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Towards a Framework for Balancing Enterprise Systems Flexibility

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Given the uncertainty and changing business conditions faced by North American manufacturers, the need to balance the flexibility of an organization's information system is more important now than ever before. Too much flexibility may result in workarounds and corrupt data leading to increased inefficiencies and levels of waste, contrary to production goals. Too rigid a system makes it difficult for the organization to adequately respond to uncertainty and change key business process to respond to changing environmental conditions. This research examines the need to balance flexibility in enterprise systems for optimal organizational effectiveness.

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Abstract
Given the uncertainty and changing business conditions faced by North American manufacturers, the need to balance the flexibility of an organization's information system is more important now than ever before. Too much flexibility may result in workarounds and corrupt data leading to increased inefficiencies and levels of waste, contrary to production goals. Too rigid a system makes it difficult for the organization to adequately respond to uncertainty and change key business process to respond to changing environmental conditions. This research examines the need to balance flexibility in enterprise systems for optimal organizational effectiveness.

Keywords
Enterprise Systems, Flexibility, Balance Factors, High Reliability

1. Introduction
Increasing global competition, combined with skyrocketing costs and scarcity of raw materials, have forced many manufacturing organizations to actively undertake inter- and intra-firm effort at improving the flexibility of their organization and supply chain. Such flexibility allows the facility and supply chain to effectively address uncertainty from a wide variety of sources, yet continue to produce efficiently different products or product volumes of acceptable quality, cost, and timeframe. The research literature and popular press have suggested a wide variety of options for improving flexibility, including hard technology solutions (e.g. robotics), people focused (e.g., cross-training), external (e.g., outsourcing), and uncertainty reduction (e.g., lean production) practices. Despite the large volume of literature and practical advice on improving flexibility in manufacturing organizations, one area of critical importance is missing, specifically the role that the flexibility of the organization's information systems (including the technology, people, processes, and procedures) plays in achieving the strategic goals of manufacturing flexibility, competitiveness and performance, and integration with key supply chain members. Given the uncertainty and changing business conditions faced by North American manufacturers,

the need to balance the flexibility of an organization's information system is more important now than ever before. Too much flexibility may result in workarounds and corrupt data leading to increased inefficiencies and levels of waste, contrary to production goals. Too rigid a system makes it difficult for the organization to adequately respond to uncertainty and change key business process to respond to changing environmental conditions. To better understand the role of IS flexibility in today's information technology dependent manufacturing organizations, this article outlines research aimed at developing a model of the relationship between IS, and more specifically, enterprise systems (ES), flexibility and risk, capability, and reliability. Future research focused on how this framework will be tested is also introduced and discussed.

2. Information Systems Flexibility

The research literature has made it clear that the information systems function in organizations has experienced great difficulties in coping with the high complexity and rapid changes characteristic of today's business and technological environments. Both researchers and IS executives have suggested that flexibility is critical in such environments. Flexible information systems are required to enable the organization to handle the turbulent environment, uncertainty, and ambiguity of the future, while maintaining effective internal and supply chain linkages. While IS flexibility is becoming increasingly important from both research (e.g., IS, supply chain management, organizational flexibility research domains) and industry (e.g., Sarbanes-Oxley (SOX) compliance in the US) perspectives, knowledge of the concept is limited. Researchers have only a vague understanding of how to assess and measure the flexibility of information systems, with prior research focusing on IT infrastructure flexibility and IS development project flexibility.

Information Systems flexibility is has been highlighted as the ability of an organization's information system to respond or adapt to the changing business and IT environment (Frazelle, 1986; Gebauer and Schober 2006). As commonly found in the manufacturing flexibility literature (Boyle, 2006), a number of researchers have suggested a gap analysis, specifically responding to and correct any gap between the current state and the desired state (Harrington et al 2004). Extending the gap analysis approach to an organization's information systems department, flexibility refers to the matching of IT infrastructure and IS capability with the ideal requirements of the information systems (Kanellis et al 1999; Ivari 1992). The desired information system response can result in extensive changes in the user requirements (Jalote, 2000; Whitten et al., 2001), technical and non-technical requirements (SEI, 1994), system inputs/outputs, logical internal files, interface files, and external inquiries (Lee and Xia 2005). Based on a review of the literature, IS flexibility is defined for this research as the ability of information systems stakeholders (including IT staff, solution providers, and end-users) *to respond and adapt to both external and internal business conditions and requirements, changes in information needs, changes in regulations, and changes in information technology through the efficient, effective and timely modification of information systems policies, procedures, system interaction, and resource capabilities.*

Achieving a balanced approach to information systems flexibility is needed to ensure that the organization can adequately respond to uncertainty and changing business conditions. If an information system is too flexible, the result could be excessive workarounds, data and process duplication, and corrupt or incomplete data. Too rigid a system makes it difficult for the

organization to respond in a timely manner to uncertainty and changes to key business process, as highlighted by the difficulties organizations are facing in ensuring Sarbanes-Oxley compliance. In order to better understand flexibility and ensure that the levels are in line with the flexibility of the organization, the role of flexibility in relation to other IS factors such as IS risk, capability, and reliability, is needed.

2.1. Balancing Reliability, Capability, Risk, and Flexibility

Some organizations have been very successful in their implementation of complex systems, e.g., those controlling nuclear power stations and chemical processes (Roberts and Bea, 2001). These organizations, by the very nature of what they do require a high degree of reliability from their systems, procedures, and people. High Reliability Organizations (HROs) operate in environments where the tolerances for error are extremely slim. Roberts (1990) identified what it means to be an HRO by posing the question, "How often could this organization have failed with dramatic consequences?" If failure could have occurred many thousands of times, but did not, the organization is highly reliable. One important characteristic of HROs is the flexibility of the organizational structure (Roberts and Bea, 2001). An organization that works toward structural agility, rather than adherence to stoic traditional models of hierarchy, will be more responsive in a dynamic complex workplace (ibid). Flexibility in organizations seeking to be reliable is important for those that have the potential to create catastrophic consequences (Roberts and Libuser, 1993). Thus, a major contributor to an organization's capability can be found in the flexibility of its structure.

The above withstanding, HROs face considerable risk (i.e., human life, financial, operational) that must be addressed and mitigated. Further, risk aversion strategies have been shown to be ineffective (Roe et al., 1998). Some organizations may have a choice to flee from risk. What separates HROs from many traditionally less critical organizations is that risk is an ever-present component of the operational formula, and attempts to avoid it lead to failure. In the case of HROs, failure is often a publicly visible man-made disaster with considerable consequences. Sullivan and Beach (2004) illustrated the concept of balancing capability and risk in studies that examined the potential to transfer factors that contribute to success in HROs to ES applications. The result is a conceptual model that illustrates the dynamics of balancing capability and risk to obtain higher degrees of reliability.

2.2. Towards a Conceptual Framework of ES Flexibility

The ability to balance capability and risk in the face of high consequence separates HROs from other of less critical organizations (Sullivan and Beach, 2004). The Sullivan-Beach Model (Figure 1) illustrates the dynamic nature of risk and the weight of capability necessary to counteract that risk. Failure occurs as a result of risk, comprised of expectations and risk factors, outweighing an organization's capability, comprised of resources and organizational competence. Ultimately, the scale tips out of balance, and consequences follow.

Bilateral relationships exist between expectations and consequences, as well as expectations and resources. Additionally, a one-way relationship between consequences and organizational competence exists. Expectations and consequences are related in that the consequences for failure are implemented according to the degree of missed expectations. For example, a delay in launching NASA's Space Shuttle by one day violates an expectation that the shuttle program

stay on schedule. However, the consequences of failing to meet this expectation are minor. Higher order expectations include returning the shuttle and its crew safely to earth. Failing to meet those expectations involves much more severe consequences (ibid).

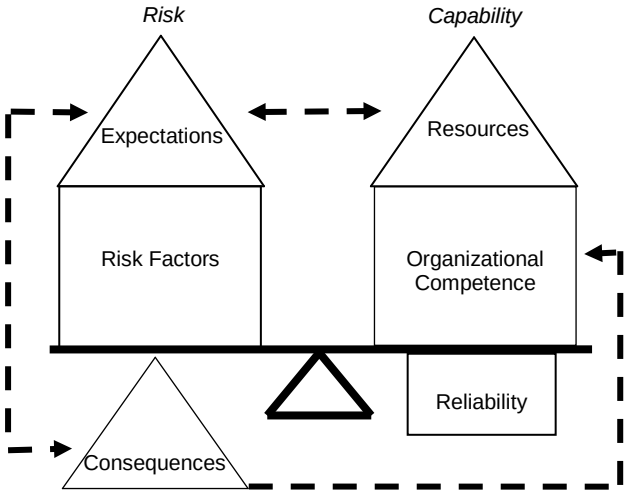

Figure 1: Conceptual Model for How HROs Manage Complex Systems.

The relationship between expectations and resources reflects the principle of stakeholders (government agencies, for example) providing resources to an organizational entity. A variety of expectations, such as a return on investment, or enhanced public image, accompany those resource commitments. Conversely, if resources are withdrawn, managers will insist that stakeholders lower their expectations, or failure will result. Similarly, if expectations increase, managers will demand additional resources (ibid). Finally, the one-way relationship between consequences and organizational competence illustrates organizational learning. When HROs fail, an investigation follows, findings are disseminated in the public domain, and what is learned contributes to changes in policies and procedures that increase organizational competence so that a particular type of failure does not repeat itself (ibid).

2.3. Applying the Sullivan-Beach Model to Balancing ES Flexibility

An enterprise system is an off-the-shelf information system comprised of tightly integrated modules used to carry out the most common business activities including manufacturing, finance, accounting, and human resources. In addition to this internal focus (known as enterprise resource planning), enterprise systems also link upstream and downstream members of the supply chain through e-business, customer relationship management (CRM), supply chain management (SCM), and data warehousing applications. As a result, these state-of-the-art information systems offer the greatest opportunity for integration within manufacturers and between members of their supply chain. There is considerable common ground between HRO system and ES applications. Both environments exhibit the following characteristics:

- high expectations for success,
- significant risk factors,
- involve substantial resource investment,
- require high levels of competence, and

- highly consequential failures.

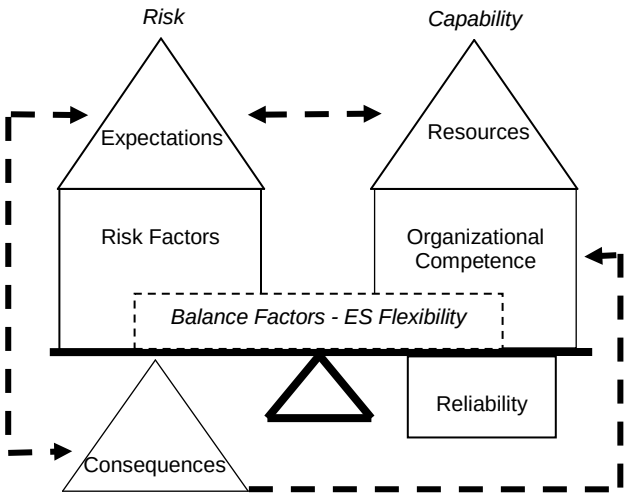

Figure 2: Potential Revision to the Model.

As such, the Sullivan-Beach Model may provide an effective foundation for studying system flexibility for ES applications. A research project that develops a framework for evaluating levels of system flexibility may provide competitive insight for practitioners. In recognition of the above benefits, this research may involve modifications to the model. For example, it was stated above that a system having some flexibility is beneficial. However, too much flexibility is detrimental and thus, maximum benefits of flexibility require obtaining the optimal amounts. Therefore, it might be revealed that system flexibility should be represented in the Sullivan-Beach Model as a risk factor, a competence factor, or both depending on how much flexibility is incorporated in a system. Modifications to the model may include the recognition of *balance factors* (Figure 2) that affect both sides of the scale. Findings from this research have the potential to make contributions to understanding system and organizational flexibility as well as provide additional insight into the development of the Sullivan-Beach Model.

3. Future Research: Testing the Framework

To further develop the Sullivan-Beach Model and to test its applicability in an ES context, future research will focus on undertaking three stages of data collection. Given the nature of the research questions (e.g., time-dependent, unknown causal factors) and the limited prior research in the area, a field-based study is both necessary and appropriate, and will be main focus of Stage I. Stage II will address the inherit weaknesses of the interview technique (i.e., lack of generalizibility) by conducting an international survey of ES flexibility. Stage III of the research will present to IS managers and end-users both measures of ES flexibility and the revised Sullivan-Beach Model in order to gauge their appropriateness and applicability. These three stages are presented in detail below. To gain a better understanding of ES flexibility and develop a more holistic initial model, field-based interviews with various IS end-users from 30 manufacturing organizations will be conduced as part of the first stage of framework testing and

development. As IS flexibility may mean different things to different user groups, a wide variety of people within the organization (e.g., operations manager, owner/CEO, end-users, IT staff) and external (e.g., consulting group/company implementing the system, major suppliers, and customers) will be contacted. The relationship between IS flexibility and other IS capabilities (e.g., risk, reliability), as well as performance, competitiveness, and supply chain integration will be examined, as well as ways in which IS flexibility can be measured. This stage will control for the information system used. Specifically, organizations using SYSPRO will be contacted. SYSPRO is a leading enterprise system for medium-sized companies and based on prior research of the authors is a common choice of companies undergoing lean, process, and flexibility improvement activities.

Although interviews can provide rich data, as is common with this technique, the generalizability of the findings will remain questionable. To address this concern, Stage II of the research will administer an on-line survey questionnaire to support or deconstruct the major findings from the interviews (i.e., stage one) and gain a broader perspective of ES flexibility. Stage Two will administer an international questionnaire to approximately 1000 manufacturers of varying sizes. During this stage, the SYSPRO control from Stage One will be removed, allowing for cross-ES software comparisons. For example, SAP discourages extensive modifications to their ES software and makes it difficult to do so. Open source ES providers, such as Compiere, allow for much easier changes. Such characteristics of the software (e.g., ease of software changes) must be taken into consideration when examining ES flexibility. This stage will therefore allow for cross-cultural, cross-industry, and cross-ES software comparisons to occur and be incorporated into a final framework. The final goal of Stage I and II is to develop a complete framework that companies can use to ensure that their IS flexibility is, and remains, in balance (i.e., not too much nor too little). Stage III is focused on testing this resulting framework and making revisions if needed. To determine its relevancy for improving ES flexibility in manufacturers and identify any missing components, the framework will be transposed into an on-line survey questionnaire and sent to an additional 1000 manufacturers using enterprise systems for their feedback.

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