INFLUENCE OF TRANSPORTATION SERVICES PERFORMANCE ON SUPPLY CHAINS SAFETY

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Abstract

In the presented paper, authors focus on the investigation of the concept of supply chain safety in the relation to the risk assessment in transportation process performance. Thus, the disruption event definition is explained and the literature review on supply chain safety is given. The case study conducted in the transportation company presents risk analysis in the context of supply security assessment. The work ends up with conclusions and directions for further research.

Keywords: Supply chain, safety, risk, transportation process performance

1. INTRODUCTION

The current economic environment, in which supply chains perform their functions and tasks, is characterized by a high dynamics of change. The constantly changing customer requirements, technological development, as well as social and legal conditions accompanying business processes have an impact on this dynamics. These high dynamics of changes characterizing current conditions of material flows along the supply chain makes the identification and risk management occurring in logistics processes ever more important in the business planning process. The importance of this approach is now confirmed e.g. by a lot of research work conducted in the field of risk management in the supply chain. And while only a few years ago, when investigating the risk in supply chains, the authors focused exclusively on the chemical and nuclear sectors, today the risk assessment becomes a popular tool supporting the decision-making processes of managers from all sectors of the economy. This is due to the fact that currently managers want to create not only lean and flexible supply chains, but above all safe and reliable ones.

Following this, the purpose of the article is to present the concept of supply chains safety and to analyze the influence of undesirable events identified for the transport process performance on supply chain security. As a result, in the next section, there are presented the most important theoretical issues regarding risk and safety in the supply chain. Later, the results of research carried out in a selected transport company were presented. The carried out analysis was aimed at identifying adverse events in the transport service process performance and assessing their impact on supply security. At the end, final conclusion and summary were presented.

2. SUPPLY CHAIN SAFETY

Supply chain vulnerability, resilience, risk and safety have become a field of research over the past 15 years, and a number of definitions have been made [1,2]. In order to properly explain these concepts, first the disruption definition and disruption profile should be explained. Any threat which could cause an interruption in the flow from raw material to the end user is a supply chain risk and any interruption in the flow of material is a supply chain disruption [3]. Disruptions can be divided into three categories to facilitate estimating their likelihood [2]: natural disasters, accidents (faults, failures), intentional attacks and the methods of estimating their likelihood are different. Moreover, based on [4,5,6], main supply chain disruptions may arise from such sources as: natural disasters (e.g. earthquakes, cyclones, epidemics), terrorist incidents, accidents (e.g. fire

of supplier's factory), or operational difficulties (connected with e.g. variability in supply, demand uncertainties, or price variability).

Svensson in his work [7] considers them in terms of analysis inbound logistic vulnerability and divides them into direct and indirect sources of disturbance. Moreover, following [8, 9], terrorist attacks, wars, politic problems or natural disasters should be considered as risks external to the supply chains. Risks related to processes and activities should be considered as internal to the company, and risks coming from the market or from suppliers should be considered as external to the company and internal to the supply chain. Treating supply chain disruptions as unexpected events occurrence, they can be described as having uncertainty in logistic process operation [10]. Uncertainty in the process is connected with definition of perfect operation of logistic system and may be described by 7R formula: Right product, Right quantity, Right quality, Right place, Right time, Right customer, Right price. Thus, different aspects are taken into consideration, such as [10]:

- time (in the sense of duration of activity/process, starting/ending moment of activity realization, frequency of activity/demand occurrence),
- quantity (of supply, demand or physical transfer of goods),
- location/place (where activity starts/ends),
- quality (of service/products),
- cost (fluctuation, occurrence.

However, not every disruption occurrence leads to logistic system failure appearance. The critical factor which determines the logistic system failures is time. In a situation, when disruption (connected with e.g. improper delivery quality/quantity, improper location) occurs, there is a necessity to find out if we have enough time to correct the problem. When the spare time let us to remove the disruption - logistic system is not defined as failed. In other words, time redundant system has the ability to tolerate interruptions in their basic function for a specific period of time without having the negative impact on the system task performance.

It is therefore necessary to define the supply chains safety. According to [11], safety can be treated as a sense of certainty that the state of threat will not occur as a result of various random events, both predictable and unpredictable. In the aspect of crisis management, the following are safe: an individual, a social group, a nation, an institution, a state, when they do not feel threatened for their being and their existence, are calm and confident in their interests, do not need someone to look after them [12]. In terms of system analysis, safety is captured in two dimensions [13]:

- as the property of an object characterizing its resilience to dangerous events (threats),
- the system's ability to protect internal values against external threats.

Thus, safety means absence of critical/dangerous events while security is focused on protecting system environment against the effects of these damages. Safety is measured generally by risk - two-dimensional combination of probability of an undesirable event and possibility of loss (consequences). Risk assessment consists on process of risk identification related to threat, includes its possibility (likelihood or probability), impact, and consequences [14].

One of the more frequently cited definitions of supply chain safety is that proposed by [15] - "*managing supply chain safety means applying policies, procedures and technologies to protect supply chain resources (products, equipment, information and personnel) against theft, damage or terrorism and preventing the entry of smuggling and unauthorized people or weapons of mass destruction into the supply chain*". This definition is multidimensional and refers to both material and information flows, being carried out in the logistics chain. A similar context of understanding the concept of supply chain safety is presented in [16], where the authors define three groups of tasks related to the safety of supply chains including physical security, information security, and freight security. Later, the authors of [13] postulate that ensuring the desired level of safety of the logistic network means the necessity of (1) quality management (goods, services), (2) reliability management

(technical means, devices), (3) risk management of external threats (vulnerability, resilience of network elements). However, the author in [12] defines the security of the logistic system as a non-threated state of logistic objects, connections (external and internal supplies), an environment and users. The analysis and classification of the main threats to the supply chain safety is presented in [12].

3. IDENTIFICATION OF ADVERSE EVENTS OCCURRENCE IN TRANSPORT SERVICE PERFORMANCE

Transport is a key element of the material flow process between individual links in the supply chain. The correctness of its implementation has a significant impact on the parameters of the assessment of the delivery performance. At the same time, it is the process most exposed to the occurrence of numerous adverse events. This is due to two main reasons:

- the transport process is carried out with the use of external infrastructure, which is shared with other users, whose behavior cannot be controlled; also the road infrastructure itself is not under the control of the enterprise, which limits its impact on the condition and availability of the infrastructure elements used,
- the transport process requires a high degree of coordination of activities, as it combines the activity of at least three links in the supply chain - the carrier, the sender of the cargo and the recipient of the cargo.

There are a lot of publications on safety and hazards in various modes of transport (e.g. [17-22]. However, only a few publications focus on the assessment of operational risk related to freight transport performance [23]. Meanwhile, research conducted in a road transport company shows that when assessing risks in the cargo transport process performance, one cannot focus only on adverse events related to classic transport safety (reduction of accidents). Adverse events affecting the safe and timely delivery of transport should be identified much more widely.

The research was carried out in a road transport company, which currently has a fleet of 60 own vehicles and a crew of 80 professional drivers. The conducted analysis was based on expert opinions. The following employees were asked to be experts: the manager of the forwarding department, the transport manager and the manager of the HR department. The identification of adverse events gave the possibility to define 20 adverse events that were classified into 5 groups. These events are related to:

- Group 1 - driving fluency/safety,
- Group 2 - technical condition of vehicles,
- Group 3 - organization / implementation of transport order service,
- Group 4 - drivers,
- Group 5 - cargo.

The identification of events was carried out in the context of their impact on the achievement of the assumed goal for transport service. This objective was defined as providing timely and complete delivery of undamaged cargo in accordance with the assumed implementation costs. **Table 1** presents the identified adverse events with an indication of their impact on the final result of the process.

The results of the analysis presented in **Table 1** prove that for the 20 identified adverse events only 7 events can be included in the risk related to road safety. Other adverse events result mainly from errors in planning and organization of the transport service process performance. This gives a wide range of opportunities to improve the service process, in particular when the source of danger is the company's own resources or applicable procedures and standards. In this situation, the managerial staff may take actions aimed at improving the company's internal procedures and implementing the scenario planning. However, the basis for these activities has to be a multi-criteria risk assessment, which will allow a comprehensive analysis of the conditions for the implementation of the service process.

Table 1 Adverse events that occur in the process of transporting cargo in the examined enterprise [own study]

Group	Adverse event definition	Type of influence
G1	An accident on the route of third parties	Delivery delay
	Accident in which our driver participated	Delay of delivery, damage / loss of cargo
	Increased vehicular traffic on the route causing a congestion	Delivery delay
	Route maintenance	Delivery delay
	Third party intrusion into the vehicle	Delay of delivery, damage / loss of cargo
G2	Electrical system defect	Delivery delay
	Vehicle failure	Delay of delivery, increase of operational costs
G3	Lack of proper documentation	Increase of operational costs
	Exceeding the driver's working time limit	Delay of delivery, increase of operational costs
	Incorrect place of loading / unloading indicated	Delay of delivery, increase of operational costs
	No guarded parking places along the route, which meet the requirements of the company	Damage / loss of cargo
	Poor time management	Delivery delay
G4	A sudden driver's absence	Delivery delay
	Lack of driver with the required permissions	Delay of delivery, increase of operational costs
	Drunk driver	Damage/loss of cargo, increase of operational costs
	Failure to comply with traffic regulations by the driver	Damage of cargo, increase of operational costs
G5	Theft of cargo	Loss of cargo
	Inadequate securing of cargo	Damage / loss of cargo
	Exceeding the permissible payload of the vehicle	Loss of cargo, increase of operational costs
	Incorrect load labeling	Damage / loss of cargo

4. CONCLUSIONS

The classic risk analysis performed for road transport focuses primarily on negative events concerning road safety. The subjects of the analysis are therefore road accidents and their causes. The identification of adverse events for the transport service process proved that when assessing the risk in the context of the reliability of the supply chain and the safe achievement of the assumed goal for the transport service process, the analysis cannot be limited only to the issue of road safety. The safety and reliability of the transport service process is influenced by the correctness of the current procedures and planning, taking into account the possibility of adverse events occurrence.

When assessing the risk in the context of the supply chain, the attention of decision-makers is not focused solely on the issues related to possible road accidents. Transport safety is only an element ensuring achievement of the assumed goal defined by the 7W rule. For this reason, when analyzing the risk for handling transport orders, they are evaluated through the prism of ensuring a safe and reliable delivery. It is a business approach that dominates in supply chain management.

The results presented in this article are the part of a broader study on the design of safe and reliable supply chains. The next stage of the work will be connected with the identification of factors characteristic for various sectors that influence the risk assessment for material flows in the industry supply chains.

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