

INTELLIGENT SYSTEM FOR RISK MANAGEMENT DEDICATED TO ROAD TRANSPORT COMPANIES

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Abstract

In the presented paper, authors focus on the issues connected with risk management in road transport processes performance. Following this, in the article the main transport risk management definitions are discussed. Later, there is presented the main assumptions and results of project ZEUS - the integrated system of transport safety. This gives the possibility to define the main guidelines for the conception of risk management system dedicated to road transport companies. Article ends with some conclusions and directions for future research.

Keywords: Risk assessment, transport system, support system

1. INTRODUCTION

The road transport system is sensitive to the occurred disruptions of both, external and internal type. Due to the related responsibility both for their own and other people's property, enterprises performing transport services are particularly vulnerable to various types of risks, the occurrence of which leads to the often enormous damages and losses. Therefore, it is crucial to recognize the sources of risk, which will influence both its causes and effects, helping to maintain continuity and timeliness of the transport process performance [1]. Following this, transport companies should regularly carry out risk analysis, which is based on identification of potential hazards or situations or conditions that lead to threats. These risks are associated with the occurrence of events, both random and non-random ones. It is unbelievably important that companies, involved in the transport services performance, identify the greatest number of hazards (both, random and non-random), and also define the places in the transport chain being the most vulnerable to the risk occurrence [2].

Following this, in the article authors focus on the issues connected with risk management in road transport processes performance. The aim of the article is to present the guidelines and main assumptions for risk management system dedicated for road transport companies. As a result, in the next Section, there is provided a brief overview of the literature in the area of transport risk management. Then, authors focus on the presentation of the main assumptions and results of project ZEUS regarding the integrated system of transport safety and being carried out in 2007-2010 time period. This allowed for developing the conception of risk management system dedicated for road transport companies that bases on ISO 31000 standard and Enterprise Risk Management conception implementation. The article concludes with a summary and guidelines, including directions for further research.

2. RISK MANAGEMENT IN TRANSPORT - REVIEW

Risk management for transport system performance has received a growing interest in recent years, see e.g. [3, 4, 5] for comprehensive reviews. In parallel, there is a recent focus on risk assessment and risk management in scientific environment, concerned with risk analysis, risk perspectives, or decision-support issues [6].

There can be found many risk definitions in the recent literature. If we study the research works we find a number of different ways of understanding the risk concept. Some definitions are based on probability, chance or expected values, some on undesirable events or danger, and others on uncertainties [7]. These definitions have been comprehensively overviewed and classified in works e.g. [3, 7, 8, 9]. Taking one step further, the risk management field is investigated in two main pillars: the main risk management strategies available, and the structure of the risk management process. For a review of major strategies commonly used to manage risk we refer to [6]. The risk management process can be broken down into the six main steps (compatible with e.g. ISO 31000 standard): a) establishing a context, b) identifying hazards and threats, c) conducting cause and consequences analysis of these events, d) making judgements of the likelihood of the events and their consequences, e) evaluating risk, f) risk treatment [6]. The transportation risk management issues are investigated in [10]. Following the author, the risk management is focused on two primary causes of concern, natural and man-made disasters. According to Cirjaliu et al. [11] the transport companies should focus on the implementation of occupational risk methods. In this context, there can be defined a lot of organizational and technical factors that can influence on risk in transportation, like: the size of the company, the nature of the business, the safety culture in the company, the presence of safety management systems in the company, or fleet size. The classification of the main transportation system disruptions is given in e.g. [12, 13]. The transportation risk issues are also investigated in e.g. [3, 14], where the maritime transportation issues are overviewed, in [4, 15], where safety management issues are analysed, or in [5, 16] focused on transportation disruptions and decision support systems.

Following a literature review, there can be defined the four main problematic areas (1) hazardous material transport performance, (2) transportation infrastructure issues, (3) accidents in transport, and (4) environmental protection issues. Usually, the proposed scientific research regards to the chosen type of risk issue without taking into account the numerous links with other groups of threats and hazards. Thus, there is still the need for research works in the area of holistic approach for risk management performed in transport companies.

In the '90s a particular importance was gained by a holistic approach to the risk analysis in the form of the concept of Total Risk Management (TRM). Heimes [17] defined TRM as a *systemic, statistically based, and holistic process that builds on formal risk assessment and management (answering the previously introduced two sets of triplet questions for risk assessment and risk management) and addresses the set of four sources of failures within a hierarchical-multiobjective framework: (1) hardware failure; (2) software failure; (3) organizational failure; (4) human failure*. On this basis, there was developed a conception of Enterprise Risk Management (ERM). The Committee of Sponsoring Organizations of the Treadway Commission (COSO) provides a definition of ERM that has gained considerable acceptance [18]. In comparison to the earlier risk management approaches, ERM is more holistic and stresses all the risks that an organization may be facing. It promotes a 'portfolio approach' to risk management. It provides a structure that links various risks together. It promotes risk management that does not merely focus on the sum of various risk elements. It should also consider risk interactions (see e.g. [18, 19, 20, 21]). The possibility of this conception implementation in road transport companies' performance is analysed based on the investigation of ZEUS project principals and risk management system conception development.

3. AN INTEGRATED SYSTEM OF TRANSPORT SAFETY (ZEUS PROJECT) [22, 23]

In 2007-2010, a scientific consortium led by the Gdansk University of Technology carried out the research project entitled "*The integrated system of road safety - ZEUS*". The main objective of the ZEUS project was to develop a model of an integrated transport safety system so that it serves as a tool for policy-makers to make the right decisions concerning the construction and development of infrastructure and transport means, as well as for professionals implementing these decisions. This project concerned the development of a uniform safety

management system in all modes of transport: road, rail, air, and water. However, due to the research area, the authors focus only on the characteristics relating to road transport system performance.

In the performed project work, the risk in road transport was defined as *the uncertainties of taken by human activities*. The risk was also linked closely to the issue of choice understanding as:

- taking a decision regarding the risk of dangerous behaviour with having a knowledge that there may happen an accident, or
- an attempts to limit, reduce or eliminate the risk of an accident occurrence by driving appropriate to the existing conditions.

The authors of the project also found that the risk in road transport is a combination of the probability of hazard event activation and caused in connection with it the damages or losses. They identified the two types of risk in road transport: the engineering risk and economic risk. Engineering approach applies to the activities carried out by the municipal roads in the course of the life cycle of the road technical objects (planning, design, construction, operation and maintenance), where should be used the full procedure of risk management (analysis, evaluation, elimination, and information). The risk here is the category associated with the choice of action or omission. The approach is similar to the economic but related to individual traffic participants. The driver, in order to achieve the pursued objectives (e.g. travel time), decides to take risky actions, especially in situations of bad traffic conditions or adverse weather conditions. The benefit is then the reduction of travel time by driving at a speed much higher than the permitted, and the loss can be connected with obtaining a mandate for dangerous driving. Simultaneously, the project authors adopted the two groups of measures for analysis and risk assessment for the road network: individual risk and social risk. Individual risk was attributed to the behaviour of a single participant traffic on the road. It is the probability of loss of a specific gravity within a single journey or during the time period in which the traffic participant is exposed to the danger caused by road infrastructure and traffic. The social risk was referred to the behaviour of the entire groups of road users in the selected area. It was defined here as a loss (the number of victims and material losses suffered and occurred in road accidents) in a given time period, in a selected area, which can predictably occur as a result of hazardous events caused by a malfunction of the safety system.

In their research studies, the authors of the project emphasized clearly that in contrast to many fields of engineering, there had not been yet developed a uniform method of risk management for road transport. There are created only the basis for relevant methodology that is established on standard elements: risk analysis, valuation and risk assessment, and the removal of risk and control of remaining risk.

Based on the conducted analyses, it was found that the integration of risk management methods in road transport should aim towards: (a) the implementation of integrated risk management in organizations involved in the management of road transport (ministries, agencies, local authorities); (B) the development and implementation of integrated method for risk management of the road network; (C) the development and implementation of risk management method in road transport companies; (D) harmonization of risk management methods between different modes of transport, through the creation of general management principles.

4. CONCEPTION OF RISK MANAGEMENT SYSTEM DEDICATED FOR ROAD TRANSPORT COMPANIES

The results of published studies conducted in the framework of the ZEUS project were concerned with the narrow view of risk management in road transport. The project authors deliberately confined them mainly to transport security, for which the main measure of risk is the number of recorded accidents. This resulted primarily from the objectives of the project, the effects of which were created to serve departmental transport safety strategy. It would therefore be right to indicate the need to develop and implement of risk management

method in the road transport company. However, making research efforts aimed only at safety issues are currently not sufficient. It is necessary to broader look at the risk factors associated with transport activities performance. Risk analysis should therefore apply not only to the issues of transport safety, but also its reliability and efficiency. This requires identifying the various sources of danger associated with road transport operators' performed processes, and the starting point should be a holistic analysis of the process of freight transport performance (see e.g. [24]). So extensive look at the risk assessment requires the need for collection and processing of numerous data of a quantitative (including statistical data, cost and time) and qualitative nature (such as customer preferences, characteristics of routes). Effective use of these data in the form of risk analysis is only possible thanks to the support of appropriate software to support decision-making processes of managers.

For this reason, the authors of the article began their research on the development of an advisory system (class of decision support system) for managers in road freight transport companies and dedicated to it knowledge base in the field of operational risk management. With the use of the Enterprise Risk Management concept, the decision support system will support decision-making processes in the road freight companies by: (a) improving the planning process of transport in conjunction with the maintenance and operation services, taking into account available resources and the efficiency of performed tasks, and (b) improvements of control system on reliability and effectiveness of the transport services utilizing feedback mechanism and the Deming cycle, which guarantees learning process of the organization. The aim of the implementation of such a tool in a transport company is to assist in a comprehensive planning process and available resources of the transport carrier, increasing performance flexibility, shortening decision-making by managers, and reducing the risk associated with the lack of the required information.

The system will be in accordance with the requirements of ISO 31000 standard. The proposed solution will be characterized by a holistic process approach to the management of risk, and will take into account the complexity of the organization of road freight transport. The risk assessment will therefore be structured as a multi-module one corresponding to the defined groups risks associated with freight transport services (detailed characteristics of particular groups of risk for this process is presented in [12]), **Figure 1**:

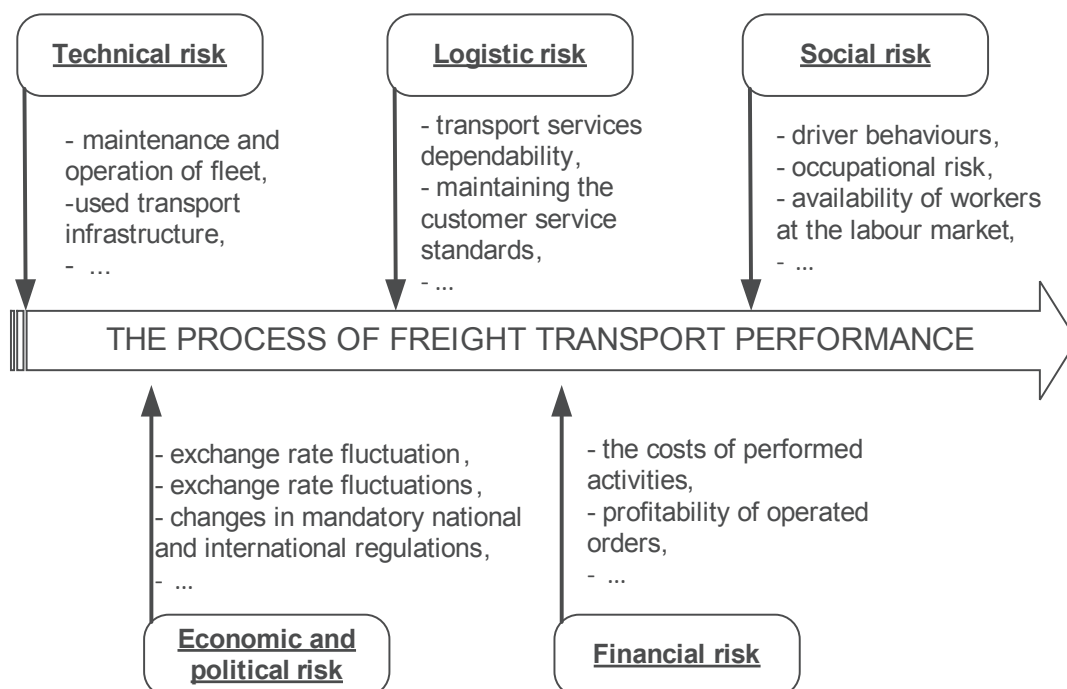


Figure 1 The groups of risk in the freight transport performance

Based on: (a) the frequency of occurrence of monitored events (or the likelihood of their occurrence) and (b) the consequences of each event for the business enterprise, which values are defined by the decision-makers on the basis of parameters estimated by the system - the algorithm will evaluate the risk parameters with accompanied costs. On the basis of estimated risk parameters, there will be possible to prepare multi-criteria analyses corresponding to the information needs of decision makers in the company. This will allow for the optimization of processes and taking important steps from the point of view of the rational use of vehicles based on, among others, the type of operating technical objects, type of cargo, route, or logistics and maintenance facilities. For risk identified at medium and high level, there will be prepared suggested performance scenarios, supplemented by the estimated costs of their completion and execution times. It will be also possible to define the best solution for given boundary conditions. In order to ensure the function of organizational learning, the reporting process integrated into the knowledge base will provide the information necessary for continuous improvement of developed scenarios. Algorithms for monitoring the correct implementation of processes will be based on the individualized system of control indicators. They let for keeping responding to changing operating conditions. This enables flexible operations that limit the effects of existing threats, as well as the implementation of preventive actions (based on the results of the implemented Deming cycle). An important innovation of the prepared solution will also be connected with taking into account the specifics of the operation of transport companies and with the inclusion of analyses based on the concept of Risk Based Maintenance (RBM) to the prepared tool.

5. SUMMARY AND CONCLUSIONS

Analysis of the available tools to support risk management in organizations has shown that, at present, there is no available product at the Polish market, which is consistent with the analytical and decision-making needs of managers employed in the road transport enterprises.

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