Facilitating Flexibility in Supply Chain Organizations: The Confounding Effect of Information

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ABSTRACT
As globalization continues to create interdependencies, organizations find themselves exposed to multiple vulnerabilities that may result in disruption of organizational activity. Contingency planning is widely touted as a method of dealing with and preparing for such interruptions. This risk management technique has many attributes that promote organizational flexibility; however, the effect of information technology on those attributes is not well understood. Accordingly, this study examines the effect of information technology on inter-organizational collaboration, intra-organizational collaboration, and information sharing and their respective relationships with organizational flexibility.

KEYWORDS
supply chain, flexibility, contingency, information, global disruption, vice contingency

INTRODUCTION
The demand for effective preparation and response activities for supply chain disruptions has dramatically increased over the last two decades. Global sourcing, off-shoring, and outsourcing have increased the level of interdependence between organizations and is exceptionally visible in today’s supply chain environment. Whether the disruption event is natural or man-made, the impact on many businesses can result in significant losses. According to the Florida Division of Emergency Management, approximately 40% of small businesses that close due to a disaster never re-open (FDEM, 2007). According to a 2005 Aon Trade Investment Division Report, U.S. firms face over $300 billion in exposure to world-wide supply chain disruptions (Leonard, 2005).

An organization must continuously identify and evaluate its operating environment so that interruptions caused by disruptions are dealt with efficiently. Many organizations have numerous interdependencies and a single contingency can ripple across multiple operations (Peck, 2005). These organizations may be a single company or may exist as a group of entities linked together by a common effort. In the latter case, the organization is often referred to as a supply chain and is particularly vulnerable to disruptions.

While there are many technical definitions of a supply chain, a simple definition suffices for this study. Christopher (1992) described a supply chain as a network of organizations involving both upstream and downstream linkages whose processes and activities produce value to the consumer in the form of products and services. The management of a highly interconnected organization is an ever-increasing challenge in today’s competitive business environment. Higher levels of uncertainty in supply and demand, shorter technology and product life cycles, globalization of the market, and the increased use of distribution, manufacturing, and logistics partners result in a complex international network and increase the level of risk (Christopher, 2002).

DISRUPTIONS
Supply chain disruptions are unplanned events that affect the expected flow of materials and information (Svensson, 2002), and are recognized as an inevitability. Stated differently, a disruption event is the manifestation of risk within the supply
chain process. Therefore, the study of risk, interdependence, and impacts of a supply chain disruption is a growing area of interest. Several studies, including Fawcett, Calantone, and Smith (1996) and Goldsby and Stank (2000) found that organizations characterized by higher levels of flexibility are more capable of responding to disruptions.

The emergence of flexibility as an important strategic capability creates a need for better understanding of the relationships of information sharing and collaboration to organizational flexibility (Fawcett, Calantone, & Smith, 1996). This study of flexibility is designed to contribute to the growing body of evidence on the impact of disruptions to organizations. As a result, the study’s goal is to examine antecedents related to communication, along with information technology, to ascertain the impact they have on flexibility. For our purposes, organizational flexibility is defined as the ability to adapt to unexpected circumstances and focuses on an organization’s ability to encounter, resolve, and exploit an unexpected opportunity (GLRT, 1995).

THEORETICAL FOUNDATION

Contingency theory implies that firms adapt to changes in their environment by modifying their approach to competition in order to maintain or enhance performance (Hoffer, 1975). Contingency theory provides a basic rationale for emphasis on flexibility-based strategies that represent a strategic response to emerging threats (Fawcett, Calantone, & Smith, 1996). The willingness and ability of organizations to deal with changes in their operating environment has been documented as a cornerstone of firm strategy and performance (Hambrick, 1983).

Risk Management

Unsurprisingly, organizational integration brings additional risk. When an organization gives up part of its autonomy by working with other firms, its fortunes meld with its partners (Spekman & Davis, 2004). They are now interdependent and exposed to opportunities of shared success and failure. Today, one of the many challenges of organizational management is to plan, control, and monitor the intersections between the organization and its partners. This process creates a boundary used to control the effects of disruption (Sinha, Whitman, & Malzahn, 2004).

In today’s global marketplace, flexibility is characterized as speed, responsiveness, agility, or adaptability in meeting environmental changes (Stalk Jr, 1988). If flexibility is achieved, it can be the cornerstone of an organization’s ability to respond more quickly than competitors, thus achieving a competitive advantage (Fawcett, Calantone, & Smith, 1996). The following discussion highlights three important antecedents to flexibility.

Contingency Planning

As a better understanding of the causes of risk has been reached, the realization that there is no single method of controlling disruption has also been re-enforced. One preemptive measure used to manage the impacts of disruptions is the contingency plan. Contingency planning provides a blueprint for responding to risks associated with an unknown event (La Londe, 2005), thereby increasing organizational flexibility. As such, contingency planning provides an excellent context for this study.

Information Sharing

Information sharing is the willingness to make strategic and tactical data available to others involved in the planning process (Mentzer, 1993). Without adequate communication and information sharing, members are forced to choose between effective and efficient responses to potential disruptions (Mohr & Nevin, 1990). Organizations must be willing to share information concerning plans and potential disruptions to prevent problems and meet customer requirements (Stank, Emmelhainz, & Daugherty, 1996)

**Hypothesis 1:** Information sharing is significantly related to organizational flexibility.

Collaboration

Knowledge increases an entity’s capacity to interpret information and to ascertain what additional information is necessary to make a decision, making collaboration critical to a disruption response (Huber, 1991). Collaboration between organizational entities can increase joint knowledge creation, expertise sharing, and flexibility (Sinkovics & Roath, 2004). Benefits emerge when partners are willing to work together by sharing information and resources in order to achieve collective goals which in turn creates greater relevance to customer needs, and increases flexibility in response to a changing environment (Stank, Keller, & Daugherty, 2001).

**Hypothesis 2:** Intra-organizational collaboration is significantly related to organizational flexibility.

**Hypothesis 3:** Inter-organizational collaboration is significantly related to organizational flexibility.

Information Technology
IT capabilities include the application of hardware and software to enhance information flow and facilitate decision making. Information systems allow an organization to implement strategy and planning by making decisions more quickly and improve performance (Stank & Lackey, 1997). Many systems are designed to enhance knowledge and information sharing or to facilitate other areas of information-rich processes, such as collaboration. These systems have been shown to improve knowledge management within organizations (Orlikowski, 2000). However, there are some confounding results. For instance, studies suggest that the efficacy of information technology may be a result of contingencies in its application or the effect of people in the technology – performance relationship (Barua, Kriebel, & Mukhopadhyay, 1995; Boudreau & Robey, 2005). Lucas and Olson (1994) found that information technology may be both a facilitator and a barrier to flexibility, depending on design and implementation. Pavlou and El Sawy have called for IS researchers to “look beyond the firm-level IT infrastructures and focus attention on how business units can leverage IT functionalities.” (2006, p. 398). The current study takes a needed step in that direction by identifying IT’s impact on flexibility through moderation of information-based antecedents and by proposing ways to leverage IT in the quest for increased flexibility. Thus, we posit:

**Hypothesis 4:** Information technology use is significantly related to organizational flexibility.

**Hypothesis 5a:** Information technology moderates the relationship between information sharing and organizational flexibility.

**Hypothesis 5b:** Information technology moderates the relationship between intra-organizational collaboration and organizational flexibility.

**Hypothesis 5c:** Information technology moderates the relationship between inter-organizational collaboration and organizational flexibility.

**METHODOLOGY**

Data was collected from a sample of practitioners in the fall of 2007 via a survey, which is recognized as the most frequently used data collection method in organizational research for assessing phenomena that are not directly observable (Smith & Dainty, 1991) such as the perception of employees or the relationship between process attributes on an organizational capability. A web-based survey was used and the research was performed in a manner consistent with guidelines suggested by Flynn et al. (1990). The instrument is a combination of previously established multi-item scales as follows: organizational flexibility from Fawcett, Calantone, and Smith (1996), information sharing and information technology from Stank and Lackey (1997), and inter- and intra-organizational collaboration from Stank, Keller, and Daugherty (2001). The instrument is available from the authors. In addition to items measured by the instrument, data was collected on organizational size for use as a co-variate because of its importance in organizational research (Claycomb & Germain, 1999).

Our sample was 75 personnel involved in CP for a governmental organization. The participants, primarily upper- and mid-level managers, represent a wide range of functions within the organization and represent multiple facilities within numerous departments. Respondents were reminded to keep their references focused on CP in order to differentiate from other types of planning, i.e. financial, career, or operations planning. Of the 75 respondents, 22% were senior managers, 50% were middle managers, 12% were professional, and 16% were technicians. Fifty-six percent of the respondents were plan developers and 44% were plan implementers. Organizational size categories ranged from 26% less than 50 (personnel), 20% between 51 and 100, 24% between 101 and 200, 14% between 201 and 300, to 16% greater than 300. Respondents averaged 5.6 years in the current position, 10.4 years in the current organizations, and 10.6 years planning experience.

**ANALYSIS**

Multiple regression analysis was used to examine the data. First, instrument validity was examined. Because prior measures were used, content validity is assumed. Construct validity was assessed using principal component analysis with Varimax rotation. The KMO measure of sampling adequacy (.855) along with Bartlett’s Test (p<.001) indicate the sample is adequate to factor. Results of this analysis indicate all items are highly correlated within their construct and no item loads lower on its intended construct than on another, showing both convergent and discriminant validity (Cooke, 2002). Table 1 shows the results of the factor analysis.

Reliability was measured by Cronbach’s alpha. Results indicate reliability for each construct ranging from a low of .88 (flexibility and information sharing) to a high of .946 (information technology). Table 2 shows the means, standard deviations, and reliabilities for the constructs.
Table 1. Results of the factor analysis

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>Mean</th>
<th>SD</th>
<th>Cronbach's Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility</td>
<td>3</td>
<td>4.111</td>
<td>.872</td>
<td>.880</td>
</tr>
<tr>
<td>IT Use</td>
<td>4</td>
<td>3.707</td>
<td>.980</td>
<td>.946</td>
</tr>
<tr>
<td>Information Sharing</td>
<td>3</td>
<td>3.040</td>
<td>1.041</td>
<td>.880</td>
</tr>
<tr>
<td>Intra-organizational Collaboration</td>
<td>4</td>
<td>3.460</td>
<td>.995</td>
<td>.875</td>
</tr>
<tr>
<td>Inter-organizational Collaboration</td>
<td>4</td>
<td>3.367</td>
<td>.992</td>
<td>.940</td>
</tr>
</tbody>
</table>

Table 2. Construct Descriptives

Hierarchical multiple regression allows the researcher to account for variation caused by controls in the initial model so that the effects of the variables of interest are clearly evident in the second model. In this study, the control variable (size) was first entered in the first step of this regression; the constructs of interests were entered in the second step. However, the size of the organization did not have a significant effect on the model and was dropped from further analysis. The regression was conducted with all direct effects entered in Step 1, and the interaction terms entered in Step 2. Table 3 shows the results of the regression and Table 4 shows the model summary.
### Table 3. OLS Regression Results

As expected, information sharing, information technology use, and inter-organizational collaboration are significantly related to organizational flexibility. Interestingly, however, intra-organizational collaboration was not. In addition, information sharing and intra-organizational collaboration are negatively related to organizational flexibility. Hypotheses 1, 3, and 4 are supported.

The moderating effect of information technology use was examined in step 2 of the regression. Both intra- and inter-organizational collaboration interact significantly with information technology use; hypotheses 5b and 5c are supported.
DISCUSSION

In response to disruptions, organizations must work quickly and efficiently to identify and counteract potentially devastating conditions. Flexibility has been shown to support such action. This study begins the investigation of the antecedents that support flexibility. Our results indicate that much of the variance in flexibility is explained by the moderating effect of information technology use on intra/inter-organizational collaboration. First, however, we discuss the findings of our direct effects.

We hypothesized that information sharing (IS), intra-(IC) and inter-organizational (EC) collaboration, and information technology (IT) were significantly related to organizational flexibility. We found that IS, IT, and IC were related.

Information sharing has been shown to be an important organizational characteristic, especially in the communication of best practices and increasing response time to change (Stank, Emmelhainz, & Daugherty, 1996). Interestingly, while we did find that IS is a significant factor, we found that it had a negative effect on organizational flexibility. Perhaps the respondents’ organizations do not operate in an environment of open IS or find it cumbersome, thus drawing away from flexibility. It is also possible that these organizations focus too much on the information sharing process, thereby increasing rigidity rather than flexibility.

Another possibility is lack of top management support which has been shown to enhance organizational processes in general. If difficult sharing processes are in place and there is little management support, it is likely that respondents will not consider IS to be a valuable tool. Technology in and of itself can reduce flexibility by increasing structure and being difficult to change (Lucas Jr. & Olson, 1994). Further research is needed to understand this phenomenon.

Our hypothesis regarding intra-organizational collaboration (IC) was not supported. This is a surprising finding as literature suggests that collaboration may be the basis for quick response (Andraski, 1998). Many organizations utilize resources to build internal communications technologies and work to define processes to facilitate IC. If these factors are not in place, internal collaboration may be considered insignificant. If so, it is imperative that management review such technologies to ensure that they are designed properly. Lack of use of such technology may result in a dearth of critical information during a crisis, leading to response rigidity rather than flexibility (Barnett & Pratt, 2000). If, however, our findings reflect a perception of the lack of importance of IC, managers must change their focus.

Although not significant, the negative effect indicated by the regression is intriguing. It is possible that many of the same explanations for information sharing are appropriate here as these are closely related contexts. Our finding may also be an artifact of our sample size. Prior to beginning this research, we ascertained that to obtain a power of .8 with a minimum effect size of .15, a sample of 103 would be required. As this study is in its early phase, we expect that, as our sample size increases, we may indeed find a significant result for IC’s relationship with organizational flexibility.

The hypothesis regarding EC was supported, and EC is positively related to organizational flexibility. During disruptions it is imperative that organizations focus on those elements that may have potential impact on them, such as supplier down time, increased consumer demand, or government mandates. Without being acutely attuned to its external environment, an organization may not be able to react quickly enough to prevent problems or seize opportunities. In planning for disruptions and pursuing the flexibility capability necessary for efficient reaction, organizations would be well served to appropriate resources to the area of EC. This is particularly critical when organizational partners are globally dispersed.

IT is a means of facilitating the flow of information necessary to react quickly in a dynamic context (Dyer, 1997; Sambamurthy & Zmud, 2000); in the case of a disruption, this ability is even more critical. Our research indicates that IT use...
is an important predictor of organizational flexibility in the supply chain organizations represented. This coincides with other research that indicates that some of the facilitators of flexibility include information systems that have structured data connectivity and deep coordination-related knowledge (Gosain, Malhotra, & El Sawy, 2004). The former indicates a need for consistent information bases across an organization’s external network; the latter indicates that consistent interaction, planning, and practice may be required between external members in order to effect the most appropriate reaction. IT, particularly business-to-business (B2B) may be used to structure, standardize, and coordinate planning activities, thus playing a broad role in supporting organizational flexibility.

Although the verification of direct effects is important, our primary interest is how our constructs interact with IT. Our results indicate that both IC and EC are moderated by IT use. Accordingly, we further analyze the findings to understand the context in which this modification occurs. We include information sharing, although it is a non-significant reaction, in the hopes that we may be able to understand its negative relationship with organizational flexibility. Figure 1 shows the relationships between high and low information technology use, each of the remaining constructs at low, medium, and high levels, and organizational flexibility.

![Moderating Effect of Information Technology](image)

**Figure 1. The moderating effect of information technology use**

The graph above clearly shows that information technology moderates both collaboration and information sharing. As would be expected, high IT use when combined with high levels of collaboration results in increased organizational flexibility. However, flexibility suffers as information sharing increases under conditions of both high and low information technology use. A potential explanation is that IT poses rigidity within the system that encourages members to forego IS over that medium. It is possible, then, that IS takes place via other mediums, perhaps face-to-face discussions, particularly in times when rapid response is needed. However, the graph does confirm that higher levels of IT use, regardless of the level of IS, results in more flexibility than with lower levels of use.

Under conditions of low information technology use, IC, like IS, negatively impacts flexibility as the level of collaboration increases. While the arguments made above regarding information sharing can be used here, there may be a different explanation. Put simply, collaboration requires more than technology. Whereas information sharing may be facilitated by relatively simple technologies such as a database or bulletin board, collaboration requires the ability to search for and retrieve information, coordinate processes with peers, facilitate meetings, and to communication. Peer-to-peer (P2P) technology is a
relatively new concept designed, in part, to support internal OC by facilitating inter-group knowledge transfer. Research suggests that such a system should be structured to be easy to use, work both in real time and in an asynchronous mode, give the appearance of co-location, and be interoperable across the organization (Gupta & Bostrom, 2006). If systems represented by our respondents do not incorporate the above, it is possible that the systems are simply abandoned as a collaborative medium, especially during high-stress times when IC is critical. As information technologies fail to support collaboration, the flexibility influenced by both collaboration and information technologies would also suffer.

Of particular interest is the indication that the most flexibility attained in this model occurs when information technology use is low at any level of IC. Under conditions of high information technology use, IC marginally outperforms inter-organizational collaboration. However, whereas flexibility decreases as IC increases, flexibility increases as EC increases under conditions of low IT use. Even at low levels of inter-organizational collaboration, more flexibility is achieved than any other combination of IC, IS, and IT use. Clearly, information technology is not driving EC. Research suggests that complex interactions such as learning require rich media; face-to-face communication is considered to be the most effective method (Daft, Lengel, & Trevino, 1987; Leonard, 2005). Inter-organizational collaboration requires an element of finesse, political correctness, and gamesmanship more so than either IC or IS. Because our results show that EC is the strongest influencer of flexibility, and our moderation analysis indicates that flexibility increases as EC increases despite low information technology use, it is clear that there are other means of communication and collaboration at work. While high levels of IT use attain more flexibility than lower levels (with the noted exceptions), it may be more effective for organizations desiring to increase flexibility to maintain IT systems while enhancing individual communication and collaboration skills.

Given the results discussed above, a number of potential future directions are evident. For instance, what is it about IC that is perceived as not important to flexibility? Are there levels of IC that should be considered, such as communication between management levels? If the entire organization does not benefit from IC, is it possible that parts of the organization do? The same perspective is possible with inter-organizational collaboration. What takes priority in the communication chain when resources are limited? What are the processes by which EC collaboration is facilitated? Are traditional linkages a priority over, for instance, organizational to municipal collaboration? Why is information sharing, heavily touted in the knowledge management literature as a critical component of organizational success, negatively associated with organizational flexibility? Future efforts might include a longitudinal study to determine if the import of these attributes change over time.

As with any research effort, this study has limitations that could impact the generalizability and validity of the results. For instance, the respondents were all representatives of the federal government. While representing multiple branches and organizations and a wide range of locations, they do ultimately belong to the same higher organization. A wider range of respondents could make the results more generalizable. The validity of the study could be affected by common method bias although measures were taken to reduce the effect. These biases are a problem because they are one of the main sources of measurement error and threaten the validity of conclusions about relationships between measures (Nunnally, 1978). Finally, as this research is in its infancy, the size of the sample may not have allowed small effects to be recognized.

CONCLUSION

This research effort contributes to our understanding of the antecedents of flexibility on two levels by adding academic rigor to practitioner relevance. While both are important, arguably the most important contribution is to the field of planning practitioners. There are many “how to” examples of what an organization should do to prepare for potential disruptions, but most have little academic rigor and many come with an attached consulting fee. This effort allows managers at multiple levels to understand the primary planning attributes to increase flexibility and therefore to expend resources effectively. In many situations both time and fiscal resources are constrained, forcing managers to focus on limited aspects of a project. The results of this effort demonstrates that managers should focus limited resources on some aspects of information technology, but also on proper training of personnel to collaborate in a global setting. From a practical standpoint, this study identifies the conditions when an organization might most benefit from an investment in IT, and perhaps more importantly, the condition that would not benefit from additional IT system purchases. In a time of ever constraining budgets, knowing the added value of the system under certain conditions could allow for reallocation of resources in other areas. As discussed earlier in this research, much effort has been applied to strategic planning. However, little academic research has been applied specifically to designed flexibility. This research provides a foundation for examining designed flexibility in the context of supply chain organizations.
REFERENCES


