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Identifying risk issues and research advancements in supply chain risk management

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ABSTRACT

The purpose of this paper is to investigate the research development in supply chain risk management (SCRM), which has shown an increasing global attention in recent years. Literature survey and citation/co-citation analysis are used to fulfil the research task. Literature survey has undertaken a thorough search of articles on selected journals relevant to supply chain operations management. Meanwhile, citation/co-citation analysis uses Web of Sciences database to disclose SCRM development between 1995 and 2009. Both the approaches show similar trends of rising publications over the past 15 years. This review has piloted us to identify and classify the potential risk associated with different flows, namely material, cash and information flows. Consequently, we identify some research gaps. Even though there is a pressing need and awareness of SCRM from industrial aspect, quantitative models in the field are relatively lacking and information flow risk has received less attention. It is also interesting to observe the evolutions and advancements of SCRM discipline. One finding is that the intellectual structure of the field made statistically significant increase during 2000–2005 and evolved from passively reacting to vague general issues of disruptions towards more proactively managing supply chain risk from system perspectives.

1. Introduction

Production in the early years was simple, with single flow of products moving from raw material suppliers, to manufacturers and then to markets. Nowadays, shorter product lifecycle and increasing demand among all have led to a complicated supply chain. Due to cost pressure and competitive advantages, companies are adopting globalization and outsourcing strategies. This also requires an extended supply chain network, hence increases the nodes in the system. In addition, many companies have introduced lean production concepts, which intend to remove "wastes" from a supply chain, for instance, by reducing the number of suppliers. This helps in smoothing the operations but it would also create problems if unexpected events happen in a supply chain. The rising use of internet helps supply network in sharing information visibility (Christopher and Lee, 2004; Lee, 2002, 2004; Narayanan and Raman, 2004). It is indubitable that the emerging uses of enterprise resource planning (ERP) solutions such as Oracle and SAP have cut down the information transaction time and reduced the incidents of inaccuracy and redundancy. Vast assistance from these systems has, however, exposed to another consequence, namely information disruption.

All the above changes have inevitably increased the importance of supply chain risk management (SCRM). One typical example is Ericsson's crisis in 2000. Since a single-source policy was used, a fire accident in its chips' supplier immediately disrupted the material supply. Ericsson's loss was estimated to reach USD 400 million in the T28 model (Norrman and Jansson, 2004). In June 2008, Volvo Cars reported 28% reduction of sales compared with the same period in previous year, with the biggest loss in its SUVs for about 50%. Fredrik Arp, CEO of Volvo Cars stated that "*the weak dollar reduces the revenue and it will further reduce the opportunities for R&D*". Another example is the Taiwan earthquake in December 2006, which caused breakage in undersea cables and slowed down internet. One immediate effect is a prolonged waiting time of containers in the Shanghai sea port in China, since all claim procedures rely on information systems. Nature disaster, terrorist attack, labor strike, accidents can all be the causes for supply chain disruption and delay (Berger et al., 2004; Christopher and Lee, 2004; LaLonde, 2004; Norrman and

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Jansson, 2004; Poirier et al., 2007; Quinn, 2006; Tang, 2006a). The above examples show that any material, financial or information risk could create problems in a supply chain. Any hiccup transpired within the supply chain will cause delay and even disruption (Buzacott, 1971). Disruption does not only halt the supply chain operations but without preparation and precaution, it takes time for the affected system to recover (Sheffi and Rice, 2005; Hendricks and Singhal, 2005.

The above background provides the motivation to investigate the current trend and issues in SCRM. Our main objective is through literature review to (i) define the important risk issues and mitigation techniques in SCRM; (ii) understand the research trend both from industrial and academic perspectives; and (iii) identify the possible research gaps and opportunities in the field.

2. Research process

This study is based on the review of existing literature using two approaches; literature survey as well as basic bibliometric method of citation and co-citation analysis. Before we present the details of these two approaches, we need to clarify some definitions.

2.1. Risk definition

In SCRM literature, there exist various definitions of risk. In particular, it is not clear to distinguish risk and uncertainty in supply chain operations. Risk sometimes is interpreted as unreliable and uncertain resources creating supply chain interruption, whereas uncertainty can be explained as matching risk between supply and demand in supply chain processes. We believe that two dimensions are important in discussing risk: the outcome of risk impact and expectation of risk sources. As in most literature, we also agree that risk issue is associated with negative consequences of impact (Christopher and Lee, 2004, Paulson, 2005, Spekman and Davis, 2004, Wagner and Bode, 2006). However, the second dimension, expectation of risk is difficult to define. Should risk event be expected (as supplier has quality deficiencies experienced by Robert Bosch GmbH, Wagner and Bode, 2006) or unexpected (such as wars, strikes or terrorist attacks, Christopher and Lee, 2004; Kleindorfer and Saad, 2005; Quinn, 2006)? Furthermore, could the expectation be described by probability and how? These questions have been debated for centuries and these are the reasons for having vague definitions of risk.

In our opinion, a better definition of supply chain risk should refer to (i) events with small probability but may occur abruptly and (ii) these events bring substantial negative consequences to the system. Consequently, we follow the SCRM definition from Tang (2006a) "*the management of supply chain risk through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity*".

2.2. Literature survey

Literature survey aims at understanding the important issues and mitigation techniques in SCRM, including the current status and the development tendency in the area. Thus we attempt to make a thorough search of articles in related publication databases. Articles are selected from business review journals, operations management journals, as well as management science or operations research (MS/OR) type of journals. The operations management journals can be either conceptual modeling or quantitative modeling orientated, in order to understand the practical needs as well as the theoretical development in SCRM. In addition, journal is selected only if it is related to supply chain management. The list of journal is given in Table 1.

Table 1
List of journals reviewed.

I: Business/Management Review
California Management Review
Decision Sciences
Harvard Business Review
Interfaces
MIT Sloan Management Review
Supply Chain Management Review
II: Operations management journals
International Journal of Logistics Management
International Journal of Logistics: Research and Application
International Journal of Operations and Production Management
International Journal of Physical Distribution and Logistics Management
Journal of Operations Management
Production and Operations Management
Supply Chain Management: An International Journal
III: MS/OR type journals
European Journal of Operational Research
International Journal of Production Economics
International Journal of Production Research
Journal of the Operational Research Society
Management Science
Omega
Operations Research
Production Planning and Control

Based on the description of definitions in previous section, we use search keywords *supply chain*, *supply chain risk* or *supply chain risk management* together with *risk* or *uncertainty*. After obtaining these articles, we use the criteria "high impact and low probability risk" to filter the most relevant ones. Finally we have shortlisted and reviewed 138 articles between the years of 1995 and the first half of 2008.

2.3. Citation and co-citation study

The study result in literature survey is subject to the articles chosen within limited number of journals selected. Thus we propose citation/co-citation analysis to comprehend our findings. Citation/co-citation analysis is a quantitative method and it adopts bibliometric approach to investigate the structures and evolution of research in a particular discipline, in this case, SCRM. In particular, citation analysis is used to obtain some statistics data relating to gathered publications. Meanwhile, co-citation approach serves very well for the purpose of defining the intellectual structures in the area (Pilkington and Meredith, 2009).

Citation/co-citation analysis has its limitation in terms of the search method. In our case, articles are gathered based on searching abstract and keywords, which are provided by either authors or journal editors. However, the keywords used and the abstract presented might not always get aligned with our needs, since authors often have own reasons and styles in highlighting their articles. Thus, we could gather some articles irrelevant to the study, or we may have missed some relevant articles. In order to reduce this problem, we limit our search on Web of Sciences (WoS) database. Even though WoS has its limitation on the number of journals in the database (as compared to Scopus for instance), it is very selective and covers only peer-reviewed journals with high impact factors. As a result, WoS often includes high-cited articles, which are more rigid in keywords assignment and abstract presentation.

We then use the same search keywords on WoS database and attempt to disclose SCRM development during 1995–2009. The