The Evaluation of the Selected Risk Types in External Transport with the Use of the Matrix Method

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Risk is a common phenomenon in daily life of natural and legal persons. It concerns all branches of the economy and relates to making decisions concerning the unknown future. There are various types of risk related to business operations and the majority of business entities take effort to protect themselves against its adverse effects. The development of the field of risk management allows for partial or total risk elimination. Road transport is exposed to various types of risk which may lead to usually considerable damage and losses. This publication is aimed at presenting selected groups of risk factors occurring in the logistics process and at determining their influence on enterprise functioning. It is also supposed to emphasize the significant role of risk analysis in the transportation business.

Keywords: logistics, risk management, risk.

1. INTRODUCTION

The term "risk" appears in daily life of all people and in operations of all business entities, including in the transport industry. It affects all branches of economy to a different extent. Risk is a common phenomenon. Most of natural and legal persons aim at limiting or eliminating adverse consequences of risk. This requires a risk analysis and attempts at bringing it to a level acceptable to a given entity.

Risk management within a supply chain involves the identification and control of internal and external threats which may affect its effective functioning. The basis of risk management is risk estimation, while the determination of risk factors is a basis for risk estimation. Progress in knowledge and development of modern technologies contribute to a reduction of certain risk types, but they also generate new forms of risk. The purpose of this publication is to present risk factors occurring in the transportation process and their influence on the functioning of businesses [1-3].

2. THE ESSENCE OF TRANSPORT IN LOGISTICS PROCESSES

The basic definition of transport determines the concept as activity of covering distance. In economic terms, transport is the activity involving paid or unpaid performance of services leading to the movement of persons or cargo and creation of auxiliary services. Auxiliary services include, for example, forwarding services, counting of cargo items, determination of weight, and services of freight brokers [4]. A range of elements, e.g. transport infrastructure, means of transport, people and established rules, rules of service performance, are necessary for rendering transport service. All these elements together form a transport system. Figure 1 shows the transport system in its environment.

In national economy, transport may be considered both as a donor and a taker. On the one hand, transport industry takes advantage of the production of various branches of national economy, but on the other hand, it renders transportation services. Transport industry as a donor allows for the exchange of goods and services. Raw materials, materials and semi-finished goods intended for use in production and
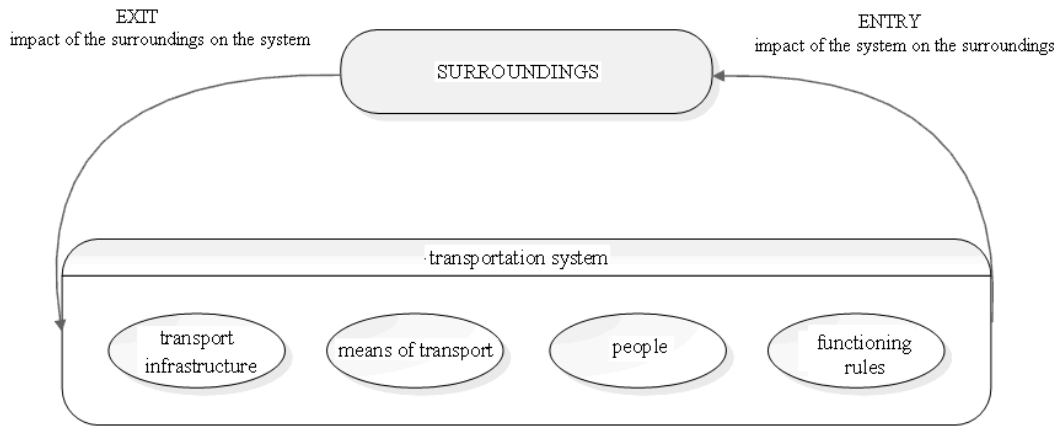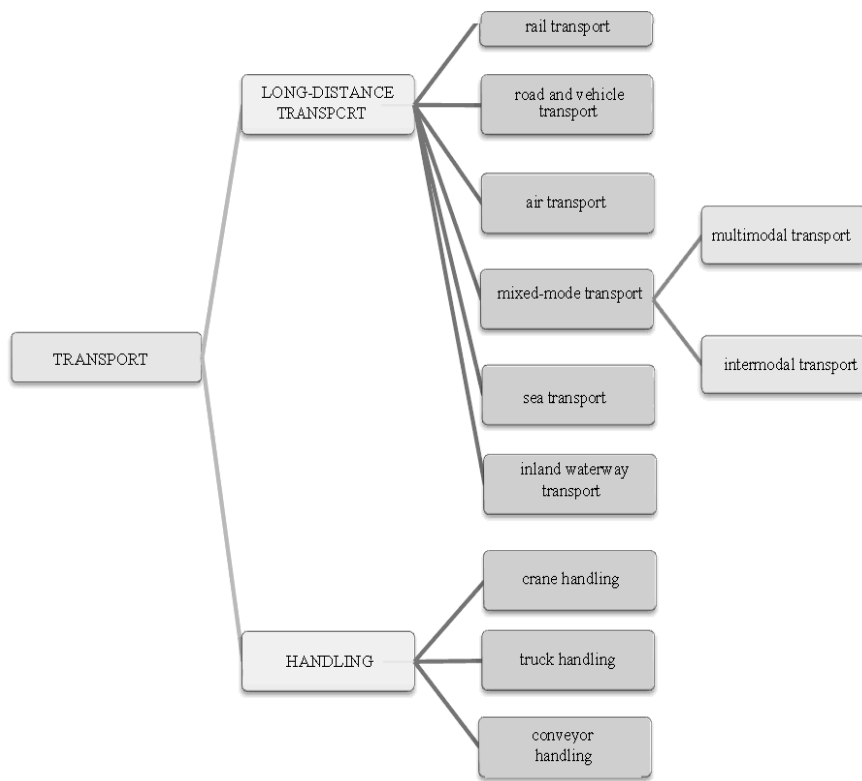
Fig 1. Transport system and its environment

Fig. 2. Division of transport by range.

ready products intended for personal consumption and satisfaction of transportation needs through the rendered transportation services are transported. Economy may not function without transport. It would make no sense to organize transportation without the developed economy. If transport develops, other branches of economy develop simultaneously [5]. Transport may be divided depending on the kind of surroundings in which it takes place and the range of transport. Fig. 2 presents the division of transport by different criteria.

3. RISK MANAGEMENT IN LOGISTICS PROCESSES

Effective risk management should be executed following a thorough analysis of factors affecting its occurrence in logistics processes. Risk factors are either external, inherent in the environment of the enterprise, or internal – related to enterprise operations. Risk resulting from external threats includes natural and other disasters such as hurricanes, earthquakes, floods and consequences of international terrorism, which are direct effects

of a specific terrorist act (destruction and death of humans) or secondary consequences which may cause even greater disturbance in the supply chain [6-7]. Enterprises are unable to protect themselves against such threats. They may only reduce potential consequences by shifting liability for risk on third parties (e.g. with insurance). External risk factors may also include changes in legal and tax regulations, increased competitiveness – restricted opportunities to choose clients, increased awareness of clients, expansion of an array of products available in the market. Internal risk factors may be grouped into two categories:

– a human factor which should be understood as decisions and behaviours of organisation employees affecting its functioning, resulting not only from qualifications but also honesty and attitude to professional duties.

– a technical factor with an increasingly visible influence on process risk in confrontation with unprecedented technical progress which makes enterprises dependent on electronic data processing systems, production process, etc.

Risk management involves the identification of risk generated by all areas of process activity. Thanks to the analysis of individual risk factors, they may be classified in different ways. From the perspective of logistics processes, the division into risk factors which are beyond enterprise's control and risk factors on which the enterprise has an influence and control becomes most essential. The same risk factors have differing likelihood of occurrence and cause a different scale of potential consequences [8]. Therefore, the identification of risk factors may be considered individually in a given enterprise. When an enterprise does not have a risk management system, it is exposed to disturbances in its functioning. In general, risk management is aimed at reasonable optimisation of benefits and reduction of losses.

4. METHODS OF RISK MANAGEMENT ANALYSIS IN THE TRANSPORTATION PROCESS

One of risk analysis methods in transportation services is the matrix method. It allows for determining main and most important threats from the enterprise's perspective and risk-related opportunities to counteract them [9]. The method is about preparing tables of threat and opportunity analysis with regard to major risk types occurring

in transportation services. A three-step scale has been adopted for risk assessment:

m - low probability,
s - moderate probability,
d - high probability,
M - low opportunity/low risk,
S - moderate opportunity/average risk,
D - high opportunity/high risk.

This scale is used to determine the likelihood of the occurrence of a threat or opportunity, and severity and positive impact of consequences. The next stage of the method is to prepare a matrix of relation intensity based on the previously prepared table of opportunities and threats. Relations between the probability of occurrence and positive impact or severity of the occurrence of consequences have been taken into account to build an intensity matrix. Then, identical relations have been counted and saved in the relevant matrix fields, followed by the designation of three groups of factors; A, B, C. Group A: dD, dS, sD – these are relations between high probability and high severity or positive impact, high probability and moderate severity or positive impact, moderate probability and high severity or positive impact. Group B: mD, sS, dM – these are relations between low probability and high severity or positive impact, moderate probability and moderate severity or positive impact, high probability and low severity or positive impact. Group C: mS, mM, sM – these are relations between low probability and moderate severity or positive impact, low probability and low severity or positive impact, and moderate probability and low severity/positive impact. Subsequently, in order to compare threats and opportunities, and related severity and positive impact, a quantitative and value comparison has been made in individual groups [10-11].

The method uses threats and opportunities in land transport related to risk in the areas of personnel, ecology and politics. Charts 1 and 2 present threats and opportunities related to personnel risk.

The presented analysis of threats related to personnel risk (chart 1) indicates that driving without the required rest is the most frequent threat. This threat is often a result of exceeding the permitted driving time of a driver and by burdensome waiting in lines at the border crossing. Taking into account the opportunities to counteract risk (chart 2), the greatest opportunities lie in the observance of road traffic regulations by drivers.

Following these rules reduces the frequency of road accidents. Charts 3 and 4, in turn, present threats and opportunities related to ecological risk.

The greatest threats to transportation companies related to environmental risk (chart 3) are excessive noise emission, and emission of harmful pollutants. Their influence on human life and the environment is unfavourable. The greatest opportunity to minimise harmful environmental impact (chart 4) is to hand over used tyres and batteries to recycling plants. This helps limit air pollution caused by burning used tyres. Used tyres can be used to cover surfaces of playgrounds or sports fields.

Chart 1. Analysis of threats related to personnel risk.

	THREATS	Probability of occurrence	Severity of consequences
1.	Insufficient qualifications of drivers who start work.	D	S
2.	Drivers' failure to use knowledge learnt during trainings and courses.	S	S
3.	Lack of knowledge or failure to follow occupational health and safety rules and regulations	M	S
4.	Road accidents caused by non-observance of road traffic rules, e.g. exceeding the speed limit.	S	D
5.	Providing drivers from other companies with information concerning transportation (e.g. when goods are transported, freight values), which may expose an enterprise to losses.	M	D
6.	Performing work while intoxicated or consuming alcohol during work.	M	D
7.	Leaving the vehicle unattended or parking vehicles on non-guarded car parks, without surveillance.	D	S
8.	Damage to goods caused by improper protection of transported cargo.	M	S
9.	Driving without required rest. Tiredness frequently results from exceeded working time and burdensome waiting for customs clearance in queues at a border crossing	D	D
10.	Occupational diseases of drivers.	S	S

Chart 2. Analysis of opportunities related to personnel risk.

	OPPORTUNITIES	Probability of occurrence	Positive impact of the occurrence of consequences
1.	Introduction of a driver profession to vocational education.	m	S
2.	Verification of knowledge gained by drivers during trainings and courses with the use of periodic tests.	m	M
3.	Additional OHS training.	s	S
4.	Following road traffic regulations by drivers.	d	D
5.	Imposing disciplinary penalties on drivers and in certain cases even dismissals from work.	s	S
6.	Breathalyzer tests on drivers before and after completion of transport.	s	M
7.	Parking in safe places, in guarded car parks with surveillance.	s	S
8.	Proper protection of transport in order to avoid destruction of goods.	s	D
9.	Observing the working time by drivers. Construction of buffer car parks along with sanitary infrastructure and social amenities where traffic would be associated with border control.	s	D
10.	Performing periodic tests. Observing the working time. Use of leaves.	s	D

Chart 3 Analysis of threats related to ecological risk.

	THREATS	Probability of occurrence	Severity of consequences
1.	Excessive noise which is harmful to the environment and to human health.	d	D
2.	The emission of harmful air pollutants which cause respiratory tract and circulation system diseases, and contribute to the emergence of smog and acidity of the environment	d	D
3.	Road contamination with harmful substances resulting from a poor technical condition of the vehicle.	d	S
4.	Disposal of rubbish, destruction of roadside areas caused by poor knowledge of ecology.	m	M
5.	Pollution of waters and soil with salt used for snow removal during the winter period.	s	S
6.	Burning used tyres which leads to atmosphere pollution.	s	D
7.	Storage of used batteries in places which are not destined for this purpose, e.g. in forests or landfill sites	m	S
8.	Scrap yards - vehicle wrecks are a very serious threat to the environment due to consumable fluids in vehicles.	m	S
9.	Ecological disasters caused by accidents of tankers transporting oil used in vehicle transport.	m	D

Chart 4 Analysis of opportunities related to environmental risk.

	OPPORTUNITIES	Probability of occurrence	Positive impact of the occurrence of consequences
1.	Construction of noise barriers which provide protection against noise.	s	D
2.	Use of alternative energy sources (biofuels, LPG, CNG) and observing exhaust fume emission standards (e.g. EURO 5, EURO 6)	m	D
3.	Additional vehicle inspections aimed at detecting leaks in engines and power lubrication systems.	s	S
4.	Increased ecological awareness of drivers provided through trainings and courses devoted to ecology.	m	S
5.	Applying less sodium chloride for snow removal. Applying alternative snow removal means, e.g. sand, calcium chloride.	m	D
6.	Disposal of used tyres to establishments where they will be recycled for subsequent use to cover surfaces of playgrounds or sports fields.	d	D
7.	Disposal of used batteries to recycling establishments.	d	D
8.	Construction of vehicle dismantling stations where wrecks are safely prepared for recycling.	s	D
9.	Use of biofuels or transport of oil using other forms of transport	s	D

Charts 5 and 6 present the analysis of threats and opportunities related to political risk in transportation companies

As is shown in chart 5, the highest values are for two threats associated with political risk. The first one is the current crisis of the TIR system, for example, in Russia since July 2013. Since them, Russia has seriously restricted the application of the provisions of the TIR Convention. The Federal Customs Service of Russia operated in contrast to international laws by making a decision on additional purchase of additional guarantees. The carrier holding the TIR Carnet may enter Russia from Belarus and Kazakhstan. Otherwise, they are forced to purchase Russian guarantees which increase the company's expenses. Another threat is the introduction of

Chart 5 Analysis of threats associated with political risk.

	THREATS	Probability of occurrence	Severity of consequences
1.	Illegal migrants getting on vehicles during stop-overs.	s	D
2.	Seizure of vehicles when goods subject to excise duty are smuggled by drivers.	m	D
3.	Insufficient number of permits.	m	S
4.	Unstable provisions concerning the TIR system in EU states.	d	D
5.	Introduction of embargo on goods.	d	D
6.	Cancelling transactions caused by an unstable political situation (wars, riots).	s	S

Chart 6 Analysis of opportunities related to political risk.

	OPPORTUNITIES	Probability of occurrence	Positive impact of the occurrence of consequences
1.	Parking vehicles on guarded car parks, with surveillance and lighting.	s	D
2.	Imposing disciplinary penalties on drivers who smuggle goods or in certain cases even terminating their employment contracts.	d	S
3.	Transportation of goods to countries for which the company has permits.	s	S
4.	Introducing uniform legal provisions for all member states concerning international transport services.	s	S
5.	Seeking new transportation offers.	d	D
6.	Analysis of the political situation of countries with which the company cooperates.	s	D

an embargo on goods. Both threats have caused the reduction of the number of transports. Chart 6 indicates that the action that may be taken in order to counteract negative consequences of political risk is seeking new business parties and offers of transportation to Western European countries.

The next stage in the matrix method is to build a relation intensification matrix based on tables of opportunities and threats prepared at an earlier stage. Subsequently, identical relations have been counted and saved in the relevant matrix fields. Then three factor groups have been distinguished: A, B, C. Results are presented in chart 7-15 for each analysed risk type in quantitative terms and values.

Chart 7 Event matrix: opportunities – probability – severity with reference to personnel risk.

		Severity		
		D	S	M
Probability	d	1	2	0
	s	1	1	0
	m	2	3	0

For severity:

Quantitative presentation of results:

S_{DA} = dD + dS + sD = 1 + 2 + 1 = 4 – sum of events in the threat matrix in group A

S_{DB} = mD + sS + dM = 2 + 1 + 0 = 3 – sum of events in the threat matrix in group B

S_{DC} = mS + mM + sM = 3 + 0 + 0 = 3 – sum of events in the threat matrix in group C

S_Z = S_{DA} + S_{DB} + S_{DC} = 4 + 3 + 3 = 10 – sum of elements in the threat matrix – threats

Presentation of results by values:

GROUP A	$K = \dfrac{S_{DA}}{S_Z} = \dfrac{4}{10} = 0{,}4$
GROUP B	$K = \dfrac{S_{DB}}{S_Z} = \dfrac{3}{10} = 0{,}3$
GROUP C	$K = \dfrac{S_{DC}}{S_Z} = \dfrac{3}{10} = 0{,}3$

As it results from chart 9, the group of A factors takes the highest value for severity - 0.4. The group causes unfavourable consequences associated with personnel risk. For positive impact, the highest value is assumed by the group of A factors and it amounts to 0.5. Transportation companies should take effort to restrict personnel risk as this pays off.

Chart 8 Matrix of events: opportunities – probability – positive impact with reference to personnel risk:

		Positive impact		
		D	S	M
Probability	d	1	1	0
	s	4	2	1
	m	0	1	1

Chart 10 Matrix of events: opportunities – probability – severity with reference to environmental risk:

		Severity		
		D	S	M
Probability	d	2	1	1
	s	1	1	0
	m	0	2	1

For positive impact:

Quantitative presentation of results:

$S_{KA} = dD + dS + sD = 1 + 0 + 4 = 5$ – sum of events in the opportunity matrix in group A

$S_{KB} = mD + sS + dM = 0 + 2 + 0 = 2$ – sum of events in the opportunity matrix in group B

$S_{KC} = mS + mM + sM = 1 + 1 + 1 = 3$ – sum of events in the opportunity matrix in group C

$S_S = S_{KA} + S_{KB} + S_{KC} = 5 + 2 + 3 = 10$ – sum of opportunity matrix elements – opportunities

For severity:

Quantitative presentation of results:

group A $S_{DA} = dD + dS + sD = 2 + 1 + 1 = 4$
group B $S_{DB} = mD + sS + dM = 0 + 1 + 1 = 2$
group C $S_{DC} = mS + mM + sM = 2 + 1 + 0 = 3$
$S_Z = S_{DA} + S_{DB} + S_{DC} = 4 + 2 + 3 = 9$

Presentation of results by values:

GROUP A	$K = \dfrac{S_{DA}}{S_Z} = \dfrac{4}{9} = 0{,}444$
GROUP B	$K = \dfrac{S_{DB}}{S_Z} = \dfrac{2}{9} = 0{,}222$
GROUP C	$K = \dfrac{S_{DC}}{S_Z} = \dfrac{3}{9} = 0{,}333$

Presentation of results by values:

GROUP A	$K = \dfrac{S_{KA}}{S_S} = \dfrac{5}{10} = 0{,}5$
GROUP B	$K = \dfrac{S_{KB}}{S_S} = \dfrac{2}{10} = 0{,}2$
GROUP C	$K = \dfrac{S_{KC}}{S_S} = \dfrac{3}{10} = 0{,}3$

Chart 9 Juxtaposition of quantitative and value assessment of opportunities and threats:

	Severity		Positive impact	
	Quantity	Value	Quantity	Value
GROUP A	4	0.4	5	0.5
GROUP B	3	0.3	2	0.2
GROUP C	3	0.3	3	0.3

Chart 11 Matrix of events: opportunities – probability – positive impact with reference to ecological risk:

		Positive impact		
		D	S	M
Probability	d	2	0	0
	s	3	1	0
	m	2	1	0

For positive impact:

Quantitative presentation of results:

group A $S_{KA} = dD + dS + sD = 2 + 0 + 3 = 5$
group B $S_{KB} = mD + sS + dM = 2 + 1 + 0 = 3$
group C $S_{KC} = mS + mM + sM = 1 + 0 + 0 = 1$
$S_S = S_{KA} + S_{KB} + S_{KC} = 5 + 3 + 1 = 9$

Presentation of results by values:

GROUP A	$K = \dfrac{S_{KA}}{S_S} = \dfrac{5}{9} = 0{,}556$
GROUP B	$K = \dfrac{S_{KB}}{S_S} = \dfrac{3}{9} = 0{,}333$
GROUP C	$K = \dfrac{S_{KC}}{S_S} = \dfrac{1}{9} = 0{,}111$

Chart 12 Juxtaposition of quantitative and value assessment of opportunities and threats

	Severity		Positive impact	
	Quantity	Value	Quantity	Value
GROUP A	4	0.444	5	0.556
GROUP B	2	0.222	3	0.333
GROUP C	3	0.333	1	0.111

As is shown in chart 12, the group of A factors takes the value of 0.444 for severity. The group causes most unfavourable consequences of environmental risk. For positive impact, the highest value is assumed by the group of A factors and it amounts to 0.556. Factors from these groups are most important for the proper functioning of the company and its environmental impact. Due to the fact that both with regard to severity and positive impact, the highest value is reached by the group of A factors, transportation companies should take action to limit the mentioned threats.

Chart 13 Matrix of events: opportunities – probability – severity with reference to political risk:

		Severity		
		D	S	M
Probability	d	2	0	0
	s	1	1	0
	m	1	1	0

For severity:

Quantitative presentation of results:

$S_{DA} = dD + dS + sD = 2 + 0 + 1 = 3$
$S_{DB} = mD + sS + dM = 1 + 1 + 0 = 2$
$S_{DC} = mS + mM + sM = 1 + 0 + 0 = 1$
$S_Z = S_{DA} + S_{DB} + S_{DC} = 3 + 2 + 1 = 6$

Presentation of results by values:

GROUP A	$K = \dfrac{S_{DA}}{S_Z} = \dfrac{3}{6} = 0{,}5$
GROUP B	$K = \dfrac{S_{DB}}{S_Z} = \dfrac{2}{6} = 0{,}333$
GROUP C	$K = \dfrac{S_{DC}}{S_Z} = \dfrac{1}{6} = 0{,}167$

Chart 14 Matrix of events: opportunities – probability – positive impact with reference to political risk.

		Positive impact		
		D	S	M
Probability	d	1	1	0
	s	2	2	0
	m	0	0	0

For positive impact:

Quantitative presentation of results:

$S_{KA} = dD + dS + sD = 1 + 1 + 2 = 4$
$S_{KB} = mD + sS + dM = 0 + 2 + 0 = 2$
$S_{KC} = mS + mM + sM = 0 + 0 + 0 = 0$
$S_S = S_{KA} + S_{KB} + S_{KC} = 4 + 2 + 0 = 6$

Presentation of results by values:

GROUP A	$K = \dfrac{S_{KA}}{S_S} = \dfrac{4}{6} = 0{,}667$
GROUP B	$K = \dfrac{S_{KB}}{S_S} = \dfrac{2}{6} = 0{,}333$
GROUP C	$K = \dfrac{S_{KC}}{S_S} = 0$

Chart 15 Juxtaposition of quantitative and value assessment of opportunities and threats:

	Severity		Positive impact	
	Quantity	Value	Quantity	Value
GROUP A	3	0.5	4	0.667
GROUP B	2	0.333	2	0.333
GROUP C	1	0.167	0	0

As is shown in chart 15, the group of A factors takes the value of 0.5 for severity. The group causes the most unfavourable consequences related to political risk. With regard to positive impact, the highest value is reached by the group of A factors and it amounts to 0.667. Factors from this group are most important to the proper functioning of a company. Due to the fact that the highest value is assumed by the group of A factors both for severity and positive impact, action should be taken to enable restriction of the mentioned threats.

The performed analysis of threats and opportunities has allowed the author to indicate the main benefits and threats related to the occurrence of different risk types in the company and in its surroundings. Actions aimed at restricting the occurrence of unfavourable consequences related to political and environmental risk will bring the most benefits. However, the company should not forget about counteracting personnel risk because both are related to basic operations of transportation companies.

5. MEASURES TO PREVENT THE OCCURRENCE OF RISK IN ROAD TRANSPORT

In order to minimise the consequences of the occurrence of the analysed risk groups, transportation companies should hold insurance covering goods both in domestic and international transport. The insurance should mainly cover transportation of cargo of perishable foodstuffs with vehicles equipped with temperature recording equipment and holding a valid ATP approval. Furthermore, cooling equipment should be controlled on a regular basis. Insurance coverage should also include damage caused during the carriage of shipment and financial losses resulting from delayed deliveries. The following should also be covered:
- material damage caused by robbery,
- damage caused by an accident of a means of transport being driven by a person without the

relevant licence where no more than 30 days elapsed since its occurrence,
- damage resulting from the loss or improper use of documents mentioned in the waybill,
- damage caused by gross negligence of company's staff and persons contracted by it,
- damage to cargo while the vehicle is parked or stops at a guarded car park or in a place where security is ensured, e.g. hotel car park, 24h petrol station, border crossing, customs office, a fenced area with surveillance,
- material damage caused by improper protection of cargo or unloading,
- insurance cover is extended by the lack of a valid technical inspection record of the vehicle in case the technical condition of the vehicle was not the cause of damage.

Companies should also furnish insurance policies for their staff and hold insurance of their property: buildings, structures, premises, plant and machinery, equipment and electronic devices. This should be insurance against fire and other fortuitous events, including burglary and robbery, which prevents the occurrence of adverse fortuitous events and due to the fact that insurance cover is for the entire term of the agreement, the insurance should enable business entities to take risk-burdened actions. In the event of damage, insurance compensates for the damage caused. Contemporary insurance policies are common and varied, so they largely reduce adverse consequences of risk in transportation companies.

6. CONCLUSIONS

In order to manage risk effectively, an enterprise should determine areas of risk, its extent, ways of influencing activity, process, organisation, and steps to be taken in order to eliminate or restrict risk to an acceptable level. Risk management may bring expected effects, e.g. reduce losses when activities are undertaken in the enterprise in a continuous and effective manner. Management involved in effective risk management in the enterprise should conduct training on risk and educate its staff about potential losses related to risk, as well as reward them for their creativity with respect to effective risk management in the enterprise. It is also necessary to understand a negative impact of risk on the supply chain.

The conducted analysis of opportunities and threats with the use of the matrix method has allowed for indicating major benefits and threats concerning the occurrence of various risk types in a transportation company and its surroundings. Transportation company X is exposed to various kinds of risk, e.g. personnel risk, environmental risk, and political risk. Actions aimed at reducing the possible occurrence of adverse consequences related to political and environmental risk will bring the greatest benefits to the company. In case of transportation companies, insurance policies belong to the most frequently used and most effective methods of risk management. Companies interested in using this form of risk funding should analyse thoroughly individual insurance product types in order to ensure proper insurance cover for the difficult and risky activity of road transport of goods.

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