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Analysis of Risk Management in Supply Chain: Forms and Tactics

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Abstract: A comprehensive decision-making model for supply chain (SC) management is fairly efficient to evaluate the SC risk management. Risk management of a supply chain has a great influence on the stability of dynamic cooperation among the SC partners and hence very important for the performance of the SC operations as a whole. To identify the best supply chain strategy, many quantitative and qualitative attributes such as cost, responsiveness and flexibility should be taken into account. In other words, delivery of the right product to consumers, at the right time with a reasonable cost is not only to competitive success but also the key to survival. In this paper, a decision-making model based on internal triggering and interactive mechanisms in an SC risk system was proposed. The model takes into account dual cycles, the operational process cycle and the product life cycle. We explore the inter-relationship among the two cycles, SC organizational performance factors and available risk operational practice, as well as the risk managerial elements in operational process cycle (OPC) and product life cycle (PLC). We built this dynamic relation into SC risk managerial logic and designed a corresponding decision making path. The results verified the strategic decision model which is a feasible access to the suitable risk operational tactics for practitioners.

Key words: Supply chain · Risk management · Operational process cycle (OPC) · Product life cycle (PLC)

INTRODUCTION

Various factors contribute to the complexity of an SC risk system [1]. In addition, suppliers may make the system very difficult to maintain a stable relationship. The uncertainty of the system caused by cross-production processes created more complexity. A long logistics cycle affects availability and increases the risk of inventory obsolescence. Expanded product catalogues make the supporting system more complex and hence increase the cost and undermine its responsiveness. With the logic integration of numerous risk managerial factors in an SC risk system, we committed to a comprehensive risk decision- making model. The model may improve stability of decision-making process and pertinence of risk measurements. We explored an analysis path for the framework based on the operational process cycle (OPC) and the product life cycle (PLC), as well as SC organizational performance factors (OPF) and available risk operational practice (ROP). According to the dual-cycle' role as a main clue of the decision-making process, the relationship of relevant risk managerial clusters has logically been investigated as well as ones among SC's performance criteria and dual-cycle. Furthermore, we built the influence and correlation between OPC and PLC into the decision- making process. That would provide a deeper insight on SC risk management for practitioners involved.

There has been more research reported in the literature on the uncertainty and risks in SC management. Lin, *et al.* [2] have developed a fuzzy system to simulate vendor managed inventory (VMI) that represents a deep dynamic relationship in SC. Although there are number of researches regarding conceptual approaches for selecting the supply chain strategy, most of the related literatures are devoted to some specific perspectives, such as supply chain type, product type and etc. It is clear that, selecting the supply chain strategy without considering all the relevant aspects does not lead to an effective outcome. This paper exploits the advantages of previous works to develop a comprehensive model for selecting the best supply chain strategy, while considering all the relevant dimensions and using both quantitative and qualitative criteria. To overcome the issue of complexity and

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uncertainty in the discussed issues, the fuzzy technique for order performance by similarity to ideal solution (Fuzzy-TOPSIS) is used to identify the most appropriate supply chain strategy [3].

Cheng and Wee [4] have studied a production inventory deterioration model considering pricing policy, warranty period, imperfect production and stock dependent demand. Wang *et al*. [5] have empirically showed different deterioration rates in each echelon affect performances of individuals and integrated inventory policies. To the best of our knowledge, this is the first study considering perishable items in a two-echelon supply chain having production at the first stage and warehouse at the second stage.

Tang [6] has suggested that robust strategies for mitigating supply chain disruptions and highlighted that these strategies not only can manage the inherent fluctuations efficiently regardless of the occurrence of major disruptions but also lead to a more resilient supply chain in the face of major disruptions.

Huchzermeier and Cohen [7] have showed that global coordination, logistics and postponement can enhance operational flexibility and reduce the system risk effectively. Thonemann and Bradley [8] have found that changes in manufacturing processes and in the SC structure can improve SC performance. Nagurney [9] has developed a model for the modelling, analysis and computation of solutions to global supply chains.

While it is interesting to have an increasing number of choices for risk management methods and tools in practice and also know how to tailor them with their various functionalities and features which is still a big challenge [10]. In this paper, we responded to this challenge by proposing a decision-making model and a methodology for SC risk management.

The paper is organized as follows. In sections 2 and 3, various risk forms in SC management are considered in terms of performance. Possible reasons of their fluctuation and tactics are also analyzed based on SC operational processes, which include procurement, production, marketing, logistics and service. We are led to questions of how to incorporate an operational process into a product life cycle and what SC risk management methods should be chosen [11]. In section 4, we present a hierarchical model for selecting the best supply chain strategy and decision making criteria. In sections 5 and 6, we analyze some interactive mechanisms between the OPC and the PLC. Different value-added activities in SC operational processes have different risk features and influences at a special period of PLC. In section 7, we make some concluding remarks on the strengths and limitations of our proposed decision making model.

Supply Chain Risk Forms: Grey and Shi [12], Smith and Huchzermeier [13] have showed that a clear recognition of risk features is the very beginning of effective SC risk management, as illustrated in Figure 1. By keeping a clear map in mind on the variety and inter-connectedness of SC risk, managers can tailor their operational tactics for the companies [1]. Risk features may vary along SC operation processes. However, there are several ultimate forms of SC risks: quantity, cost, quality and time. These would be explained in turn as follows:

Cost also has a wide range of influences. The fluctuation of procurement cost may intensify the swing scale of revenue and profit [14]. Too much variation on slack in production system, such as back up production utilities, too many shift-work employees and long lead-time, always increases production cost. An unreasonable decision on price will lead to a loss of

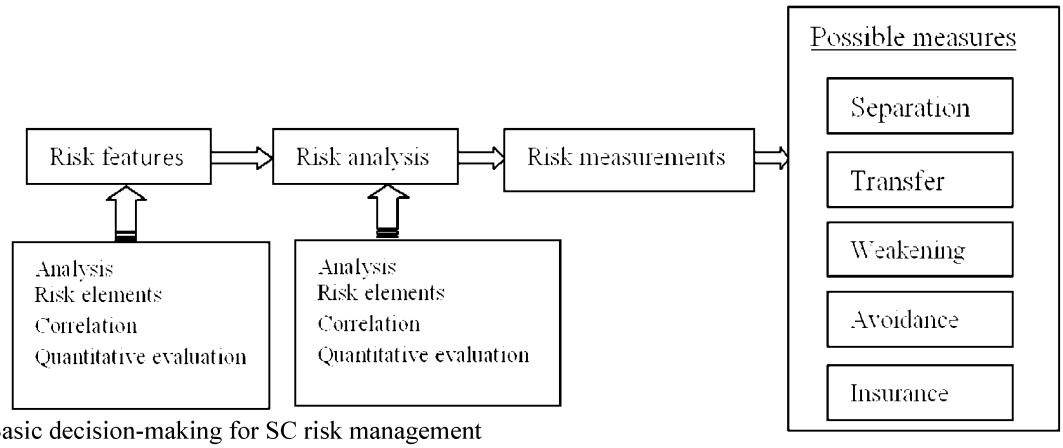

Fig. 1: Basic decision-making for SC risk management

market share and an increase in inventory. A defective service supporting system may increase the frequency of emergency service, which is the very reason of a climbing logistics cost.

Quality may influence SC operation in many ways. A low-level quality of components and parts in procuring process will decrease the outcome of production and affect consumer experience, which in turn would harm sales and image of the enterprise. Furthermore, it always increases the cost of warranty and after-sale service. Failures on an SC structure and operational process design are the very reason of a low-level flexibility, which is the obstacle to enforcing just-in-time (JIT) and vendor management inventory (VMI) [15]. The quality of after-sale supporting system influences customer satisfaction. Ultimately, a low-level quality will speed up the obsolescence of products. As a risk forms, time has various influences on an SC. Competence of timely delivery is seriously affected by the fluctuation of a production cycle [11].

Risk Management Methods and Combined Tactics: One of these risk management methods and tools are achievements of innovation in the financial field. Traditional insurance and other financial products benefit practitioners and help ease the negative influences resulted from climate change, intensive price fluctuation and energy shortage during SC operations, such as procurement, production, distribution and service. The risk and uncertainty resulted from excessive or shortage of inventory can be combined and hawked to investors in a relevant market. New products in finance, such as mutual credit transaction and option, can decrease the loss resulted from an infrequent but very serious risk incident that may cause fatal end, while mortgage and spot transaction can transfer and completely avoid any risks [12]. It is obvious that a risk form, its influence scale and intensity may vary during a PLC of a supply chain. In other words, there are special features of risk at each stage of a PLC. During the introduction period, product design orientations, which include demand analysis, standardization, modularization and environmental friendly view, obviously influence operational activities [16]. At the other stages of a PLC including growth, maturity and decline, there will be similar situations. To deal with these various risks with different attributes, practitioners may have many choices, such as separation, transfer, weakening, avoidance and insurance (Figure 1).

Actually, a good performance of SC risk management can be achieved with an appropriate integration of the operational and financial levers in practice [13]. Therefore, it is necessary to design a combination of risk management methods with prospective risk managerial factors and organization goals. Such a combination will help control risks with different SC attributes.

The performance of SC risk management is affected by many factors as mentioned above. We can classify these factors into four clusters: PLC including introduction, growth, maturity and decline, supported by an SC; OPC consisting of five value-added activities from procurement to service; organizational performance factors (OPF) indicating the strategic orientation of organization; and available risk operational practice (ROP).

A Hierarchical Model for Selecting the Best Supply Chain Strategy: The first step is devoted to construct a model to identify the system alternatives and criteria to evaluate the supply chain strategies. Due to the complexity of the decision making process in selecting the supply chain strategy, a hierarchical model is used. Figure 2 shows the hierarchical model for selecting the best supply chain strategy. The key parameters for this model can be categorized into four levels. The first level of the model deals with the essence of the difference between leanness and agility in terms of the total value provided to the customer, which included responsiveness, (service level) that is the critical factor calling for agility and cost, that is clearly linked to leanness [17]. In order to specify the effects of cost and responsiveness on decision making alternatives, these two criteria are broken into relevant sub criteria which lie in level 2. Sub criterions of cost are inventory cost, process cost, supply cost, transportation cost and shortage cost. Sub criteria of responsiveness are flexibility, lead time and innovation. The third level of model consists of flexibility's sub criteria which are product type flexibility (machine flexibility), volume flexibility (production capacity flexibility), supply flexibility, manpower flexibility and transportation flexibility. The fourth level of model deals with the decision making alternatives which are lean, agile and leagile strategies. The overall objective is to select the best strategy for improving performance of the case supply chain.

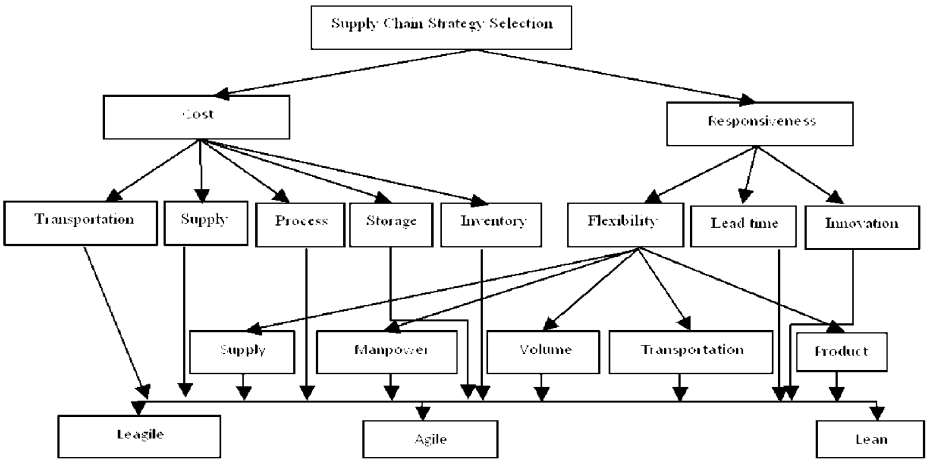

Fig. 2: The hierarchical model for selecting the best supply chain strategy

Analysis of Product Life Cycle (PLC): In the introduction stage of a PLC, a new product design with customer orientation, environmental friendly view and standardization concept will boost the realization of an SC goal in its subsequent operational processes. The standardization and modularization of a product design make it possible to minimize the number of component items as well as suppliers, to decrease the need of adjusting production processes. In order to decrease procurement costs of new products, in turn improve suppliers' responsiveness and availability of components and parts; hence stabilize the quality of components and end products. All these achievements will enhance the competence of the supply chain to prevent potential risks [11].

When a product enters into the decline stage, it is necessary to take action to ensure successful withdrawal from certain markets without a negative influence, which heavily relies on the positive adjustment of business processes and efficient reverse logistics. There are an increasing consciousness and expectation on environmental issues, which results in extended responsibilities of enterprise. While organizations collect obsolete and failure products, they have to plot a re-utilization system. Failure to fulfill this duty may lead to a serious risk from public media, regulations and even law [18]. The new challenges at this stage trigger designers and technicians to think twice about the convenience, feasibility of collection reusing, remanufacturing and disposal of products.

Analysis of Operational Process Cycle (OPC): While PLC is a significant factor in SC risk management, OPC plays an essential role. The OPC in an SC usually consists of procurement, production, distribution, logistics and service. It is the OPC that supports the strategic goals at different stages of a PLC and decides the efficiency of value delivery to an end market [11].

There are even more potential managerial risk elements in production, which include process competence, machine stability, planning capability and employees' quality. These elements can influence product quality and accuracy of deliveries in an SC. Continuous quality improvement across the internal production system of an SC, coupled by suitable outsourcing of some non-core business, is an efficient way to weaken and transfer risks.

In conclusion, there are many different tools in SC risk management and each has its own functionalities. But there is no single method that can cope with all risks in an SC.

CONCLUSIONS

In this paper, we introduced a strategic model of a SC risk management decision-making system with operational process cycle (OPC) and product life cycle (PLC), which is subject to two assumptions. In the remaining sections, the dynamic relationship among four risk managerial cluster, operational process cycle (OPC), product life cycle (PLC), organizational performance factor (OPF).

The proposed method provides more information for strategy selection and evaluation in supply chain system. The systematic framework for strategy selection in a fuzzy environment discussed in this paper is easily used to different type of supply chains. The verification of the unilateral, bilateral and internal circulation relationship provides a deeper insight and complete map about SC risk

management system. For the complexity of the decision process, integration of qualitative and quantitative analysis is directly applicable as a decision tool and also help in developing intuition for the hard task of managing SC risk system. While the simplex numerical analysis is relatively straight forward but tends to offer less insight than our analytical structure. As the model complexity increases, it becomes difficult to obtain and interpret the outcome of model.

All the modeling results showed that the model can provide significant insight on SC risk management; which is not only has a strategic but also operational perspective and also help to tackle the fundamental and crucial relationship in SC dynamic risk system.

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