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# HEAVYWEIGHT AND OVERSIZED CARGO TRANSPORTATION RISK MANAGEMENT

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The most important factor affecting the quality of transportation heavy goods is safety and security. Risk evaluation and management is one of the key issues during the planning oversized goods safe transportation and investments into transport infrastructure reconstruction. Usually it is international transportation and decision-making requires through analysis of the problem both, on the national and international scale and only then the most rational decision (transportation route) can be made with the view of the effective risk lowering, i.e. seeking the last possible reconstruction costs. The objective of the risk evaluation when investing into infrastructure reconstruction is to safeguard heavyweight or oversized goods transportation. When making the quantitative and economic assessment of the risk the theory of chances and mathematic statistics are most commonly used methods, because they are denoted to describe an event or process in case of ambiguous possibilities.

**Keywords:** heavy and oversized goods, transport, risk management

## 1. Risk Substance and Definitions

Risk definitions for the term in the literature are quite different. The term “risk” as well as the instruments that are used for risk measurement strongly depends on the field of research [M. Christopher & H. Peck, 2004]. Definitions of risk are based on the volatility of possible return, the concept of information deficits and the willingness to accept a potential loss if positive returns are expected [I.S. Baird & H. Thomas, 1990]. Risk means a potential changes in the expected result. Usually risk is associated with some probability of adverse event realization. Risk – the uncertainty associated with a certain probability, the potential of a variety of action results in the future, the probability of an unfavourable or accidental occurrence enterprise, the instability of economic situation, the uncertainties which arise, because of changes which is difficult to provide, or because of events which possibility cannot be calculated exactly [Wright et al., 1999]. Risk is also defined as a decision-making situation, where is possible potential effects of volatility and there is likely to change them. Risk is defined as the potential for realizing undesired impacts. Risk is uncertainty, which lies within the market economy and the company may incur losses. Possible loss is often measured by the appearance of adverse event facility. In foreign literature, the term “risk” has a quite wide definition, which often depends on results of environmental study. The studies of fundamental investment decision-making [Markowitz, 1952; Sharpe, 1963; Tobin, 1965; Vaughan, 1997] disclose the existence of the efficient line in the mean profitability-risk plane, which is measured by profitability standard deviation. The main characteristics of the efficient line is that its points – investment possibilities, measured against profitability-risk indicators, cannot be improved on account of reducing mean profitability or riskiness if the value of the collateral parameter for evaluation is not changed. In evaluating the risk of being involved in a fatal crash, risk is commonly defined as the ratio between the number of fatal crashes associated with a specific set of conditions and the amount of travel performed under the same conditions.

As one of the measures for the information system development and cultivation of the investment criteria adequacy is classification of decision possibilities [Rutkauskas et al., 2008], taking into account possibility efficiency and reliability as well as the level of riskiness which depends on the riskiness of the processes under analysis (interest rate, currency exchange rate and alike) and on the ability of a subject – the recipient of the risk consequences to manage it. To understand the risk just a negative sense is incorrect. Under favourable_circumstances, risk can bring substantial benefits, because the assumption of low risk or risk avoidance in general, economic activity does not result a competitive advantage.

## 2. Risk Factors and Classification

There are many risks in competitive business world. Various authors identify and classify risk very differently. Generally speaking the unified classification is practically impossible, because of different type of activities.

Examining the risks, which influences heavyweight and oversized loads, it is appropriate to focus on risk according to their areas of influence (Figure 1). This means: technical, economical, social and political types of risk.

*Technical risk* – the factors determining possibilities of load carrying in technological sense. It means vehicle selection risk, the risk of selecting technologies of loading, the route length, parameters of cargo, cargo storage needs, the risk of transportation mode choice. It should be noted, that most important factor in determining the risk is parameters of the cargo (cargo dimensions and weight). Also, to term of technical risk the safety of transportation and probability of accident risk during transportation process could be attributed. Human factors affect the probability of errors, therefore, they would also be appropriate to assign to the technical risk area.

*Economic risk* can be attributed to the banking policy. Heavyweight and oversized loads are inevitably associated with new technology and industrial development, that's why the role of banks in this area is very important [Labanauskas, Palsaitis, 2010]. The conditions of procuring new technologies, interest rates, bank financing conditions determine development of innovative technologies and thus promote or inhibit heavyweight and oversized loads transportation. Other very important factors in this area are the competitive conditions for such loads transportation, labour costs and access in these areas in which such type of loads are transported. These factors have a significant impact on the price of heavyweight and oversized loads transportation and determine the choice how, by which ways or by which countries such loads should be carried.

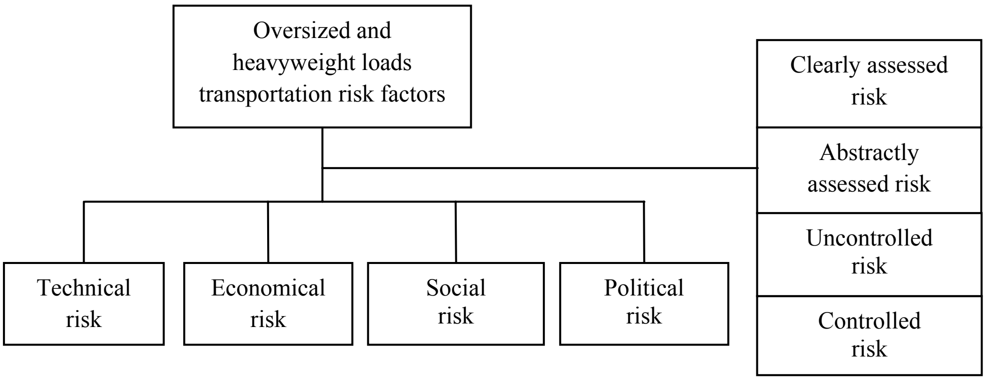


*Figure 1.* Risk factors for carrying oversized and heavyweight loads

*Social risk* means public tolerance for carrying oversized and heavyweight loads in the territory. Transportation of such loads is associated with certain restrictions in the region through which the load is moving. First of all transportation of such loads could make a significant negative impact in public/ community live. Qualified labour force, expectations of community members can be defined to social risk area. Expectations of community results positive or negative attitude for transportation oversized and heavyweight loads.

*Political risk* depends on political attitudes to the heavyweight and oversized loads transportation process existing in certain country. Public policy could stimulate or break such processes. Government institutions are a tool which helps to control these processes. Fiscal policy (tariffs – the charges rates for using transport infrastructure, permission getting procedures, routing coordination procedures, and decision–making regulation) influenced choice of transportation mode and load transportation route. To political risk is also attributed perception of the economic development needs. Decision-making regulation shows the political will of the country. If there will not be unanimous understanding of the impact of economic development, government institutions in deciding carry or not oversized or heavyweight loads will work not coordinated. Another very important factor for such loads is transit.

These four heavy weighting and oversized loads risk areas and influence of them to transportation process could be clearly or abstract assessed. The impact of different factors can be quantified and also not all factors of risk could be controlled and measured.

## 3. Risk Evaluation and Modelling Process

Evaluation of risk is made up of several stages (Figure 2). First stage involves diagnose of potential risk in oversized or heavyweight loads transportation process. A model could not be developed unless there is a clear understanding of its definition and identification of issues involved in the process.

The next step is a model of risk assessment and related data collection. Diagnose of potential type of risk is necessary to identified reasons/factors which could cause denial impact of a transport process. The evaluation of the results let’s to estimate risk reducing techniques and helps to choose a strategy for reduction negative impact in order to minimize risk The process involves a cycle of risk estimation, evaluation of risk estimates, identification of risk reduction strategies and implementation of risk reduction strategies

In load transportation process the most important factor for calculating of accident probability. Evaluation of potential participants in accident can be divided into two groups of vehicles: cargo and passenger vehicles used for commercial purposes and private cars. According to the character of load carried by commercial vehicles it is appropriate to distinguish perishable, not perishable and dangerous goods. All these factors influence risk level.

Vehicles during the transportation process cause some negative affects such as delay, damaging of the load, drivers or other road users death, negative impact to the physical road condition and people, who are living in environment of road.

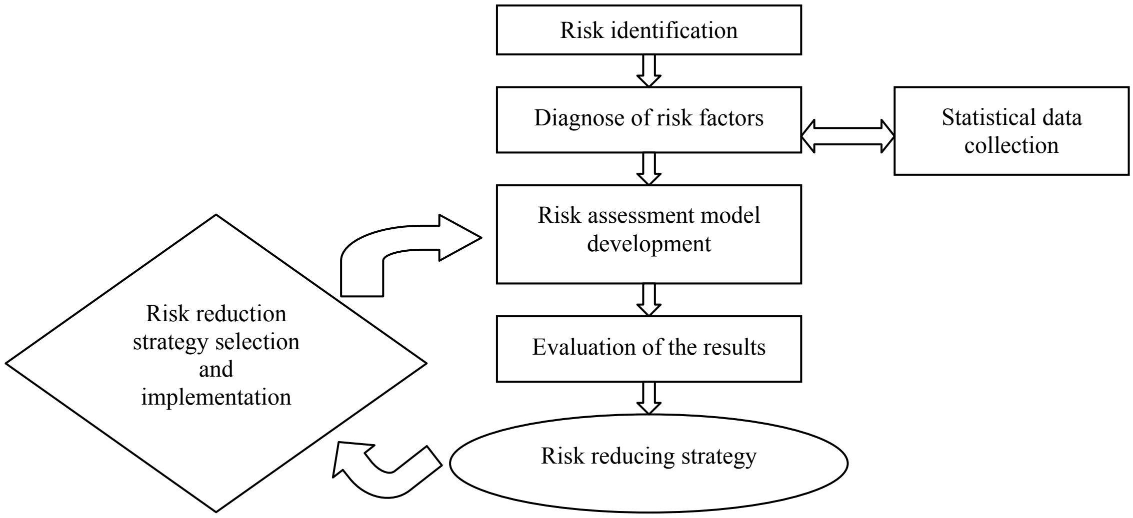


*Figure 2.* Risk evaluation process

In transportation process of oversized and heavyweight loads it is possible temporary to prohibit the movement of other transport means in order to reduce the risk in section of the route or along the route. In such case accident scheme would look like it is shown on Figure 3.

Movement of oversized and heavyweight cargo may be affected by the occurrence of an accident on the road. Two scenarios are possible. The first scenario may be an accident involving vehicle(s) other than trucks, while the second scenario may be an accident involving truck carrying oversized and heavyweight cargo. In the former case where an accident involves other vehicle(s), the truck experiences non-recurrent delay in addition to recurrent congestion delay that is normally factored to transport cost. In the latter case where an accident involves a truck, the truck not only experiences delay, but also experiences a more serious and costly consequence. Depending on the severity of an accident, such may include damage of oversized and heavyweight cargo by improper action of extraneous people or atmospheric impact during longer period of stay.

The data required for risk modelling of oversized and heavyweight cargo transportation processes:

- Highway network data, including physical and operational characteristics of the transportation system;
- Truck accident data, including frequency and severity of an accident;
- Traffic flow data, including directional distribution pattern;
- Freight data, including shipment type, shipment volume.

These are spatial data which may be presented in GIS format. The highway network, truck accident and traffic flow data are readily available from various transportation agencies. However, freight data are rare and difficult to find. Most freight data do not have information that could be used to obtain the desired level of accuracy of risk estimates.

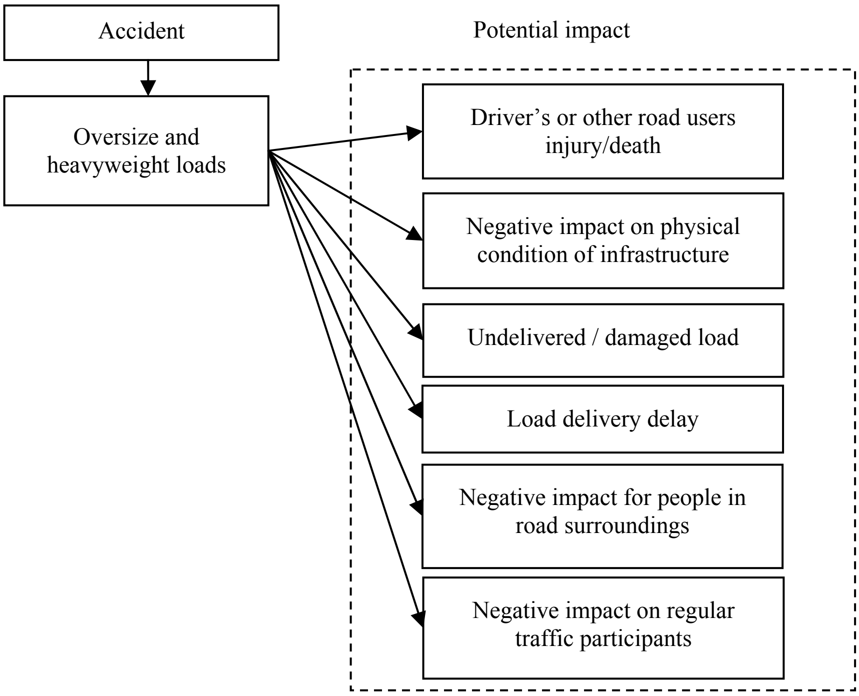


*Figure 3.* Possible accident consequences assessment scheme for carrying oversized and heavyweight loads

Calculation of risk is always adapting to a simple and more comprehensive in its evaluation methods. In classical risk model for calculating the risk is as follows:

$$R = p \times C\,, \tag{1}$$

where

$R$ – risk;

$p$ – accident probability;

$C$ – the consequences of an accident.

Accident probability calculation is based on the assumption that calculation unit is clear and is modelled using Poisson distribution:

$$f(k;\lambda) = \frac{e^{-\lambda}\lambda^{k}}{k!}\,, \tag{2}$$

where

$e$ – is the base of natural logarithm ($e$ = 2.71828…);

$k$ – is number of occurrences of an event;

$\lambda$ – is a positive real number, equal to the expected number of occurrences during the given interval;

$k!$ – is the factorial of $k$.

An accident is measured per unit of time (accident per year) or space (accident per vehicle-kilometre). If heavyweight and oversized load is moving without limiting the movement of other road users in section of the route in that case it should be measured number of accidents within the road section within a given unit of time per kilometre. The annual accident rate per thousand is calculated using the following formula:

$$R_A = \frac{A \times 1000}{TNA \times 365}\,, \tag{3}$$

where

$R_A$ – accident rate;

$A$ – the number of accident involving heavyweight vehicles per year;

$TNA$ – transportation distance.

Probability of an accident in the transportation route depends on various factors such as load carrying frequency, heavyweight vehicle traffic, transportation distance, road technical parameters, pavement quality, daytime and seasonality (Figure 4).

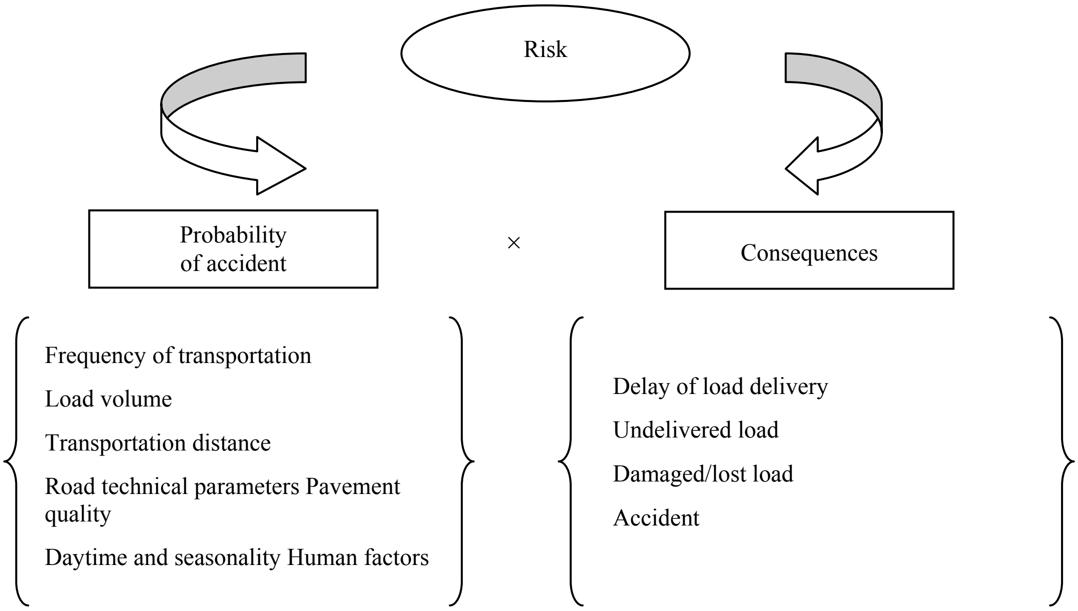


*Figure 4.* Risk evaluation scheme

Risk evaluation scheme may include more factors. Evaluating the probability of an event needs to analyse the frequency of load carrying and travel distance.

*Consequences.* Consequences may be determined by the potential effect. As example could be late delivery of goods lost or damage, the number of fatalities. Evaluation of consequences in road section depends on access of data about accidents and consequences. Negative consequence per year can be calculated using the following formula:

$$C = VMTPS \times 365 \times M \times c\,, \tag{4}$$

where

$VMTPS$ – is the average daily amount of heavyweight transport means passing route segment;

$M$ – average weight of the load;

$c$ – cost for carrying 1 ton of load.

The risk of road segment from point to point can be expressed:

$$R_{ij} = P_{ij} \times VMPS_{ij} \times 365 \times M \times c\,, \tag{5}$$

where

$R_{ij}$ – risk of road segment $i - j$, per year;

$P_{ij}$ – accident probability in road segment $i - j$.

The modelling process involves three main components mentioned in the risk assessment process: development of database, risk estimation and evaluation of results. GIS is an appropriate tool for this effort because of its ability to handle large data, support spatial analyses and generate meaningful graphics.

Database development is the most time consuming in this oversized and heavyweight cargo risk evaluation process, especially because the most data comes in various formats and have to be converted into a GIS-compatible format. Extra effort is needed to ensure accuracy during data scanning, conversion and manipulation. Based on topographic features, the database comprises two types of data: linear data such as highway network and point data, which include the traffic volumes and accident locations.

GIS-based analysis can be performed at various levels of detail depending on the need of the user. For example, estimates can be obtained to evaluate the relative risk of transporting oversized and heavyweight cargo on various routes. Estimates can also be obtained at the segment level to identify the most critical section of the route.

The advantage of risk modelling in a GIS platform is the ease of enhancing the model by simply adding a new variable as an attribute of the network and recalculating risk. For example, human factor can be integrated in the model to account for driver's experience, age, heath.

## 4. Conclusions

Risk management is one of the key issues during the planning oversized goods safe transportation and investments into transport infrastructure reconstruction.

Examining the risks, which influence heavyweight and oversized loads, it is appropriate to focus on technical, economic, social and political factors of risks.

It is necessary to identify factors, which could cause denial impact of a transportation process. The oversized goods transportation risk evaluation results allows identifying risk reducing armamentarium and helps to choose a strategy of most secure oversized goods transportation.

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