Loading (revised model)
BH5	The IT personnel are cross-trained to support other IT services outside their primary knowledge domain	0.78	0.78
Business knowledge and skills			
BS1	The IT personnel are knowledgeable about the key success factors that must go right if the company is to succeed	0.77	0.74
BS2	The IT personnel are encouraged to learn new information technologies	0.62	Dropped
BS3	The IT personnel closely follow the trends in current information technologies	0.63	Dropped
BS4	The strategies of the IT unit and the company's strategies are well aligned	0.80	Dropped
BS5	The IT personnel understand the company's policies and plans	0.83	0.79
BS6	The IT personnel are able to interpret business problems and develop appropriate technical solutions	0.88	0.92
BS7	The IT personnel are knowledgeable about business functions	0.85	0.91
Range of physical capabilities			
PC1	The IT unit provides a wide range of *channel management* services (*electronic channel to the customer or partner to support multiple applications*, *such as point of sale*, *Web sites*, *call centers*, *mobile computing*)	0.76	0.76
PC2	The IT unit provides a wide range of *security and risk management* services (*security policies*, *disaster planning*, *firewalls*)	0.77	0.76
PC3	The IT unit provides a wide range of *communication* services (*network services*, *broadband services*, *Intranet capabilities*, *Extranet capabilities*, *groupware*)	0.80	0.80
PC4	The IT unit provides a wide range of *data management* services (*key data independent of applications*, *centralized data warehouse*, *data management consultancy*, *storage area networks*, *knowledge management*)	0.78	0.78
PC5	The IT unit provides a wide range of *application infrastructure* services (*centralized management of applications*, *middleware*, *mobile and wireless applications*, *ASP*, *workflow applications*, *payment transaction processing*)	0.78	0.78
PC6	The IT unit provides a wide range of *IT facilities management* services (*large scale processing/mainframe*, *server farms*, *common systems development environment*)	0.77	0.77
Range of managerial capabilities			
MC1	The IT unit provides a wide range of *IT management* services (*IS planning*, *investment and monitoring*, *IS project management*, *negotiations with suppliers and outsourcers*, *service level agreements*)	0.83	0.83
MC2	The IT unit provides a wide range of *IT architecture and standards* services (*specify and enforce architectures and standards for: technologies*, *communications*, *data*, *applications*, and *work*)	0.85	0.85
MC3	The IT unit provides a wide range of *IT education* services (*training in the use of IT*, *management education for generating value from IT use*)	0.73	0.73
MC4	The IT unit provides a wide range of *IT research and development* (*R&D*) services (*identify and test new technologies for business purposes*, *evaluate proposals for new IS applications*)	0.78	0.78
Strategic alignment			
SA1	IT shared across the company aligns well with stated organizational goals	0.84	0.84
SA2	IT shared across the company helps establish useful linkages with other organizations	0.79	0.79
SA3	IT shared across the company enables the company to respond more quickly to change	0.82	0.82
IT-based competitive advantage			
CA1	The company often uses IT as a component for an information-based innovation	0.85	0.85
CA2	The company's IT-induced market position is such that competitors are forced to adopt less favorable competitive postures	0.82	0.82
CA3	The company utilizes IT to widen the array of products without increasing costs	0.67	0.67
CA4	The IT infrastructure in the company would be difficult and expensive for rivals to duplicate	0.53	0.53

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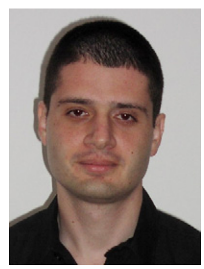

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