

# Impact of Strategic Sourcing, E-Business Technologies & Integration on Supply Chain Risk Mitigation

Minkyun Kim\*, Nallan C. Suresh  
Department of Operations Management & Strategy, School of Management  
The State University of New York, Buffalo, NY 14260, USA  
\*EMAIL: mk94@buffalo.edu

**Abstract:** Supply chain risk management has emerged as an important issue in recent years, given more dynamic and turbulent business environments. This study investigates the impact of strategic sourcing, e-business technologies and supply chain integration on supply chain risk mitigation. Based on the theoretical background of dynamic capabilities, it also examines the role of business environment and characteristics. A structured survey methodology is used, collecting 152 responses from purchasing and supply management executives from US manufacturing industry. The results empirically confirm that strategic sourcing, e-business technologies and supply chain integration have a negative relationship with supply chain risk. The study also shows that if business environments are dynamic and competitive, more emphasis is found on implementing these three supply chain practices. It is also shown that business environments have a moderating effect on the relationships of strategic sourcing, e-business technologies and supply chain integration, with supply chain risk.

**Keywords:** Strategic sourcing, e-business, supply chain integration, and supply chain risk mitigation.

## I. Introduction

Supply chain management risk mitigation is receiving increasing attention for coping with the challenges generated by competitive and dynamic markets. Current business trends such as increased use of outsourcing, globalization of supply chains, reduction in the supply base, etc. lead to greater exposure to risks. Other potential risks arise from more integrated processes among supply chain members, a reduction in buffer inventories, an increasing demand for on-time delivery, within more limited time intervals, shorter product life cycles and time-to-market, as well as capacity limitation and relatively high demand in the early stages of the product life cycle [17]. Managers are not able to control all aspects of the supply chain, which requires them to take selective actions in dealing with the risk. According to McKinsey Global Survey, executives are not adequately prepared to manage supply chain risks. According to AMR research, 60% of organizations in the US do not have effective supply chain risk management policies. High risk generates inefficiencies in the supply chain [8], and tangible risks in the supply chain have been confirmed to be one of the causes for poor performance [21].

This research attempts to fill gaps in the literature by investigating factors to mitigate supply chain risks. The risks in the supply chain come from three major sources, according to Christopher and Peck [9]: 1) internal to the firm, such as process and control; 2) external to the firm, but internal to the supply chain network such as demand and supply; and, 3) external to the network, such as environmental risks. Chopra and Sodhi [7] categorize these risks, which are interconnected, into several other categories, including supply chain disruption, delay, forecast, procurement, risk, capacity and inventory risks. This study focuses on managing supply risks in the supply chain from the inbound perspective.

Past literature has suggested various supply chain strategies. First, it is important for researchers to identify and understand supply chain risk while minimizing the impact of the risk [17]. In order to mitigate risk, prior studies present one common strategy, namely the significance of internal and external integrations in a supply chain for mitigating supply chain risks [13]. Information sharing and collaborative relationships in supply chain networks also lessen supply chain risks. In supply chain risk management, the significance of information sharing and the development of relationships have been emphasized. In addition, cultural factors can also make a significant impact on supply chain risk mitigation [19]. This research investigates supply chain management practices such as strategic sourcing, e-business technologies, and supply chain integration to mitigate supply chain risks.

Previous literature has indicated that supply chain management practices such as strategic sourcing, e-business technologies and supply chain integration, make a positive impact on performance (Carr and Pearson [2]; Chen, Paulraj, and Lado [5]). This research examines the role of these supply chain management practices in helping to mitigate supply chain risks.

A detailed literature review is presented in the expanded version of this paper.

The specific objective of this research is to investigate the impacts of strategic sourcing, e-business technologies and supply chain integration in the context of supply chain risk mitigation. In addition, this study examines the role and impact of business environment, and other business

characteristics on supply chain management practices and supply chain risks. Specifically, the following research questions are addressed:

- What impacts do strategic sourcing, e-business technologies and supply chain integration have on mitigating supply chain risk?
- What impacts do business environment and characteristics have on supply chain management practices as well as supply chain risk?

The next section describes the conceptual model relating to supply chain risk management as they are linked to the business environment and characteristics. The various constructs and hypotheses are developed in the context of designing the research model. The following section describes the research methods employed. This is followed by data analysis and findings, along with the managerial implications.

## II. Model Development

This research adopts dynamic capabilities as a theoretical background to explore various factors that mitigate risks stemming from an unpredictable business environment. Dynamic capabilities enable firms to leverage resources for establishing and maintaining relationships with suppliers as well as customers. In the dynamic business environment, a firm can face a variety of risks while managing and interacting in its supply chain. Since a strategic approach to supply chain management can be a component of a firm's core competence, the firm's ability to configure and relocate resources to avoid or reduce various risks in the supply chain will contribute to a firm's performance. This study investigates how a firm can utilize its' capabilities to reduce risks in the supply chain by identifying risk mitigating factors.

In recent years, the theory of resource-based view (RBV) of the firm has been applied extensively to investigate how firms can acquire competitive advantages through managing their routine operations successfully. The relationship between strategic purchasing and a firm's performance based on RBV has been investigated and it has been found that strategic purchasing has a positive impact on the firms' performance (Carr and Pearson [3]). RBV considers a firm's possession of heterogeneous resources, such as financial, physical and human resources as a source of core competence within the firm. Based on the resource based view, the theory of dynamic capabilities was subsequently introduced as a more developed theory (Teece, Pisano, and Shuen [20]).

Two main characterizations of dynamic capabilities are extracted from the terms "dynamic" and "capabilities".

"Dynamic" indicates "the capacity to renew competences so as to achieve congruence with the changing business environment". The term "capabilities" refers to strategic management of a firm's resources including internal and external skills as well as functional competences that respond to a rapidly changing business environment [20]. Therefore, the term dynamic capabilities entails creating higher order skills as well as innovative and agile resources toward a dynamic environment that are beyond operational functional skills and resources that are required for every-day operations.

Within this context, the first independent variable considered was strategic sourcing. Based on many past definitions, strategic sourcing has been found to consist of two main aspects and four dimensions. The role of purchasing within the firm represents two dimensions, which are a strategic role on the status of purchasing and effective internal coordination of purchasing with other functions of the firm. The building of effective relationships represents two dimensions, which are information sharing with suppliers and development of suppliers (Kocabasoglu and Suresh [14]). Strategic sourcing enables buyers to develop relationships with suppliers through information sharing as well as internal integration. This study anticipates strategic sourcing to affect supply chain risks negatively, leading to:

*H1: Strategic sourcing mitigates supply chain risks.*

Many studies indicate that E-business technologies offer organizations the benefits of cost savings on transactions, inventory reduction, improvement on products and establishment of better communication networks between buyer and supplier relationships (Min and Galle [16]). E-business technologies can also promote effective supply chain management decision-making by enabling the collection and analysis of real time information, which revitalizes collaboration between firms. E-business technologies promote better firm management of information and supplier knowledge, better understanding of weaknesses, better control of supplier operations, and they decrease procurement mistakes, help optimize inventories and increase the number of products by main suppliers. One of the benefits of e-business technologies is that it gives purchasers the capability of increasing the speed, quantity and quality of information processing, especially with international suppliers. E-business technologies have been found to foster integration with suppliers and customers. Based on these findings, it can be concluded that e-business technologies help supply chain entities share their real-time information, integrate with each other and manage information better, thus increasing flexibility. Thus, this study posits that e-business technologies will reduce supply chain risks:

*H2: E-business technologies mitigate supply chain risks.*

As supply chain networks become increasingly complex and the level of competition in the global market becomes extremely competitive, the implementation of supply chain integration becomes critical to mitigate supply chain risks. The basic elements of supply chain integration are cooperation, collaboration, information sharing, trust, partnership, information technology sharing, and managing integrated processes in the supply chain. Power [18] also identified five aspects of supply chain integration: information flows, physical logistics, partnerships, alliance and cooperation. It has been pointed out that information technology enables supply chain entities to share all information, resulting in minimizing the inventory level and improving the partnerships in the supply chain networks.

While supply chain integration might provide many solutions for mitigating supply chain risk, it has also been found that internal and external integration positively affect supply chain agility, which help mitigate supply chain risk (Braunscheidel and Suresh [1]). It is empirically confirmed that integration mitigates supply chain process variability in high demand, unpredictable circumstances (Germain, Claycomb, and Droge [11]). Based on such reasoning, this study anticipates that supply chain integration will reduce supply chain risk:

*H3: Supply chain integration mitigates supply chain risks.*

In our conceptual model, business environments and characteristics are also considered because they are important factors that affect managers' perception toward supply chain risk and performance. In the supply chain risk management framework, environments and industry characteristics are included as sources of risk (Ritchie and Brindley [19]). Environmental factors are critical in influencing strategic purchasing as well as buyer-supplier relationships in the supply chain (Chen and Paulraj [4]). Business environments and uncertainties have been applied as antecedents to forward and reverse supply chain risk propensity, which highlights the significance of business environment (Kocabasoglu, Prahinski, and Klassen [15]).

In this research, business environments are considered as an external factor for affecting supply chain practices as well as supply chain risks. Past research has often been criticized that they have often neglected business conditions in the study of supply chain practices. In this research, business characteristics are considered as an internal factor of influencing the relationship between supply chain practices such as strategic sourcing, e-business technologies and supply chain integration and supply chain risks.

The current research focuses on four dimensions of business environment: munificence, dynamism, hostility and heterogeneity and investigates both their direct and indirect impact on supply chain risk. Integrating these four dimensions of business environments, this research focuses

on dynamic and competitive market conditions that firms deal with.

Based on these, the following set of hypotheses is proposed in this context:

*H4a: Dynamic and competitive business environments have a direct impact on strategic sourcing.*

*H4c: Dynamic and competitive business environments have a direct impact on e-business technologies.*

*H4e: Dynamic and competitive business environments have a direct impact on supply chain integration.*

*H4b: Dynamic and competitive business environments have a moderating impact on the relationship between strategic sourcing and supply chain risk.*

*H4d: Dynamic and competitive business environments have a moderating impact on the relationship between e-business technologies and supply chain risk.*

*H4f: Dynamic and competitive business environments have a moderating impact on the relationship between supply chain integration and supply chain risks.*

*H4i: Dynamic and competitive business environments have a direct impact on supply chain risks.*

Business characteristics are also important factors for supply chain practices and supply chain risks because there are a lot of possibilities that business characteristics can be a source of supply chain risks or they may be useful tools for mitigating supply chain risks. Among these, the size of the firm may be critical because if the firm size is greater, the firm has a capability of better utilizing its resources to mitigate supply chain risks. On the other hand, if firm size is small, the firms may have greater flexibility to react to supply chain risks quickly. Thus, this research investigates firm size as one of the business characteristics. In addition, this research examines how push and pull approach to manufacturing affect the relationship between supply chain practices and supply chain risks.

This study also makes an interesting point about how the prevalence of global suppliers may affect the relationship between the supply chain risks and supply chain practices. Since there is a long distance and time difference between suppliers and buyers, it will generate many problems on communication, quality management and flexibility toward supply chain disruptions. Thus, this research also examines the factor of suppliers' locations and proximity. Adding to suppliers' location, this research also investigates the market locations. The comparisons of the research model in this study will depend on manufacturing approach, such as push and pull types, industry types, globalization, and firm size. Therefore, this reasoning leads to:

*H5: The relationship between supply chain practices and supply chain risks will differ depending upon the organization's business characteristics.*

### III. Research Methods

The survey instrument was developed based on scale measurements from prior literature. Since it does not utilize newly created constructs, it is expected that all constructs have acceptably reliable and valid survey measurements. These measurements were applied at the firm level. These are presented in greater detail in the expanded version of this paper.

A pilot study was done as a first step in order to increase the quality of the survey. The survey was reviewed by a group of experts in the field of supply chain management. They went through the survey and provided feedback on how well the survey items were worded and measured. Their recommendations were incorporated and the instrument was modified based on their feedback by rewording items to increase clarity and make them easier to answer. The most common criticism was that the initial survey was not easy to answer. A total of 32 responses were collected for the pilot study. The respondents were supply managers, purchasing managers, vice presidents and purchasing and supply management executives of manufacturing companies located in the mid-western United States. The respondents were in high enough positions that they were able to answer all questions in the survey. Based on the results of Cronbach's  $\alpha$ , several survey items, with a value of less than 0.60, were removed.

The full-scale study required a two-step process. The first step identified the target population and selected an appropriate sample. The target population for this survey was executives in US manufacturing firms. First, institutions, including the National Association of Purchasing Management (NAPM)-Buffalo, the Association for Operations Management (APICS)-Buffalo and the Institute of Supply Management-Pittsburgh, were contacted and sent an e-mail announcement requesting their participation in the survey, which helped to increase the response rate. Second, supply and purchasing managers in companies located on the West Coast, in the Mid-West and Eastern US were contacted and sent an e-mail announcement to encourage completion of the survey. These methods were adopted to increase the response rate. This research utilized a web version of the survey.

After collecting all survey responses, the evaluation of measurement models and structural models by using partial least squares was conducted. The partial least squares (PLS) technique of structural equation modeling (SEM) was used to establish measurement models and investigate the structural model. PLS, a variance-based approach to

structural equation modeling, can be used to specify both the relationships among the constructs as well as a measurement of the constructs. Compared to LISREL or AMOS, PLS has the advantage of not making any assumptions about population or scale measurement while working with no distributional assumption. The other advantage of PLS is that it is less restrictive with regard to sample size with unbiased estimates. Using partial least squares, convergent and discriminant validity, as well as reliability were examined. In addition, a confirmatory factor analysis was conducted.

### IV. Data Analysis and Findings

The respondents were composed of purchasing and supply management executives from manufacturing firms located in the US. They were members of ISM-Buffalo, APICS-Buffalo, ISM-Pittsburgh and ISM members in the Eastern and Western U.S. The respondents were mainly from the manufacturing industry with SIC codes ranging from 20 to 39. Table I summarizes the frequency of responses from each type of industry.

Table 1 Respondent Firms

Industry (Industry Code)	Frequency
Furniture and fixtures (25)	8
Chemicals and allied products (28)	10
Rubber and plastic products (30)	2
Stone, clay, glass & concrete products (32)	3
Primary metal products (33)	15
Fabricated metal products (34)	14
Industrial m/c & computing equipt (35)	41
Electronic & electrical equipt. and components (36)	37
Transportation and machinery items (37)	11
Measuring, analyzing & controlling instruments (38)	9
Missing	2
Total	152

Because this research investigates the moderating impact on the relationship between supply chain practices and supply chain risk, it was found necessary to categorize the firms based on business characteristics, manufacturing approach, suppliers and market location and firm size. Table II summarizes the business characteristics of the samples, manufacturing approach, suppliers and market location and firm size. Customary procedures were followed to confirm the absence of non-response bias.

#### *Evaluation of Measurement Model.*

All survey items were adopted from previously published literature. All items were assessed using a 7-point Likert scale. The strategic sourcing indicator assessed, on many dimensions, the purchasing functions with respect to the

firm's competitive strategy. The supply chain integration indicator measured a firm's internal integration as well as its integration with suppliers. The e-business technologies indicator measured functions and degree of usage of e-business technologies. The supply chain risk indicator measured the probability and magnitude of supply chain disruption risk. The business environments indicator measured a firms' competitive environment, the rate of change in the industry, market activity and market heterogeneity.

Table 2 Business Characteristics of Respondent Firms

Manufacturing Approach	
Pull	Push
85	61
Suppliers Location	
US	Global
70	77
Market Location	
US	Global
62	84
Firm Size by Annual Sales	
Less than \$10 million	4
\$10 to \$50 million	29
\$51 to \$100 million	24
\$101 to \$250 million	18
\$251 to \$500 million	22
\$501 to \$1 billion	20
Over \$1 billion	31

For assessing reliability, the factor loadings of the indicators of latent constructs must be greater than 0.7 in order to establish strong reliability (Fornell and Larker [10]). Cronbach's  $\alpha$  was used to assess reliability. The acceptable score for Cronbach's  $\alpha$  is 0.7 for existing constructs and 0.6 for newly created constructs. Based on these criteria, all indicators of the measurement model were found to be of acceptable reliability.

Composite reliability (CR) and average variance extracted (AVE) were used in this study to assess convergent validity. Values above the threshold value of 0.7 for composite reliability suggest good internal consistency (Hulland [12]). Additionally, AVE, representing the proportion of average variance between constructs and indicator variables, needed to be greater than 0.5 to suggest good convergent validity (Chin [6]). All measures of CR and AVE indicated adequate levels of convergent validity.

Using PLS, a factor analysis was conducted on survey items. All loadings were above 0.7, which is acceptable [6] and no significant cross loadings were found, which provides evidence of scale unidimensionality.

For evaluating discriminant validity, this study followed the suggestion of Fornell and Larker [10]: the square root of AVE should be greater than the correlations of the variables in order to confirm discriminant validity. Accordingly, the value of diagonal elements should be greater than those of off-diagonal elements [10]. Thus, all the values were found to indicate good discriminant validity.

#### Evaluation of Structural Model.

The results of the research confirm that strategic sourcing negatively affects supply chain risk, which supports H1: strategic sourcing mitigates supply chain risks. The results indicated that there is statistical significance to this negative relationship, with a path coefficient of -0.220 and t-score of 2.33 at a 0.01 level of significance.

The results also showed that there is a negative relationship between e-business technologies and supply chain risks, supporting H2: e-business technologies mitigate supply chain risks. The results showed that there is a statically significant negative relationship between the path coefficient of -0.175 and t-score of 2.17 at a 0.01 level.

Similarly, H3 was also supported by the research results as implementing supply chain integration was found to have a significantly negative relationship with supply chain risks, with a path coefficient of -0.208 and t-score of 2.84 at a 0.01 level of significance.

The data analysis results showed that dynamic and competitive business environments positively affect strategic sourcing, supporting H4a: dynamic and competitive business environments have a direct impact on strategic sourcing. A statistically positive relationship was found between a path coefficient of 0.163 and a t-score of 1.89 at a 0.05 level.

Hypothesis H4c, that dynamic and competitive business environments have a direct impact on e-business technologies, was also supported by the research results as business environments have a positive impact on e-business technologies. The path coefficient was 0.314 and the t-score was 3.05 at a 0.01 level significance. The results supported H4e, that dynamic and competitive business environments have a direct impact on supply chain integration, as a positive relationship between business environments and supply chain integration was shown. A path coefficient of 0.282 with t-score of 3.70 indicated a statistically positive relationship. Likewise, the results also supported H4i: dynamic and competitive business environments have a direct impact on supply chain risks. The results showed statistically significant positive relationship between business environments and supply chain risks with the path coefficients, 0.215 and t-statistics, 2.78 at  $p < 0.01$  significance level.  $R^2$  for supply chain risks in the structural model was found to be 36.64%.

Regarding moderating effects, First, the research results showed that dynamic and competitive business environments have significant moderating effects on the relationship between strategic sourcing and supply chain risk. The effect size of the interaction between strategic sourcing and supply chain risks indicated an  $f$  statistic of 4.01 with significance at a 0.05 level, and a Cohen's  $f$  of 0.05. Thus, the negative relationship between strategic sourcing and supply chain risks was stronger when business environments become more competitive, which supports H4b.

Second, the effect size of the interaction between e-business technologies and supply chain risks indicates an  $f$  statistic of 3.85, which is significant at the 0.05 level, and Cohen's  $f$  of 0.05, which is again a small effect size. This result points out that the negative relationship between e-business technologies and supply chain risks becomes stronger in more dynamic markets, supporting hypothesis H4d.

Similarly, the effect size of the interaction between supply chain integration and supply chain risks indicated an  $f$  statistic of 5.96, significant at a 0.025 level, and Cohen's  $f$  of 0.07. Thus, dynamic and competitive business environments were found to affect the relationships between supply chain integration and supply chain risks, supporting H4f.

Regarding the moderating effects of firm size, the effect size of the interaction between strategic sourcing and supply chain risks indicated an  $f$  statistic of 4.05, significant at the 0.05 level, and Cohen's  $f$  of 0.04. The effect size of the interaction between e-business technologies and supply chain risks indicated an  $f$  statistic of 3.93, at the 0.01 level, and Cohen's  $f$  of 0.04. The effect size of the interaction between supply chain integration and supply chain risks indicated an  $f$  statistic of 5.21, at the 0.025 level, and Cohen's  $f$  of 0.06. This result indicates that, as the firm size increases, the negative relationships hypothesized were found to be are stronger, supporting H5.

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## Background of Authors

**Minkyun Kim** is currently a strategic sourcing executive for POSCO Steel in S. Korea. He received his PhD degree in supply chain & operations management from The School of Management, The State University of New York, Buffalo, USA. He also received MS degree from SUNY at Buffalo and a BS degree from University of Illinois at Urbana-Champaign.

**Nallan C. Suresh** is UB Distinguished Professor and Chair of the Department of Operations Management & Strategy at School of Management, The State University of New York, Buffalo. He received his PhD degree from University of Cincinnati, Ohio, USA, an MBA degree from McMaster University, Ontario, Canada, and a B.Tech. degree from Indian Institute of Technology, Madras, India. He has published widely in leading operations management journals such as *Journal of Operations Management*, *Management Science*, *Journal of Supply Chain Management*, *Decision Sciences*, *European Journal of Operational Research*, *International Journal of Production Research*, EMAIL: ncsuresh@buffalo.edu.