Conceptualizing Supply Disruption Management: Organizational and Inter-organizational Influences

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The rich stream of supply disruption management (SDM) literature is devoted to understanding the nature of disruptions and detailing appropriate disruption management strategies. Much less attention, however, has been paid to understanding what factors influence the viability of one SDM strategy over another. Using the current literature stream on SDM, we develop four propositions that detail factors both intrinsic and extrinsic to the firm that affect the viability of supplier co-ordination, inventory buffers, and supply base flexibility as SDM strategies. Specifically, in accordance with our conceptual framework, we suggest that product complexity, industry uncertainty and geographic diversification have significant and highly dynamic effects on the effectiveness of SDM strategies. Thus, our research highlights that understanding the nature of risks and disruptions cannot be isolated from other salient factors that characterize the firm's operating environment.

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I. INTRODUCTION

Supply disruptions are unplanned and unanticipated events that disrupt the inbound flow of goods between a firm and its supply network (Craighead et al., 2007). Disruptions have varying degrees of extremity: ranging from minor cases in which material flow stoppages are close calls and avoided at the very last minute, to major cases in which there is a complete stoppage in material flow for an extended period of time (Habermann et al., 2015) as illustrated by halt of the supply of automotive parts due to the Tsunami in Japan in 2011 (Swink et al., 2014). However, regardless of extremity, supply disruptions can have unprecedented effects on the financial viability of the purchasing firm. As illustrated by Hendricks and Singhal (2005), firms that experience supply-demand mismatches experience significantly lower sales growths, higher growths in costs and may take more than two years for their operating performance to recover. Furthermore, due to the closely inter-related nature of contemporary supply chains, a disruption can cause the collapse of the entire supply chain (Kern et al., 2012). Thus, because of the wide recognition that all supply chains are exposed to some level of susceptibility to disruptions, research interest in disruption management has been exponentially increasing in recent years.

There is a large and growing body of literature that has addressed the topic of disruptions from a diverse standpoint. As expounded in later sections, numerous studies have been devoted to understanding potential sources and drivers of supply disruptions, as well as disruption management techniques. Sources of supply disruptions may be linked to individual supplier failures, such as capacity constraints and delivery failures, or risks associated with external marketing characteristics, such as market shortages and commodity price changes (Manuj and Mentzer, 2008; Zsidisin, 2003a; Zsidisin and Wagner, 2010). Researchers have also elaborated on several supply disruption management (SDM) strategies. A classic example is raw material inventory buffers, in which purchasing firms may purchase extra raw material which is leveraged to ensure business continuity in the face of a supplier disruption (Modi and Mishra, 2011). Alternatively, firms may choose to adopt a flexible supply base strategy to mitigate supply disruptions. A flexible supply base strategy refers to the ability to rapidly (1) shift orders among existing suppliers, (2) add or eliminate suppliers rapidly, (3) develop suppliers, or (4) temporarily shift orders to a backup supplier while the main supplier executes a delivery disruption recovery plan (Liao et al., 2010). Firms may also opt, through sending needed resources and/or expertise, to co-ordinate with the supplier that has been affected by a disruption in order to reduce the disruption recovery period, thereby reducing the severity of the disruption (Christopher and Peck, 2004).

While significant research has been devoted to understanding disruptions and detailing disruption management strategies, much less attention has been devoted to understanding what factors influence the viability of one SDM strategy over another. Understanding these factors is important for two critical reasons. First, empirical and anecdotal evidence exists that while there are multiple different mechanisms to respond to a specific disruption, each mechanism will have its own distinct level of efficacy. A quintessential example often cited in disruption-related literature is the different responses that Nokia and Ericsson had in response to a disruption from a shared major supplier, Phillips. As the Phillips manufacturing plant was dealing with the aftermath of a severe plant fire caused by a lightning strike, Nokia opted to develop alternative sources of supply, while Ericsson opted to "ride out" the disruption by leveraging buffer inventory (Schmitt, 2008). However, the disruption period extended much longer than Ericsson had anticipated resulting in severe losses (Ellis et al., 2011).

Second, the disruption management strategies themselves may have associated costs and risks. For example, while raw material inventory buffers can effectively mitigate the effects of temporary stoppages in inbound flow, excessive inventory buffers would increase a firm's inventory holding costs, as well as expose them to obsolescence risks (Modi and Mishra, 2011; Eroglu and Hofer, 2011). Collectively, it is important to understand under what existing conditions would one SDM strategy be more effective over another, and therefore a more rational choice. Uncovering and explicating these factors would provide significant academic implications in advancing the theory of SDM, as well as providing managerial guidance in disruption assessment and management. Thus, this research is driven by the following research question:

RQ: What factors influence the viability of an SDM strategy over another?

Our research contributes to the body of SDM in the following ways. First, we demonstrate that inventory buffers, supplier co-ordination and supply base flexibility are SDM strategies that are not universally applicable to handle supply disruptions in all contexts. The efficacy of an SDM strategy is not only tied to the nature of the supply risk, but is also influenced by other salient factors that characterize the firm's operating environment. In particular, we demonstrate that product complexity, industry uncertainty and geographic diversification significantly influence the efficacy of SDM strategies. Secondly, not only do we show that the efficacy of SDM strategies vary in accordance with the firm's operating environment, we also show that this relationship can be highly dynamic. For example, we demonstrate that supplier co-ordination may be an effective SDM strategy in an operating environment characterized by high industry uncertainty; however, it may not be an effective SDM strategy in an environment with a supply base that is geographically diverse.

II. RELEVANT LITERATURE

2.1 Supply Risks and Disruptions

Although clearly related, extant literature makes note of the differences between risks and disruptions. While risks are potential threats to supply chain operations, disruptions are actual events. Thus, risks are antecedent to disruptions and due to this inter-relatedness, while our primary focus is on supply disruptions, we have to make mention of supply risks as well.

Supply risks are potential threats that may disrupt normal procurement operations. They mainly consist of issues and problems that can arise from capability-related failures of the individual suppliers in the supplier portfolio of the purchasing firm, including the interactions between the two organizations (Zsidisin and Wagner, 2010). Supplier capability-related failures may arise from business-related failures such as financial instability, default, insolvency or bankruptcy (Wagner and Bode, 2008). They may also arise from production and operations management failures, such as supplier production disruptions and capacity constraints, and inbound delivery failures and delays (Zsidisin, 2003b). Such failures may directly lead to disruptions if the purchasing firm does not directly intercede in managing the risk, making it imperative for the purchasing firm to develop strategies that mitigate or eliminate these risks and/or subsequent disruptions. Many companies find themselves in situations where risk elimination is not possible, improbable, or overly costly and financially infeasible.

2.2 Supply Disruption Management Strategies

SDM is a subset of risk management that deals with mitigating the effects of an inbound disruption. Specifically, it may involve utilizing contingency plans to ensure that the supply disruption does not affect the purchasing firms' operations, or taking steps to minimize the downtime length of the disruption.

There are several identified SDM strategies, of which more detailed reviews exist (e.g Jùttner et al., 2003; Tang, 2006a; Sodhi et al., 2012). Of particular interest in this study is the synthesis of individual SDM strategies into common typologies. Zsidisin and Ellram (2003) categorize disruption management strategies between behavior based management and buffer-based management. They detail that behavioral based disruption management involves the purchasing firms' influencing supplier behavior through certification and development programs in order to improve the supplier's capabilities or contingency plans. While these strategies are primarily proactive, supplier development may be used in a post-disruption scenario as a collaborative effort between the firm and supplier to minimize the disruption downtime. Buffer-oriented management, on the other hand, involves holding extra resources as reserve which would then be utilized as the main supply to recover from a disruption. According to Zsidisin and Ellram (2003) buffer oriented management may include build ups of excess inventory, or using more than one active supplier for the same sourced components. While maintaining these distinctions, in this study, we treat supply base flexibility as a separate category from buffer-oriented management. We contend that this distinction is necessary because, as detailed in subsequent sections, the mechanism through which firms achieve a flexible supply base is fundamentally different from the mechanism firms utilize to create inventory buffers. We discuss each of the three SDM strategies in the following subsections.

2.2.1 Buffer Inventory

Buffer inventory refers to inventory that firms hold for the primary purpose of guarding against unexpected variation from supply uncertainty. With the ability to reduce the effects of variability, buffer inventory has been commonly used to decouple demand signals from production processes (Stratton and Warburton, 2003). Thus, the link between buffer inventory and variability is well established empirically, that its use has even been labeled as "ubiquitous" (Hopp et al., 2012). Consequently, the use of buffer inventory in guarding against disruptions is also very well established in disruption management literature, as a buffer inventory of sourced components may be utilized to ensure production processes continue as planned in the event of a supplier experiencing a disruption (Christopher and Peck, 2004; Blackhurst et al., 2011; Ambulkar et al., 2015). The primary benefit of buffering via inventory is that it is relatively very simple and quick to implement (Azadegan et al., 2013). In the context of this study, implementing supply side inventory buffers may be as simple as editing ordering policies to increase raw material inventory holdings.

However, while relatively simple and quick to implement, buffer inventory may be very costly. Increasing raw material inventory levels increases a firm's inventory holding costs (Eroglu and Hofer, 2011; Modi and Mishra, 2011). Furthermore, it also exposes firms to risks associated with obsolescence, pilferage, spoilage, etc. Thus, buffer inventory beyond normal variation levels is not well regarded as a long term solution, and is often associated with being a stop-gap measure while firms develop other means to manage variability (Newman et al., 1993; Mukhopadhyay, 1995).

2.2.2 Supply Base Flexibility

Supply base flexibility generally refers to the ability to quickly change inputs or the mode of receiving inputs (Pettit et al., 2010). Supply base flexibility may be accomplished via various means. First, supply base flexibility may be made possible via the ability to rapidly shift order allocations among existing suppliers with slack capacity. Flexible order allocation is predicated on the existence of a supply network which has multiple sources of supply for a single sourced component (Burke et al., 2007). Alternatively, supply base flexibility may be accomplished via the ability to add or eliminate suppliers rapidly (Zsidisin, 2003). These strategies may be augmented with initiatives such as flexible supply contracts (Tang, 2006). Finally, supply base flexibility may be implemented by utilizing backup suppliers who would be allocated orders in the event that the main supplier experiences a disruption (Tomlin, 2006) or a spike in demand. Taken together, supply base flexibility manages disruptions from a source diversification standpoint. Specifically, supply base flexibility allows for purchasing firms to ensure that their inbound flow of materials remains uninterrupted due to the ability to divert orders to alternative sources of supply that are not being affected by disruptions (Hitt et al., 2006; Hendricks et al., 2009).

However, despite these benefits, supply base flexibility may prove to be very costly and has other associated risks as well. In particular, supply base flexibility associated with multiple sourcing and adding new suppliers may increase the difficulty that the purchasing firms face in managing their supply network and that of their upstream suppliers. Increases in number of suppliers increases the number of information flows, physical flows and relationships that need to be managed (Bozarth et al., 2009). This difficulty is illustrated by the recent recall of the Samsung Galaxy Note 7 smartphones, in which a large network and complex network of suppliers made it difficult to address and diagnose the cause of the overheating batteries, ultimately forcing Samsung to halt production of the phone (Loten et al., 2016). Due to supplier heterogeneity, purchasing firms may be faced with the possibility of having to cater their supplier relationship management processes to each individual supplier (Talluri and Narasimhan, 2004). Thus, purchasing firms incur additional costs associated with generating structures and processes required to manage the additional complexity and stress on the supply base (Lu and Beamish, 2004). Furthermore, adding suppliers and utilizing backup suppliers faces additional challenges. Specifically, backup suppliers and new suppliers already rely on other firms as their main source of revenue. Thus, given their existing utilization rates, they may not be able to fully meet a new purchasing firm's demand requirements in a timely manner as it is highly unlikely that they have existing slack capacity that is equivalent to the overall capacity of the main supplier (Chen et al., 2012).

2.2.3 Supplier Co-ordination

Supplier co-ordination functions in the context of an existing relationship of buyer-supplier networks, in which purchasing firms pursue initiatives to ensure that their suppliers are engaging in continuous improvement (Chiang et al., 2012). Thus, as an SDM strategy, supplier co-ordination involves sending resources and/or expertise upstream to a supplier experiencing a disruption in order to provide assistance to their disruption recovery plans. The primary benefit of supplier co-ordination as an SDM strategy is that it keeps the current configuration of the supply network in place, and avoids the increases in costs and risks associated with seeking alternative sources of supply. Thus, supplier co-ordination relies on the existence of a firm-supplier relationship characterized by a long-term orientation. It may also serve as the only SDM option in cases where raw material sources are limited due to characteristics of the raw materials, or due to other factors such as supplier patents (Zsidisin and Ellram, 2003). However, in the case of a supplier disruption of unprecedented length, it may not be an effective SDM strategy.

As supplier co-ordination relies on the existence of a long-term orientation in the firm-supplier relationship, it follows that this SDM strategy may be enhanced via supplier certification. Supplier certification may be used to ensure that suppliers have their own SDM strategies, ensuring that the supplier is prepared with plans in place to react to upstream threats eventually passed through the chain. Moreover, it ensures that a supplier may have alternative sources identified to meet short-term downstream customer needs. Supplier co-ordination becomes less acute during a disruption mitigated by customer-supplier pre-built relationships with a philosophy of continuous improvement.

III. CONCEPTUAL FRAMEWORK

The effectiveness of strategic and tactical decisions made by firms are not only influenced by the firm itself, but also by their existence within a network of suppliers, customers and shareholders (Pfeffer and Salancik, 1978). Similarly noted by Carter et al., (2015) is the notion that supply chain management phenomena exists both within and outside an organization's boundaries. An example they provide is new product development, a phenomenon that occurs at the organizational level (individuals and crossfunctional product teams), as well as across organizations (the firm-supplier and the firm-customer interface). Thus, there are multiple potential levels of analysis, all of which play a significant role in influencing the effectiveness of new product development or existing product continued improvement toward customer satisfaction. However, they also note that most supply chain management research employs single-level theorization with the ultimate consequence of restricting our understanding of complex Supply Chain phenomena, and thus its limited application provides ample opportunity for theorization relevant to supply chain management.

Expanding on our conceptualization of the viability of SDM strategies, we identify additional salient factors and contextualize them in a multilevel framework. Our multilevel theorization, relying on the framework developed by Carter et al., (2015) is detailed in Figure 1 below. We use their nested-level framework to identify the four nested level factors that would influence the viability of each SDM strategy. Specifically, our framework consists of product level factors (Level 1) nested within the firm-supplier interdependencies (Level 2), which are in turn nested within industry-related factors (Level 3), which are in turn nested within supply chain related characteristics (Level 4).

Since our discussion is focused on supply disruptions, our focal level of analysis is the firm-supplier relationship. Thus, we frame our arguments in the context of how Level 1, Level 3 and Level 4 factors significantly influence the effectiveness of SDM strategies in the context that Level 2 factors exist.

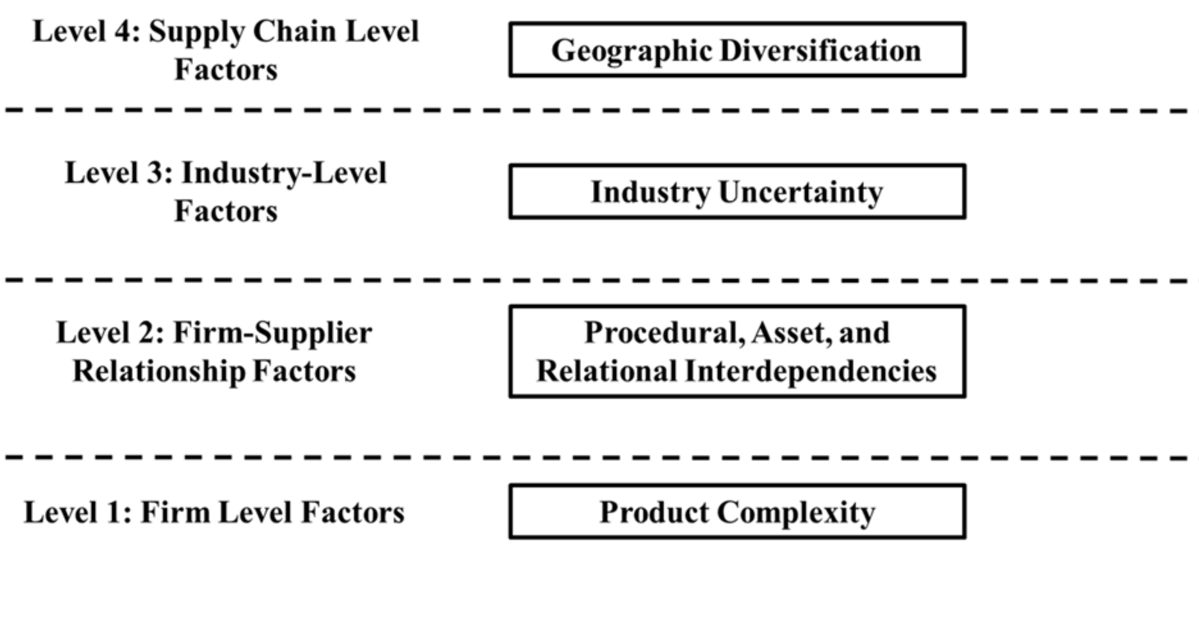

FIGURE 1. FOUR LEVELS OF FACTORS INFLUENCING VIABILITY OF SDM STRATEGIES.

3.1 Product-Level factors – Product complexity

Given that our focus is on supply disruptions, our proposed unit of analysis would be the firm-supplier relationship. Thus, relying on prior literature (Peck, 2006; Leuschner et al., 2013), our conceptual framework relies on characterizing firm-supplier interdependencies based on three major characteristics, namely, (1) procedural interdependencies, (2) asset and infrastructure interdependencies, and (3) relational interdependencies. As detailed below, these three major characteristics comprehensively capture how firms relate to their supply network, most importantly, information flows, material flows as well as capturing supply chain relationships.

Procedural interdependencies refer to the level of inter-relatedness of the work and information flows between a firm and its supplier portfolio (Peck, 2006). Thus, on one hand, a low level of procedural interdependencies may suggest that firms are primarily communicating with their suppliers only when necessary for transactions to occur. On the other hand, a high level of procedural interdependencies may suggest that firms have a high level of integration with their suppliers in forecasting, planning, scheduling and replenishment systems with multi-enterprise collaborative integrated technology. Procedural interdependencies create structures that enable work processes and decision making among firms and their suppliers to be coordinated (Leuschner et al., 2013) thereby having significant effects of material and information flows, such that order fulfillment costs, transportation and inventory costs may be optimized (Balakrishnan et al., 2004; Cannella and Ciancimino, 2010).

Asset and infrastructure interdependencies refer to the extent to which a firm relies on specific physical facilities of a supplier, and/or preexisting transportation networks (Peck, 2006). Such an interdependency may arise if, for example, the purchasing firm purchases a component that is only manufactured at a supplier's specific manufacturing facility due to the supplier's use of the focused factory concept – a prominently used strategy to handle multiple manufacturing facilities with severe advantages over unfocused factories (Brumme et al., 2015). Such interdependencies may also arise if the number of suppliers is limited due to the existence of monopoly, or oligopoly conditions in the supply market, or due to localized raw material availability (Zsidisin, 2003b).

Finally, relational interdependencies refer to the extent to which the connection between a firm and its suppliers are characterized by elements of social capital such as trust, commitment and long-term orientation (Chen et al., 2004; Leuschner et al., 2013) Relational interdependencies are primarily pursued to create new value that neither partner can create independently (Dyer and Singh, 1998), such as the ability to secure valued resources and technologies, harness supplier skills and strengths, as well as gain quality and process improvements (Nyaga et al., 2010). Thus, many studies have demonstrated that relational interdependencies are associated with improved metrics of operational and financial performance (Leuschner et al., 2013; Mackelprang et al., 2014), and other key benefits, such as customer responsiveness (Chen et al., 2004; Bernardes, 2010), joint innovation (Cao and Zhang, 2011) and agility (Gligor and Holcomb, 2014)The existence, and the extent of the existence of interdependencies play a significant role in determining the viability of the previously mentioned SDM strategies. As firm-supplier interactions exhibit increasingly higher levels of interdependencies, the ability to develop alternative sources becomes increasingly limited, as the firm's normal course of operations may become characterized by this interdependency. Thus, with the case of procedural interdependencies, a purchasing firm that has a highly integrated

CPFR system with a specific supplier may be faced with increased difficulty in shifting orders to another supplier merely due to high switching costs. Similarly, with the case of asset and infrastructural interdependencies, a firm's reliance on a supplier's physical facility due to a supplier patent or due to the supplier's use of focused factories may make it virtually impossible to seek alternative sources of supply. Finally, as relational interdependencies necessitate a long-term orientation, a firm whose normal course of procurement operations relies on existing relationship-specific assets that are not easily transferred to other suppliers may also be faced with difficulties in developing alternative supply sources. Taken together, we posit that high levels of interdependencies will limit the viability of SDM strategies that rely on the flexibility to seek alternatives, and will strengthen the viability of SDM strategies that make use of existing supplier configurations. Thus,

P1: Higher levels of interdependencies are associated with a:
a) higher viability of supplier co-ordination SDM strategies
b) higher viability of inventory buffer SDM strategies
c) lower viability of flexible supply base SDM strategies

3.2 Product-Level factors – Product complexity

In order to remain competitive, firms often face pressures to increase the variety of products in order to meet more specific customer demands (Closs et al., 2010). Product complexity, a result of increasing demand for product performance and variety arises from several sources, including technological novelty, quantity of sub-system components, degree of customization of components in the final product, and quantity of alternative design and delivery paths (Harland et al., 2003). While the end result of product complexity is increased competitiveness, product complexity may increase a firm's additional costs, such as inventory holding costs for the additional variety of sub-components, as well as the potential of increasing risks associated with having multiple production cycle times for each of the subcomponents (Closs et al., 2010). Thus, firms have to develop strategies in order to mitigate the negative effects of product complexity. We focus on two of these strategies: design modularity, and postponement.

Modularity is the degree to which a product's components can be separated and recombined, and is achieved via designing complex products such that they can be easily decomposed into simpler autonomous sub-modules (Mikkola and Gassmann, 2003). Thus, the main benefit of modularity is the enabling of these heterogeneous inputs to be recombined into a variety of heterogeneous configurations, thereby increasing the product variations that firms may be able to provide (Schilling et al., 2000). Thus, design modularity enables firms to combine the uniqueness of craft manufacturing with the efficiencies associated with mass production (Duray et al., 2000).

As a strategy to manage product variation, postponement is about delaying the point of differentiation between products until more accurate information about customer demands is received (Tang, 2006). The later the point of differentiation in the production cycle, the more the manufacturing firm is able to simplify their production process and reduce inventory costs. As illustrated by the painting industry, by postponing the final mixing of colors until the customer order arrives, normally at the point of sale, outlets selling paint are able to maintain desired product variety, while still achieving significant savings in transportation and inventory costs (Yang and Yang, 2010Thus, in relation to our study, reducing product complexity via design modularity has significant implications for the viability of SDM strategies in the context of a firm-supplier interdependency. Design modularity may aid in flexibility in sourcing, as it allows for firms to decouple individual supplier contributions (Choi et al., 2001). If a supplier of a sourced component experiences a disruption, a purchasing firm may opt to rapidly redesign the product's submodule such that its reconfigured product may rely on a component from a backup supplier or from any form of an alternative supplier. Thus, modular design is significant in that if design and production of any module could be multi-sourced, SDM is enhanced. This is illustrated in our earlier example of Nokia's response to Ericsson's disruption. Nokia's ability to develop alternative sources of supply relied on the modular design of their phone (Schmitt, 2008). Similarly, postponement may increase the viability of developing alternative sources of supply. Since postponement delays the final production phase of a component, it may give firms the opportunity to change the configuration of one product at the last possible moment in the case of the disruption in supply of a component, as it allows for increased ability of a product design to be altered before completing the full manufacturing cycle (Ogawa and Piller, 2006; Yang and Yang, 2010). Additionally, alternate assembly areas would be essential to SDM in case one was eliminated or severely disrupted.

These arguments can be generalized to how firms may use inventory as an SDM strategy. In the case of modular designed products, a firm may rapidly redesign and reconfigure their submodules such that their product portfolio makes use of existing inventory and is less reliant on a component sourced from a supplier that has experienced a disruption. Similarly, the use of large inventory holdings in a pre-postponed form may be able to withstand the impact of a supplier disruption. Thus, design modularity and/or postponement may make the increase the viability of inventory as an SDM strategy.

Taken together, in the context of firm-supplier interdependencies, reducing product complexity via design modularity and/or postponement may potentially expand a firm's SDM portfolio, by allowing for the increase of the viability of developing alternative sources of supply, increasing the viability of buffer inventory without compromising the supplier co-ordination SDM strategy. Thus:

P2: For a given level of firm-supplier interdependency, reductions in product complexity
(a) are neutral on the viability of supplier co-ordination SDM strategies
(b) are positively associated with the viability of inventory buffer SDM strategy
(c) are positively associated with the viability of flexible supply base SDM strategies

3.3 Industry-level factors – Industry uncertainty

Industry uncertainty refers to the difficulty with which firms have in predicting future requirements, either due to incomplete information, or due to the volatility of operating conditions (Germain et al., 2008). Industry uncertainty has long been considered a key characteristic in describing the nature of the industry, and a determining factor of successful operations and supply chain strategies (Ward and Duray, 2000; Wong et al., 2011). Industries with high uncertainty are typically characterized by shorter product lifecycles, shorter lead times, more intense competition and higher contribution margins, thereby requiring a different market approach than industries that are relatively stable (Fisher, 1997).

Expounding on the concept of industry uncertainty, Dess and Beard (1984) identify three important dimensions of environmental uncertainty – dynamism, complexity and munificence. Industry dynamism describes an operating environment that changes very rapidly and unpredictably such that there is an increased difficulty in forecasting, assessing changes in demand and developing appropriate operational responses (Nadkarni and Barr, 2008; McCarthy et al., 2010). Complexity refers to a high degree of heterogeneity in the industry, caused by multiplicities of inputs (suppliers and materials) and outputs (customers and products) (Dess and Beard, 1984), thus increasing the amount of resources and knowledge required to form successful firm strategies (Mintzberg, 1979). Munificence refers to the degree to which resources are supportive of sustained growth for the overall set of firms within the industry and is commonly associated with the ability of the firms within the industry to grow sales (Heeley et al., 2006). Thus, low munificent environments present limited growth opportunities for firms, pressurizing them to maintain their sales volumes as well as increase demand for their products at the expense of their competitors (Rosenzweig, 2009). Taken together, dynamism can be viewed as uncertainty on the demand side, complexity as uncertainty on the competition side, and munificence as uncertainty arising from long term industry trends (Xue et al., 2011).

Thus, in the context of this study, the viability of SDM strategies would be expected to be heavily influenced by the ultimate goal of ensuring business survival. While buffer inventory is a viable SDM strategy in the context of high levels of firm-supplier interdependencies, we posit that industry uncertainty mitigates this viability. While much of the literature related to buffering argues for the strong relationship between buffers and variability (Rumyantsev and Nettessine, 2007; Shan and Zhu, 2013) we contend that buffer inventory is only effective in a specific narrow context in industry uncertainty. Specifically, buffer inventory is most well suited in guarding against uncertainty that results in an unexpected demand surge. Not only is buffer inventory ineffective in situations of uncertainty that results in unexpected drops in demand, it may result in significantly increased holding costs. Furthermore, uncertainty due to increased competitive pressures and low munificent environments, puts great pressure on profit margins, thereby creating a managerial incentive to increase efficiency in order to maintain profit margins at a sustainable level (Cachon and Olivares, 2010; Eroglu and Hofer, 2014). Therefore, while buffer inventory is a relatively simple and effective SDM strategy in the context of a firm-supplier interdependency its implementation may prove to be detrimental to a firm's competitiveness in the context of high industry uncertainty.

Conversely, industry uncertainty may magnify the viability of supplier co-ordination as an SDM strategy. As earlier mentioned, industry uncertainty places great incentives on firms not only to ensure business survival, but to augment their competitive position. Much of the literature has delineated the benefits of enhancing collaboration with suppliers. Thus, closely working with suppliers may be a means through which firms may manage the pressures of environmental uncertainty (Liao et al, 2010). In the context of SDM, firm-supplier interdependencies, through the creation of structures that facilitate information and resource exchange as well as the acquisition of social capital, lay the groundwork through which supplier co-ordination may flourish (Braunscheidel and Suresh, 2009; Gligor and Holcomb, 2012; Gligor et al., 2015). Thus, there is easier facilitation of the transfer of information, resources and expertise to a disrupted supplier in order to minimize the effect of a supply disruption (Kleindorfer and Saad, 2005)We also posit that in high uncertain industries the viability of supply base flexibility as an SDM strategy is compromised. Supply base flexibility is effective only with the ability to replace one supply source for another with low cost and in a short time, with little negative effect on component quality and design (Liao et al., 2010). While already difficult to implement in the context of firm-supplier interdependencies, industry uncertainty increases the difficulty of implementation. Industry uncertainty strains the firm's decision makers, due to the inability to develop and assess the nature of demand and competitive environment and developing appropriate responses. Thus, achieving supply base flexibility via having multiple supply sources or alternative sources of supply further increases the difficulty and costs required to manage an increasingly complex supply base. Thus, not only are the firm's costs increased thereby decreasing their competitiveness, the increased complexity and difficulty in assessing strategies may limit their effectiveness as decisions made in a complex environment are less likely to result in optimal outcomes due to this increased complexity pushing decision makers beyond their rational decision making limits (Larsen et al., 2013).

In summary, industry uncertainty significantly affects the viability of SDM strategies, as it constrains their viability only to those strategies that maintain and support the firm's goal of maintaining their competitive position. Thus, in the context of firm-supplier interdependencies, industry uncertainty may potentially restrict a firm's SDM portfolio, by reducing the viability of inventory buffers and flexible supply base strategies due to their associated risks and costs. However, due to the ability of supplier co-ordination to enhance a firm's competitive position in an uncertain industry, its viability as an SDM strategy is increased, as it effectively meets the criteria of having SDM strategies being confined by the firm's survival priority. Thus:

P3: For a given level of firm-supplier interdependency, industry uncertainty
a) is positively associated with the viability of supplier co-ordination SDM strategies
b) is negatively associated with the viability of inventory buffer SDM strategies
c) is negatively associated with the viability of flexible supply base SDM strategies

3.4 Supply Chain Level Factors – Geographic Diversification

A geographically diverse supply network is one in which a firm's suppliers are not clustered closely together, but have great distances between each other, and with the firm, potentially spanning several national and international boundaries (Craighead et al., 2007). As a result of increasing customer pressure and competition, today's marketplace is characterized by businesses operating on a global level in order to access new markets, as well as take advantage of potentially lower cost sources of labor and raw materials (Craighead et al., 2007; Manuj and Mentzer, 2008). In addition to these economic advantages, geographic diversification may also function as a hedge against disruptions that affect localized areas. Specifically, firms with supply bases that are geographically dispersed are able to mitigate disruptions that are localized. Thus, a single disruptive event may not affect all the firms in the supply base with the same magnitude (Habermann et al., 2015).

However, despite these benefits, firms with extremely dispersed supply bases face unique supply management challenges that have severe impact on the viability of SDM strategies. First, the dispersion of suppliers results in structurally longer and more stretched supply chains, may result in longer product and information lead times (Hendricks et al., 2009). Secondly, geographically diverse supply bases introduce additional complexities such as cultural and language differences between firm and local suppliers (Stratman, 2008), as well as increases in risks associated with regional macroeconomic fluctuations and other geo-political risks (Alessandri and Seth, 2014). This is illustrated by the recent requirement imposed by the Chinese Government of fumigating all containers originating from Zika-infected countries, thereby adding delays and costs (Paris, 2016). Thus, the combination of structurally longer supply chains and increased complexities adversely affect the viability of SDM strategies.

With respect to inventory buffers, we posit that geographic diversification magnifies this SDM viability in the firm-supplier interdependency context. Firms, by necessity, will have to maintain large levels of raw material inventory holdings given the already long delivery lead times that are characteristic of globalized sources. Buffer inventory may also be a means through which firms may opt to reduce the complexities with managing a geographically diversified supply base (Galbraith, 1973; Ketokivi, 2006).

Conversely, we posit that geographic diversification mitigates the viability of supplier co-ordination as an SDM strategy for several reasons. First, supplier co-ordination as an SDM strategy relies on the ability to reduce the length of the disruption. A geographically diverse supply base introduces longer information lead times, and longer delivery lead times. Thus, even if the length of a disruption through the use of co-ordination is reduced, the increased lead times may not prevent the purchasing firm from stocking out of raw materials. Thus, a growing body of literature suggests that longer supply chains have reduced disruption detection capabilities, and reduced disruption recovery capabilities (Blackhurst et al., 2008; Hendricks et al., 2009).

Similarly, the combination of increased complexities and lengthened lead times further reduce the viability of using flexible supply base SDM strategies. Due to increased lead times, maintaining relationships with multiple suppliers for the same component in a geographically diversified supply base would compromise the ability to invoke a flexible response. The time it takes from disruption detection, to creating and rerouting orders to another supplier, to receiving deliveries from the alternative supplier may be very lengthy in a geographically diversified context and may not effectively prevent a raw material stockout. This situation may also occur with adding suppliers and/or maintaining relationships with backup suppliers. These flexibilities may also be compromised due to a large variety of cultural differences given the additional complexities associated with maintaining relationships with dispersed suppliers across multiple countries.

Taken together, given the increases in information and delivery lead times, as well as accompanying increases in complexities and risks associated with geographically diversified supply chains may potentially restrict a firm's portfolio of viable SDM strategies as there is a reduced effectiveness of supply base flexibility and supplier co-ordination. However, the viability of utilizing inventory buffers is magnified. Thus:

P4: For a given level of firm-supplier interdependency, geographic diversification
a) is negatively associated with the viability of supplier co-ordination SDM strategies
b) is positively associated with the viability of inventory buffers SDM strategies
c) is negatively associated with the viability of flexible supply base SDM strategies

IV. DISCUSSION

The propositions developed in this conceptual note make the case that the viability of SDM strategies is not solely dependent on the nature of the supply risk that the firm is facing, but rather that their viability is significantly influenced by other salient factors that characterize firm's operating environment. Contextualized in a framework that captures salient organizational and inter-organizational characteristics, our arguments suggest that factors influencing SDM viability may be intrinsic to the firm and are solely within the firm's domain of control, (i.e. product complexity), or extrinsic to the firm and are partially or fully outside the firm's domain of control, (i.e. industry uncertainty and geographic diversification). Thus, these findings help to expand the present perspective of supply risk identification, assessment and mitigation, with significant implications for research and practice, as outlined below.

4.1 Implications for Research

The propositions developed help to inform the theoretical developments governing supply risk management and disruption management in key ways. First, with notable exceptions (Ellis et al., 2013; Habermann et al., 2015), there has been limited research that explicates their effectiveness in generalized contexts. This research opportunity was noted by Juttner et al., (2003) who noted that risk and disruption management cannot be assumed to have an overall generalizable picture, but must be evaluated within supply chain and industry-specific contexts. In the absence of this contextualized evaluation, risk and disruption management literature would have limited implications for practice, a common critique of current risk and disruption management literature (Bode et al., 2011; Blackhurst et al., 2011; Ambulkar et al., 2015). Thus, by considering additional salient factors that affect SDM viability, this study suggests that the process of developing and assessing the nature of risks and disruptions is a much more comprehensive process that should involve the evaluation of factors that may or may not be directly tied to the nature of the risk itself.

Additionally, the developed propositions suggest that not only does the viability of SDM strategies vary across different contexts, but rather this variability is highly dynamic and in some instances can contradict each other. This dynamic relationship is illustrated in Table 1. As shown in the table, we find that proposition 1 and 3 argue in favor of using supplier co-ordination strategies, yet proposition 4 argues against it. Similarly, we find that proposition 1 and 3 argues in favor of inventory buffers, yet proposition 4 argues against it. Ultimately, proposition 2 argues in favor of the viability of supply base flexibility, yet propositions 1, 3 and 4 argue against it. The high variability in the effectiveness of SDM strategies further re-iterates the importance of evaluating risk and disruption management strategies across different and contingent contexts.

TABLE 1: SUMMARY OF THE VIABILITY OF SDM STRATEGIES IN IDENTIFIED CONTEXTS

SDM Viability in a Firm-Supplier Interdependency Context			
Factors (Proposition 1)	**Supplier Co-ordination**	**Supply Base Flexibility**	**Buffer Inventory**
Supply Chain Factors: Geographic Diversification (Proposition 4)	Negative Association	Negative Association	Positive Association
Industry Level Factors: Industry Uncertainty (Proposition 3)	Positive Association	Negative Association	Negative Association
Product Level Factors: Reducing Product Complexity (Proposition 2)	Neutral Association	Positive Association	Positive Association

4.2 Implications for Practice

Understanding and managing risks and disruptions has been recognized as an important issue in business and has been extensively studied in a variety of business disciplines (Zsidisin, 2003b). Due to the potential for severe losses, the increasing awareness of the importance of risk and disruption management in the supply chain management context has been noted to take on an increasing strategic role in firms (Blackhurst et al., 2011). This study highlights the managerial importance of creating addressing disruption management in a strategic context involving all functions within the organization, as well as the firm's interactions with supply chain partners. Of particular significance in this study, we have demonstrated that even restricting the analysis to supply side disruptions, SDM implications extend beyond the area of domain of the procurement function. For example, our second proposition highlights that SDM viability may be affected by product design factors, suggesting that product development teams and marketing functions have a role to play in the development of disruption management strategies. Thus, in the final analysis, all aspects of the enterprise must assess and address disruptive management strategies.

4.3 Limitations and Directions for Future Research

While we are confident that the propositions outlined are theoretically and logically sound, we wish to acknowledge the limitations in scope of our study that provide several avenues for future research. Our first limitation may exist in the scope of the factors identified. The levels and the risk mitigation mechanisms are factors that are prominently featured in supply risk and disruption literature – as shown in Table 2 below. Additionally, the mitigation mechanisms relate well to the factors identified in highly dynamic ways. Thus, these ensure the robustness of our arguments. However, we acknowledge that these are by no means a comprehensive set of factors. Thus, future research may add or complement the present study by identifying other factors that may affect the viability of the identified SDM strategies.

Additionally, we limited the scope of our study to only one tier upstream in the supply chain. Thus, opportunities for future research exist in extending the current framework to disruption management viability for internal, as well as demand-side disruptions, for a more comprehensive supply chain disruption management framework. With recent catastrophic weather events affecting large areas worldwide, SDM must be applied to demand-side disruptions of varying length and intensity, all with factors related to product complexity, industry uncertainty, and geographic diversification. The higher product complexity, industry uncertainty, and geographic diversification and their interaction, risk will be exponentially increased. Likewise, reducing any of these factors may exponentially decrease risk. The importance of product complexity and geographical diversification, with recent strides in manufacturing and integrated systems, along with technological changes in the transportation industry all will reduce the total risk associated with disruption and recovery. Moreover, emerging studies in network disruptions suggest that disruptions arising from suppliers' suppliers and customer's customers may have detrimental effects on the focal firm (Kim et al., 2015). Thus, future studies may extend the present framework through the exploration of factors that may affect SDM viability from a network perspective.

Moreover, future research may also extend the findings in this study by examining additional more complex interactions that may be potentially considered. For example, this study highlights that the effectiveness of supply base flexibility as an SDM strategy is increased by reduced product complexity but is reduced by industry uncertainty and geographic diversification. Thus, what is the viability of supply base flexibility as an SDM strategy for a firm that has adopted modular design, has a geographically diverse supply base, and operates in an industry environment that is highly uncertain? Additionally, in this study we have only examined the viability of SDM strategies in isolation. In theory and in practice, firms do not implement SDM strategies individually, but may form a portfolio of SDM strategies. Thus, future research may also extend the present study by examining the viability of SDM strategies that consist of portfolios rather than considering the viability of one SDM strategy in isolatioFinally, in addition to the conceptual expansions of our initial framework, the empirical validation of the developed propositions in the present study through the development of measurement instruments that may be used for data collection. Thus, taken together, the conceptual expansion of our present framework, and the empirical validation of the current propositions will yield greater academic and managerial insight on to the nature of risk and disruption management.

TABLE 2. IMPORTANCE OF SELECTED FACTORS.

Factors	Rationale	References
Level Factors		
Geographic Diversification	Major source of risk, associated with longer lead times as well as increased supply chain complexity	Blackhurst et al., 2008; Hendricks et al., 2009; Alessandri and Seth, 2014; Habermann et al., 2015;
Industry Uncertainty	Major source of risk that significantly impacts the firm's competitiveness within industry competitors	Ward and Duray., 2000; Wong et al., 2011; Xue et al., 2011;
Firm supplier interdependencies	Comprehensively captures product, information and financial flows between firms and partners	Peck 2006; Blackhurst et al., 2011;
Product Complexity	Major source of risk associated with a more complex supply base and more complex production cycle	Harland et al., 2003; Closs et al., 2010;
Mitigation Factors		
Supplier coordination	Allows for firm-supplier coordinated responses to a risk or disruption	Zsidisin and Ellram, 2003; Chiang et al., 2012
Buffer inventory	Allows for firms to use surplus raw material inventory holdings to mitigate a supplier disruption	Christopher and Peck, 2004; Blackhurst et al., 2011 Ambulkar et al., 2015
Supply base flexibility	Allows for firms to mitigate a supplier disruption by rapidly switching suppliers	Burke et al., 2007; Pettit et al., 2010;

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