A grounded definition of supply risk

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Abstract

All purchasing organizations encounter supply risk, whether it is explicitly understood and assessed, or reactively managed. The purpose of this paper is to provide a grounded definition of supply risk. Case study data from seven purchasing organizations uncovered various definitions of supply risk. These definitions focus on the sources of supply risk, emanating from individual supplier factors and market characteristics, and the outcomes of supply risk events, which involve the inability of purchasing firms to meet customer requirements and threats to customer life and safety. Findings from this research provide practitioners and academicians a starting point for understanding supply risk and insights as to how supply risk can negatively affect business operations.

Keywords: Supply risk; Grounded theory; Risk; Uncertainty

1. Introduction

Risk and uncertainty have been studied in numerous business settings and have warranted significant investigation in corporate functions, such as managerial decision making (March and Shapira, 1987; Shapira, 1995; Yates and Stone, 1992), strategy (Rueffli et al., 1999; Sitkin and Pablo, 1992; Wiseman and Bromiley, 1991), operations (Newman et al., 1993; Pagell and Krause, 1999), accounting (Ashton, 1998; Baucus et al., 1993), finance (Chow and Denning, 1994; Ho and Pike, 1992) and distribution (Celly and Frazier, 1996; Lassar and Kerr, 1996). Risk has been defined as “the extent to which there is uncertainty about whether potentially significant and/or disappointing outcomes of decisions will be realized” (Sitkin and Pablo, 1992, p. 10). Inherent in this definition are the dimensions of outcome uncertainty, outcome expectations, and outcome potential.

From transaction cost (Williamson, 1975) and agency (Eisenhardt, 1989a) theory perspectives, outcome uncertainty is associated with the variability of outcomes, lack of knowledge about the distribution of potential outcomes, and uncontrollability of outcome attainment. According to prospect theory (Kahneman and Tversky, 1979), outcome expectations suggest that positive expected returns facilitate different decision framing and decision-making behavior than negative expected outcomes. The third dimension of risk, outcome potential, argues that individuals often overweight extreme outcomes, even if their likelihood of manifestation is removed (Kahneman and Tversky, 1979; Sitkin and Pablo, 1992).

Risk within a supply management context may be viewed in a similar manner. For example, there can be outcome uncertainty associated with whether a supplier is able to make product design and specification changes in a timely manner for new products (Bidault et al., 1998). However, there is little understanding of what risk means within a supply management context, although a few scholars have begun to address the issue. Harland et al. (2003), in their study of risk assessment and management tools, adopt a definition of input risk from Meulbrook (2000). In addition, Zsidisin et al. (1999) provide a preliminary definition of supply risk in their exploratory study of supply risk assessments and contingency plans. However, a grounded definition of supply risk has yet to emerge in the purchasing and supply management literature. Therefore, the purpose of...
this paper is to provide the purchasing and supply management field with a definition of supply risk in order to guide and encourage future research on supply risk and its management.

2. Definitions of risk

The concept of risk has been extensively studied in various business contexts. Three notable studies providing insights to the meaning of risk are provided below.

2.1. Baird and Thomas

Baird and Thomas (1990) have defined risk from eight different perspectives. Their arguments incorporate views from finance, marketing, management, strategy, and psychology. Table 1 presents the eight risk definitions and a brief description of each. The first three definitions—variability of returns, variance, and market risk—focus on the organization’s financial return. The last two definitions of risk as disaster and as accounting risk measures relate to the risk of a company going bankrupt. These definitions of risk provide evidence that risk is a multi-dimensional construct and differs according to business function.

2.2. Shapira (1995)

An often-cited definition of risk in the academic literature is “the variance of the probability distribution of outcomes” (March and Shapira, 1987, p. 1404; Shapira, 1995, p. 43). However, Shapira (1995) found that very few managers define risk in those terms. Instead, managers identify (1) the downside of risk, (2) its magnitude of possible losses, (3) the act of risk taking involving the use of skills, judgment and control, and (4) risk as a concept that cannot be captured with a single number. A list of these four risk aspects and brief definitions is also presented in Table 1. These findings also suggest that the term “risk” can be perceived in different ways, and no single definition of risk may be appropriate in all circumstances.

2.3. Yates and Stone (1992)

Yates and Stone (1992) note that risk entails (1) the elements of loss, (2) the significance of loss, and (3) the uncertainty associated with loss. Within the elements of loss are three additional factors. First, risk is not limited to one specific loss that can occur. This is similar to the variance of outcomes discussed by March and Shapira (1987), with the exception that it focuses only on losses. For example, a fire that destroys a supplier’s plant can affect production for 1, 2 days, or even months. The incident can result in various degrees of loss (outcomes) for the supplier as well as the supplier’s customers. Losses are also experienced in reference to an outcome. What is important is not the loss itself, but the actual outcome in comparison to an expected outcome. Another facet of loss is multiplicity, in which losses can transcend multiple categories such as financial, performance, and time loss.

The second aspect of risk is the significance of loss. It is often assumed by researchers and laypersons that the more significant the potential losses in a situation, the greater the implied risk. For example, there would be greater perceived loss by a purchasing firm if a supplier’s

<table>
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<th>Risk characteristics</th>
<th>Definition</th>
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<tr>
<td>Baird and Thomas (1990)</td>
<td>Variability of returns</td>
<td>Firm performance evaluated in terms of return and growth criteria</td>
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<td></td>
<td>Variance</td>
<td>Variability of the probability distribution of returns</td>
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<td></td>
<td>Market risk</td>
<td>The use of the capital asset pricing model to measure risk</td>
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<td></td>
<td>Risk as innovation</td>
<td>Risk conditions equated with conditions characterized by newness, uncertainty, and lack of information</td>
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<td></td>
<td>Risk as lack of information</td>
<td>Information scarcity as a key facet of uncertainty in terms of the existence of important resources and commitment duration</td>
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<td></td>
<td>Risk as entrepreneurship</td>
<td>Independence of action in venturing into the unknown</td>
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<td></td>
<td>Risk as disaster</td>
<td>Strategies that could result in corporate disaster, bankruptcy or ruin</td>
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<td></td>
<td>Accounting risk measures</td>
<td>Accounting ratios related to risk of ruin, default or bankruptcy</td>
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<tr>
<td>Shapira (1995)</td>
<td>Downside of risk</td>
<td>Risk being associated with a negative outcome</td>
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<td></td>
<td>Magnitude of possible losses compared to its probabilities</td>
<td>At least one possible outcome of an uncertain situation having a bad outcome</td>
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<tr>
<td></td>
<td>Distinction between risk taking and gambling</td>
<td>Risk taking is associated with using skills, judgment, and control, while gambling is not</td>
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<td></td>
<td>Risk as a multi-faceted construct</td>
<td>Risk cannot be captured with a single number, since multiple facets such as financial, technical, marketing, production and other risk aspects exist</td>
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failure results in the chance of losing $10,000 of customer business as compared with the chance a recall will occur that would result in a loss of millions of dollars in revenue.

The third risk element is uncertainty, where uncertainty is associated with the degree of confidence a decision maker can develop probability and outcome assessments of decisions (Mitchell, 1995; Luce andRaiffä, 1957; Chiles andMcMackin, 1996). Additional facets of uncertainty involve a lack of understanding by decision maker about the loss categories that exist, and which losses can occur.

3. Prior definitions of supply risk

There are few definitions for risk within the context of supply. Kraljic (1983) discusses risk in terms of supply market complexity. Kraljic’s perspective of risk incorporates supply scarcity, the pace of technology and/or materials substitution, entry barriers, logistics cost or complexity, and monopoly or oligopoly conditions. Other definitions of supply risk that do exist have emerged from research studies focusing on supply risk assessments and management. Harland et al. (2003) define supply risk as one of 11 risk types. They adopt Meulbrook’s (2000) definition of supply risk as “adversely affects inward flow of any type of resource to enable operations to take place; also termed ‘input risk.’” (p. 308). In addition, Zsidisin, Panelli, and Upton define supply risk as “the transpiration of significant and/or disappointing failures with inbound goods and service” (p. 187). This definition focuses on outcomes and was proposed in an exploratory study of supply risk assessments and contingency plans. Mitchell (1995) has investigated risk within organizational buying behavior. His literature search uncovered numerous factors that potentially affect managerial risk perceptions of purchasing professionals. A summary of prior definitions of supply risk and supply risk factors can be found in Table 2.

The remainder of this paper will discuss the research method implemented for creating a grounded definition of supply risk. Next, the research findings, which describe supply risk by its sources and outcomes, are presented. Industry characteristics and differences are then presented to illustrate how they affect organizations’ definitions of supply risk. Managerial implications and conclusions are provided at the end of the paper.

4. Research method

The research process consisted of conducting case studies with purchasing organizations involved in supply risk management. The case studies were used to build a
theory of supply risk using a grounded theory approach (Eisenhardt, 1989b; Glaser and Strauss, 1967; Wacker, 1998), where “the researcher begins with an area of study and allows the theory to emerge from the data” (Strauss and Corbin, 1998, p. 12). Case study participants were pre-screened through initial telephone, in-person, or e-mail interviews. Organizations with established supply risk assessment or risk management processes were solicited for further study, even if no formal definition of supply risk existed at their firms. The case studies were conducted until the researcher reached a point of information saturation, where many of the concepts of supply risk discussed by the case study participants became repetitive (Strauss and Corbin, 1998).

A case study research protocol was created prior to data collection and refined after the pilot case study. All of the case studies were conducted at the companies’ locations. In the few circumstances where in-person interviews were not possible with certain individuals, telephone interviews were conducted following the guidelines proposed by Walton (1997).

The case study organizations consisted of a convenience sample of electronics and aerospace firms. Five manufacturers in the electronics industry were selected due to rapid technological development cycles and dynamic customer demand changes (Fine, 1998). To obtain insights as to whether supply risk and supply risk management differ between industries, two firms in the aerospace industry were also selected. Information gathering techniques such as obtaining historical data and documentation, and conducting anywhere from three to six structured interviews with various professional purchasing personnel and other key informants from each firm, were implemented during the case studies.

Since one of the goals of the research was to investigate how purchasing organizations define risk, the purchasing function was the unit of analysis. Purchasing professionals were asked how their organizations define supply risk. If a formal organizational definition of supply risk did not exist, the researcher asked how that individual defined supply risk from a purchasing organization perspective.

Data generated in the case studies was subject to open and axial coding analysis, as per the guidelines set by Miles and Huberman (1984), Strauss and Corbin (1998), and Yin (1994). Open coding breaks down case study data in order to analyze, conceptualize, and develop categories for the data. Axial coding is a technique that makes connections among categories, groups issues during first-level coding, and summarizes the issues into themes.

5. Research findings

The research findings indicate that there are a variety of ways to define supply risk. Two of the organizations, Cell and Semi1, have formal organizational definitions of supply risk. The five other organizations did not have formal definitions of supply risk disseminated throughout their firms. However, each of the case study participants had an explicit understanding of what supply risk means within their position and organization. These definitions of supply risk were discussed in terms of sources and outcomes, as discussed below.

5.1. Organizational definitions of supply risk

Cell defines supply risk as “the danger that events or decisions will obstruct the company’s achievement of its objectives.” The events and decisions include potential direct losses as well as opportunity costs. This definition of risk is disseminated and understood throughout the organization. The purchasing and supply management function at Cell has adopted this definition of risk in its supply strategy to support overall corporate goals and direction.

In contrast, Semi1 defines supply risk as “anything that impedes the introduction of a new product, or any event that could disrupt production.” This definition of supply risk focuses on the introduction of new products. By the time a product is considered mature, Semi1 believes that most supply risk characteristics have already been identified.

5.2. Classification of supply risk

The majority of firms in this study do not currently have formal definitions for supply risk. However, each of the respondents from those firms had strong conceptions of what supply risk means to their organizations. Case study participants provided definitions of supply risk by its sources and outcomes. The sources of supply risk were described in terms of individual supplier failures and supplier market characteristics. Respondents conceptualized the outcomes of supply risk by the inability to meet customer requirements and threats to customer life and safety. Table 3 provides an overview of the classifications and related factors that the case study participants used to define supply risk.

5.2.1. Sources of supply risk

According to the case studies, the sources of supply risk tend to arise from individual supplier failures and from market factors. The individual supplier failures that define the scope of supply risk were the inability to handle demand fluctuations, quality problems at supplier plants, and the inability to stay in pace with technological changes. In addition, supply risk was understood in terms of supplier market characteristics. Market characteristics include sole sources (such as
suppliers having a patent) and market capacity constraints.

5.2.1.1. Individual supplier failures. Five of the seven firms noted individual supplier factors within their definitions of supply risk. For example, a respondent from Aero1 stated “Supply risk is when there are suppliers that their failure would affect the ability for our firm to make financial goals at the end of the year.” This definition of supply risk specifies supplier failures as a cause of supply risk. However, the definition does not provide any detail about what constitutes failure.

Two additional definitions of supply risk provide more details regarding individual supplier failures. A respondent from Comp1 believed, “Supply risk is the inability to develop products on time and deliver those products into manufacturing.” In addition, one Comp2 participant stated, “Supply risk is the uncertainty associated with supplier activities, obligations, and in general, supplier relationships. Supply risk boils down to the three components of price (best deal), quantity, and demand.” These definitions of supply risk indicate that supply risk originates from individual supplier failures, and these failures consist of issues such as quality, delivery, relationships, and price.

5.2.1.2. Market characteristics. Several supply risk definitions focused on factors originating from market characteristics instead of individual supplier failures. For example, a respondent from Aero2 was concerned with availability. This respondent noted, “Supply risk is having a single or sole source supplier, without having a proven or established second source...[which] occurs when there are patents on [the] supplier end without a backup.”

There were two recent incidents related to market characteristics that affected the perceptions of many case study respondents. The first one involved the tantalum capacitor shortage that occurred in 2000. Several of the case study respondents noted that part of the shortage was due to the rapid growth of the cellular phone industry. Although most of the firms expected greater demand for those capacitors, none of them anticipated the extent that the cellular phone growth

<table>
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<tr>
<th>Table 3 Classification of supply risk definitions</th>
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<tr>
<td>Sources</td>
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<tr>
<td>Individual supplier failures</td>
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<tr>
<td>New product development problems</td>
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<td>Delivery failures</td>
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<tr>
<td>Relationship issues</td>
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<td>Supplier obligations to other customers</td>
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<td>Quality problems</td>
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<tr>
<td>Price/cost increases</td>
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<tr>
<td>Inability to meet quantity demand</td>
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<tr>
<td>Technologically behind</td>
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<tr>
<td>Discontinuity of supply</td>
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<tr>
<td>Market characteristics</td>
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<tr>
<td>Sole source/limited qualified sources</td>
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<tr>
<td>Market shortages</td>
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<tr>
<td>Commodity price increases</td>
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<tr>
<td>Geographic concentration of suppliers</td>
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<tr>
<td>Supplier patents</td>
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<tr>
<td>Outcomes</td>
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<tr>
<td>Inability to meet customer requirements</td>
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<tr>
<td>Unable to meet customer specifications</td>
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<tr>
<td>Subcontractor failures</td>
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<tr>
<td>Impedes new product introductions</td>
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<tr>
<td>Missed shipments</td>
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<tr>
<td>Negative effect on profit targets</td>
</tr>
<tr>
<td>Loss of customer business</td>
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<tr>
<td>Failure to meet customer demand</td>
</tr>
<tr>
<td>Threats to customer life and safety</td>
</tr>
<tr>
<td>Product liability and integrity</td>
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<tr>
<td>Quality failures result in loss of life</td>
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would have on their firm’s ability to acquire piece parts such as tantalum capacitors. This incident was discussed by many case study respondents in their perceptions of what supply risk means to their organizations.

A second incident that several of the case study respondents described in their definitions of supply risk was the September 1999 earthquake in Taiwan. This event had significant repercussions for many firms, especially in preparation for forecasted sales of the holidays. The earthquake disaster had detrimental effects on many suppliers, which had subsequent ripple effects throughout many supply chains.

5.2.2. Outcomes of supply risk

Supply risk was also defined in terms of negative outcomes, specifically the inability to meet customer requirements or threats to customer life and safety. All the firms understood supply risk in terms of meeting customer requirements, which can result in the loss of customer business and detrimentally affect revenues and profits. Threats to customer life and safety, on the other hand, arise from issues with product integrity, durability, and reliability. If a product has a failure in the field, such as a part on an aircraft, the ramification of that failure can lead to consumer injury or even death.

5.2.2.1. Inability to meet customer requirements. All of the organizations stated that supply risk results in the inability of the purchasing firm to meet their customers’ requirements. For example, one respondent from Aero1 stated, “Supply risk is the failure to provide a seamless flow of product to the customer that meets or exceeds specification.” Another example of supply risk resulting in the inability to meet customer requirements was provided by a participant in Comp2, who stated, “Supply risk affects getting product out to market (i.e. built by subcontractors). It is an event that disrupts the delivery of products to the customer, or impedes the production of new items to customers.”

Since these firms perceive the effects of supply risk from a supply chain perspective, the organizations are defining supply risk in reference to meeting customer demand. Specifically, the case study firms not only looked at supply risk from the link between their firm and supplier organizations, but also its effect on their internal operations, on customer firms, and eventually on the final consumer. To emphasize this point, one respondent from Comp1 stated, “Supply risk is the potential for a supply constraint on a subassembly or component that affects the shipment of product.” In addition, an Aero2 case study respondent viewed supply risk as “...not being able to satisfy customer demand. It affects the longevity of our firm and jobs.” These definitions of supply risk focus on the ability to meet customer demand, and, eventually its impact on the entire supply chain.

5.2.2.2. Threats to customer life and safety. Two of the organizations also stated the effect of supply risk in terms of customer life and safety. Both of these firms are suppliers in the aerospace industry, where the ramifications of quality and reliability problems can have devastating effects on consumers. For example, a case study participant from Aero2 understood supply risk to “consist of product liability and integrity where the parts must meet requirements.”

The final product manufactured by aerospace companies can have a direct impact on customer safety if a failure occurs. Failure of the products manufactured by electronics firms normally does not have life or death ramifications for their customers. As noted by one respondent from Aero2, “There are no service stations at 33,000 ft.”

6. Proposed definition of supply risk

The findings from this research provide evidence that, similar to prior definitions of risk, purchasing organizations perceive supply risk as a multi-dimensional construct (Hallikas et al., 2002; Shapiro, 1995; Yates and Stone, 1992). The scope of supply risk was defined in terms of sources, either from individual supplier failures or market factors, and outcomes, which include the inability to meet customer requirements and threats to customer life and safety. Therefore, a new definition of supply risk is proposed below:

Supply risk is defined as the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety.

Supply risk is a multi-faceted concept, since its scope includes risk sources and outcomes. In addition, the scope for understanding supply risk differs according to industry. As the research indicated, aerospace firms are more likely to understand supply risk in terms of threats to customer life and safety. The finding that supply risk is a multi-faceted concept that differs according to industry is similar to prior studies investigating risk definitions (Pablo, 1999).

7. Managerial implications

Understanding and managing risk is an important issue of business and has been extensively studied in many business disciplines. Even though there is a rich stream of literature investigating risk, there has been little research applied to the risk that exists with inbound supply. In order to start closing the research
gap in supply risk management, this research, through the use of case studies, investigated how organizations define supply risk.

The definitions of supply risk provided by case study participants show that supply risk is a multi-dimensional construct. The most widely held definition of supply risk focuses on understanding how risk affects a purchasing firm’s ability to meet its customers’ requirements. However, the meaning of supply risk can differ according to factors such as industry, source, and outcome. This contributes to theory by providing researchers with an empirically based definition for supply risk and presenting insights into how those definitions may change according to industry context.

In addition, having an empirically grounded definition of supply risk provides greater detail for understanding an overall supply network risk tool proposed by Harland et al. (2003). The tool, which can be found in Fig. 1, begins with mapping the supply network, then involves identifying risk and its current location, assessing that risk, managing the risk, forming a collaborative supply network risk strategy, and, finally, implementing a supply network risk strategy. One key element missing within this tool is how organizations define supply risk. Although Harland et al. (2003) provide an initial definition of supply risk, that definition had not been empirically validated and was only one type of risk identified. This research provides a grounded definition of supply risk, which can help purchasing organizations understand the sources and outcomes of supply risk for their firms.

The sources and outcomes of supply risk discovered in this research are not mutually exclusive. In fact, several of the risk characteristics may have a compounding effect. For example, the source of risk from the September 1999 earthquake in Taiwan was that many suppliers of passive components were located within the same geographical location. From a supply side perspective of several of the firms in this study, this event manifested in market shortages for these components as well as significant commodity price increases. In addition, the outcomes of this event resulted in the loss of customer business, the failure to meet customer demand, and negative effects on profit targets. The managerial implications of this finding parallels the research of Hallikas et al. (2002), who discovered “vicious circles” of supply network risk due to factors such as pricing, forecasting, delivery performance, and financial implications. Therefore, it is imperative for supply management professionals to understand both the sources as well as outcomes that incorporate supply risk because the effects of detrimental supply events can have ramifications throughout a firm’s supply chains or networks. The insights for understanding what supply risk means provides a starting point for managing that risk.

In defining supply risk, most of the research participants went beyond viewing risk inherent in dyadic interorganizational relationships with suppliers. This was reflected in the findings that supply management professionals understand the effects of risk on meeting their customer requirements. In addition, several examples of supply risk provided by the research participants involved supply failures from second and third tier suppliers, such as the negative ramifications of the Taiwan earthquake in 1999 and tantalum capacitor shortage of 2000. This view of supply risk becomes a cornerstone for understanding supply chain or supply network risk, which would involve defining and studying risk at numerous inter- and intra-organizational levels. Future research would be necessary for providing academicians and practitioners alike insight for defining, and eventually assessing and managing, supply chain or supply network risk. These studies can investigate risk in additional industry areas as well, such as automotive, telecommunication, and pharmaceutical firms, to determine if additional nuances for defining supply and supply chain risk exist.

8. Conclusion

Risk exists in virtually all firms, and has been extensively studied in various business contexts. However, a gap exists in studying risk within purchasing and supply management. This study has investigated, through the use of case study data, how risk is defined within a supply management context. Supply risk was perceived by purchasing organizations to incorporate its sources and outcomes. In addition, industry differences were found in the case study data, where suppliers in the aerospace industry focus on the threats to customer life and safety. From the case study data, an empirically grounded definition of supply risk was provided.
Theoretical and managerial implications were also discussed. By establishing a grounded definition of supply risk, purchasing professionals have a starting point for creating strategies, which include assessing and managing supply risk, to better meet customer firm and consumer requirements.

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