Supply Chain Risks: A Review Study

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Abstract

This paper presents a literature review regarding the supply chain risks. The principle intention is to distinguish and characterize the risks compromising the Supply Chain. The operations complexity makes managing the supply chain risks a significant challenge; and any complexity prompts risks and vulnerabilities. The literature review of 160 publications permitted us to accumulate a few risks that are assembled into operational and disruption risks, ordered appropriately to their appearance in the publications, which allowed us to focus on the risks, and perceive their consequences on the smooth running of the supply chain. At last, it is necessary to be aware and knowledgeable about these risks in order to take them into consideration, so as to work on mitigation actions and alleviate any damage to the supply chain performance.

Keywords

Logistic risks; Risk Assessment; Risk Management; Supply Chain; Supply Chain Risks.

1. Introduction

During these last decades, logistics researchers and practitioners are always looking for new opportunities of improvement of the supply chain (SC) performance. This is explained by the numerous researches on this subject, they try to identify the risks threatening the good functioning of the SC operations, using different tools that would allow them to differentiate between the aberrant risks in order to define, prioritize, analyze and finally manage them. La Londe and Masters (1994) proposed that a supply chain is a set of firms that pass materials forward. Normally, several independent firms are involved in product manufacturing and placing it in the hands of the end-user in a supply chain—raw material and component producers, product assemblers, wholesalers, retailer merchants, and transportation companies are all members of a supply chain. In the same way, Lambert et al. (1998) define a supply chain as the alignment of firms that brings products or services to market. These concepts of the supply chain include the final consumer as part of the supply chain. Christopher (1992) define the supply chain differently: “supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer”. Mentzer et al. (2001) summarize all the definitions listed above as “supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer”.

The supply chain knew a very important development, very rapid technological development, population growth, and radical technological change. In addition, the diversification of products and services had led to a large amount of raw material extraction, excessive consumption, and a large amount of waste generation. (Efendigil et al., 2008) (Govindan and Bouzon 2018) (Govindan and Hasanagic 2018) (Khor and Hazen 2016) (Prajapati et al. 2019). As well as, with the increased competition, companies were compelled to seek ways to improve their operations and look over the whole supply chain instead of being limited to internal production, develop their products and stay aligned with the market's needs (Sfinij and El Abbadi 2020).

On the other hand, the operations of the supply chain are complex, as affirmed by (Svensson 2002), the supply chain risk is a complex phenomenon that can be divided into sources and types of risk; this complexity comes from the fact that products require very specific manufacturing processes, a very complicated control circuit, a diversification of components 'suppliers, distribution all over the world and increasing consumption of raw materials. All these parameters make the supply chain very vulnerable to risks and uncertainties; especially, when considering the required time to make strategic decisions. Schmidt and Wilhelm (2000) confirm that uncertainties in logistic operations exist at strategic, tactical, and operational levels.

The risk concept had always been present in industrial activities. There are multiple definitions of the term "risk" in the literature. Al-Bahar and Crandall (1990) and Lam et al. (2007), for instance, decamped the risk into three components: the risk event (what might happen to the detriment or in favor of the project), the uncertainty of the event (the chance of the event occurring) and the potential loss or gain (the consequence of the event happening). Whereas, the risk is a situation or event where something of human value (including humans themselves) has been put at stake and where the outcome is uncertain referring to (Rosa 1998). According to Risk Management Vocabulary (ISO 2002), the risk is a combination of the probability and scope of the consequences and it is simply equal to expected damage (Campbell 2005). Therefore, the risk handling idea took place through what is called "Risk management". Risk management is the process whereby decisions are made to accept a known or assessed risk or the implementation of action to reduce the consequences or the probability of occurrence of an adverse event (Cheng et al. 2012). Risk management refers to strategies, methods, and supporting tools to identify and control risk to an acceptable level (Bruckner et al. 2001).

According to ISO 31000:2009 (Risk management: principles and guidelines), risk management refers to a coordinated set of activities and methods that are used to direct an organization and to control the many risks that can affect its ability to achieve objectives. The risk assessment is included in the risk management process. It is a necessary step for the selection of suitable corrective actions for the risk identified (Ennouri 2013). In addition, the risk assessment is a tool to represent and describe the knowledge and lack of knowledge, and then other criteria need to be used to evaluate reliability and validity (Aven 2016). Another definition (Haimes 2008) says that risk assessment is a systematic and holistic approach to dealing with risk, risk assessment; the analysts often attempt to answer a set of questions.

Supply chain risk is 'The potential deviation from the expected value of a certain supply chain performance measure' (Wagner and Bode 2008) (Kumar et al. 2010). In supply chain, there are different categories of risk, (Jones and Towill 1998) suggested five overlapping categories of supply chain risk sources: environmental risk sources, demand and supply risk sources, process risk sources, and control risk sources. The notion of risk management in the supply chain has developed rapidly over the recent decades and has become very important (Lavastre et al. 2012) Supply chain risk management is defined as the process of risk mitigation achieved through collaboration, coordination, and application of risk management tools among the partners, to ensure continuity coupled with long term profitability of the supply chain (Ennouri 2013).

As analyzed by Tang (2006) Sreedevi and Haritha Saranga (2017) Lockamy and McCormack (2012), supply-chain risk has high multisource and multidimensional characteristics, the risk factors of which are extremely complex (Tang 2006) (Wu, and al. 2006) (Lockamy and McCormack 2012). Moreover, it is a common belief that logistics systems, in the global business era, are vulnerable (Xanthopoulos et al. 2012) and open to many sources of threats (Sodhi et al. 2012). Therefore, according to Asbjørnslett (2009), vulnerability is "the properties of a supply chain system that may weaken or limit its ability to endure threats and survive accidental events that originate both within and outside the system boundaries".

Supply chain risk management (SCRM) is a network of facilities and distribution options that performs the functions of procurement of materials, a transformation of these ones into intermediate and finished products, and the distribution of these finished products to customers according to (Ganeshan and Harrison, 1995). The SCRM can be defined as a structured and synergic process throughout the supply chain, which seeks to optimize the

totality of strategies, processes, human resources, technology, and knowledge in the aims are to control, monitor , and evaluate supply chain risk and to safeguard the continuity and maximize profitability (Sun et al. 2012). Referring to (Lee and Corey 1995) stated that SCM consists of the integration activities taking place among a network of facilities that procure raw materials, transform them into intermediate goods and then final products, and deliver products to customers through a distribution system. This paper presents a literature review on supply chain risk, it aims to identify and analyze different supply chain risks.

2. Research Methodology:

Several researchers examined the risks in the logistic and supply chain, and identified different risks that need to be measured and controlled. Similarly, this research focused firstly on publications based on supply chain and logistic risks. The second step of this research, was devoted to gathering and categorizing the different risks, per risk family as possible, to obtain the percentages of all risk and risk family, and classifying each type of risk by percentage. In order to find the most important or common risk among researchers. Finally, the critical risks on the supply chain with a high percentage were described and analyzed.

To realize this literature review of supply chain risks, papers and articles were researched online using the following keywords “Logistic risks”, “Risk assessment”, “Risk management”, “Supply chain” and “Supply chain risks”. These words are searched in the databases: Google Scholar (www.scholar.google.com), Scopus (www.scopus.com), Elsevier (www.elsevier.com); Taylor & Francis Online (www.tandfonline.com); Science Direct (www.sciencedirect.com). These databases were considered principal sources of information to establish an understanding of topic. The selection of articles and papers to be read emphasized on the importance and manner in which the topic of logistics risk assessment was handled.

Using these keywords, based on 160 publications; published in the period 1976-2020 in different journals/conferences. The number of publications per year (Fig.1)

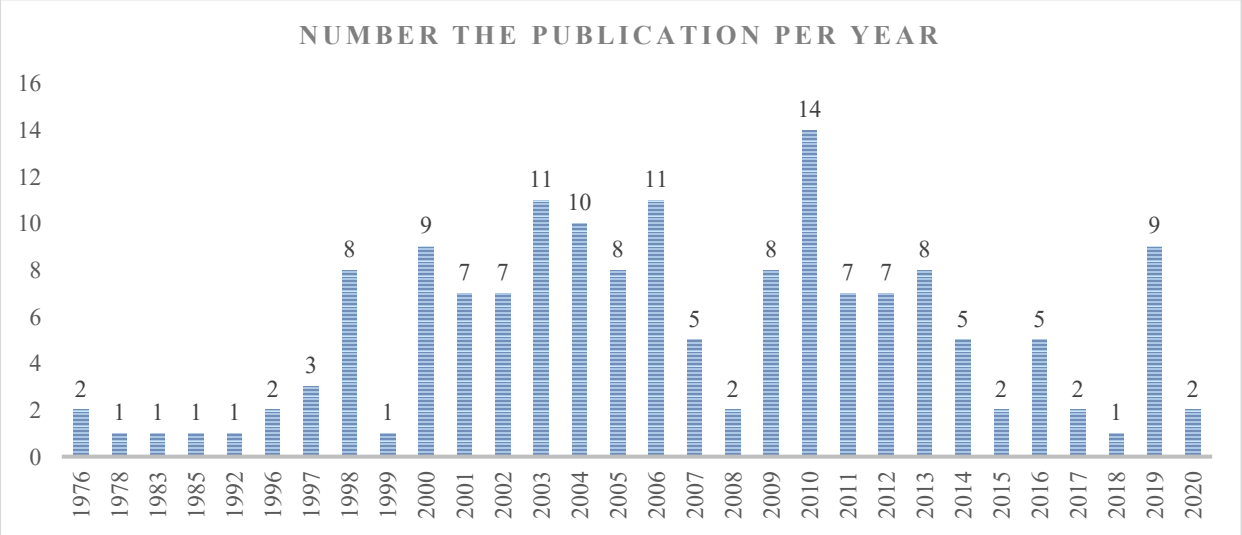

Figure 1 Journal and conference publication per year

The chart above represents the growth of the research on the risk field and risk management related to the supply chain and how it has progressed throughout the years from its start in 1976.

3. Result and discussion

Using the Pareto method, the following chart was made out of the obtained results of the literature review analysis. It presents 20% of the SC risk types with 83% appearance in the treated publications. This analysis shows that there are some risks with high proportions and others with lower ones. A summary of those results is shown in Figure 2.

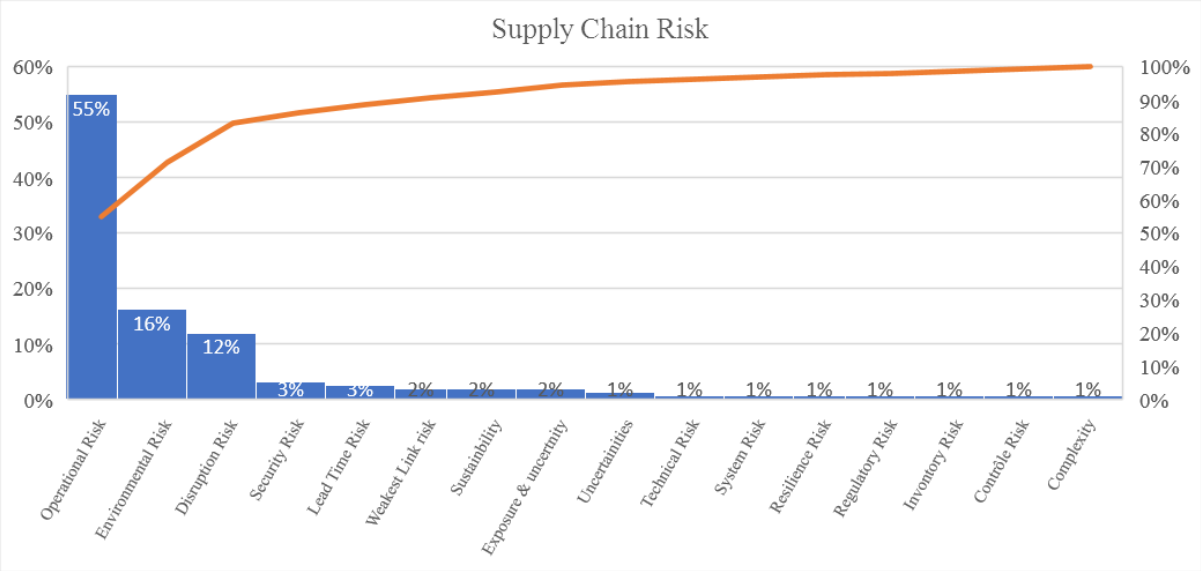

Figure 2 Supply Chain Risk

Based on the outcome of the Pareto diagram, focused on the risk assessment of 83% of the publications covered. These risks are as follows:

a. 55% Operational Risk.
b. 12% Disruption Risk.
c. 16% Environnemental Risk.
d. 17% Other risks

The next step is to define these risks threatening the supply chain, assess them and determine their different sources.

a. Operational Risk:

In literature, operational risk has different definitions: operational risks mainly refer to the risks owing to supply/ demand uncertainties, human mistakes, and accidents that would decrease the service level or threat the normal operations (Choi et al. 2016). Another affirmation by Bhattacharyya et al. (2010) and Lockamy III and McCormack (2010) that operational risk is more about supply-demand coordination and results from inadequate or failed processes, people, and systems. Some other explanations, the high supply and demand uncertainties along the logistic system lead to a high-level operational risk (Lewis 2003) (Cheong and Song 2013). Finally, Chen et al. (2013) term three types of supply chain operational risk as supply risk, demand risk, and process risk.

In this study, the operational risk is cited in 55% of the publications of which 6 % of publications reported operational risk without specifying the type. According to the different definitions of operational risk, it is noted that supply risk, demand risk and process risk are the three main operational risks of the Supply Chain, in turn, they have been composed of micro risks which constitute the original risk.

- **Demand risk**:

Kumar et al. (2010) defined demand risk as the potential deviations of the forecasted demand from the actual demand. Hence, demand risk is any risk associated with the outbound logistics flows (Svensson 2002), and product demand, which can be caused either by inbound disruptions or, e.g. by seasonality, volatility of fads, new product adoptions, or short product life cycles (Johnson 2001).

In this research, demand risk is mentioned on 21% of publications, which explain the demand risk is more critical on operational risk since it touches the outbound logistic flows and items demand that impact the supply chain performance.

- **Process risk:**

Kumar et al. (2010) defined Process risk as the potential deviations from producing the desired quality and quantity at the right time. Hopp and Spearman (2000) have summarized two main types of variability in a manufacturing system. One is process variability which is mainly caused by various detractors such as machine downtime, setups, or operator unavailability. The other is flow variability which is caused by the way the work is

released to the system and the movement between stations. These factors may result in inconsistency in the throughput time, process yield, and product quality which makes the performance of the production process unpredictable and induces process risk (Chen et al. 2013).

This definition makes it possible to classify process risk among the risks to which the supply chain is more vulnerable after having 16% in totality of publications presented process risk.

- **Supply Risk** :

Supply risk is the possibility of an event occurrence associated with inbound supply that may cause failures from the supplier(s) or the supply market, such that the outcome results in the inability of the focal firm to meet customer demand within anticipated costs, or causes threats to customer life and safety (Zsidisin et al. 2004). Supply and demand risk arise from operations external of a focal firm, while the process risk comes from within the company. However, as implied by a system perspective, process risk can also result from external risks. In this research, supply risk comes in a last of operational risks, it presents 12% of publications.

b. Disruption Risk:

Disruption risks have been recognized as a crucial research avenue in supply chain literature (He et al. 2019). (Kleindorfer and Saad 2009) (Tang 2006) (Knemeyer et al. 2009) (Wakolbinger and Cruz 2011) (Craighead et al. 2007) defined supply chain disruptions as "unplanned and unanticipated events that disrupt the normal flow of goods and materials. Similarly, disruptions are unforeseen events that interfere with the normal flow of goods and/or materials within a supply chain [adapted from (Craighead et al. 2007).
Disruption risk is caused by man-made or natural disasters such as terrorist attacks, strikes, earthquakes, and floods (Chen et al. 2013). The difference between operational risk and disruption risk that disruption risk is less controllable while the operational risk is relatively more controllable (Byrne 2007). Furthermore, supply disruptions can be characterized as glitches (Hendricks and Singhal 2003) and may be attributable to many factors including supply market complexities and the importance of the purchased product (Kraljic n.d.). Supply disruptions may have immediate or delayed negative effects on buying firm performance over the short and/or long-term, pending the severity of the disruption and the buying firm's recovery capabilities (Sheffi and Rice Jr 2005).
12% of the authors have introduced a general overview regarding the potential troubles and perturbations that can affect the supply chain without them providing the type of these disorders. However, many details were delivered concerning the environmental risk due to its high criticality.

c. Environmental risk:

Environmental risk sources include any external uncertainties arising from the supply chain such as disruption caused by political (e.g. fuel crisis), natural (e.g. foot and mouth outbreak, fire, earthquake), or social (e.g. terrorist attacks) uncertainties (Jüttner 2005).On the other hand,(Schneider 2011) affirms that climate change is unarguably the greatest challenge of the century and is inevitably affecting society, the environment, and business operations**.** There is a growing recognition that climate change-related events can pose serious financial risks to global industry sectors (Nikolaou et al. 2016). In addition, the costs of disruption due to extreme weather conditions have increased considerably (Halldórsson and Kovács 2010)**.** Moreover, Logistics activities such as transportation and warehousing certainly represent a key component of the environmental sustainability of the entire supply chain **(**McKinnon et al., 2012).

On the other hand, Zhang and Zheng (2019), Hallegatte (2019), and O'Rourke (2014) argued that demand-management risk mainly derives from the risk generated by the perturbation of product demand by environmental changes. However, in this analysis, the environmental risk with its various forms takes the second-ranking in the order of the supply chain risks quoted in this research with a percentage of 13%, and appears over the years from 1998 until 2020. Therefore, this kind of risk continues to exist, and it is necessary to put environmental protection in the first place and take necessary measures to improve it in the supply chain and logistic.

d. Other risks :

Previously in this document, 83% of the SC risks were elaborating, the remaining 17% are minority risks with percentages ranging from 3% to 1%. Firstly, security risk, lead time risk, and weakest link risk represents 3%. In addition, sustainability risk, exposure, and uncertainty represent 2%. Finally, uncertainties, technical risk, system risk, resilience risk, regulatory risk, inventory risk, control risk, and complexity represent 1% of the publications studied. These risks are not cited much in the literature, but this does not take away their criticality. There are, for instance, some publications introducing the uncertainty notion but in a vague way. This risk can be apparent and included in the operational risks or on disruption risk as defined by Christopher and Lee (2004) "Uncertainties (in

demand/supply or lead-time, etc.) increases risks in supply chains"; thus, risk occurs when there is exposure and uncertainty (Holton 2004) (Chiu and Choi 2016) ; (Shen and Li 2017).

Taking a second example of security risk that fits into the disruption risk family and has several sources, such as (Spekman and Davis 2004) defined "The sources of information security risk include individuals within the firm leaking vital information to competitors, system hackers, and weak security/firewalls of members of the supply chain". Significant elements of infrastructure security risks are public and private utility services, for example, waterways, highways, airports, electricity, and communications (Manuj and Mentzer 2008). Taking the last example, weakest link which can intervene in any operation of the supply chain either at the level of purchase, production, distribution, control, etc...; in the same topic, Handfield et al. (2002), Baiman et al. (2004) and Kunreuther and Heal (2004) add "Depending on the product and supply chain characteristics, robustness and/or profitability will be strongly affected by the weakest link in the chain".

Conclusion

Through this paper, we wanted to facilitate for researchers and casual readers the identification and the definition of the SC risks. The obtained results show that the SC risks are tightly linked. First of all, we have the operational risk that appears in the chain of the commodities and supplies purchasing, where threats come from the suppliers, the market or from the fluctuations of the forecasted demand and the reel one, additionally to the changes affecting the product such as the appearance of a new model, seasonality or other product life cycle-related factors. Operational risks take place due to the manufacturing process variability e.g. production line stoppage because of machines breakdown or unavailability of workers and the information flow variability between working stations as well. All those risks threaten the production process, impact the quality, and cause production and shipment delays. Secondly, there are perturbation risks. Those are the external unpredicted risks. They directly or indirectly have an impact on the purchasing, the supply, the demand, and the production in the SC. Many causes are potential in the case of this risk type, the environmental risk for instance due to the severe climate changes, natural disasters, terrorist attacks, political conflicts, pandemics, etc... This generates financial losses to the company, besides the environmental sustainability which is in increased growth. Last but not least we have the various risks which are several but with low occurrence percentages.

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