A LITERATURE SURVEY ON RISK MANAGEMENT IN SUPPLY CHAINS

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Abstract

Adequate functioning of the supply chain is one of the key prerequisites for successful functioning of business activities within contemporary organizations. Globalisation of business activities, related to advances in information technology and its effects on the supply chain activities, may lead to increased risk in any part of the supply chain, especially in terms of the company not being able to optimize its supply chain activities. Failures or inadequacies in any part of the supply chain may result in significant financial or reputational loss for the company. It is therefore crucial for companies to manage its supply chain risks properly. The aims of this paper are: (1) to present a comprehensive overview of literature related to supply chain risk management, based on which aspects of risk management and advances in this area that may be related to supply chain will be evaluated and (2) to give suggestions for improvement and future research in the analysed area. Special accentuation is put on holistic view on risk management in the company, having on mind that this view leads to optimization of risks and adding value to the company.

Key words: supply chains, risk management, holistic view

1. INTRODUCTION

In the era of increased global competition and constant pressure for companies to upgrade their business processes in order to remain competitive, successful functioning of the supply chain represents a prerequisite for business success. On the other hand, external and internal risks companies are faced with are continuously increasing. The impact of risks on the supply chain may lead to its inadequate

functioning and significant reputational or financial losses for companies included in the supply chain. The purpose of this paper is to increase scientific awareness on this topic by giving a literature review and niches for future research. In order to achieve the purpose of the paper, scientific databases like Emerald, ProQuest and Taylor and Francis have been examined by key words, such as: "supply chain risk management", "supply chain risk practices", "supply chain risk". The time criteria for analysed papers has been set to papers published in the time period from 2007-2018. It is important to mention that also several papers published prior to 2007 have been included in this paper due to actuality of knowledge they are representing in the field of supply chain risk management. Paper is divided into following sections: following the introductory notes is the section related to the overview of review and empirical papers from the field of supply chain risk management. Third section of the paper is related to presentation of general terms related to supply chain risk management and typologies of risks in the supply chain. Fourth section of the paper is related to risk identification and measurement and different strategies that may be used in the supply chain risk management. Final section deals with discussion related to conducted literature review, direction for future research and conclusions.

2. LITERATURE REVIEW OF RESEARCH RELATED TO THE SUPPLY CHAIN RISK MANAGEMENT

In the last decade, parallel with the increase of external and internal risks companies are faced with, there is a growing body of literature related to supply chain risk management. As it has been mentioned in the Introduction, scientific databases Emerald, ProQuest, Taylor and Francis and IEEExplore have been examined in order to find papers dealing with this topic. In this section a review of scientific papers oriented on the topic of supply chain risk management will be presented. Structurally, there are two subsections: one oriented on overview of scientific papers that are categorized as literature review and second, oriented on presentation of empirical research in the field. Throughout this section results and conclusions of these papers are presented. The discussion of results is presented in the section Discussion and conclusion.

The paper of authors Ho et al (2015) is related to analysis of papers related to supply chain risk management in the time period 2003-2013. They found that the number of papers published in this time period has constantly been increasing, reaching its peak in year 2013.

Prakash, Soni and Rathore's (2017) paper presents a systematic literature review on supply chain risk management covering time period from 2004-2014 and findings of the research have indicated a significant rise in the analysed period, especially after year 2005. The analysis method was content analysis and its performance resulted in the conclusion that firms have most benefit from supply chain risk management implementation when it is implemented on the supply chain level and strategically managed.

Fan and Stevenson's (2018) literature review have conducted a descriptive, thematic and content analysis of articles related to supply chain risk management in

time period 2000-2016 and their analysis also supports findings cited from previous studies that the body of literature on this topic is in constant growth. Their analysis also indicates that most of the research is conducted in more developed countries. One of the interesting findings of this research is that the papers they have analysed are oriented more on buyer's perspective than on supplier's.

Zhu, Krikke and Caniels (2017) have analysed and categorized articles in time period from 1998-2015 and have applied the contingency analysis on these papers. Unlike previous studies of this kind, their research does not support fully the hypothesis that number of literature in the field is in constant growth, but that in years 2014 and 2015 there is a slight decrease when compared to year 2013. This difference in comparison to previous papers may be the result of different databases search. As for the analysis Zhu, Krikke and Caniels (2017) have conducted related regarding to the themes of the papers, they found that most researched themes are: risk sources in the supply chain, scopes of supply chain risk management, dimensions and scopes of performance related to supply chain risk management.

Lavastre, Gunasekaran and Spalanzani (2014) have conducted a research on the effect of firm characteristics, supplier relationships and the used techniques on the supply chain risk management. The research sample consisted of French industrial firms operating in the field of industrial sector. The results of the research indicate supply chain risk management is not related to managers age, gender, experience in the firm and previous professional experience. The length of partner relationships is very important for supply chain risk management due to the fact that length of this relationship influences the methods used in supply chain risk management. It is also proved that in order for supply chain risk management to be effective, it needs to be considered at the strategic level and it requires long-term information and strategic information exchange with partners. The results of the research have also indicated that the methods based on collaboration with partners are the most effective when companies are trying to implement supply chain risk management.

According to research conducted by Chen, Sohal and Prajogo (2013) managing supply chain partners is important for adequate functioning of the business process and supply chain, but the process risk, that is a result of the internal processes within a firm, has the severest direct effect on supply chain performance and most of the external risks, both from the supply and demand side, are mediated through the process risk.

Thun, Druke and Hoenig (2011) have used the data obtained by German automotive industry companies in order to address the key drivers of the supply chain risks and adequacy of supply chain risk management instruments for creating a resilient supply chain. The results of the research are supporting the hypothesis that small and medium-sized enterprises are regarding their supply chain as more vulnerable than the large scale enterprises. Also there is evidence that small and medium-sized enterprises are more strongly affected by the developments towards globalization and lean supply chains and that medium-sized companies are rather reactive in usage of risk management instruments when compared to large companies that are proactive.

Grötsch, Blome and Schleper (2013) have conducted research on the antecedents of a proactive supply chain risk management from the contingency perspective. The

results indicate that management control systems, decision makers' cognitive style and the buyer-supplier relationship directly influence the proactiveness of the supply chain risk management.

Bandaly, Satir and Shanker (2014) have proposed an integrated approach to supply chain risk management due to their conclusion that this emerging field is lacking integrative approach across different disciplines. Main contribution of the model is collaboration of supply chain members and functional units of these members. Also financial and operational risk management decisions are integrated in order to minimise the expected total opportunity cost and the model is proved to be superior to previous sequential models and more robust for the changes from the business environment. Machowiak (2012) states that the aim of every risk management process, including supply chain risk management, is its integration with company's strategy what is also in line with risk management standards and alliance its importance for holistic view of risk management.

Truong and Hara (2018) have used structural equation modelling, multiple-group analysis and theory of goods-dominant logic and service-dominant logic in order to compare the influence of different risks on the manufacturing oriented companies and service oriented companies from the supply chain perspective. The results of the research have led to conclusion that manufacturing oriented companies are exposed to operational and demand risk and that they have significant impact on performance of the companies. Information risk is an opportunity for manufacturing companies to improve the supply chain risk management. As for service-oriented companies the results have indicated that they are dominantly exposed to the supply risk and that its adequate management may influence the performance of these companies.

Kwak, Seo and Mason (2018) have proposed and validated a theoretical model that is designed to test whether supply chain innovation has a positive effect on risk management capabilities and to test whether these capabilities are improving competitive advantage of firms. The findings of the research indicate that innovative supply chains indeed do have a positive impact on enhancement of firms' risk management capability resulting in increase of competitive advantage.

Durach and Machuca (2017) have used structural equation modelling method on the sample of 229 manufacturing companies from Austria, Germany and Switzerland in order to test whether interpersonal relationships have positive impact on company's risk resilience, but no significant relationship has been confirmed. Trkman, de Oliveira and McKormak (2016) have used the case study method in order to research how different attitudes towards supply chain risk management may lead to greater value creation for members of the supply chain. The results are indicating that the most of the companies have the attitude that risk avoidance is the primary goal of supply chain risk management and not values creation. In continuance to this finding, risk avoidance does not lead to creation of extra value as the attitude of value generation itself.

Andjelković (2017) has done a research on the connection of proactive approach towards supply chain risk management and supply chain vulnerability on the sample of Serbian companies. The conclusion is that the companies from the sample of very unaware of supply chain risk management benefits and they do not practice a

proactive approach and also a high level of vulnerability in supply chains has been established leading to conclusion that indeed a proactive approach might be helpful to reduce the vulnerability of the supply chain.

Table 1 shows an overview of the empirical researches analysed in this paper. To compare this researches authors have used 4 basic elements in each paper: sample, respondents, data collection and methods. Studies of supply chain risk management have mostly been conducted on the sample of dominant industries in each country, except Serbia where the research included large enterprises irrespective of the activity. A good example for this statement is Germany. Supply chain risk management in Germany is researched on the key sector of this economy - automotive industry. In this kind of research, questionnaires are the most used method for data collection. Likert scale with five or seven point, from "strongly disagree" to "strongly agree", is used to help participants express their opinion on a claims related with the risks in the supply chain. None of this research points out the reasons for using a particular scale. Exceptions are the research from Kwak, Seo and Mason (2018), they used seven, instead of a five-point scale, to reduce attenuation problems caused by range restriction. A Likert scale is a quick and efficient way to collect data. However, it has also disadvantages. Firstly, answers could be influenced by answers on previous questions. Secondly, respondents might avoid choosing the extreme options (strongly disagree or agree). In order to avoid the above disadvantages, a better way to collect data might be conducting interviews. Such method had been used by Grötsch, Blome Grötsch and Schleper (2013). Each of the conducted interviews lasted between 30 and 60 minutes. They identified themes in groups of words and interpreted co-occurrences as associations of underlying concepts. Respondents were mostly supply chain, production and purchasing managers. The authors expected that this type of respondents should have the knowledge regarding the overall operations of the supply chains of their firms. On the other hand, Trkman, Oliveira and McKormak (2016) have include in their research only participants with a master`s degree in supply chain management. Andjelković (2017) concludes that managers have problems to recognize supply chain risks and that could be a limitation in the research. Besides descriptive statistics, the most widely used method for testing the hypothesis has been structural equation modelling.

Table 1. Overview of the empirical research

Author	Year	State	Sample	Respondents	Data collection	Methods
Thun, J.H., Druke, M., Hoenig, D.	2011	Germany	67 automotive industry companies	respondents who are in charge of supply chain management or logistics	Questionnaire; five-poin Likert scale from "strongly disagree" to "strongly agree";	Descriptive statistic
Chen, J., Sohal, A.S., Prajogo, D.I	2013	Australia	203 manufacturing companies	supply chain managers, production managers or other senior managers	Questionnaire; seven-poin Likert scale from "strongly disagree" to "strongly agree"; respondents choose their most important product as the context for their survey response	SEM (Structural Equation Model)
Grötsch, V.M., Blome, C., Schleper, M.C.	2013	Germany	63 firms in the automotive industry	senior managers; chief purchasing officer or senior vice president of purchasing, director of purchasing or head of supply chain risk management	interview lasted between 30 and 60 minutes; interviews were recorded; transcripts were evaluated;	identified themes in groups of words and interpreted co-occurrences as (relational) associations of underlying concepts; SEM (Structural Equation Model)
Lavastre, O., Gunasekaran, A., Spalanzani, A.	2014	French	164 people in 41 different French-based companies in a variety of manufacturing industries	general Managers and logistics and supply chain managers	Questionnaire; seven-poin Likert scale from "strongly disagree" to "strongly agree";	Descriptive statistic
Trkman, P., Oliveira, M., McKormak, K.	2016	Brazil, Canada and the USA	89 participants	Participants in those holding with a master's degree in supply chain management	Questionnaire; seven-poin Likert scale from "strongly disagree" to "strongly agree"; case study	descriptive statistics, cluster analysis
Durach, C.F., Machuca, J. A.D.	2017	Austria, Germany and Swizerland	229 manufacturing firms	supply chain managers, production managers	Questionnaire; seven-poin Likert scale from "strongly disagree" to "strongly agree";	SEM (Structural Equation Model)
Andjelković, A.	2017	Republic of Serbia	52 large companies	company managers	Questionnaire; five-poin Likert scale from "strongly disagree" to "strongly agree";	Descriptive statistics, the chi-square test, and cluster analysis
Truong, H.Q. Hara,	2018	Vietnam	283 companies in the construction sector	managers, co-ordinators	Questionnaire; five-poin Likert scale from "strongly disagree" to "strongly agree";	SEM (Structural Equation Model)
Kwak, D., Seo, Y., Mason, R.	2018	South Korea	174 manufacturers and logistics intermediaries	global logistics or supply chain management (SCM) experts in the companies	Questionnaire; seven-poin Likert scale from "strongly disagree" to "strongly agree";	SEM (Structural Equation Model)

Source: authors

3. GENERAL OVERVIEW OF SUPPLY CHAIN RISK MANAGEMENT

3.1. Supply Chain Risk Management

According to Vahrenkamp (2007) basic aim of supply chain management is improvement of supply chain performances, efficiency and efficacy of creating added value to the process. Adequate implementation and supply chain management is requiring establishment of risk management and hence insurance of higher security level for all participants of the supply chain. Nowadays the complexity of supply chain is constantly increasing due to stronger integration of companies within the supply chain making the management of firm-supplier-customer link more complex (Kliemann Neto et al, 2011).

Contemporary supply chain is exposed to many kinds of risks, where risk in the supply chain may be defined, according to Zsidisin and Ritchie (2008), as "the probability of an incident associated with inbound supply from individual supplier failure or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet the customer demand or cause threats to customer life and safety". Supply chain risk management is a part of the supply chain management encompassing all strategies and measures, knowledge, institutions, processes and technologies that are appropriate and adequate technically, personally and organizationally for risk mitigation within the supply chain (Kersten et al, 2007).

Hofmann et al. (2014) state that inadequate supply chain risk management may have serious consequences on sustainability of the company. They state that ordinary supply chain risk path, i.e. supply chain risk sources are leading to disruptions and damage to the local firm, while supply chain sustainability risk path is leading to the stakeholder reaction thus imposing threat to the local firm.

Vahrenkamp (2007) argues that when compared to risk management on the level of an individual enterprise, risk management in supply chain is characterized by the following:

- The framework for risk management activities is expanded due to the fact that it is applied on the level of whole supply chain,
- There are information symmetries between individual companies and supply chain,
- Risks in the supply chain are not equal to the sum of all risks of individual companies within the chain,
- Having on mind that one company may be a part of several supply chains, their readiness for adjustment to special standards of supply chain is limited,
- International supply chains are expanded through several countries so there is a possibility that different national requirements are imposed on companies related to risk management.

3.2. Supply Chain Risk Typologies

In order for companies to be able to manage risk, they firstly have to recognize the risk, i.e. be able to put a certain risk into a certain category. It is therefore important to use a typology of risks present in the supply chain. Kersten, Hohrath and Winter

(2008) argue that when applying the definition of risk, i.e. the probability of occurrence of a certain event and the resulting damage, on to the supply chain, the risk of the supply chain is representing the estimated damage with the probability of its occurrence and its effects on more than one company within the supply chain, where the cause of the event may be within the company, supply chain or its environment. In this way, risks in supply chain are typically encompassing more than one company within the supply chain. According to Kersten, Hohrath and Winter (2008) risks that are occurring in the supply chain may be characterized by different features, such as location of occurrence and location of its effect within the supply chain, affected managerial level or potential damage amount. Named, but also some other features, may be used for classification of risks within the supply chain, but also for identification of appropriate measures for risk classification.

Cavinato (2004) is categorizing risks in the supply chain in the five subchains or networks as:

- Physical – the actual movements and flows within and between firms, transportation, service mobilization, delivery moment, storage and inventories,
- Financial – the flows of cash between organizations, incurrence of expenses and the use of investments for the entire chain or network and settlements,
- Informational – the processes and electronic systems, data movement triggers, access to key information, capture and use of data, enabling process, market intelligence,
- Relational – the appropriate linkage between a supplier, the organization and its customers for maximum benefit, includes internal supply matter relationships throughout the organization,
- Innovational – the process and linkages across the firm, its customers, suppliers and resource parties for the purpose of discovering and bringing to market a product, service and process opportunities.

Tummala and Schoenherr (2011) have presented the following supply chain risk categories and their triggers as:

- Demand risks – order fulfilment errors, inaccurate forecasts due to longer lead times, product variety, swing demands, seasonality, short life cycles, small customer base, information distortion due to sales promotions and incentives, lack of the supply chain visibility, exaggeration of demand during product shortage,
- Delay risks – excessive handling due to border crossings or change in transportation mode, port capacity and congestion, custom clearances at ports, transportation breakdown,
- Disruption risks – natural disasters, terrorism and war, labour disputes, single source of supply, capacity and responsiveness of alternate supplies,
- Inventory risks – costs of holding inventories, demand and supply uncertainty, rate of product obsolescence, supplier fulfilment,
- Manufacturing (process) breakdown risks – poor quality, lower process yields, higher product costs, design changes,
- Physical plant risks – lack of capacity flexibility, cost of capacity,

- Supply (procurement) risks – quality of service, supplier fulfilment errors, selection of wrong partners, high capacity utilization supply source, supplier bankruptcy, rate of exchange, percentage of a key component or raw material procured from a single source,
- System risks – information infrastructure breakdowns, lack of effective system integration or extensive system networking, lack of compatibility in IT platforms among supply chain partners,
- Sovereign risks – regional instability, communication difficulties, government regulations, loss of control, intellectual property breaches,
- Transportation risks – paperwork and scheduling, port strikes, delay at ports due to port capacity, late deliveries, higher costs of transportation.

Kumar, Tiwari and Babiceanu (2010) have presented a classification of operational risks related to the supply chain into internal and external risks. Internal risks are the demand risk, production and distribution risk, supply risks. External risks are natural risks, the risk of political systems, competitor and market risk.
Hotwagner (2008) offers a following risk categorization: on individual and total risk, where individual risk is the effect of individual decisions within the company or disruptions in business activity resulting from internal or external sources, such as price risk, transport risk or quality risk. Total risk is the correlation of individual risks that may mutually increase its effect. Thiemt (2003) argues that in order for a company to succeed special accentuation must be devoted to the category of total risk. Also, in order to quantify the present risks, it is necessary to calculate the risk value that is the result of risk and the probability of its occurrence (Hotwagner, 2008).

From the literature that has so far been analysed, it is evident that there are many different categorizations of supply chain risks, but it is evident that they are overlapping and that many authors are finding similar characteristics of supply chain risks. Also, it may be stated that with the expansion and introduction of new technologies into business activities and into the supply chain, the exposure of the supply chain to the risk becomes increased. It is therefore of extreme importance for companies belonging to the supply chain to adequately manage risks.

4. MANAGING SUPPLY CHAIN RISKS

4.1. Risk Identification and Measurement

Elleuch et al. (2016) argue that there are two basic factors that are influencing performance and stability of the supply chain, namely resilience and vulnerability of the supply chain. Generally speaking, vulnerability relates to the intensity of the impact that an external threat is representing to the company, while resilience is the ability of the company to proceed its functioning regardless of threats that are imposed on it. According to Svensson (2000) the vulnerability of the supply chain increases with its increasing uncertainty. Tummala and Schoenherr (2011) have introduced a systematic and structured approach to enumerate the supply chain risks and in order to evaluate their severity and likelihood and based on this evaluation to propose risk mitigation strategies. The process consists of risk identification and risk measurement,

followed by risk assessment and evaluation, risk mitigation and contingency plans and the final step is risk control and monitoring. Sanvedi, Jain and Chan (2013) have used the fuzzy analytical hierarchy process and fuzzy TOPSIS in order to quantify the supply chain risks based on determination of the risk index. The risk index is generic in its nature and the recommendation of the authors is for companies to regularly assess it in order to decide which area of the supply chain requires attention due to the risk exposure. Goh, Lim and Meng (2007) have developed a stochastic model for risk management in global supply chain networks. The model is based on Cohen and Huchzermeier's model and is extended by incorporation of new properties. This improved algorithm can be used for smoothing of nonsmooth functions for rapid convergence and is therefore applicable for solving practical supply chain network problems.

Xia and Chen (2011) argue that based on risk features, a risk analysis and risk measurement are performed, resulting in decision on strategies how to deal with risk. These strategies encompass separation, transfer of risks to third party, weakening, avoidance of risks or insurance. Xia and Chen (2011) have therefore developed a comprehensive decision-making model for risk management in supply chains that is based on discovering interrelationship between dual cycles: the operational process cycle and the product life cycle. The authors have used analytical hierarchy method in order to optimize decision making in the area of managements selection of risk management methods and tools.

4.2. Supply Chain Risk Mitigation Strategies

Aqlan and Lam (2015) are dividing risk response strategies onto:

- Risk avoidance – strategy that is oriented on zero residual risk, i.e. complete avoidance and elimination of risk root causes and consequences. It is suitable in cases when risk has high probability of occurrence and high impact and when risk is critical and can stop the business activity. This method may involve change in method of operation, plan or redesign of the supply chain.
- Risk reduction – by using this strategy risk is reduced but not fully eliminated. It is suitable in cases when risk has high probability of occurrence and low impact and especially in handling operational risks of daily issues. Examples of risk reduction practical usage are including redundancy, more quality tests, better tools and operator training.
- Risk transfer – is situation in which risk is transferred to third party despite the fact that residual risk may exist. It is suitable for application in cases when risk has low probability and high impact, such as natural disasters or terrorist attacks. Common methods here include insurance and contracts.
- Risk acceptance – is suitable when risk has low probability of occurrence and low impact and when cost of avoiding, reducing or transferring risk is much higher that its expected impact. It is important to mention that residual risk remains the same as before using this method and usual representative of this method is formulation and application of contingency plans.

- Ignoring risk – is related to the situations when risks are ignored and not identified nor studied. The ignorance of risks can be a cause of certain risks occurrence.
- Risk exploitation- is related to situations when risks are assumed to have a positive impact and are used in order to gain benefit from risky events.

Ambulkar, Blackhurst and Cantor (2016) have hypothesised that the risk mitigation competency is related to manager's absorptive capacity that is dependant of knowledge acquisition, knowledge dissemination and knowledge usage. The greater the absorptive capacity, the greater is individual's risk mitigation competency. Micheli, Mogre and Perego (2014) are discussing the importance of selecting appropriate risk mitigation measure for supply chain risks and are offering a quantitative decision support system for selecting risk mitigation methods. The system is formulated according to stochastic integer linear programming framework. The formulated analytical approach is appropriate both for academics and practitioners because the model is based on the expected impact of alternative sets of mitigation measures based on the indicator of supply chain risk profile.

5. DISCUSSION AND CONCLUSION

Based on the analysis of the available literature it is evident that supply chain risk management is an area of research interesting both to scientists and practitioners due to its impact on success of contemporary organizations. In order for companies and whole supply chains to remain competitive and sustainable in their business activities, it is necessary that the supply chain increases its resilience on internal and external factors that may have impact on its functioning and threaten the relationships among partners in the supply chain, but also the possibility of the supply chain in continuation of its business activities. The first part of the paper has been oriented on definition of supply chain risk management and presentation of diverse typologies of supply chain risks that have been identified within the analysed literature. The analysis has indicated that there are more typologies based on their authors scientific interests, but there are many overlappings in these typologies. Basically, risks that are affecting the supply chain may be internal or external and it is of extreme importance for the companies within the supply chain to identify and measure these risks. In this paper the authors have also tried to present an overview of contemporary scientific solutions that have been used in order to quantify the risks or to decide which risk mitigation strategy to use. Also, an overview of literature related to empirical research has been presented. It is evident that there is less literature regarding the supply chain risk management that is empirical in its nature. It would therefore be interesting for future research to be oriented on practical research on supply chain risk management in different countries or different types of supply chains (different sizes, different industries, etc.). Also, a very meaningful contribution for the future research would be to analyse in more detail the holistic view on supply chain risk management and how proactive risk management may not only be used in order to resolve negative situations, but to actively manage positive exposures to risks and to research how proactive risk management may add value to the supply chain.

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