

SUPPLY CHAIN RISKS: AN AUTOMOTIVE CASE STUDY

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ABSTRACT

The supply chain is a complex system exchanging information, goods, material and money within enterprises, as well as between enterprises within the value chain. An effective supply chain management contributes to large corporate profits and it is therefore a valid path to reinforce the enterprises' competitiveness. However, supply chain is exposed to influences from undesirable factors both from the outside environment and the entities in the chain. Moreover, industrial trends towards lean production, increasing outsourcing, globalisation and reliance on supply networks capabilities and innovations, increase the complexity of the supply chain. Therefore, managers need to identify, and manage risks, as well as opportunities, from a more diverse range of sources and contexts. This paper contributes to identify and categorise supply chain risks based on a literature study and an automotive manufacturer's viewpoint. The empirical results indicate suppliers and raw material prices as the major internal and external potential risks.

Keywords: supply chain management, risk assessment, automotive industry

1 INTRODUCTION

Supply chain is a complex system which exchange different information, goods, material and money internally within the enterprise or externally with other companies. Firms' profits can depend heavily on its supply chain management and the supply chain management is a valid path to reinforce the enterprises' competition (Li and Xie, 2009). However, supply chain is easy to be influenced by undesirable factors, both from the outside environment and from the entities in the chain (Cunlu and Peiqing, 2006). Furthermore, changes in organisational structure lead to complexity in the supply chain and increase the risks in it (Pereira, 2009). Take an action regardless of the whole system, cause supply chain instability and interruption by financial losses, loss in demand, damage in security and health and finally bad reputation (Hui-hui, 2010, Thun and Hoenig, 2011). One could assume that the more complex the interactions and the tighter coupled the supply chain, the more prone the supply chain is to unexpected, untoward events (Wagner and Bode, 2006). Correspondingly, supply chain disruptions can have significant impact on a firm's short-term performance and long-term financial performance (Tang, 2006).

Production risk concerns any undesired consequences in the production process, such as the possibility of danger, damage, loss and injury (Harland et al., 2003). In other words, Royal Society (1992) risk as "*the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge*". Risk management in supply chain has become crucial due to industrial trends in today's market such as increase in outsourcing, globalisation, reliance on supply network for specialised capabilities and innovation. Supply Chain Risk Management (SCRM) is a process of identifying potential risks of entire supply chains, analysing and determining characteristics and sources in order to manage the risks (Neiger *et al.*, 2009) which can affect market, operational and financial performance. Companies are mostly aware of supply chain risks but owing to underestimation of the impact and lack of knowledge about tools, managers neglect to implement appropriate instruments (Wu, 2010). The first and the most important step in SCRM is risk

identification and supply chain expansion makes risk identification a challenging task (Karningsih *et al.*, 2010).

The focus of this paper is to by a literature frame of reference and an empirical study identify and distinguish the internal and external supply chain risks for a large automotive manufacturer of today. Consequently, identified aspects are ranked by a performed survey at a heavy automotive industry manufacturer. Finally, the obtained results are discussed in respect to both literature and the empirical findings, in the effort of acting proactively and minimising the risk of incidents within the supply chain.

2 RESEARCH METHODOLOGY

This paper is based on structured literature review about risks of supply chain management as well as conducting a survey at a heavy automotive manufacturer: Volvo Construction Equipment in Eskilstuna, Sweden. Automotive manufacturing was chosen due to the inclusiveness and complexity of supply chain in such industries.

Based on a review of 21 articles, 16 different risks were identified and divided into 2 main categories: internal and external risks. Internal risks imply as interactions within a company which can be controlled whereas external risks occur due to interactions of a company with its environment which are out of its control. Based on the literature review, a questionnaire with 16 question about each risk was disseminated to the company. The questions were formulated so they could be measured by a five-point Likert scaling system, ranging from “very low” to “very high” in order to analyse the risks according to each participant’s viewpoint. 10 respondents from the logistics department and 9 respondents from the purchasing department at the company were involved to answer the questionnaire. The respondents were inquired to measure the vulnerability of each risk in the supply chain regarding to their experience, from very low to very high i.e. from 1 to 5. A statistical analysis was thereafter conducted on the answers by SPSS software, in order to rank the risks. As this type of information follows a normal distribution, a mean and standard deviation test (Motulsky, 1995) was used to identify each risk’s importance.

3 SUPPLY CHAIN RISKS

Clustering supply chain risks into different categories has been done previously by number of scholars, for instance studies by Harland *et al.* (2003), Kleindorfer and Saad (2005), Gaonkar and Viswanadham (2007), Li and Xie (2009), Narasimhan and Talluri (2009), Tang and Nurmaya Musa (2011) and Thun and Hoenig (2011).

Supply chain risks can be divided into two main groups: internal risks within a company such as machine breakdowns or IT problems and external risks such as natural disasters or man-made activities. Internal risks generally have higher possibility to occur whereas external risks generally have a higher impact. Perspectives of risk could be about organisational buyer behaviours, procurement and supply, purchasing strategy selection, and strategic risk, such as outsourcing risk, environmental risk and e-business risk (Harland *et al.*, 2003). According to supply chain system constitution, risk sources by supply chain entity lie within the boundaries of the supply chain parties and range from labour or production to IT-system uncertainties (Cunlu and Peiqing, 2006). IT disruptions is caused by increasing in usage of internet for sharing information or using enterprise resource planning solutions like Oracle and SAP. It leads to reduce the transactions’ time and inaccuracy, although may cause information distribution (Tang and Nurmaya Musa, 2011).

Trends toward lean production have led also to take more risks in planning, producing, transportations, packaging (Thun and Hoenig, 2011). Moreover, global sourcing is usually associated with increased uncertainty as well as poorer transparency and visibility. Globalisation and outsourcing obviously have hidden cost and managerial difficulties like import/export duties, tax policy or fluctuation in currency exchange rate in partner country (Tang and Nurmaya Musa, 2011).

Complicating factors that have to be tackled are longer lead-times due to long routes of transportation, which causes loss in material cost and increase the time of transportation. By the same token, rational usage of transportation space is another thing to be considered. Besides, supplier should be flexible enough to respond to any order quantities and rush orders (Schoenherr *et al.*, 2008). More issues to highlight are reliance on critical infrastructures, financial instability, lack of ability to

settle payment, inappropriate investment and having large capital tied up. The latter is a common problem in low cost countries which should be avoided.

Jiang *et al.* (2009) argued that most common risks in supply chains are based on short-term uncertainties of certain events, which could be called production risks such as equipment failures, lack of proper documentation to clear customs, quality problems due to excessive employee turnover, sudden changes regarding to emergence disruptions, reduction or stop in production or lack of key personnel. Wagner and Bode (2006) defined a model which incorporates three supply chain risk sources: demand-side, supply-side, and catastrophic. Demand-side risks result from disruptions emerging from downstream supply chain operations. This includes on the one hand disruptions in the physical distribution of products to the end-customer with particular issues in transportation operations and the distribution network. On the other hand, demand-side risks can originate from the uncertainty surrounding the random demands of the customers which is also called operational risks (Narasimhan and Talluri, 2009). These kind of risks implied as product sales rate, respond to demand's variation, forecast demand, flexibility to order quantity changes, keep customers satisfied by new product and increasing the price. The last risk source deals with natural disasters, economic and socio-political instability and terrorist attacks.

Supply risks associate with suppliers adequate and their ability to fulfil the product quality and quantity in terms of delivery punctuality and on budget which both have high probability and impact. Considering the requirement of single or multiple sourcing is another risk in this matter. However, financial problems, capacity, lack of flexibility in production and design are the others. Supply-side risks reside in purchasing, supplier activities, and supplier relationships. These include supplier business risks, production capacity constraints on the supply market, technological changes, innovation or new designs which these cause disturbance for suppliers. Capacity constraints or shortages as well as poor logistics performance derive from unsolved problems in the supplier's production and operations management. Furthermore, poor quality in the purchased products or services is a significant risk. The inability of suppliers to adapt to technological or product design changes may have detrimental effects on the customer's costs and competitiveness (Wagner and Bode, 2006). Additionally, dealing with suppliers' labour problems is a timely and important managerial topic, because these problems are exposing the global supply chain to be harmed by business risks. Reduction of supplier makes the supply chain unstable and increases the risk of supply interruption (Pereira, 2009).

Another type of risk is the management risks. Making wrong decision in different situation such as choosing unsuitable partners cause some problems in production which lead to lack of capability to provide customer demands (Wu, 2010). In the supply chain, numbers of partner companies are connected to each other which all the enterprises have to cooperate, control and monitor one another. Another type of risk, therefore arise which called "Risk of supplier becoming competitor"(Neiger *et al.*, 2009). If more companies get involved, then the chain becomes larger and more complex and therefore the further companies should be reliable, responsible, and dependable, otherwise the entire supply chain will encounter the risk of supplier's supplier.

External environmental risk sources comprise any uncertainties arising from the supply chain-environment interaction which are referred to the major disruptions caused by natural and man-made disasters (Narasimhan and Talluri, 2009). These risks were recognised by the focal firm, and may be the result of accidents (e.g. fire), socio-political actions (e.g. fuel protests or terrorist attacks like the 9/11/2001 World Trade Centre attack), civil unrest, political instability, war, and social risks, economic disruptions, geographical reasons like extreme weather, or natural disaster like earthquakes, tsunamis, droughts, hurricanes, and floods. They have low probability to happen but if they do, it will have huge effect on supply chain. The negative consequences of catastrophic risk on supply chains are obvious since production facilities and transportation are highly vulnerable to natural disaster. Moreover, market risks such as instability in cost of raw material or products in market or change in market opportunities and economical risks like economic unsteadiness such as fluctuations or rapid growth could affect the company's supply chain (Thun and Hoenig, 2011).

As a result of the literature review, 16 main risks were identified and classified into internal and external aspects, with the internal risks being: machine breakdowns, supplier failure, supplier quality problems, delivery chain disruptions, change in customer demand, transportation failure, malfunction of system, import or export restrictions, technological change, accident and increasing customs duty

and the external risks being: increasing raw material prices, natural disaster, oil crisis strike and terrorist attack.

4 EMPIRICAL FINDINGS

In the performed survey at Volvo CE in Eskilstuna, 16 different risks have been analysed by 19 people from logistics and purchasing department. A questionnaire with 16 question about each risk was disseminated to be filled based on participant’s viewpoint and experience. The respondents were inquired to measure the vulnerability of each risk in the supply chain regarding five-point Likert scaling system ranging from 1 to 5 i.e. very low, low, moderate, high and very high. and the corresponding scales were calculated in each risk aspect. According to the conducted survey, 93.75 % of the risks have more than 50% of likelihood to occur. Table 1 represents the final ranking of the variables. A statistical analysis was consequently conducted on the answers by SPSS software in order to rank the risks. As this type of information follows a normal distribution, a mean and standard deviation test (Motulsky, 1995) was used to identify each risk’s importance.

Table 1: Descriptive statistics of risks in Volvo CE

Risks	N	Mean	Standard Deviation	Standard Error Mean
Increasing Raw Material Prices (External)	19	3.63	1.065	0.244
Machine Breakdowns (Internal)	19	3.63	1.012	0.232
Supplier Failure (Internal)	19	3.58	0.838	0.192
Supplier Quality Problems (Internal)	19	3.58	0.838	0.192
Delivery Chain Disruptions (Internal)	19	3.47	0.905	0.208
Change In Customer Demand (Internal)	19	3.42	0.838	0.192
Transportation Failure (Internal)	19	3.32	0.946	0.217
Malfunction of IT System (Internal)	19	3.16	1.119	0.257
Natural Disaster (External)	19	2.84	1.302	0.299
Oil Crisis (External)	19	2.79	1.032	0.237
Import or Export Restrictions (Internal)	19	2.79	1.084	0.249
Technological Change (Internal)	19	2.79	0.855	0.196
Accident (Internal)	19	2.74	1.046	0.240
Increasing Customs Duty (Internal)	19	2.74	0.872	0.200
Strike (External)	19	2.63	1.257	0.288
Terrorist Attack (External)	19	2.26	1.147	0.263

As shown, “Increasing raw material prices” risk has the highest rank in the company’s point of view and “Terrorist Attack” risk has the lowest one which is the only risk under the 2,5. “Increasing raw material prices” and “Machine breakdowns” have the same mean value, but the first risk has a highest standard deviation indicating it to have a higher likelihood. The most considerable risks (“High” risk) are “Increasing raw material prices”, “Machine breakdowns”, “Supplier failure” and “Supplier quality problems”, all given the risk value of more than 3.5. “Delivery chain disruptions”, “Change in customer demand”, “Transportation failure”, “Malfunction of IT system” were given a mean risk value between 3 to 3.5, indicating a “moderate” risk. Finally “Natural disaster”, “Oil crisis”, “Import or export restrictions”, “Technological change”, “Accident”, “Increasing customs duty”, “Strike”, “Terrorist attack” were all given a risk value between 2 and 3, considered as “Low” importance risks. According to the results, there are no risks related to “Very High” or “Very low” importance.

5 DISCUSSION

According to Table 1, 50% of the “high” risks consist of suppliers issues, which means selecting right suppliers is a key contribution in managing the supply chain. On the other hand, increasing raw material prices is the significant risk in supply chain in the company’s standpoint, which is uncontrollable although forecasted and planned in advance.

Considerable vulnerability in supply chain may be related to the organisational structure. When the supply network complexity increases, risks increase as well (Harland *et al.*, 2003). Changes in raw material prices is considered the highest risk for the supply chain while supplier failure and supplier quality problems has the second rank. Thun and Hoenig (2011) asserted that supplier quality problems must be regarded as the most critical risk since they have both high probability and high impact. This study therefore, have approximately the same result to reveal that supplier issues and increasing raw material prices were highly influential parts of supply chain risk that can be controlled and managed by supply chain partners. Supplier failure and a malfunction of the IT system are seen as severe problems but are less likely to occur in Volvo’s viewpoint. The highest probable risks are observed in terms of increasing raw material prices, customer demand changes, and delivery chain disruptions. Wagner and Bode (2006) stated that risk derived from supply-side risk sources is elevated by supplier dependence, single sourcing, and global sourcing. Supplier dependence obviously amplifies the threat from poor quality, supply shortages, sudden demise of one of these suppliers and poor logistics performance but it could decrease the risk exposure to catastrophes. Single sourcing approach seems to be less uncertain since it is usually aligned with a closer relationship that might absorb some of the supply-side risk. Global sourcing boosts particularly risk stemming from the upstream supply chain. However, according to results by (Li and Xie, 2009) selection of vendors and selection of clients play the key roles among all the factors and bad record of partners is the most outstanding risk factor. Harland *et al.* (2003) notes that the current business trends of increasing product/service complexity, outsourcing, globalisation and e-business that have led to more complex, dynamic supply networks, have resulted in risks shifting around supply networks. In order to lessen these risks establishing the monitoring mechanism based on the cooperation record can enhance the mutual trust and strength communication between partners. Another thing that can lower these types of risks could be the climate of the job for workers, Jiang *et al.* (2009) stated that since workers show lower job commitment, greater job dissatisfaction and higher turnover, suppliers’ production capacity and quality levels are more at risk, which seriously threatens the global supply chain’s performance.

Changes in customer demands can have a “moderate” risk for the supply chain. Firms that are dependent on some customers are exposed to a risk of suffering from the detrimental effects of demand volatility and poor downstream information. However this sort of risk is also related to supplier failures due to the fact that dependence on suppliers generally implies a lack of switching options and weak negotiation power. A firm is therefore, less flexible on the supply side and consequently less capable of dealing with volatile demand and poor information from the demand side. Moreover, inventory level set is the most outstanding effect risk factor and strengthen honest culture and establishing the mechanism of risk-sharing. Incentive leads avoiding this situation effectively.

6 CONCLUSION

According to the empirical data, internal risks are the driving force in the supply chain although “increasing raw material prices” is considered to have the most extreme consequences. In the last decade, emergence catastrophe has occurred around the world such as Japan’s earthquake in 2011, economic crisis in 2009, etc. which affected the world business, most of the times cause financial loss. Internal adverse factors in business which are also happened around each company and make supply chain vulnerable in term of competitiveness, complexity, globalisation and product variants. Hence, the role of supply chain management become more influential due to responsibility to make various decisions in different situations including choosing the right supplier or strategy beside of synchronising the members inside the company and relations between supply partner. The trend toward lean production by reducing the inventory, outsourcing, globalisation in order to capture more markets and concentrating on efficiency, make supply chain network more complex which lead to take more risks in planning, producing, transportations, packaging. Managers need to identify, analyse

and manage risks, as well as potential opportunities, from a more diverse range of sources and contexts. When risk issues and its impact on the performance measures is not considered in supply chain management, suboptimal results and inconsistent processes are inevitable. In order to prevent risk comprehensively, risks need to be identified and actions have to be taken before the incident. Evidences depict that neglecting the SCRM lead to irrecoverable disruption such as reduction in profitability and loss in costumers.

REFERENCES

- Cunlu, Z. & Peiqing, H. Supply chain risk by structure. Service operations and logistics and informatics, 2006. Soli '06. Ieee international conference 21-23 june 2006. 300-303.
- Gaonkar, r. S. & Viswanadham, N. 2007. Analytical framework for the management of risk in supply chains. *Automation science and engineering, ieee transactions on*, 4, 265-273.
- Harland, C., Brenchley, r. & Walker, h. 2003. Risk in supply networks. *Journal of purchasing and supply management*, 9, 51-62.
- Hui-hui, H. The key factors affecting supply chain risk towards emergencies. Management and service science (mass), 2010 international conference on, 24-26 aug. 2010 2010. 1-4.
- Jiang, B., Baker, r. C. & Frazier, g. V. 2009. An analysis of job dissatisfaction and turnover to reduce global supply chain risk: evidence from china. *Journal of operations management*, 27, 169-184.
- Karningsih, p. D., kayis, B. & Kara, S. Development of scris: a knowledge based system tool for assisting organizations in managing supply chain risks. Advanced information networking and applications workshops (waina), 2010 ieee 24th international conference on, 20-23 april 2010 2010. 55-60.
- Kleindorfer, p. R. & Saad, g. H. 2005. Managing disruption risks in supply chains. *Production and operations management*, 14, 53-68.
- Li, Y.-f. & Xie, q.-h. A method of identifying supply chain risk factors. Software engineering, 2009. Wcse '09. Wri world congress 19-21 may 2009. 369-373.
- Motulsky, H. 1995. *Intuitive biostatistics: a nonmathematical guide to statistical thinking*, oxford university press.
- Narasimhan, R. & Talluri, S. 2009. Perspectives on risk management in supply chains. *Journal of operations management*, 27, 114-118.
- Neiger, D., Rotaru, K. & Churilov, I. 2009. Supply chain risk identification with value-focused process engineering. *Journal of operations management*, 27, 154-168.
- Pereira, j. V. 2009. The new supply chain's frontier: information management. *International journal of information management*, 29, 372-379.
- Schoenherr, t., Rao tummala, v. M. & Harrison, t. P. 2008. Assessing supply chain risks with the analytic hierarchy process: providing decision support for the offshoring decision by a us manufacturing company. *Journal of purchasing and supply management*, 14, 100-111.
- Society, r. 1992. Risk: analysis, perception and management. London, uk.
- Tang, c. S. 2006. Perspectives in supply chain risk management. *International journal of production economics*, 103, 451-488.
- Tang, O. & Nurmaya musa, S. 2011. Identifying risk issues and research advancements in supply chain risk management. *International journal of production economics*, in press, corrected proof.
- Thun, J.-h. & Hoenig, d. 2011. An empirical analysis of supply chain risk management in the german automotive industry. *International journal of production economics*, 131, 242-249.
- Wagner, S. M. & Bode, C. 2006. An empirical investigation into supply chain vulnerability. *Journal of purchasing and supply management*, 12, 301-312.
- Wu, q. Supply chain risk assessment and prevention. E-business and information system security (ebiss), 2010 2nd international conference on, 22-23 may 2010 2010. 1-4.