Minimizing supply chain disruption risk through enhanced flexibility

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Abstract

Purpose – The purpose of this paper is to examine the use of a strategic approach (contingency planning) to minimize risk exposure to a supply chain disruption. Specifically, the relationship between several attributes of a contingency planning process and flexibility are examined.

Design/methodology/approach – This effort develops a model that will provide both researchers and practitioners a means of determining the attributes with the highest relationship to flexibility. The model is then tested using multiple regression techniques.

Findings – Based on the sample used in this survey, top management support, resource alignment, information technology usage, and external collaboration provide the largest contributions to flexibility. Flexibility has been shown to enhance the ability to minimize risk exposure in the event of a supply chain disruption.

Research limitations/implications – In this research effort, the multiple regression results produced an R^2 of 0.45, indicating that additional variables of interest may need to be identified and investigated. Furthermore, a wider range of respondents could make the results more generalizable.

Practical implications – This effort will help to allow managers at multiple levels to understand the primary planning attributes to use to increase flexibility.

Originality/value – The paper develops a model that can be used to identify the specific areas that can lead to improved flexibility. Based on the model, managers, and planners can develop appropriate strategies for minimizing risk exposure in the event of a supply chain disruption.

Keywords Supply chain management, Business continuity, Strategic planning, Contingency planning

Paper type Research paper

Introduction

Recent world events have highlighted the need for effective solutions to managing supply chain disruptions. For example, soon after the September 11 terrorist attacks on the USA, the Toyota Sequoia plant in Indiana came within hours of halting production due to delays in the delivery of critical steering sensors (Sheffi, 2001). In cases such as this, where an unplanned disruption can cause a production delay, corporate and network wide risk exposure is tremendous and can be extremely costly. In a separate

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instance involving Toyota, fire at a supplier facility forced the automotive manufacturer to shutdown 18 plants for nearly two weeks in February 1997. The estimated costs of the 1997 disruption included $195 million in damage and inventory loss with an additional estimated opportunity cost of lost sales of $325 million on 70,000 cars (Converium, 2006).

Complex organizations such as Toyota are very interdependent, with a single disruption creating a ripple effect that can dramatically impact the entire operation (Peck, 2005). These complex organizations may be a single entity, such as a large corporation, or may exist as a group of entities linked together in a common or shared effort. In the highly common latter case, the groups of organizations are often referred to as a supply chain network.

The two Toyota scenarios described above are each examples of common business situations that meet the definition of a supply chain disruption. According to Svensson (2002), a supply chain disruption is an unplanned event that might affect the normal, expected flow of materials, information, and components. As illustrated above, an organization must continuously identify, measure, and evaluate its operating environment and continually assess the risk associated with a potential disruption if they plan to effectively minimize the negative impacts of the disruption.

This research effort strives to examine the issue of supply chain disruptions and the risk exposure they create for individual companies and their supply chain networks. Given the risk associated with supply chain disruptions, we propose a model for dealing with disruption risk through the use of a strategic planning tool known as contingency planning. Specifically, we expand on prior research that shows flexibility has a positive impact on an organization or network trying to manage a supply chain disruption.

Literature

Recent studies focusing on transportation delays and port stoppages (Chapman *et al.*, 2002), accidents and natural disasters (Cooke, 2002), poor communication, part shortages and quality issues (Craighead *et al.*, 2006), operational issues (Chopra and Sodhi, 2004), labor disputes (Machalaba and Kim, 2002), and terrorism (Sheffi, 2001) have all documented the many, potentially negative, impacts of disruptions on various supply chain structures in nearly every industry and market segment. These studies have also illustrated the impact of frequent and/or severe disruptions on individual corporate or overall supply chain performance levels.

The management of a highly interconnected supply chain 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 all results in a complex international network. Given the complexity of many supply chains, experiencing a disruption is recognized by many organizations as being inevitable. In reality, it is not a matter of a supply chain system encountering a problem, but rather a matter of when a problematic event will occur and the severity of the event.

As the levels of complexity increase and supply chain interdependency becomes more prevalent, increased levels of risk occur (Christopher, 1992). Therefore, the study of risk, interdependence, and the associated impact of a disruption on supply chain

performance is a growing area of interest to many as they strive to reduce uncertainty in an attempt to better insulate their organization's supply chain from the risks of a disruption. Wagner and Bode (2008) suggest that managers pay particular attention to these risks and have issued a call for empirical research into supply chain performance, strategic choice, and the context of risk. In fact, risk exposure is broader than ever before, and evaluation of supply chain issues through a risk and uncertainty lens is extremely important and useful for supply chain managers (Barry, 2004).

While disruptions and heightened risk levels can cause serious challenges, several studies, including Fawcett *et al.* (1996), Goldsby and Stank (2000), Fredericks (2005), and Swafford *et al.* (2006) have found that organizations characterized by higher levels of flexibility are more capable of responding to unexpected events such as a disruption in a more successful manner when compared to their non-flexible counterparts. Supply chain flexibility acts as a measure of risk management to organizations facing increased supply chain risk. Disruptions that impact the day-to-day operations of a given member of the supply chain are likely to have an impact on other supply chain network member organizations. Therefore, it is important that organizations throughout the chain engage in planning processes to reduce the impact of disruptions and, by doing so, increase their flexibility. Duclos *et al.* (2003, p. 450) state that:

> [. . .] flexibility in the supply chain adds the requirement of flexibility within and between all partners, including departments within organizations and external partners, including suppliers, carriers, third party companies, and information systems.

Several studies suggest that entities may not always be able to predict or avoid a disruption, but they can reduce their risk exposure by enhancing flexibility through the implementation of key strategic planning tools. If employed properly, these strategic initiatives enhance the ability of the organization or network to respond to a disruption effectively, minimizing the negative impacts of the event on overall supply chain performance levels.

Contingency planning is a valuable strategic planning tool for many organizations that can bring about enhanced flexibility. Specifically, contingency planning is a special type of planning that provides a blueprint for responding to the risks associated with an unknown event (La Londe, 2005). A properly prepared contingency plan should detail a timely and complete response to a specific risk or a cluster of risks (La Londe, 2005).

Contingency planning has been identified as a crucial issue for many organizations. In the 2003 and 2005 Bain Management Tool Surveys, 70 and 54 percent, respectively, of companies surveyed cited widespread use of contingency planning within their organizations (Rigby, 2003; Rigby and Bilodeau, 2005). Additionally, the Deloitte & Touche/CPM (2005) Business Continuity Survey found that the number of companies that have invested in contingency planning increased by 53 percent in six years from 30 percent of those surveyed in 1999 to 83 percent in 2005 (Deloitte & Touche, 2005). Research involving contingency planning has become widespread across multiple disciplines (Barnes, 2001) including manufacturing (Iyer and Sarkis, 1998), supply chain management (Svensson, 2002, 2004), and logistics (Hale and Moberg, 2005).

The aim of the contingency plan is to minimize potential loss by identifying, prioritizing, and safeguarding assets that need protection, with the goal of the organization being able to reduce risk exposure and save valuable resources in the event of a disruption

or disaster. Borrowing from the work of Rice and Caniato (2003), contingency planning means developing a plan to be resilient, or prepared to respond to and restore operations after an unexpected disruption occurs. Barnes (2001) adds that this form of planning is the integration of formalized procedures and resource information that organizations can use to recover from a disaster that causes a disruption to business operations.

The potential impacts of a supply chain disruption and the risk exposure created by a disruption make it critical to identify the appropriate managerial preparation and response for planning and responding to these types of situations in a way that allows the network to maintain a certain performance level. The emergence of flexibility as an important strategic capability, with potential to enhance our ability to minimize the impacts of a disruption, has created a need to gain a better understanding of the relationship between contingency planning and flexibility (Fawcett *et al.*, 1996). This paper responds to the need to enhance our understanding of flexibility by examining key contingency planning attributes and their impact on flexibility.

The study presented here follows calls by Wagener and Bode (2008) and Frankel *et al.* (2008) and focuses on an element of strategic choice for risk management (contingency planning). Specifically, we analyze how a contingency planning process affects flexibility, which in turn reduces risk exposure and, therefore minimizes the impact of a disruption not only for an individual firm but potentially for the entire supply chain network. Our study differs from those of Wagner and Bode (2008) and Hendricks and Singhal (2003, 2005a, b) since the primary focus of this paper is to examine the planning process and assess its impact on flexibility.

Conceptual development

The current effort strives to use contingency theory and effective planning attributes as the basis for the development of a theoretical model of the impact of contingency planning on flexibility. Since flexibility has repeatedly been shown to enhance an organization's ability to effectively react to disruptions (Fawcett *et al.*, 1996; Fredericks, 2005; Goldsby and Stank, 2000; Swafford *et al.*, 2006), this paper's results should help management identify key variables of interest when implementing strategies (contingency planning) designed to combat the potentially negative risk exposure created by a supply chain disruption. This paper should also provide insight into how to better address both the limited amount of progression towards scientific theory-building and the limited number of studies on descriptive/prescriptive information available for managers (Craighead *et al.*, 2007).

Organizations of all types share at least one common characteristic; they all seek to improve their organizational performance. Improved organizational performance, especially in times of crisis, can mean the difference between earning a profit or loss, achieving acceptable or unacceptable customer service or productivity levels, or even directly impacting the likelihood of firm survival. One way to enhance organizational performance is through the effective implementation of key strategies.

The application of strategic planning processes allows an organization to focus their resources in a manner that enhances firm performance via a competitive driver (Fawcett *et al.*, 1996). Strategy can help an organization in a variety of ways including by identifying the organization's core objectives and guiding the process by which a firm's resources are developed, organized, and allocated in order to achieve selected objectives (Fawcett *et al.*, 1996). Contingency planning has been shown to have a

positive impact on a firm's flexibility, ultimately enhancing their ability to respond to unforeseen disruptions in a manner that minimizes overall risk exposure (Fawcett *et al.*, 1996). For purposes of this research, we concur with Wagner and Bode (2008, p. 309), who defined supply chain risk as a "negative deviation from the expected value of a certain performance measure, resulting in undesirable consequences."

In today's global and highly competitive marketplace, flexibility is often characterized as doing things fast, being responsive to the market, or providing a company with the opportunity to pursue innovation and allowing for adaptability to changing circumstances (Bower and Hout, 1988; Goold and Campbell, 2002; Stalk Jr, 1988). In fact, flexibility is often touted as the ready capability to adapt to new, different or changing requirements. If flexibility is achieved, it can be the cornerstone of an organization's ability to respond more quickly than competitors, thus placing an organization in a position of competitive advantage (Fawcett *et al.*, 1996).

Flexibility is concerned with the ability to adapt to unexpected circumstances and concerns an organization's ability to encounter, resolve, and exploit an unexpected emergency or opportunity (Global Logistics Research Team at Michigan State University, 1995). Flexibility also permits an organization to continuously improve customer satisfaction by leveraging routine performance to high levels of non-routine compliance (Bowersox *et al.*, 1992). For our purposes, flexibility is defined as the ability to adapt to unexpected circumstances and focuses on an organization's ability to encounter, resolve, and when appropriate, exploit an unexpected opportunity (Global Logistics Research Team at Michigan State University, 1995).

The emergence of the concept of flexibility as an important strategic capability has created a need to gain a better understanding of how organizations and supply chain networks can engineer flexibility into the fabric of their existence. One possible tool to assist organizations or networks in their quest for flexibility is the implementation and use of an effective strategy such as a comprehensive contingency planning process. As contingency planning is effectively implemented throughout the organization or network, the relationship between contingency planning and flexibility can be maximized (Fawcett *et al.*, 1996).

The next section of this paper outlines the hypotheses and a discussion of the application of theory and planning components. The methodology section follows and details how the current research is conducted. A discussion of the results follows, including conclusions and managerial implications of the research.

Hypotheses

The following discussion highlights several important attributes of contingency planning processes and describes their potential relationship with flexibility.

Top management support. Top management support often validates a program to other members of an organization (Curtis and Sambamurthy, 1999). The impact and importance of management support is established in Drucker's (1969) framework of the theory of business and has been identified as a key variable of success in studies concerning resource allocation (Cerullo and Cerullo, 2004), successful management initiatives (Fawcett *et al.*, 2006; Marien, 2000), and contingency planning (Zsidisin, 2003; Zsidisin and Smith, 2005). Without planning, support, patience, and leadership from management, many programs can become large drains of time, effort and resources for an organization.

The commitment from top management must be continuous throughout the process, or any initiatives will soon be abandoned (Wisner and Lewis, 1997). Min and Mentzer (2004) reinforce this concept by adding that top level support is a must for successful implementation of management programs. Bardi *et al.* (1994) also conclude that without top management support, many systems will not develop beyond minimum requirements stage, failing to reach their intended goals of improved efficiencies and potential for achieving a competitive advantage. Therefore, *H1* is based on the expected relationship described above:

H1. Top management support for contingency planning is positively related to flexibility.

Goal alignment. The strategic goals of the firm are important to the contingency planning process. Mutual goals refer to where the organization or network places emphasis within each firm or network. This typically takes place through strategy development, corporate values, rules, procedures, and resource allocation (Mollenkopf *et al.*, 2000). Goal alignment helps to ensure that multiple components are focused on the same, or very similar, process outcomes. The development of mutual goals for the achievement of integrated planning activities plays an important role in enforcing a system-wide planning effort (Murphy and Poist, 1992):

H2. Goal alignment in the contingency planning process is positively related to flexibility.

Resource alignment. Intra- and inter-organizational resource alignment represent the physical and process coordination activities necessary to achieve flexibility (Murphy *et al.*, 1996). Inter-organizational resource alliances can be a powerful way to gain flexibility, and ultimately competitive advantage (Global Logistics Research Team at Michigan State University, 1995). Alliances can offer the benefits of joint synergy and planning without the risks associated with complete control and ownership. Each member of the alliance, or supply chain, may take advantage of multiple strengths (Larson, 1994) to address both shared and individual weaknesses (Spekman and Davis, 2004), thereby increasing the level of flexibility (Goldsby and Stank, 2000). The coordination of resources, or resource alignment, in a planning alliance increases organizational responsiveness and flexibility (McGinnis and Kohn, 1990, 1993):

H3. Resource alignment within the contingency planning process is positively related to flexibility.

Information. An organization's ability to generate, combine, and make use of information is vital. The firm's ability to capture information for use in the planning process is critical to selecting and developing appropriate capabilities to deal with disruptions (Fawcett *et al.*, 2000). Organizations need information and the ability to share that information in order to develop contingency plans, to manage the planning process, and to control daily operations (Kaplan, 1991). Central to the ability to plan is the exchange of large amounts of information within and between organizations (Sanders and Premus, 2002). Information is seen as the glue that holds organizational or network structures together, allowing for agile and flexible responses to a contingency (Whipple *et al.*, 2002). The Global Logistics Research Team (1995)

identified information technology (IT) as an indicator of information's relationship to flexibility.

Information technology. IT capabilities include the application of hardware, software, and networks to enhance information flow and facilitate decisions. IT enables an organization to maintain key information in an accessible format, process requirements, and make operating and planning decisions. Information systems allow an organization to implement strategy and planning by making decisions more quickly (Stank and Lackey, 1997) and improve organizational or network-wide performance levels (Sanders and Premus, 2005):

H4. IT usage in the contingency planning process is positively related to flexibility.

Information sharing. Information sharing is the willingness to make strategic and tactical data available to others involved in the planning process. Open sharing of information provides the glue that holds the supply chain together (Mentzer, 1993). Without adequate communication and information sharing, supply chain members are forced into trade-off situations and must choose between effective and efficient responses to potential disruptions (Mohr and Nevin, 1990). Information sharing regarding both the pros and cons of one method over another, such as competing transportation routes, leads to better decisions whether the situation is proactive or reactive. To effectively plan for, and react to, various contingencies organizations and networks should strive to build institutional memory into information management and collaborative systems.

Certainly institutional memory contains information that provides analysts with additional information to analyze during the decision-making process, potentially enhancing the likelihood of a well informed and successful solution. Contributing to a system, whether contributing initial information or commenting on or amending existing information, requires information sharing. But, rather than hoarding and releasing information only to solve day to day problems, organizations must be willing to share information on a network wide basis. This information could include information concerning plans, best practices, and even potential disruptive events in an effort to prevent problems and to meet customer requirements (Lee *et al.*, 2004; Stank *et al.*, 1996):

H5. The level of information sharing in the contingency planning process is positively related to flexibility.

Connectivity. Connectivity reflects the ability of an organization or network to share and utilize information. It includes the ability to deploy jointly developed, or agreed upon, information systems such as electronic data interchange, or an enterprise resource planning system (Gomes and Knowles, 2004; Hakansson and Eriksson, 1993). Computer systems and IT provide data for improving decision making and enhancing the planning process through effective resource allocation (Auramo *et al.*, 2005), organizational alignment (Kent and Mentzer, 2003), and reduced notification and time when action is necessary (Auramo *et al.*, 2005). An integrated system, or systems, of information exchange provides an organization or network with the means to collect, disseminate, and utilize information in a timely fashion (Stank and Lackey, 1997). Connectivity embodies this overall capability (Global Logistics Research Team at Michigan State University, 1995):

H6. System connectivity in the contingency planning process is positively related to flexibility.

Planning process. The process of planning plays a key role in securing increased levels of firm performance and the development of critical capabilities (Fawcett *et al.*, 1996). In fact, the primary purpose of strategy is to identify and select a specific capability to perform a particular function (Stalk Jr, 1988). In this case, contingency planning impacts the development of flexibility by processing information and organizing resources (Bowersox *et al.*, 1989; Fawcett *et al.*, 1996).

Comprehensiveness. The role of planning is to establish the organization or network's direction by evaluating objectives, alternatives, and the resources (Hayes *et al.*, 1988). The effective development and allocation of resources is particularly important in complex, changing environments (Fawcett *et al.*, 1997). The comprehensive aspect of the planning process assists in the configuration and coordination of operations more effectively and thus increases the level of flexibility (Fawcett *et al.*, 1997; Kuicalis, 1991). A comprehensive plan must follow a formal planning process identified by the organization or network to ensure appropriate planning aspects and planning steps are included in different functional areas. Formality is the incorporation of analysis of risks and benefits, documentation of alternatives, and communication of organizational or network wide objects and strategies (Fawcett *et al.*, 1996). This paper borrows the definition used by Fawcett *et al.* (2000) stating that comprehensiveness is the extensive analysis of risks and benefits, documentation of alternatives, and communication of the organization's objectives and strategy implementation processes to relevant management levels:

H7. The comprehensiveness of the contingency planning process is positively related to flexibility.

Standardization of processes. Standardization refers to the establishment of common policies and procedures to facilitate the planning process (Global Logistics Research Team at Michigan State University, 1995). Explicit and systematic planning processes have been linked to competitive success (Andersen, 2000; Ansoff *et al.*, 1970; Herbane *et al.*, 2004; Herold, 1972; Peattie, 1993; Wood and LaForge, 1979). Standardization of benchmarked practices ensures that activities that have proven to be successful are utilized throughout the organization or network. This standardization of benchmarking of the contingency planning process has also been identified as important to competitive success (Bowersox *et al.*, 1989). Standardization of the planning process also ensures shared knowledge, or at least awareness, of the responsibilities and actions of other organizational or system-wide components. In fact, standardization provides an organization or supply chain network with consistency, or a baseline, used to handle situations ranging from the norm to the unusual (Bartlett and Ghoshal, 1998):

H8. Standardization of the contingency planning process is positively related to flexibility.

Collaboration. Collaboration involves an interdependent relationship where the parties work closely together to create mutually beneficial outcomes for all participants (Jap, 1999, 2001). True collaboration between organizations, or between elements of a single organization, can result in benefits including joint knowledge creation, expertise

sharing, and understanding of the other party's intentions and strategic approaches (Chapman *et al.*, 2002; Sinkovics and Roath, 2004). It is generally believed that increased collaboration from both an intra- and inter-organizational standpoint increases performance and flexibility (Andraski, 1998; Cooper *et al.*, 1997; Sinkovics and Roath, 2004).

Benefits often emerge when partners, either intra- or inter-organizational, are willing to work together to understand each other's viewpoints by sharing information and resources in order to achieve collective goals (Stank *et al.*, 2001). Stank *et al.* (2001) add that the benefits of collaboration include a reduction in resource duplication, creation of greater relevance to customer needs, and increased flexibility in response to changes in customer needs and the environment:

H9. Intra-organizational collaboration in the contingency planning process is positively related to flexibility.

H10. Inter-organizational collaboration in the contingency planning process is positively related to flexibility (Table I).

Methodology

An understanding of the relationship between constructs such as those of interest in this research effort can be gained by gathering data from actual organizational settings (Bruns and Kaplan, 1987). Therefore, an empirical study utilizing a survey methodology was used to examine the proposed model and associated hypotheses.

The use of surveys is recognized as the most frequently used data collection method in organizational research for assessing phenomena that are not directly observable (Schneider *et al.*, 1996; Smith and Dainty, 1991) such as the perception of employees, or the relationship between process attributes on an organizational capability. Bachmann *et al.* (1999) found that electronic surveys provided the advantages of low-cost, quick response time, and equivalent response rate when compared to traditional mail surveys. Griffis *et al.* (2003) also report that response rates, response speed, nature of

Table I.
Summary of proposed study hypotheses

Hypotheses	
1	Top management support for contingency planning is positively related to flexibility
2	Goal alignment in the contingency planning process is positively related to flexibility
3	Resource alignment within the contingency planning process is positively related to flexibility
4	Information technology usage in the contingency planning process is positively related to flexibility
5	The level of information sharing in the contingency planning process is positively related to flexibility
6	System connectivity in the contingency planning process is positively related to flexibility
7	The comprehensiveness of the contingency planning process is positively related to flexibility
8	Standardization of the contingency planning process is positively related to flexibility
9	Intra-organizational collaboration in the contingency planning process is positively related to flexibility
10	Inter-organizational collaboration in the contingency planning process is positively related to flexibility

response, and cost per response for online based surveys were superior when compared to traditional mail surveys. Therefore, a web-based survey was utilized in the current research. The basic survey methodology was performed in a manner consistent with the guidelines suggested by Flynn *et al.* (1990).

In this paper, a model is proposed and tested. The model consolidates existing literature on supply chain disruption, risk, flexibility, strategy, and contingency planning and tests the relationship of several planning attributes with flexibility. The model posits that flexibility is positively related to specific aspects of top management support, goal and resource alignment, IT and sharing, connectivity, planning comprehensives and process standardization, and finally, internal and external collaboration. Figure 1 depicts the model.

Measures

The measurement instrument for this paper is a combination of previously used and well-established multi-item scales for the dependent and independent variables.

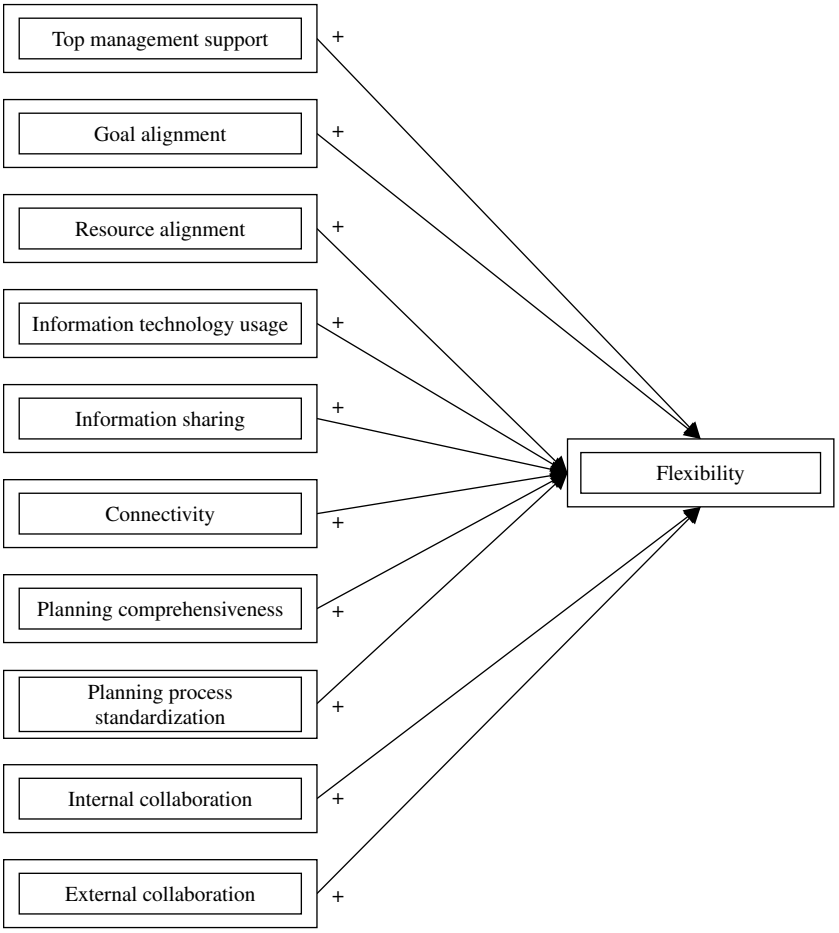

Figure 1.
Planning flexibility model

The dependent variable, flexibility was ascertained by a multi-item measure examining an organization's or network's ability to handle and adapt to change. Each of the independent variables was also measured by use of a previously established multi-item scale designed to measure each construct of interest. Table II includes a summary of the constructs, the original source, the number of items, and the original reported Cronbach's α for each scale. In accordance with Nunnally (1978), an α of 0.70 or higher which is indicative of good reliability was meet or exceeded by each original multi-item measure. The instrument for this paper consists of 47 items plus demographic information and is available upon request.

Participants

Owing to the nature of the study and the varying levels and degrees of planning throughout an organization or its network, the population of interest was narrowed to those individuals that have a key and defining role in a contingency planning process. The sample for this paper was 400 personnel involved in an advanced contingency planning process seminar for management professionals. At the conclusion of the data collection phase of the study, 168 usable responses remained for a response rate of 42 percent. These participants came from a variety of backgrounds and represented multiple organizations. Some participants were government employees while others were employees of organizations best characterized as suppliers or service providers to the government.

The sample included a variety of personnel involved in contingency planning either as planners or as implementers and representing a variety of functional areas within a supply chain. All respondents were involved with the contingency planning process and consisted of a broad range of experience levels, encompassed a wide range of positions, and represented diverse organizational types. Not only did the participants vary, but their organizational and supply chain networks differed and their planning processes were highly diverse.

The individuals from the seminar were identified and then contacted twice by electronic mail and provided a link to a web-based survey. Each respondent that filled out an online questionnaire was asked to keep their frame of reference to a specific contingency planning initiative designed to help the organization or supply chain network navigate a supply chain disruption or crisis situation. The survey was

Construct	Source	Items	Cronbach's α
Flexibility	Fawcett *et al.* (1996)	3	0.91
Top management support	Bardi *et al.* (1994)	3	0.90
Goal alignment	Min and Mentzer (2004)	3	0.84
Resource alignment	McGinnis and Kohn (1990)	2	0.72
Information technology	Stank and Lackey (1997)	4	0.84
Information sharing	Stank and Lackey (1997)	5	0.73
Connectivity	Stank and Lackey (1997)	4	0.80
Planning comprehensiveness	Fawcett *et al.* (1997)	7	0.91
Planning process standardization	Fawcett *et al.* (1996)	5	0.79
Internal collaboration	Stank *et al.* (2001)	5	0.81
External collaboration	Stank *et al.* (2001)	6	0.85

Table II.
Utilized constructs

designed to collect demographic data and measure the respondent's perceptions of the relationship between selected contingency planning attributes and flexibility. Tables III-VI include summary information about the respondents and the department or organization they represent.

Table VII provides a breakdown of the items in the research instrument, factor analysis, and comparison of the reliability score in the source (original) study and the results obtained in the current research. While conducting the factor analysis for this paper, the researchers discovered that the last two items (items 6 and 7) for the comprehensiveness scale produced a loading on two factors. Separate factor analysis runs were conducted, omitting one potentially suspect item at a time. The analysis showed that the multi-item measure produced a significantly higher reliability level when item 7 was removed ($\alpha = 0.86$) from the multi-item scale. This also allowed all remaining items to load on the same factor. For these reasons, item 7 designed to help measure the comprehensiveness construct was removed for the remainder of the analysis.

Results

Model estimation

Taken together, the constructs and associated measures allowed us to develop the following model:

$$Y = \beta_0 + \beta_1(\text{TMS}) + \beta_2(\text{GA}) + \beta_3(\text{RA}) + \beta_4(\text{IT}) + \beta_5(\text{IS}) + \beta_6(\text{CONN}) + \beta_7(\text{COMP}) + \beta_8(\text{PPS}) + \beta_9(\text{IC}) + \beta_{10}(\text{EC}),$$

where Y, dependent variable, flexibility; TMS, top management support; GA, goal alignment; RA, resource alignment; IT, information technology use; IS,

Table III. Respondent position summary

Respondent position	Senior	Middle	Professional	Technician
Percentage of sample	26.79% (45)	44.64% (75)	16.07% (27)	12.5% (21)

Table IV. Respondent experience summary

	Years in current position	Years in organization	Years planning experience
Respondent average	5.39	11.63	10.71

Table V. Level of involvement

	Plan development	Plan implementation
Respondent percentage	53.57% (90)	46.43% (78)

Table VI. Respondent organization size

	Less than 50	51-100	101-200	201-300	Greater than 300
Respondent percentage	35.12% (59)	17.86% (30)	20.83% (35)	7.74%(13)	18.45% (31)

Construct	Items	Factor analysis	Cronbach's α (original)	Cronbach's α (this paper)
Flexibility	13	0.89	0.91	0.88
	14	0.92		
	15	0.88		
Top management support	31	0.91	0.90	0.91
	32	0.96		
	33	0.91		
Goal alignment	34	0.91	0.84	0.91
	35	0.94		
	36	0.91		
Resource alignment	37	0.92	0.72	0.82
	38	0.92		
Information technology	16	0.89	0.84	0.92
	17	0.89		
	18	0.94		
	19	0.88		
Information sharing	39	0.72	0.73	0.87
	40	0.88		
	41	0.85		
	42	0.83		
	43	0.79		
Connectivity	44	0.89	0.80	0.92
	45	0.91		
	46	0.91		
	47	0.88		
Planning comprehensiveness	1	0.84	0.91	0.87
	2	0.86		
	3	0.84		
	4	0.79		
	5	0.75		
	6	0.53		
Planning process standardization	8	0.79	0.79	0.85
	9	0.81		
	10	0.75		
	11	0.79		
	12	0.80		
Internal collaboration	20	0.83	0.81	0.88
	21	0.86		
	22	0.84		
	23	0.85		
	24	0.71		
External collaboration	25	0.86	0.85	0.94
	26	0.89		
	27	0.90		
	28	0.88		
	29	0.92		
	30	0.84		

Table VII.
Utilized constructs

information sharing; CONN, connectivity; COMP, comprehensiveness; PPS, process planning standardization; IC, internal collaboration; EC, external collaboration.

In addition to the above variables, additional demographic information (specifically organizational size) was requested and included in the analysis as a linear control

variable (Claycomb and Germain, 1999; Mintzberg, 1979). The measure was used to control for organizational size since previous studies have sometimes shown that the size of an organization can have an impact on results due to the influence over partners and collaboration (Droge and Germain, 1998) and fiscal resources (Gargeya and Thompson, 1994). In spite of past research to the contrary, organizational size did not demonstrate a significant impact in the results of our study.

Results of hypotheses tests

The *H1* predicted a positive relationship between top management support for contingency planning and flexibility. The reported coefficient of 0.28 is positive in our analysis and the reported p-value of 0.00 is significant at α level 0.05. Therefore, *H1* is supported.

The goal alignment (*H2*) posited a positive relationship between the goal alignment construct and flexibility. The reported coefficient of 0.09 is positive with a reported p-value of 0.36 which is not significant at α level 0.05. *H2* is not supported.

The resource alignment (*H3*) posits a positive relationship between the alignment of resources and flexibility. The reported coefficient of 0.28 is positive and the reported p-value of 0.00 which is significant at α level 0.05. *H3* is supported.

The *H4* predicted a positive relationship between IT Usage and flexibility. With a positive coefficient of 0.26 and reported p-value of 0.00, *H4* is also supported at a 0.05 statistical significance level.

H5 predicted a positive relationship between Information Sharing and flexibility. While the reported p-value is significant at 0.00, the results demonstrate a negative coefficient of -0.25. Therefore, due to an inverse relationship, *H5* is not supported.

The connectivity (*H6*) proposed a positive relationship with flexibility. The results of the analysis did not validate this relationship with a coefficient of 0.00 and p-value of 0.96. *H6* is not supported.

H7 predicts a positive relationship between the comprehensiveness of the planning process and flexibility. The results of this analysis did not validate this relationship with a reported coefficient of 0.01 and p-value of 0.88. *H7* is not supported.

H8 predicts a positive relationship between the standardization of the contingency planning process and flexibility. This hypothesis is not supported. The analysis results demonstrate a negative coefficient of -0.06 and an insignificant p-value of 0.55. *H8* is not supported.

H9 predicted a positive relationship between intra-organizational collaboration in the contingency planning process and flexibility. Again, although the p-value of 0.04 reflects a significant outcome, the results demonstrate a negative coefficient, -0.03. Given the inverse relationship, *H9* is not supported.

The last *H10* predicted a positive relationship between inter-organizational collaboration in the contingency planning process and flexibility. The results in this case support the hypothesis with a positive coefficient of 0.21 and a p-value of 0.06. *H10* is supported at the 0.10 level of statistical significance. Table VIII provides a summary of the complete model results.

In addition to the hypotheses tests conducted above, we used t-tests (0.05 level) to examine possible differences among the various categories of participants. Two interesting results were noted during this process. First, respondents who were categorized as being senior level were statistically different from the other groups of

Construct	Coefficient	Std error	*p*-value	Sig.	Supported
1. Top management support	0.28	0.19	0.00**	Yes	Yes
2. Goal alignment	0.09	0.10	0.360	No	No
3. Resource alignment	0.28	0.09	0.00**	Yes	Yes
4. Information tech usage	0.26	0.07	0.00**	Yes	Yes
5. Information sharing	−0.25	0.08	0.00**	Yes	No
6. Connectivity	0.00	0.08	0.96	No	No
7. Comprehensiveness	.01	0.08	0.88	No	No
8. Planning process std.	−0.06	0.10	0.55	No	No
9. Internal collaboration	−0.19	0.09	0.04**	Yes	No
10. External collaboration	0.21	0.11	0.06*	Yes	Yes

Table VIII.
Model results

Note: *Significant at the *0.10, **0.05 levels

participants (middle level, professional, and technician) when considering the level of importance of planning on the ability to achieve flexibility. Second, no significant differences were noted between plan developers and plan implementers.

First, perhaps not surprisingly respondents representing the senior-level planner category noted a higher level of importance regarding the process and its ability to enhance flexibility in times of crisis or disruption. Senior-level planners are most likely to be in a position within their organization that they are integrally involved in strategy formulation including the design, implementation, and successful execution of a contingency planning process. The results support the notion that individuals in senior-level positions have key responsibility for longer-term planning, strategic planning, and are oftentimes the decision-makers in uncertain or highly risky situations.

Second, there were no significant differences noted between plan developers and plan implementers. Oftentimes those who are developing a particular process have different familiarity levels, possess different process knowledge, and have different priorities than those who are implementing the process. Therefore, one might expect to see significant differences between those planning for a possible contingency and those actually implementing a contingency plan. This was not the case, indicating that in times of crisis perhaps everyone understands the key issues and goals that are trying to be accomplished.

Discussion

Overall, the model as constructed explains roughly half of the total variance associated with flexibility, reporting an R^2 of 0.45. Six of the constructs measured here were found to be statistically significant: top management support (*H1*), resource alignment (*H3*), IT use (*H4*), information sharing (*H5*), internal collaboration (*H9*), and external collaboration (*H10*). Two of the significant findings however, did not support their corresponding hypotheses due to directional inconsistencies. Given the directional inconsistencies and the number of independent variables examined by the model, we tested for multicollinearity. While an examination of the correlation matrix showed one primary area of concern, the statistical test to obtain the tolerance value was within the 0.10 threshold, indicating that multicollinearity among the independent variables was within an acceptable level.

Information sharing (*H5*) and internal collaboration (*H9*), while significant, reported a negative coefficient, opposite of what was hypothesized. While this paper cannot attempt to demonstrate the cause of a negative relationship, several interesting observations can be made. First, with regard to information sharing, it has been shown to be an important organizational or network characteristic, especially in the communication of best practices and improving response time to change (Stank *et al.*, 1996). Information sharing both within and between organizations may affect innovation (Easterby-Smith *et al.*, 2008; Sammarra and Biggiero, 2008) which, in turn, allows organizations to develop new and novel contingency plans. Our research indicates that information sharing may have a significant impact on flexibility, but perhaps not the positive relationship predicted. This may occur because the comprehensive planning process by its definition is an information sharing process.

We may surmise that some of the information sharing held to be important in the planning process by our sample includes the type of information sharing that goes along with comprehensive planning. Thus, the more comprehensive the planning process, the more planning information is shared, reducing the impact of information sharing by itself. This may actually produce an inverse relationship.

An alternative explanation may be that our respondents believe that a comprehensive planning process builds into it an element of information sharing that reduces the importance of day-to-day information sharing processes. Perhaps, respondents discounted the importance of information sharing since it is already built into the process. They may actually believe that the sharing of additional information could have a negative impact by introducing confusion into the process. Given that the original planning process should already have information sharing built into the process, adding new and potentially contradictory information, may be a significant distraction to those tasked with following the contingency plan. If this is the case, supply chain managers throughout an organization or network must be vigilant in their efforts to continue to keep the information sharing process vibrant and flowing.

As for internal collaboration, employees may perceive internal collaboration, beyond some undefined point, as being too restrictive, and thereby reducing flexibility. The effect here could be an organization or network where every component performs processes in a very similar manner; a disruption would then influence every component of the highly aligned supply chain in a very similar or identical way. This lack of ability of a particular section of the supply chain network to innovate could be seen as a negative by employees. Also, it could be that employees feel they are a "slave" to the key enabler of information sharing which is IT. In effect, employees may feel that IT prevents them from having control, thereby limiting their ability to adjust and be flexible.

Additionally, too much sharing of information between components of a supply chain network may be perceived as harmful if the information does not have the same value across the network. A negative perception might also come from a situation where participants of the network lose the ability to generate their own information and become completely reliant on an external source. If all supply chain participants are then dependent on shared information, there may be a perception of inflexibility due to a lack of "internal" control.

As hypothesized, top management support (*H1*) was found to have a positive relationship with flexibility. As noted by Min and Mentzer (2004), top management

support including both leadership and commitment to new processes, is an absolute necessity in the supply chain. Additionally, resource alignment (*H3*) was found to have a significant, positive relationship. Goldsby and Stank (2000) reported similar findings and found that closely aligned resources help to achieve both improved service and increased ability to address problems more quickly. IT use (*H4*), as expected, was also significant. This reinforces the findings of Stank and Lackey (1997) who found that, with advanced information system use, organizations can implement strategy and make decisions more rapidly, thereby increasing their ability to react to a disruption and increase their flexibility. Finally, the external collaboration (*H10*) was supported, albeit at a significance level of 0.10. Stank *et al.* (2001) found that external collaboration is essential in collecting and sharing information and in coordination across operations. Our findings generally support this notion.

Managerial implications

The risks of, and impacts from, environmental disruptions on businesses are tremendous. As we continue to progress towards an increasingly global marketplace, the risk of a potential business disruption tends to escalate. As the operating environment continues to evolve into a complex network of interdependent supply chain participants, the need for enhanced managerial understanding of key processes escalates.

Risk management has placed many professionals in an unfamiliar and relatively new territory, forcing the application of new techniques (Elkins *et al.*, 2005) and highlighting the need for improved visibility and communication (Christopher and Lee, 2004). The large potential impact on businesses from a supply chain disruption has heightened interest in, and the application of risk management tools. One way to manage these disruptions and the risk associated with them is to use strategic planning tools to develop an effective continuity response plan in the event of a disruption. This process involves prioritization of resources, a dedication to planning, early involvement of key participants, and a process of continuous improvement (Zsidisin *et al.*, 2005).

Perhaps, not surprisingly the importance of top management support was particularly evident in our study. Any proposed innovation, action, or process usually requires strong support from key members of an organization or network if it is to be successful. Our results were no exception. It appears that without planning, support, patience, and leadership from management, many programs can become large drains for an organization (Quinn, 1985; Wisner and Lewis, 1997) with the initiative failing to reach its goals of improved efficiencies and competitive advantage (Bardi *et al.*, 1994).

The importance of top management support as a variable impacting the contingency planning process is particularly relevant since the results of this paper are aimed at enhancing managerial understanding and decision-making processes surrounding contingency planning. If managers can better address some of their key planning issues by improving their understanding levels of contingency planning processes in supply chain environments, then managerial performance can potentially be enhanced. As managers become more familiar with the key variables of interest that were identified in this research effort, they should be able to blaze a new trail of familiarity with risk assessment. This heightened familiarity of the importance of top management support in this process should help managers to better respond to risks

by developing and implementing an effective supply chain contingency planning process in their organization. The more effective managers can be at accomplishing this task, the more likely they are to preside over a highly flexible organization more capable of minimizing the negative risk exposure associated with an unplanned supply chain disruption.

Resource alignment and IT usage were also found to be key variables of successful contingency planning. Effective practice of both of these elements together allows an organization or network to have their resources properly allocated and positioned for maximum benefit. IT usage allows for effective communication and information sharing related to the allocation of resources which, combined with effective resource alignment allows an organization or its supply chain network to respond quickly and in a coordinated manner for maximum operational benefit.

External collaboration was also judged to be highly important when undertaking a contingency planning process. Given the supply chain networks associated with today's business environment, perhaps this is not surprising. Nevertheless, this result highlights the need to work with supply chain partners to address potential disruptions instead of attempting to address the situation in isolation.

The identification of which characteristics may make a supply chain contingency planning process more attractive or successful in a supply chain environment or network is highly beneficial and relevant to managers at all levels. If management and individuals within an organization or network understand the variables to review prior to considering adoption of a supply chain contingency planning process, opportunities for success through enhanced flexibility are enhanced.

One key goal of the research is to contribute to academic rigor and practitioner relevance while identifying key variables of interest in the contingency planning process. While academic rigor and practitioner relevance are both important, arguably the most important contribution of our research is to the field of planning practitioners. There are many "how to" examples of what an organization or its supply chain network should do to prepare for potential disruptions, but most have little academic rigor and many come without validation and/or with a large consulting fee attached.

The results of this effort strives to help managers at all levels to better understand the primary planning attributes to use to increase flexibility and help enhance their contingency planning processes. In many situations when both time and fiscal resources are constrained, managers must choose to focus on limited aspects of a project through prioritization. The results of this effort should enable managers to focus on certain attributes where they can receive the most 'bang' for their planning investment.

In the world of academia, this effort meets an important need by filling a gap in planning literature. As discussed previously, much effort has been applied to strategic planning with comparatively little academic research having been applied specifically to contingency planning. Furthermore, relatively little research has been conducted evaluating contingency planning processes in a supply chain context.

While our model identified some key variables, the overall fit of our model indicates that additional variables of interest need to be identified and explored. Future research into specific variables might include additional planning attributes such as technical training or the application of specific knowledge management systems. Additionally, efforts might include a longitudinal study to determine if the importance of certain

planning attributes changes over time. The methods used for data analysis might also be modified to include more powerful statistical techniques. A broader and more diverse sample could also be employed to further validate the proposed model and expand on the solid research foundation presented.

Limitations

As with any research effort, this paper has limitations that could impact the generalizability and validity of the results. In this research effort, the respondents were all representatives of a managerial contingency planning course. While they represented multiple organizations and networks, all of the respondents were identified from the contingency planning course. A wider range of respondents could make the results more generalizable.

With a reported R^2 of 0.45, this paper leaves many opportunities to explain the remaining variance in the dependent variable of flexibility. While this paper makes a significant step towards a better understanding of the make-up of flexibility and its potential impact on risk reduction through effective strategic contingency planning, there are additional opportunities to investigate additional variables of interest. Nevertheless, this exploratory study has provided considerable insight into the key variables of interest for implementation of a successful contingency planning process designed to enhance flexibility and minimize risk exposure in the event of a supply chain disruption.

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