2-DIMENSIONAL DECISION SPACE IN THE RISK ASSESSMENT PROCESS IN ROAD TRANSPORT

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Abstract

Transport is the main process connecting all the participants of the supply chain. Without it, transferring the load from the supplier to the client would not be possible. At the same time, however, it is a process that is highly prone to the occurrence of undesirable events. The aim of the article is to present the method for assessing operational risk in road transport basing on a 2-dimensional decision matrix. The research conducted by the author among road transport companies indicates, that the managers planning transport service operations take into account mostly the group of transported products and the customer segment. These are the elements that strongly influence both the frequency of undesirable events and their consequences. The article presents the results of risk assessment conducted in line with this approach. The analysis was prepared basing on real data from the researched transport company. The managers responsible for the transport process in the company took on the position of experts. The assessed risk indicators for different classes of transport services prove the proposed approach to risk assessment in road transport to be right.

Keywords: Risk assessment, decision matrix, road transport, logistic service

1. INTRODUCTION

The increasing significance of risk for companies participating in materials outflows in supply chains has led to a new concept of Risk Supply Chain Management *(RSCM)*. This concept is becoming increasingly popular, which is manifested in an increasing number of publications on the subject. Research conducted by Ho [4] and Choi [3] confirms it. The authors of both publications point out a significant increase in the number of publications on RSCM - from 44 in 2006 to 239 in 2015. Among the publications on risk in supply chain there is research whose authors distinguish between operational risk and strategic risk (e.g. [2, 3, 7-9]). The operational risk management is then strongly connected to the operational decisions and planning the outflows in the logistic network [7]. Within the operational risk, Chen has distinguished 3 groups [2]: (1) delivery risk; (2) demand risk; (3) process risk.

It needs to be pointed out, though, that the publications pay too little attention to the operational risk in the transport process. The results of research in this field should be described in articles on delivery risk or process risk. However, the analysis of the publications in this field proves, that:

- The risk connected with deliveries is analysed mostly in the aspect of potential deviations in incoming deliveries connected with time, quality and quantity, which might arise from disturbances. The discrepancies in the deliveries assessed are affected by limited efficiency of the supplier and increasing demand risk [6]. The analysed factors that influence the efficiency of the supplier are mostly: limited production capacity, lack of proper quality control, bottlenecks in the production process and machine damage [10]. This is proved by research conducted by AMR [1], where it is stated that failures at the suppliers' end are the most important risk factor.
- Process risk is described as a potential variance from producing the required quality and quantity of goods in proper time [6]. There are many varieties of that risk in different production systems. Hopp and Spearman [5] distinguished two main types of variability in the production system, which affect the extent

of the risk - (1) process variability (caused by factors such as machine shutdown, wrong configuration, unavailability of the operator) and (2) flow variability (caused by the way works are completed in the system).

The operational risk, which is the scope of the research conducted within the SCRM concept, concerns mostly the risk connected with production process and the so-called supply risk, which refers to the availability of the products within the delivery. Literature review prepared by Ho [4] clearly proves, that in the SCRM concept the main focus of the researchers is on risk factors connected with demand, production and deliveries (supply). Significantly fewer authors raise in their research issues of risk connected with physically moving the load, even though transport is the main process connecting all the participants of the supply chain. Without it, transferring the load from the supplier to the client would not be possible. At the same time, however, it is a process that is highly prone to the occurrence of numerous undesirable events. More than anything, the source of hazards stems from the need to coordinate at the same time at least 3 subjects (the carrier, the sender and the recipient of cargo) and the need to make use of the existing external infrastructure together with the other transport network users.

Due to this fact, the aim of this article is to present the method for risk assessment basing on a 2-dimensional decision matrix. The research conducted by the author among road transport companies indicates, that the managers planning transport service operations take into account mostly the group of transported products and the customer segment. In order to realise this aim the following structure of work has been adapted. Point 2 briefly describes the proposed approach to risk assessment basing on the ISO 31000 guidelines. The next point shows selected results of risk analysis conducted for a transport company. The conclusions that followed, including in particular the influence of the type of both customer and product, are presented in point 4.

2. METHOD FOR RISK ASSESSMENT BASING ON A PRODUCT - CLIENT MATRIX

Risk assessment in a company, in line with ISO 31000, encompasses 4 action steps:

- Establish the context,
- Identification of undesirable events,
- Analysis of risk
- Evaluation of risk.

As a first step, it is necessary to establish the context of the conducted risk analysis. This method for risk assessment proposes basing all the proceedings on a 2-dimensional decision matrix which takes into account the customer segment and the kind of product that is transported. This matrix was presented in **Figure 1**.

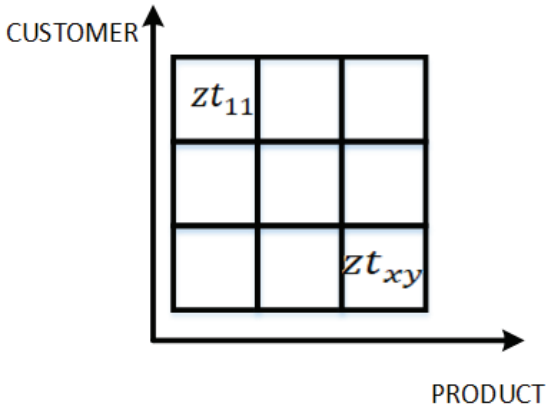

Figure 1 Decision matrix [own study]

Depending on a group of products, we can identify different types of possible undesirable events which might occur during the transport process. At the same time, however, the client segment affects significantly the scope of results of such occurrences. Therefore, the decision-makers responsible for the conducted risk analysis should first and foremost distinguish the classes of transport orders for which risk indicator will be assessed in the process of analysis.

The class of transport orders assigned to presented decision space can be described as::

$$zt \in ZT(p,k):\ p \in P, k \in K, \tag{1}$$

where:

zt - transport orders class,

ZT - set of transport order classes,

P - set of product groups,

K - set of customer segments,

p - product group,

k - customer segment,

where:

$$zt_{xy} = zt(p = x, k = y) \tag{2}$$

where:

zt_{xy} - class of transport orders for products from the *x* group, which are realised for the customer from the *y* segment.

With the context set in this way, the conducted identification of undesirable events and the risk of their occurrence relates to particular classes of transport orders. In order to assess the risk we can use key risk indicator calculated as the frequency of the occurrence of a particular undesirable event multiplied by its results.

$$R_{xy} = O_{xy} \cdot E_{xy} \tag{3}$$

where:

R_{xy} - risk indicator for a particular transport orders class

O_{xy} - frequency of occurrence of an undesirable event for a particular transport orders class

E_{xy} - results of the occurrence of an undesirable event for a particular transport orders class

Particular transport orders classes can differ in the aspects of frequency of the occurrence of the undesirable event as well as in its results.

3. IMPLEMENTATION OF THE METHOD IN THE RESEARCHED TRANSPORT COMPANY

The proposed approach to risk assessment was implemented in the selected road transport company. Basing on the proposed method, the undesirable events have been identified and a risk analysis for each particular transport order class was conducted. In this transport company, 4 groups of products and 4 customer segments have been distinguished in order to meet the decision-making needs. These groups are shown in **Table 1**.

Table 1 Distinguished groups of products and customers [own study on the basis of information received from the company]

Product group symbol	Product group description	Client segment symbol	Client segment description
HP	Hazardous products	SA	High priority customers
SP	Sensitive products	SB	Project customers
FP	Fresh products	SC	Standard customers
OP	Other products	SD	New clients/one-off clients

The estimation of size of particular parameters constituting the risk indicator was performed with the application of a linguistic approach. The set of linguistic terms together with their interpretation and the applicable points is presented in **Table 2**.

Table 2 Interpretation of the terms used for the linguistic variable *Frequency of occurrence* and *Results of occurrence* [own study]

Point range	Frequency of occurrence		Results of occurrence	
	Time	Interpretation	Time	Interpretation
1-2	Occassionally	Less often than once every 2 years	Irrelevent	A small loss of client's trust, no financial losses
3-5	Rarely	Happens once a year / once every two years	Not very significant	Costs up to 10.000 PLN
6-8	Often	Happens a few times a year	Significant	Loss of a client, costs up to 100.000 PLN
9-10	Very often	Happens at least once a month	Very significant	Loss of a market share, costs threatening with liquidity crisis

In the process of identifying the hazards 31 undesirable events have been distinguished, including:

- 6 events concerning dangerous/reckless driving,
- 4 events concerning technical condition of the vehicle,
- 9 events concerning organisation / completion of servicing transport order,
- 7 events concerning drivers,
- 5 events connected with the load.

The managers from the researched company were drawn into the process of risk assessment and they took on the role of experts. 496 cases had the risk indicators estimated (taking into account 16 classes of transport orders). **Table 3** shows selected risk indicators, which prove the approach to risk assessment basing on a 2-dimensional decision space to be right.

Table 3 Risk indicator for selected undesirable events [own study]

Undesirable event	Product	Client	Frequency	Result	Risk indicator
Accident involving our driver	HP	SA	2	10	20
Accident involving our driver	OP	SD	3	3	9
Third parties entering the vehicle	FP	SA	3	8	24
Third parties entering the vehicle	OP	SD	4	4	16
Damage to the tyre	HP	SA	4	8	32
Damage to the tyre	OP	SD	6	2	12
Theft of the load	HS	SA	2	9	18
Theft of the load	OP	SD	2	4	8

The examples presented in **Table 3** show clearly how big an influence the kind of product and the customer segment have on the assessed risk. Occurrences such as “damage to the tyre” might be minor incidents, with no effect on the process of servicing the transport (in case of standard products), but they might as well entail considerable losses for the company (in case of transporting dangerous goods).

4. CONCLUSION

The risk connected with the occurrence of undesired events during the process of servicing a transport order depends largely on the kind of product being carried as well as on a client who places an order. Therefore, risk assessment in road transport should be performed for each class or transport orders which belong to the decision matrix described by product groups and customer segments. This is the only approach which will allow in a credible manner to assess risk indicator for the transport order being serviced. The results of a risk analysis conducted in this manner can then serve to improve both operational planning and transport processes in the organisation.

The evaluation process conducted in the selected transport company has proved this approach to be right. For the same undesirable events, the risk indicator for each particular class of transport orders took on different values. Therefore, the decision-makers deemed it necessary to embrace different approaches to risk for the same undesirable events depending on the class of transport orders. The results of the assessment conducted in this manner can form a starting point for further risk management in particular transport order classes.

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