Exploring Information Technology Flexibility and Increased Complexity: Is Management Prepared?

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Abstract

Information technology (IT) flexibility has become a key enabler of increased IT effectiveness, towards improved IT-business alignment and sustained competitive advantage (Ness, 2005). However, as has been shown through this exploratory literature review, higher levels of IT flexibility also increase the level of complexity to be managed (Young, 2007; Rettig, 2007). Unfortunately, it was also found that management does not appear to be aware and/or prepared to manage the increased complexity (Wheatley, 2000; Lee, 2003), possibly resulting in more harm than good. This study are hoped to alert both IT and business management as to the opportunities existing within the area of IT flexibility, but also the risks involved if the resulting complexity level is not satisfactorily recognized and managed.

Keywords

Information Technology, IT Flexibility, IT Effectiveness, Complexity. IT-business Alignment

Introduction

In recent years, there appears to have been an increased focus on the definition, architecting, and application of flexible systems and solutions within information technology. This appears to have been for a good reason, as researchers have shown within scholarly studies conducted that IT flexibility is positively related to areas of importance to IT and business executives, alike, such as IT effectiveness and strategic alignment (Ness, 2005). In turn, IT effectiveness has been shown to be positively correlated to such business imperatives as improved firm performance (Santhanam & Hartono, 2003), and sustained competitive advantage (Clemons & Kimbrough, 1986).

However, despite this weight of evidence as to the value of IT flexibility, there is another factor - complexity, that may have an equal, and offsetting, effect on IT effectiveness, and its associated benefits for the business. If not managed, a more severe and negative correlation may

result, in that the result of pursuing increased levels of IT flexibility could result in a level increased complexity that would leave the business in a worse situation than when they started - yielding IT to become ineffective and incapable of meeting the business demand for technology-based services and solutions.

Therefore, the focus of this exploratory literature review study is to evaluate the possible relationship between IT flexibility and complexity, and whether firm management (IT and/or business) is prepared for the resulting increased levels of complexity, if exists. Within the remainder of the paper representing the work completed, the statement of the problem and purpose will first be presented, along with the significance of research, research questions, and methodological approach. This introductory section will then be followed by the literature review as the bases for the theoretical framework established for research. Lastly, this will then be followed by the research findings, and finally with the conclusions and recommendations for further research.

Statement of the Problem and Purpose

The problem to be addressed within this study is the increased complexity that may result as a result of IT executives and managers pursuing increased Information Technology (IT) flexibility (ITF) towards improved IT effectiveness (ITE), strategic alignment (SA), and sustained competitive advantage (Ness, 2005). The purpose of this qualitative study is to explore the impact of increased ITF, in terms of the level of complexity incurred, and the associated management awareness, considerations, and decision-making implications that would result from such a relationship.

Significance of Research

This research is significant for IT and business management alike, in that, IT-business alignment continues to remain one of management's top concerns. In a recent study conducted by researchers at CIO Insight (http://www.cioinsight.com), IT-business alignment was shown to be the second-highest concern among CIOs surveyed ("CIO Insight", 2008). As a result, IT flexibility is being sought in increasing proportions through efforts such as outsourcing, Service Oriented Architecture (SOA), virtualization, and other manifestations across the IT management dimensions of process, people, and technology (CMMI, 2007).

Research Questions

The primary question driving this research is: Will management be prepared for the changes imposed through increased IT flexibility, such that the result does not leave them worse off than before? The secondary questions to be explored in response to this question are:

1. Does increased IT flexibility result in increased complexity?
2. Is management generally aware-of, and prepared-for the increased complexity resulting from IT flexibility generating activities?

Methodological Approach

This study consisted of a qualitative literature review to respond to the research questions. As outlined within the remainder of this paper, an indication within the literature that IT flexibility does lead to increased complexity, would then lead to the second question to further address the relevancy of increased complexity to explore whether management is generally aware of the expectation for increased complexity when preparing-for, and/or responding-to IT flexibility initiatives.

Summary and Conclusions

Whether called agile computing, virtual computing, or IT flexibility, IT and business managers, alike, have been searching for solutions to narrow the gap between IT and business alignment (citation). When the capability comes along to reduce the alignment gap, and to achieve a state of equilibrium through IT flexibility (Ness, 2005), then it is anticipated, and has been shown, that management will be quick to do that which is necessary to achieve stronger ties between IT and business and to ensure that IT supply is able to meet business demand despite ever increasing, and rapidly changing business dynamics, brought about through increased competition, e-commerce, and a flattening of the global economy. The question is: Will management be prepared for the changes imposed through increased IT flexibility, such that the result does not leave them worse off than before?

Research as to these challenges will be the focus of the remaining sections of this paper. It is hoped that as a result of the literature review conducted, that one, or both, of the research questions will be responded to, such that the primary problem and question can be addressed.

Literature Review

Information Technology Flexibility

In research conducted by this author in 2005, a major finding from the study included the positive correlation observed between ITF and ITE (Ness, 2005). In fact, when tested within the same regression model, the correlation between SA and ITE was shown to be insignificant, as compared to ITF and ITE (Ness, 2005). Therefore, it would appear that while both strategic planning and IT flexibility are important, if one were to be chosen over the other, IT flexibility would be prioritized. Considering this further, the logic is apparent, as no degree of planning

would be effective in achieving alignment if IT were not able to respond to the business need. In fact, it was stated by one author that the lack of IT flexibility (e.g., rigidity), can be equated to IT being an anchor around the proverbial neck of business (citation).

Addressing the dimensions of ITF, there are three secondary factors that operationally define ITF, these are connectivity, modularity, and compatibility. Each will be addressed, along with the key findings from Ness (2005),

Connectivity. As cited in Ness (2005), Keen (1991) appears to have been the originator of this term as a dimension of ITF in the application of the term *reach*, referring to the points of connection that can be link to within the deployment of a platform, or technology. This concept was confirmed when Goldman, Nagel, and Preiss (1995) introduced the concept of *agility* as a means of sustained competition and the primary means to achieve the virtual organization. Duncan (1995) further defined connectivity as the application of technology components to connect to one another within, or outside of, the traditional organization. Finally, connectivity can also reflect the number of platforms that can be connected to (Duncan, 1995; Tallon & Kraemer, 2003). In addition, researchers at E-Sourcing (2002) recognized that connectivity is a key to delivering *on-demand* capabilities for IT (e.g., IT flexibility).

Modularity. Per research conducted by Ness (2005), Sanchez (1997) appears to have first introduced the concept of modularity as a key aspect of flexibility. Sanchez found that flexibility was critical for managing volatility associated with business demand, and especially within environments that experience a high degree of fluxuation. Of particular interest, Sanchez offered three additional criteria for defining the specific area of resource flexibility: increased range of uses for each resource, decreased switching costs, and reduced time to switch between resources. According to Ness, "this concept is important as it helps support the aspect of modularity, a key

factor of IT flexibility" (p. 28).

Compatibility. Similar to the concept of range, compatibility pertains to the seamless interaction among technical components (Keen, 1991). A recent innovation, SOA, provides an example of this ITF dimension (as well as others), in that, the technology layers are designed to be loosely-coupled, following strict guidelines to help ensure that components have similar qualities and that they can effectively communicate with each other (Kay, 2004). According to Ness (2005), "flexibility, therefore, includes the ability to vary the connectivity, or reach, of the technology, as well as the compatibility, or range, of the technology features" (p. 28).

Ness (2005) tested the relationship between each of the predictor variables and ITF, as shown in Figure 1.

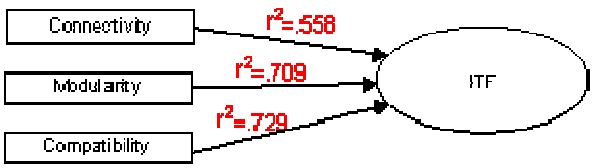

Figure 1: Conceptual ITF construct model (used with permission)

Each factor was tested as to the strength of its correlation to ITF as well as to evaluate which among them was most closely related to ITF. Each dimension was found to significantly predict ITF at $p<0.001$, including the existence of high effect sizes (Cohen, 1988). According to Ness, "this is consistent with the results of previous studies and indicates that each is closely aligned, but that modularity and compatibility are better predictors than is connectivity for IT flexibility" (p. 90).

In a seminal study reviewing the relationship between complexity and flexibility within Information Systems Development Projects (ISDPs), Lee (2003) supported the notion that

flexibility is a necessity for corporate and IT leaders within a hypercompetitive, dynamic, and complex business environment. Building upon the work of Duncan (1995), Byrd and Turner (2000), and others, Lee further established an operational definition of technological (IT) flexibility consisting of the extent of response and the efficiency of response.

Complexity

While establishing an operational definition for the ISDP complexity construct. Lee (2003) identified that the factors associated with technological (IT) complexity consistent of both *hard* components, such as hardware, software, and networking, but also *soft* components, such as knowledge, skills, and experiences. Further, Lee (citing Meyer & Curly, 1991), noted that within the context of expert systems, technology (IT) complexity consisted of four additional factors, defined as platform diversity, technology diversity, database intensity, and the degree of systems integration required.

As a function of complexity within the realm of IT management, Young (2007), asserted that outsourcing provides the opportunity for improved labor flexibility (citing "Industry Commission", 1995; Hodge, 1996; and Rimmer, 1993); however, by doing so, complexity is increased by addition layers of management to the process.

Rettig (2007), citing Ross, Weill, and Robertson (2006), asserted that the practice of applying incremental changes to legacy systems over time in response to changing business priorities and demand has resulted in increased levels of complexity that has resulted in system rigidity and has driven growth in the rate of IT investment, as well as the percent of IT investment spent on system maintenance.

Further, Rettig (2007), citing Glass (2003), noted that complex problems, lead to more complex solutions. In fact, it is estimated that "for every 25% increase in complexity in the tasks

to be automated, the complexity of the software solution itself rises by 100%" (p. 22). This implies, then, that as organizational leaders, and more specifically, IT management attempts to become more agile through increased processes, people (labor), and/or technological (IT) flexibility, the reality is that these dimensions of the IT management function may in fact be harder to manage as a result of dramatically increased complexity. What does not appear to have been addressed is whether complexity necessarily leads to rigidity, or if complexity, properly managed, can still allow IT flexibility to occur. This will be explored further.

Finally, Rettig (2007) opined that "rather than agility, they [enterprise systems] have produced rigidity and unexpected barriers to change" (p. 25). Jim Shepherd, Senior Vice-President with Boston-based AMR Research, Inc. confirmed this by stating that new systems introduce change to the organization (Rettig, 2007, citing Wheatley, 2000). Further, Orlikowski and Iaconon (2000), noted that technology changes are both "profoundly complex and uncertain" (Rettig, 2007, p. 25).

Complexity Measures for IT Software

Kearney, Sedlmeyer, Thompson, Gray, and Adler (1986), appear to have been some of the early authors to explore the area of IT complexity, and in particular, with respect to software. Addressing the question "What is Complexity?" (Kearney, et al., 1986, p. 1044, citing Basili, 1980) noted that complexity is defined as the "measure of resources expended by a system while interacting with a piece of software to perform a given task" (p. 1044), as measured by execution time and storage requirements for systems or the difficulty for performing tasks, if a programmer (Kearney, et. al., 1986). Finally, Kearney, et al. coined the term software complexity and defined it as the "interaction between a program and a programmer working on the same programming task" (p. 1044).

Research and Findings

In response to the first question: Does increased IT flexibility result in increased complexity? The answer appears to be yes, as confirmed by Young (2007) and then again by Rettig (2007), citing both Glass (2003) and Orlikowski and Iaconon (2000), in their respective findings as to the (profound) increases in complexity resulting from technology solutions and automation. Therefore, whether assessing the changes resulting from the implementation of people, processes, or technology (CMMI, 2007), there is evidence in the literature that complexity is indeed increased when improved IT flexibility is pursued.

In addition, while not sought as a primary research question within this study, the additional consideration has been raised as to whether increased complexity necessarily leads to increased levels of IT rigidity (e.g., decreased IT flexibility), which was noted by Ness (2005), citing Willcocks (1992), as rendering "IT as a marginal utility, or even worse, counter-productive to the business objectives" (p. 16). Lee (2003) partially addressed this concern by bringing to light the necessity of flexibility when managing greater levels of complexity - the implication being that complexity is best managed through increased IT flexibility. Therefore, not only does IT flexibility result in increased complexity, but complexity is dependent on IT flexibility, at least when managing technology-related disciplines, as was the focus for this exploratory review. As such, there would appear to be a potential correlation between the two phenomena, which if measured, could be quantitatively tested.

Further, the question of whether this increased complexity can be managed such that increased IT flexibility results towards increased IT effectiveness and sustained competitive advantage for the business. This is the focus of the second research question.

In response to the second question: Is management generally aware-of, and prepared-for the increased complexity resulting from IT flexibility generating activities? The response, as noted through the literature appears to be a resounding no. This is best summarized by Wheatley (2000), who, quoting the Senior Vice-President of Boston-based AMR Research, Inc., Jim Shepherd, stated that "senior managers often don't particularly want to be told that there's a high risk and that there's a great deal of expenditure involved in minimizing it [complexity]" (Rettig, 2007, p. 25). Lee (2003) also noted that management does not appear to be adequately prepared to handle business and IT environments that have become increasingly dynamic and complex.

Conclusions and Recommendations

In conclusion, as a result of conducting this exploratory research on the nature of IT flexibility, complexity, and management's awareness and preparation towards optimal levels of IT effectiveness, alignment, and sustained competitive advantage (Ness, 2005), the findings appear to be conclusive based on the literature reviewed from key authors, including Rettig (2007); Kearney, et al., (1986); Young (2007, Lee (2003); and others. What appears certain is that: (a) IT flexibility does lead to increased levels of complexity, but that technological complexity must be addressed through IT flexibility; and (b) management is either unaware and/or unprepared to manage the increased complexity - often resulting from attempts to attain greater levels of IT complexity.

For further research consideration, and based on the above findings, it is recommended that follow-up research be conducted as to the specific instances within which the balance between IT flexibility and complexity may exist - such as in the areas of IT outsourcing, software development, enterprise applications and architectures, etc. These additional areas of research, and others, would aid management in having greater understanding of the phenomenon

towards improved decision-making, managerial oversight, and success. Ultimately, in spite of increased complexity, IT flexibility should not be avoided, but embraced, as it is the key to improved IT effectiveness, IT-business alignment, and sustained competitive advantage (Ness, 2005).

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