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An exploratory examination of the relationship between flexible IT infrastructure and competitive advantage

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Abstract

Information technology (IT) professionals have discussed the potential value of an organization's IT infrastructure. Unique characteristics of this infrastructure determine its value to the organization. One characteristic, flexibility, has captured the attention of managers in organizations. A flexible IT infrastructure has even been touted by some as the next competitive weapon. Despite this suggestion, empirical evidence has been sparse. The purpose of this paper is to offer an exploratory analysis into the relationship between flexible IT infrastructure and competitive advantage. A canonical correlation analysis is used to explore this relationship. The findings support the view that there is a positive relationship between flexible IT infrastructure and competitive advantage.

Keywords: Information infrastructure; Information architecture; Organizational flexibility; Organizational performance

1. Introduction

The value of an adaptive and flexible information technology (IT) infrastructure is very apparent to researchers and practitioners alike. In a recent survey of IT executives featuring the technology issues most important to them, the development of a flexible IT infrastructure was their number one priority [7]. In another study, Davenport and Linder [15] suggest that a flexible IT infrastructure is the new competitive weapon and note that it is crucial in developing sustained competitive advantage. Rockart et al. [49] attest that an effective infrastructure is a pre-requisite for doing business globally, where the sharing of information and knowledge is vital. In a recent interview, James Cash asserts: ''A relatively unheralded component of a company's competitiveness today is the flexibility and adaptability of its IT infrastructure. The importance of having a robust infrastructure on which the frequently changing strategy and tactics of a contemporary company can be quickly built has dramatically increased'' [27]. A recent study illustrates that, as the number of infrastructure services increase in an organization, the value of that infrastructure to overall strategic objectives also increases [9].

Despite these suggestions and assertions, empirical evidence upholding this view of the value of a flexible IT infrastructure is unproven. This paper is an attempt to examine the organizational value of an adaptive and

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flexible infrastructure. Since the empirical evidence is sparse, this study uses an exploratory approach. Specifically, it employs canonical correlation analysis to explore the relationship between a flexible IT infrastructure and competitive advantage.

2. Background

The literature that relates to IT infrastructure, flexibility, and competitive advantage provides the conceptual bases for this study.

2.1. Definition of IT infrastructure

The capabilities of IT associated with the term ''infrastructure'' vary somewhat. McKay and Brockway [39] call IT infrastructure the enabling foundation of shared IT capabilities upon which the entire business depends. Weill [59] notes that IT infrastructure is a foundation for capability across business and functional units. Davenport and Linder refer to IT infrastructure as that part of the organization's information capacity intended to be shared. They conclude that an IT infrastructure is a firm's institutionalized IT practice — the consistent foundation on which the specific business activities and computer applications are built. Rockart et al. reflect on the ideal goals of an IT infrastructure as follows:

> ''. . . an IT infrastructure of telecommunications, computers, software, and data that is integrated and interconnected so that all types of information can be expeditiously — and effortlessly, from the users viewpoint — routed through the network and redesigned processes. Because it involves fewer manual or complex computer-based interventions, a 'seamless' infrastructure is cheaper to operate than independent, divisional infrastructures. In addition, an effective infrastructure is a pre-requisite for doing business globally, where the sharing of information and knowledge throughout the organization is increasingly vital''.

Duncan [18] describes IT infrastructure as a set of shared, tangible IT resources forming a foundation for business applications. These, composing an IT infrastructure, are platform technology (hardware and operating systems), network and telecommunication technologies, data, and core software applications. Keen [28] defines IT infrastructure, or IT platform, in terms of reach and range. *Reach* determines the locations to which the infrastructure can link from workstations and computers in the same department to domestic customers and suppliers, including international locations, to anyone anywhere. *Range* determines the information that can be shared directly and automatically across services and systems. Broadbent and Weill [8] and Henderson and Venkatraman [24] separate the IT infrastructure into IT architecture and IT skills. The first is the choices pertaining to applications, data, and technology configurations. The skills relate to the knowledge and capabilities required to manage the IT resources within the organization.

2.2. Competitive advantage

Practitioners of strategic management in organizations are constantly on the lookout for resources that can bring their firms competitive advantage. The concept was popularized by Porter [44,45]. He says that competitive advantage grows from the value a firm is able to create that exceeds the firm's cost of creating the product or service. Day and Wensley [16] insist that a complete definition of competitive advantage must describe not only the state but also how that advantage is gained: sustained competitive advantage flows from organizational capabilities and resources that are rare, valuable, non-substitutable, and imperfectly imitable [2,3,33]. It is obtained by firms implementing strategies that exploit their internal strengths, through responding to environmental opportunities, while neutralizing threats and avoiding internal weaknesses.

2.3. IT and competitive advantage

Over the past two decades, IT has been promoted as one of the resources that organizations could use to gain a competitive advantage [4,12–14,21,31,40,42,46]. At one time, the competitive value of IT was thought to come from the so-called strategic information systems (SISs) [47,50,51,60]. SISs change the goals, operations, products, or environmental relationships of organizations to help them gain an advantage, over other companies in their industry. During the 1980s and early 1990s, strategic systems like American Airlines' Sabre

system [25], Baxter's International ASAP system [52], Federal Express's tracking and sorting system [54], and Digital Equipment Corporation's XCON [55] were all heralded as examples. Many companies were desperately trying to develop their own SISs.

However, Mata et al. [38] reason that proprietary technologies like SISs are becoming increasingly difficult to keep proprietary. They note that a wide variety of factors — workforce mobility, reverse engineering, and formal and informal technical communications — are present to disseminate detailed information about proprietary technology like SISs. Kettinger et al. [30] provide evidence that companies implementing SISs typically do not maintain their competitive advantage over time without other factors being present. They uncovered information that the pre-existence of unique structural characteristics is an important determinant of SISs' outcomes. Neumann [41] also rationalizes that SISs need complementary assets to lead to sustained competitive advantage. Without such interrelated assets, any technology can be easily imitated, thus losing competitive advantage.

One theme seems to permeate throughout all studies: focus always falls on the importance of structural capabilities of the firms implementing SISs. Capabilities like ''unique structural characteristics'', ''complementary assets'', ''managerial IT skills'', and ''structural differences'' are always used to maintain competitive advantage. Kettinger et al. note that one of these structural capabilities that seems to make a difference was the technological platform, or infrastructure. Davenport and Linder also state that the success of the few companies with SISs really is derived from long-term, well-planned investments in networks, databases, and skills, rather than ingenious individual applications. These networks, databases, and skills are, of course, components of an organizational IT infrastructure. Researchers now feel that the search for competitive advantage from IT has shifted from SISs to the strategic value of IT infrastructure.

2.4. *Flexibility, IT infrastructure, and competitive advantage*

Flexibility has emerged as a key competitive priority in many organizational activities including automation [1], high technology maneuvers [19], manufacturing [58], and IT. *Flexibility* is defined as the degree to which an organization possesses a variety of actual and potential procedures, and the rapidity by which it can implement these procedures to increase the control capability of the management and improve the controllability of the organization over its environment [17]. Therefore, high flexibility corresponds to high control of an organization with respect to its environment [32]. The more control an organization has over its competitive environment, the better its competitive position.

Duncan said: ''One firm's infrastructure may make strategic innovations in business process feasible, while the characteristics of competitors infrastructures may likewise cause their inability to *imitate* the innovation rapidly enough to mitigate the first mover's advantage. This set of characteristics has been loosely described as infrastructure *flexibility*''. A flexible IT infrastructure can support a wide variety of technologies that can be easily diffused into the overall technological platform, to distribute any type of information — data, text, voice, images, and video — to anywhere inside of an organization and beyond [5,22]. A flexible IT infrastructure is also able to support the design, development, and implementation of a heterogeneity of business applications. These properties help to give management control over the external environment. For example, if an organization supports a wide variety of hardware and software, that organization can more easily cope with changes in industry standards.

Organizations with high flexibility in a key area should be able to respond very quickly to strategic moves by competitors. These organizations should also adapt at initiating strategic moves of their own in attempts to gain competitive advantage over their competitors [23]. These valuable assets of a flexible IT infrastructure combined with the difficulty to imitate such an infrastructure should provide a sustained competitive advantage.

Because of the scarcity of empirical research, this study focuses on the relationship between factors of a flexible IT infrastructure and measures associated with competitive advantage. It is important first to establish the link between flexible infrastructure and competitive advantage before attempting to get into the much more difficult question of whether it is really sustained over time. If a relationship between a flexible IT infrastructure and competitive advantage was

found to be positive, this advantage would most likely be sustained, since a flexible IT infrastructure is not easily imitated. However, only empirical research will be able to answer this question more definitively. The research question to be answered in this paper is

Is there a positive relationship between factors of a flexible IT infrastructure and measures associated with competitive advantage?

3. Development of the factors for the flexible IT infrastructure

The development of the factors associated with the flexible IT infrastructure follows a systemic approach suggested by Churchill [11]. Stage 1 of the paradigm describes the domain of the construct. Stage 2 operationalizes the construct by developing a measurement instrument. Stage 3 emphasizes the statistical analysis of the data gathered from administering the instrument. Churchill's methodology has been used previously for IT construct development (e.g., [34,36]).

Arguably, the best way to describe the domain of a construct is through a literature search. In reviewing the IT infrastructure literature, five models were discovered. These models are shown in Table 1. The resulting dimensions taken from these models are (1) data transparency, (2) compatibility, (3) application functionality, (4) connectivity, (5) technical skills, (6) boundary skills, (7) functional skills, and (8) technology management. The first four are elements of a physical base and the last are elements of a human component.

Data transparency is defined as the free retrieval and flow of data between authorized personnel in an organization or between organizations regardless of location. *Connectivity* is the ability of any technology to attach to any of the other technology components inside and outside the organizational environment. *Compatibility* is the ability to share any type of information across any technology components. *Application functionality* is the ability to add, modify, and remove any software applications of the infrastructure with ease and with no major overall effect. *Technical skills* are a set of measures of technical capabilities such as programming, understanding software development processes, and knowledge of operating systems. *Boundary skills* refer to the importance of IT personnel having skills and knowledge to assume roles outside their area of training or original competencies [20,35,37]. These may include areas like project management and business process support. *Functional skills* relate to the ability of IT personnel to understand the business processes they are to support and apply the appropriate technical solution to a given business problem. Lastly, *technology management* pertains to the organization's ability to deploy IT in the most effective possible manner in support of the business strategies [10,56].

A content analysis of the IT literature resulted in a pool of 181 items that were used in the development of the initial instrument. Similar items were consolidated into a single item, resulting in an initial pool of 132 items, with at least six items in each dimension. Each item is presented on a 5-point Likert scale.

The questionnaire was pre-tested with eight IT managers, four in higher education and four in the private sector. Each manager was briefed on the purpose of the study and asked to critique the items for completeness, understandability, terminology, and ambiguity. The process resulted in the instrument being reduced from 132 items to 97 items.

The resulting questionnaire was then pilot tested for a second time by IT personnel in three different types of firms: a textile manufacturer, a mass retailer, and a financial institution. At each location, a senior IT manager was asked to distribute a copy of the questionnaire to other high level IT executives. Each participant was asked to complete the questionnaire and offer any suggestions for improvement. The pilot study results in a reduction of items from 97 items to 74 items for the construct. Several items were also modified.

4. Competitive advantage

The study uses four measures of competitive advantage: single items associated with innovativeness, market position, mass customization, and difficulty to duplicate. All are 5-point Likert scale measures with (1) ''strongly disagree'' and (5) ''strongly agree'' anchoring the two sides. Innovativeness applies to a culture where the generation, acceptance, and implementation of new ideas, processes, products, and services are the norm [26]. Innovativeness is almost

Table 1
Derivation of IT dimensions from existing IT infrastructure frameworks

Gibson [22]	Davenport and Linder [15]	Broadbent et al. [9]	Duncan [18]	Lee et al. [35]	IT infrastructure flexibility dimensions
Data transparency	Business information	Data management	Data		Data transparency
Computer compatibility	Technical functionality	Standards management	Platform		Compatibility
Application functionality	Business applications	Application management	Applications		Application functionality
Communications connectivity	Core technologies	Communications management	Network telecom		Connectivity
IT organization and control		Education management		Technical specialty skills	Technical skills
	Business process support	Services management		Interpersonal skills	Boundary skills
				Business functional skills	Functional skills
		IT R&D		Technology management	Technology management

seen as synonymous with competitive advantage [48,53,57]. It is generally accepted in most research literature that being innovative leads to competitive advantage. Hurley and Hult give empirical evidence of the importance of innovativeness to competitive advantage, with a very strong relationship between the two. The item to measure innovativeness is ''Our organization often uses IT as a component for an information-based innovation''.

Relative market position is an important component for competitive advantage. Such a firm can erect strong barriers to entry for other firms. The item for relative market position is ''Our organization's market position is such that competitors are forced to adopt less favorable postures''.

Mass customization allows businesses to offer products and services to a wide variety of customers and meet changing product demands through service or product variety and innovation — all without an increase in cost [6]. The value of mass customization has been aptly demonstrated in the literature. Companies from many diverse industries have used mass customization to their competitive advantage (for examples, see [43]). The item for mass customization is ''Our organization utilizes IT to widen the array of products without increasing costs''.

One prominent research stream that has found favor in the search for competitive advantage is the resource-based view. Lado and Wilson note that this stream of strategy research ''generally posits that organizational resources and capabilities that are rare, valuable, non-substitutable, and imperfectly imitable form the basis for a firm's sustained competitive advantage''. If a valuable resource like a flexible IT infrastructure is difficult to duplicate, it is a source of competitive advantage. Respondents were asked how difficult it was for rivals to duplicate their IT infrastructures. The item for difficulty to duplicate is ''The IT infrastructure in the organization would be difficult and expensive for rivals to duplicate''.

5. Data collection

The final version of the questionnaire was mailed to senior IT managers in mainly large Fortune 1000 companies. Their titles included Chief Information Officer, Vice President of Information Services, Director of MIS, and Database Administration Directors. To identify IT managers for the target audience, the *Directory of Top Computer Executives* was used. This directory is updated annually and the 1998 release was used for this study. One thousand executives in eight private sector industries were randomly selected for this final distribution stage. A total of 207 questionnaires were returned. This response rate is in line with that for similar studies of senior executives. The demographic results are given in Tables 2–5.

Table 2
Distribution of returned questionnaire

Industry type	Mailed	Returned	Percent
Manufacturing	493	119	24.1
Insurance	120	10	8.3
Health services	91	16	17.6
Retail	76	18	23.7
Utilities	67	11	16.4
Diversified financial	60	15	25.0
Banks	57	10	17.5
Transportation	25	6	24.0
Others (not specified)	11	2	18.2

Table 3
Management level of respondents

Classification	Frequency	Percent
Executive	56	27.0
Upper middle management	110	53.1
Professional	41	19.8

Table 4
Organization size

Employees in company	Frequency	Percent
50–250	17	8.2
251–1000	38	18.4
1001–5000	104	50.2
Over 5000	48	23.2

Table 5
Revenue distribution of companies in survey

Revenues of company (in millions)	Frequency	Percent
$50–$250	18	8.7
$251–$1000	87	42.0
$1001–$5000	89	43.0
Over $5000	13	6.3

Table 6
Factors of flexible IT infrastructure

	Factor loadings
IT personnel flexibility (Cronbach's alpha = 0.93)	
Our IT personnel work well in cross-functional teams addressing business problems	0.81
Our IT personnel are encouraged to learn new technologies	0.72
Our IT personnel are able to interpret business problems and develop solutions	0.70
Our IT personnel are self-directed and proactive	0.66
Our IT personnel are encouraged to learn about business functions	0.64
Our IT personnel have the ability to work cooperatively in a project team environment	0.64
Our IT personnel is knowledgeable about the key success factors in our organization	0.64
Our IT personnel have the ability to plan and execute work in a collective environment	0.63
Our IT personnel understand our organization's policies and plans	0.63
Our IT personnel are knowledgeable about our environmental constraints	0.63
Our IT personnel are knowledgeable about business functions	0.62
Our IT personnel are skilled in multiple structured programming, CASE methods	0.60
Our IT personnel are competent in managing the development life cycle of projects	0.60
Our IT personnel are skilled in network management and maintenance	0.59
Problem resolution between IT and business units is identified as a specific job task	0.59
Our IT personnel are free to assist end user as they deem necessary	0.57
Our IT personnel have the ability to plan, organize, and lead projects	0.56
Our IT personnel have the ability to write clear, concise, and effective memos, etc.	0.56
Our IT personnel are very capable in teaching others	0.54
Our IT personnel is knowledgeable about our product delivery/logistic system	0.54
Our IT personnel understand the business environments they support	0.54
Our IT personnel are skilled in developing web-based applications	0.52
The strategies of the IT group and our organization's strategies are well aligned	0.50
Our IT personnel have the ability to work closely with clients and customers	0.48
Our IT personnel closely follow the trends in current technologies	0.47
Our IT personnel are cross-trained to support other IT services outside their domain	0.46
Our IT personnel are skilled in multiple microcomputer operating system	0.43
Our IT personnel have the ability to accomplish multiple assignment	0.40
Our IT personnel are skilled in distributed processing or distributed computing	0.40
Our IT personnel are skilled in data warehousing, mining, or marts	0.40
Integration (Cronbach's alpha = 0.75)	
Our organization offers a wide variety of types of information to end users	0.62
Our organization utilizes open systems network mechanisms to boost connectivity	0.53
Our organization provides multiple interfaces or entry points for external end users	0.53
Our organization utilizes a virtual network or VLAN to connect end users	0.52
Our user interfaces provide transparent access to all platforms and applications	0.50
End users throughout the organization utilize a common operating system	0.50
Software applications can be easily transported and used across multiple platforms	0.49
Our organization utilizes online analytical process (OLAP)	0.47
There are very few identifiable communications bottlenecks within our organization	0.47
Modularity (Cronbach's alpha = 0.75)	
Mobile users have ready access to the same data used at desktops	0.70
IT personnel utilize object-oriented tools to minimize the development time	0.59
Our organization easily adapts to various vendors' DBMS protocols and standards	0.59
Data captured in one part of our organization are immediately available to everyone	0.55
All remote, branch, and mobile offices are connected to the central office	0.54
Reusable software modules are widely used in new systems development	0.48
Our corporate database is able to communicate in several different protocols	0.44

Non-response bias was investigated by comparing the industry distribution of the returned questionnaires to the population industry distribution using a chi-square one-sample test. The use of the chi-square distribution was appropriate given a sufficiently large sample with only two of the frequencies exhibiting values between 1 and 5. The computed chi-square statistic, testing the sample industry distribution against the population distribution, is 14.0 with seven degrees of freedom and therefore not significant at the 0.05 level. This suggests that the distribution of firms in the sample does not significantly differ from the distribution of firms in the population, indicating no response bias.

Factor analysis was performed on the items measuring the flexibility of IT infrastructure. Although eight dimensions were hypothesized from the literature search, only three factors emerged from the analysis. Items from ''database transparency'' and ''application functionality'' dimensions merged together to form what is now termed ''modularity''. Items from the ''compatibility'' and ''connectivity'' dimensions were merged to form ''integration''. Most of the items from the four human component dimensions merged together into ''IT personnel flexibility''. Table 6 gives the items, the factor loadings, and the Cronbach for each factor.

Canonical correlation analysis is used to examine the relationship between the flexible IT infrastructure factors and the measures of competitive advantage. This analysis is a multivariate statistical model that facilitates the study of interrelationships among sets of multiple criterion (dependent) variables and multiple predictor (independent) variables. Whereas multiple regression predicts a single dependent variable from a set of multiple independent variables, canonical correlation simultaneously predicts multiple dependent variables from multiple independent variables.

6. Results

The objective of this analysis was to use all seven variables as input data. The flexibility factors (modularity, integration, and IT personnel flexibility) are designated as the set of multiple independent variables or the predictor variables. The measures of competitive advantage (innovativeness, market position, mass customization, and difficulty to duplicate) are specified as the set of multiple dependent variables or the criterion variables. The statistical problem involves identifying any latent relationships between a respondent's perceptions about the flexible IT infrastructure construct and the measures of competitive advantage. The analysis of the data in this study shows a definite relationship between these two sets of constructs. This provides some evidence that a flexible IT infrastructure is related to competitive advantage.

Canonical correlation must be analyzed in a systematic way to have confidence in the results. The first step is to determine the overall fit of the canonical function. Table 7 shows the overall fit indices for this data. Two canonical functions are statistically significant with p-value of less than 0.01 on their F-tests. Other test statistics (Wilks' lambda, Pillai's trace, Hotelling–Lawley trace, and Roy's greatest root) also indicate that the canonical functions, taken collectively, are statistically significant at the 0.01 level or less.

The next step in investigating the results was to examine the redundancy analysis. Table 8 shows that redundancy index for the criterion variate is 0.236. The predictor variate is 0.183 for the first canonical function. The variates for the second function are too low to be of practical importance (not shown in the table). These numbers indicate the amount of variance of one explained by the other. The number is analogous to multiple regression's R^2-statistic, and its value as an index is similar. Explaining 20% of the variance in an organization level study can be fairly significant considering all the other factors that can contribute to performance measures. Because of the statistical significance of the overall canonical function and

Table 7
Measures of overall model fit for canonical correlation analysis

Likelihood ratio	Approx. F	Num DF	Den DF	Pr > F
0.4758	6.9381	12	256	0.0001
0.8447	2.8832	6	196	0.0103
0.9938	0.3038	2	99	0.7387
Statistic	F	Num DF	Den DF	Pr > F
Wilks' lambda	6.9381	12	256	0.0001
Pillai's trace	6.0974	12	297	0.0001
Hotelling	7.6346	12	287	0.0001
Roy's GR	19.1669	4	99	0.0001

Table 8
Calculation of the redundancy indices for the first canonical function

Variable	Canonical weights			Canonical loadings	Canonical cross-loadings
	First split sample ($n = 103$)	Second split sample ($n = 104$)	Total sample ($n = 207$)		
Predictor set — flexible IT infrastructure					
IT personnel flexibility	0.8486	0.8473	0.8372	0.9629	0.6773
Integration	0.2220	0.2257	0.2238	0.5837	0.4106
Modularity	0.1638	0.1631	0.1459	0.4334	0.3048
Redundancy coefficient = 0.1828					
Criterion set — competitive advantage					
Innovativeness	0.9057	0.9053	0.9028	0.9601	0.6753
Mass customization	0.1473	0.1525	0.1369	0.4772	0.3357
Relative market position	0.2502	0.2525	0.2569	0.2950	0.2096
Difficulty to duplicate	−0.0065	−0.0134	−0.0214	0.3679	0.2588
Redundancy coefficient = 0.2362					
Canonical correlation	0.6606	0.6593	0.7034		
Canonical root (eigenvalue)	0.7744	0.7691	0.9793		

fairly reasonable redundancy coefficients, the first function is accepted.

With the canonical relationship deemed statistically significant and the magnitude of the canonical root and the redundancy index acceptable, the analysis now turns to the substantive interpretations of the results. The three methods for interpretation are (1) canonical weights (standardized coefficients), (2) canonical loading (structure correlations), and (3) canonical cross-loadings. Table 8 shows all three indices.

The first is the canonical weights. The magnitude represents their relative contribution to the variate. Based on the size of the weights, the order of contribution of independent variables to the flexible IT infrastructure variate is ''IT personnel flexibility'', ''integration'', and ''modularity''. The order of contribution for the dependent variables to the competitive advantage variate is ''innovativeness'', ''market position'', ''mass customization'', and ''difficulty to duplicate''.

The canonical loadings for the independent variate (flexible IT infrastructure) range from 0.433 to 0.963 showing fairly high shared variance for the sample used. The dependent variable's canonical loadings are lower ranging from 0.295 to 0.960, still acceptable for interpretation. With the loadings of these two variates fairly good with no negative loadings, the conclusion is that the variates are good representations of flexible IT infrastructure and competitive advantage, respectively.

The canonical cross-loadings for the independent variate range from 0.305 to 0.677. The canonical cross-loadings for the dependent variate range from 0.208 to 0.675. Both of the canonical cross-loadings for the dependent and independent variates are acceptable for interpretation. All cross-loadings are positive. This gives one more indication of a valid relationship between the two variates.

The last check is a sensitivity analysis of the canonical correlation results. One method is to split the sample into two equal sets and then run a canonical correlation on each set. The loadings should roughly be the same if the overall canonical correlations are stable. The canonical loadings in this data are remarkably stable and consistent. This reinforces the procedure of using the canonical loadings and cross-loadings for interpretation purposes.

7. Discussion and conclusion

The results of the canonical correlation analysis in this study point to a relationship between flexible IT

infrastructure and competitive advantage. All of the indicators of the canonical analysis are strong and unambiguous. At the very least, it can be said that flexible IT infrastructure as measured by integration, modularity, and IT personnel flexibility is positively related to some organizational measures of innovativeness, mass customization, difficulty to duplicate, and market position. Of course, they may be other measures that should be included in either one of the constructs. However, given the exploratory nature of this research, it is concluded that a positive relationship between the two is likely.

This study also gives some information about the strength of contribution of each factor to the relationship. The analysis shows that the IT personnel flexibility factor contributes the most among the factors of the flexible IT infrastructure to the relationship. This finding is congruent with that of Weill, who states that two firms investing the same amount in IT and with the same management directions will probably have different organizational results. He further explains this is the IT personnel, more specifically, the magnitude and quality of the knowledge, skills, and experiences of the personnel in developing major software applications. Therefore, it is reasonable to assume that the IT personnel effect is arguably the most important component of a flexible IT infrastructure.

The integration factor is next in importance. Again, this outcome fits findings of past literature. Keen [29] emphasizes the importance of reach and range in an organization. In fact, he uses the concept of reach and range, which are comparable to connectivity and compatibility in this study, to explain integration and demonstrate how companies might generate a competitive advantage from IT. The concept of connecting end users to each other sharing all types of information is much better developed than the concept of using modular technologies. The use of object-oriented tools and components is still in its infancy in most organizations, even large ones. In fact, the concept of reusability among software and data modules is just now beginning to bear fruit in some organizations.

However, despite the obvious hierarchy of importance among the IT infrastructure factors, it is important to remember that all three contribute to the positive relationship to the measures of competitive advantage. Therefore, any future studies investigating this relationship should include all three factors. Even though the findings seem to be comparable to past research literature, the dynamic nature of IT could change the order in importance in the future.

There are limitations in our findings. The relationship between flexible IT infrastructure and competitive advantage needs much more attention. The purpose of this study was to explore the possibility of a positive relationship between the two. Much more rigorous studies must be completed to ascertain antecedent and consequent relationships between these two constructs.

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