CRISIS AND RISKS ENGINEERING FOR TRANSPORT SERVICES

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Collective monograph

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Edited by Nataliia Chernova, Konrad Lewczuk

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Author team: Nataliia Chernova, Nofal Hajiyev, Viacheslav Matsiuk, Iuliia Bulgakova, Ilgar Khurshudov, Valiyeva Sapargul, Hudaygulyyev Nuraly, Yevhen Demchenko, Andrii Dorosh, Maryna Khara, Iryna Nikolaienko, Andrii Lyamzin, Valerii Samsonkin, Maral Meredova, Habib Halmamedov, Yolly Myradov, Atageldi Garajayev, Fuad Dashdamirov, Nijat Zohrabov, Sharifov Allahverdi, Olha Halan, Oksana Yurchenko.

Edited by Nataliia Chernova, Konrad Lewczuk.

Scientific editors:

Nataliia Chernova, Ph.D. in Economics, Associate Professor of the Department of Economics and Management, Ukrainian State University of Science and Technology (Dnipro, Ukraine);

Konrad Lewczuk, Vice-dean for science and development of the Faculty of Transport, Ph.D., Associate Professor of the Faculty of Transport, Warsaw University of Technology (Warsaw, Poland).

Reviewers:

Yevhen Aloshynskyi, Doctor of Technical Sciences, Professor of Cracow University of Technology;

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Marianna Jacyna, Dean of the Faculty of Transport, Full professor of the Warsaw University of Technology (Warsaw, Poland).

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Materials of scientific and practical research within the framework of the implementation of the project of the program of the European Union Erasmus+ «Crisis and Risks Engineering for Transport Services» (CRENG) are presented in the monograph.

Issues of the impact of crisis situations on the work of transport enterprises and ways to increase the efficiency of the functioning of transport and logistics systems in conditions of crises and risks are considered.

The publication is intended for scientific and pedagogical workers, graduate students and students of higher education, as well as managers and specialists of industrial enterprises and business structures, who are interested in the current state and prospects of the development of scientific research.

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AUTHOR TEAM

Nataliia Chernova, Head of International Relations Department, Ph.D. in Economics, Associate Professor of the Department of Economics and Management, Ukrainian State University of Science and Technologies (Dnipro, Ukraine);

Nofal Hajiyev, Head of IT department, lecturer in the department of Computer Engineering at Azerbaijan Technological University (Ganja, Azerbaijan);

Olha Halan, PhD in Information Technologies, Associate Professor of the Department of Information Technologies and Design of the State University of Infrastructure and Technologies (Kyiv, Ukraine);

Viacheslav Matsiuk, Doctor of Engineering Sciences, Professor of the Department Transport Technologies and Means in AIC, National University of Life and Environmental Sciences of Ukraine (Kyiv, Ukraine);

Iuliia Bulgakova, PhD in Engineering, Associate Professor of the Department of Railway Commercial Activities Management of the State University of Infrastructure and Technologies (Kyiv, Ukraine);

Mr. Ilgar Khurshudov, Senior Lecturer of Industrial Engineering Department of Baku Engineering University (Baku, Azerbaijan);

Mr. Arif Najimov, Chief Specialist of Baku Engineering University, Technopark, BEU Coordinator for Technology Commercialization and Transfer (Baku, Azerbaijan).

Valiyeva Sapargul, head of department Management and innovation technologies, Institute of Telecommunications and informatics of Turkmenistan (Ashgabat, Turkmenistan);

Hudaygulyyev Nuraly, lecturer of department Energy supply International University of Oil and Gas (Ashgabat, Turkmenistan);

Yevhen Demchenko, Ph.D in Technical Science, Associate Professor of the Transport Hubs Department, Ukrainian State University of Science and Technologies (Dnipro, Ukraine);

Andrii Dorosh, Ph.D in Technical Science, Associate Professor of the Transport Hubs Department, Ukrainian State University of Science and Technologies (Dnipro, Ukraine);

Maryna Khara, Deputy Dean of the Faculty of Transport Technologies, PhD in Engineering, Associate Professor of the Department of Transportation Technologies of Industrial Enterprises, Priazovskyi State Technical University (Mariupol, Ukraine);

Iryna Nikolaienko, Ph.D. in Engineering, Associate Professor of the Department of Technologies of International Transportation and Logistics, Pryazovskyi State Technical University (Mariupol, Ukraine);

Andrii Lyamzin, Head of the Department of Technologies of International Transportation and Logistics, Associate Professor, Dr. Sc. in Engineering, Pryazovskyi State Technical University (Mariupol, Ukraine);

Valerii Samsonkin, DSc in Technique, Professor of the Department of Transport Technology and Process Control Traffic, State University of Infrastructure and Technology (Kyiv, Ukraine);

Maral Meredova, PhD in Mathematics, MA in Economics, dosent of Exact and Natural Sciences department, International University for the Humanities and Development (Ashgabat, Turkmenistan);

Habib Halmamedov, Master of Education Management, instructor of Social Sciences department, International University for the Humanities and Development (Ashgabat, Turkmenistan);

Oksana Yurchenko, PhD in Engineering, Associate Professor of the Department of Railway Commercial Activities Management of the State University of Infrastructure and Technologies (Kyiv, Ukraine);

Yolly Myradov, Head of the educational department, candidate of technical sciences, Turkmen State Institute of Architecture and Construction на Turkmen State Architecture and Construction Institute (Ashgabat, Turkmenistan);

Atageldi Garajayev, Head of the department of Road construction, senior lecturer, Turkmen State Institute of Architecture and Construction на Turkmen State Architecture and Construction Institute (Ashgabat, Turkmenistan);

Fuad Dashdamirov, Director of the Institute of Logistics and Transport, Head of CRENG Service Office, Associate Professor, PhD, Azerbaijan Technical University (Baku, Azerbaijan);

Nijat Zohrabov, senior lecturer of the department «Transport equipment and management technologies», PhD, Azerbaijan Technical University (Baku, Azerbaijan);

Sharifov Allahverdi, Dean of the Faculty of Transport and Logistics, Associate Professor, PhD, Azerbaijan Technical University (Baku, Azerbaijan);

CONTENT

CHAPTER 6
NEW CHALLENGES FOR RISK AND CRISIS MANAGEMENT OF TRANSPORT SYSTEMS

Yevhen DEMCHENKO
Andrii DOROSH

Starting from 2020 to the present, transport sector is adapting to the updated operating conditions and gradual resumption from the crisis associated with the global COVID-19 pandemic. However, there are still a number of risks and new challenges for the global transport system. The growing number of cases from the Delta strain of COVID-19 in some regions of the world, the partial resumption of previously lifted restrictions and other factors create further uncertainty about global transport and logistics systems. At the same time, uncertainty concerns not only the timing of the return to pre-crisis indicators, but also the future image of the transport sector in the post coronavirus world as a whole.

One should also mention that Ever Given container ship ran aground in the Suez Canal, which led to the blocking of the movement of almost 450 vessels in both directions on the Asia-Europe route in the spring of 2021. The consequence of this event for World Trade became a significant increase in transport costs and cargo delivery times, a potential shortage of raw materials in production, a rapid increase in freight rates for sea vessels, etc.

Thus, the presence of random factors and unpredictable risks, both natural and human, does not allow us to fully predict the functioning of transport systems. Therefore, ensuring sustainable functioning of the global supply chain requires the development of new procedures and improvement of existing ones for risk and crisis management of transport systems, taking into account modern conditions and challenges.

6.1. Modern challenges in ensuring sustainable functioning of railway transport in Ukraine

Railway transport is one of the main modes of transport, providing about 80% of freight and almost 50% of passenger traffic in the domestic traffic of Ukraine. At present, there is a great importance of improving the safety of railway transportation in the context of the military conflict in the eastern regions of Ukraine, which has led to an increase in the number of cases of unauthorized interference in the operation of railway infrastructure facilities. Solving this problem requires implementation of modern technical and organizational solutions that should take into account the world experience of managing risks and crises on railways.

Ukraine’s National Security Strategy [39] defines the main threats to the security of the functioning of transport infrastructure facilities as: critical depletion of fixed assets and insufficient level of their physical protection; insufficient level of infrastructure protection from terrorist acts and sabotage; inefficient security management. Indeed, the functioning of railway transport is provided by a significant number of critically worn-out technical means of various levels of complexity, which are located on an extensive railway network and, as a rule, do not have a high-quality protection system against unauthorized interference in their operation. At the same time, any unauthorized interference in the operation of railway transport infrastructure facilities can be classified as a socio-political emergency, the consequences of which can lead to man-made accidents or catastrophes. In this regard, the issue of identifying and analyzing threats to the normal operation of railway transport, forming a system for countering these threats and minimizing their consequences, as well as bringing Ukraine's transport security in line with the EU requirements and international standards is relevant.

6.1.1. Critical infrastructure protection (CIP)

It is known that the functioning of the state, the safety and quality of life of its population significantly depend on the continuous and coordinated operation of a complex of enterprises and structures, which, because of their importance, are usually introducing the term of critical infrastructure (CI) [13, 14]. Governments in developed countries have given considerable attention to developing preventive measures to reduce the risk of CI interruption as a result of wars, natural disasters, worker strikes, vandalism and terrorist acts.

In order to address this issue, the EU Council adopted directive 2008/114/EC [3], on the basis of which the European Programme for Critical Infrastructure Protection was developed. Within the framework of this program, a four-stage methodology for identifying critical infrastructure objects is proposed, while identification is performed according to a number of industry-specific and cross-cutting criteria [2]. At the same time, it should be emphasized that no risk assessment work is carried out when defining these criteria.

The CIP program in the United States is implemented in accordance with Homeland Security Presidential Directive (HSPD-7) [7]. This directive defines 17 sectors, for each of which a specialized agency — Sector-Specific Agency (SSA) has been created and an industry plan for the National Infrastructure Protection Program (NIPP) has been developed [11]. Thus, the American approach is industry-specific and similar to the approach implemented in EPCIP. However, the American CIP program tends to pay more attention to sustainability issues. In addition, as noted in [5], unlike EPCIP, NIPP does not have a formalized procedure for identifying critical infrastructures.

CIP activities in Canada are carried out in accordance with the National Strategy [12], which defines key areas for ensuring the sustainability of CI, and the action plan [10], which contains procedures in the field of partnership, risk management and information exchange in the implementation of CIP. The division of responsibilities adopted in Canada between CIP entities is of considerable interest: the task of the infrastructure operator is to manage and reduce risks, and the government is to ensure the sustainability of CI. It is clear that ensuring sustainability cannot be solved at the operator level, as it requires the cooperation of different actors, and in many cases — also attracting entities from different sectors.

The concept which defines the main directions, mechanisms and terms of comprehensive legal regulation of the protection of critical infrastructure and the creation of a public administration system in the field of its protection has been approved in Ukraine [33]. This document introduces a general categorization of objects into critical, vital, important and necessary objects; at the same time, one of the priority steps in implementing this concept is to develop a methodology for identifying infrastructure objects and procedures for interaction between CIP subjects. In addition, one should note that this concept assigns financial and resource support for the protection of critical infrastructure facilities to their owners.

6.1.2. Railway transport as an object of critical infrastructure

One of the key objects of the country's critical infrastructure is the railway, a leading enterprise in the transport communications system, which, along with meeting the needs of the economy and the population for transportation, plays an important role in the state's defense activities.

Railway transport of Ukraine is a developed technological complex, the infrastructure of which includes: 19790 km of main tracks, 1447 stations and 105 railway stations, 4198 railway crossings, rolling stock of 1936 diesel locomotives, 1628 electric locomotives, 65000 freight and 3100 passenger cars, artificial structures and devices of power supply, communication, signaling, centralization, blocking, information complexes and traffic control systems [36].

As you can see, the railway is an extensive network with a large number of elements that are characterized by multi-level interactions and complex relationships within the railway and with objects of related industries. Obviously, even with the existing staff of 2.7 million employees [36], it is physically impossible to ensure full protection of the entire railway network. To protect such network structures by the author [9] it is proposed to use the Pareto Principle (80/20) and implement priority measures at the main nodes of the system. On the railway, these nodes may include stations, train stations, depots, traction substations, freight terminals, large artificial structures (bridges, viaducts, overpasses), remote switches on the main tracks, rolling stock, etc.

6.1.3. Global practices for the protection of railway infrastructure

In the period from 2011 to 2013, the METRIP project was implemented in the EU within the framework of the EPCIP program [13], which aims to develop methodological tools aimed at improving the protection of railway infrastructure Security (Ris), with a particular focus on passenger rail transport. This methodology is based on the decision-making process, which includes:

data collection and analysis of the safety status of railway infrastructure;

analysis and modeling of the functioning of railway infrastructure to quantify its vulnerability in order to identify the most critical elements of the railway that need priority protection;

classification of threats and scenarios of unauthorized interference in the operation of railway transport;

time-space assessment of the system's behavior in possible scenarios of destabilization of its functioning and development of cross-tables for system elements and attack scenarios;

development of a system for identifying critical elements of the system and selecting effective ways to protect them.

At the international level, cooperation in the field of security is carried out by a number of organizations, among which the largest are COLPOFER and the UIC security platform [13]. Thus, in 1980, the main Western European railway companies founded the COLPOFER Association (Collaboration des Services de Polica Ferroviaire et de Sécurité), which currently unites the heads of security of railway companies, representatives of the authorities and police of 24 countries. The association has developed a common approach to solving security issues: anti-social behavior and crime in passenger transportation; stowaway travel and forgery of travel documents; cargo theft; vandalism and graffiti, cyber crime and terrorism.

Another international body is the UIC security platform, which operates within the Department of fundamental values of this organization. The platform's working groups work in three areas of UIC security policy: human factor, technology, strategy, and rules. At the same time, the emphasis is placed on the fact that an effective security policy begins with providing operational personnel (human factor) with the necessary information and decision support (technology) within the regulatory framework in partnership with the public and authorities (strategy and rules). In addition, the platform hosts the annual World Safety Congress, the last one was held in October 2018 and was dedicated to the topic of crisis management and ensuring the sustainability of railway systems.

In addition to international organizations, there are national transport safety authorities in the countries. Thus, France's railways (SNCF) are divided into 11 safety zones, which are monitored by a special SUGE service and security specialists working in the regional directorates and operational institutions of the SNCF. The SUGE service is a militarized force of authorized railway security services with 2800 agents with police powers in the field of crime prevention, ensuring the safety of railway personnel, customers and property; agents can make arrests in the event of a crime committed on the railway.

On the Railways of Spain, safety control is entrusted to the special service RENFE. The RENFE Security Department coordinates and organizes security activities. The Protection Department of this service deals with natural (snowstorms, floods), social (terrorism, strikes) and environmental risks (transportation of dangerous cargo).

In Switzerland, under the leadership of the Federal Department of transport, the Swiss railway company SBB CFF FFS operates a security service and Transport Police, which are granted the right to remove persons from transport facilities, and if necessary, to carry out arrest.

In Italy, there is a railway police that prevents and stops crimes, protects public order and ensures the safety of citizens at railway facilities and on trains.

In Ukraine, control over public order at railway transport facilities is entrusted to the structural bodies of the Ministry of internal affairs — linear police departments.

Important infrastructure facilities (railway bridges, tunnels) are protected by the Armed Forces and the National Guard.

6.1.4. Legal and regulatory framework in the field of countering interference in operation of transport in Ukraine

Activities in the field of preventing illegal interference in the operation of transport are regulated by a number of international and national regulatory legal acts. So, the concept [22] classifies an act of illegal interference of a terrorist nature in the operation of railways as an action (inaction) that threatens the safe functioning of railway complex and entails or creates a threat of causing harm to the life and health of people and causing material damage.

National legislation [21, 23] liability is provided for a number of illegal actions on transport that have signs of unauthorized interference in its operation, namely:

theft or seizure of railway rolling stock;

blocking of transport communications, as well as the seizure of a transport enterprise;

unauthorized unnecessary stopping of the train;

damage to railway tracks and other track objects, structures and alarm and communication devices;

placing objects on railway tracks that may cause train traffic disruption;

damage to the internal equipment of passenger cars.

At the same time, according to analysis [16], there are no regulatory documents regulating the procedure for conducting a survey of railway transport infrastructure facilities for protection from terrorist acts in Ukraine indicated. So, in [26, 38] criteria for analyzing terrorist activity as a whole as a social phenomenon, and at railway transport infrastructure facilities and rolling stock as a component of it are not defined. These documents are primarily aimed at preventing terrorist manifestations in transport, but do not disclose the methodology of these preventive activities.

6.1.5. Analysis of the main threats to the operation of railways

Authors [13] have identified the following main threats to the normal operation of railway transport:

disruption of train schedules, employee strikes;

robbery of passengers, stowaway travel and forgery of travel documents;

driving on unset or improperly set routes, collisions of rolling stock and derailment;

collisions with motor vehicles at railway crossings;

livestock accident with cattle or wild animals;

force majeure, emergencies, fires;

dangerous cargo accidents;

theft of railway property, cargo;

damage to railway infrastructure and rolling stock, vandalism in transport;

putting foreign objects on the rails, illegal stopping of trains;

unauthorized interference operation of railway equipment;

extremism and terrorism;

attacks on passengers and railway workers, seizure of transport facilities.

Most of these events can be classified according to their signs and consequences of occurrence (death or injury of people; damage to rolling stock of railway transport, technical means; violation of the train schedule; damage to the environment). [30] as transport events that threaten the sustainable and safe operation of the railway.

As research shows [4, 15], due to the large number of passengers in railway stations, stations and trains, the railway has recently become one of the main targets for committing acts of terrorism with a large number of victims and significant material damage. Since the beginning of the military conflict in the Donetsk and Luhansk regions of Ukraine, domestic railways have also been subjected to massive terrorist attacks. So, according to the resource data [6] between 2014 and 2016, there were 38 events on railway transport classified as terrorist acts (see table. 6.1).

Table 6.1. Cases of terrorist attacks and accidents on railway transport in Ukraine

№ s/n	Region	Date	Object					Nature of the event
			track	artificial structures	rolling stock	sta-tion	de-pot	
1	2	3	4	5	6	7	8	9
1	Donetsk region	22.06.14	X		X			explosion
2	Donetsk region	22.06.14	X					explosion
3	Donetsk region	24.06.14	X					explosion
4	Donetsk region	24.06.14	X					explosion
5	Donetsk region	07.07.14		X				explosion
6	Donetsk region	07.07.14	X					explosion
7	Kharkiv region	07.07.14			X			grenade explosion
8	Donetsk region	21.07.14					X	shelling
9	Luhansk region	22.07.14		X				explosion
10	Donetsk region	28.07.14	X					explosion
11	Kharkiv region	23.08.14	X					explosion
12	Luhansk region	10.08.14	X					explosion
13	Donetsk region	10.08.14				X		explosion
14	Donetsk region	27.10.14		X				shelling
15	Kharkiv region	11.09.14			X			explosion
16	Donetsk region	23.12.14		X				explosion
17	Odesa region	24.12.14			X			explosion
18	Zaporizhzhia region	20.01.15			X			explosion
19	Odesa region	02.06.15		X				explosion attempt
20	Luhansk region	12.02.15		X				explosion
21	Luhansk region	09.03.15	X					explosion
22	Luhansk region	17.03.15		X				explosion
23	Luhansk region	19.03.15		X				explosion
24	Kharkiv region	30.03.15			X			explosion
25	Kharkiv region	31.03.15			X			explosion
26	Dnipropetrovsk region	31.03.15	X					explosion attempt
27	Kharkiv region	04.07.15			X			explosion
28	Donetsk region	10.04.15	X					explosion
29	Donetsk region	23.04.15			X			explosion

1	2	3	4	5	6	7	8	9
30	Odesa region	28.04.15	X					explosion
31	Donetsk region	29.04.15	X					explosion
32	Odesa region	13.05.15	X					explosion
33	Odesa region	06.04.15			X			explosion
34	Kharkiv region	15.07.15				X		explosion attempt
35	Kharkiv region	08.12.15				X		explosion attempt
36	Donetsk region	16.02.16			X			explosion
37	Kharkiv region	25.02.16		X				explosion attempt
38	Luhansk region	26.08.16	X					explosion attempt

Author's development based on data [6]

As can be seen from the table and analysis [1], the most common method of committing a terrorist act on transport is an explosion; at the same time, as studies have shown [19], in the world, terrorists mainly use 2 schemes:

a car bomb explosion near crowded places of passengers or railway infrastructure;

placing an explosive device inside buildings or transport rolling stock.

At the same time, the analysis of terrorist acts on the Railways of Ukraine shows that in most cases the explosive device was placed directly on the railway tracks; in that connection, in 35% of cases, the explosion occurred during the passage of rolling stock. According to the data [6, 1] the authors analyzed the distribution of terrorist acts at the place of their committing on the Railways of the EU and Ukraine (fig. 6.1).

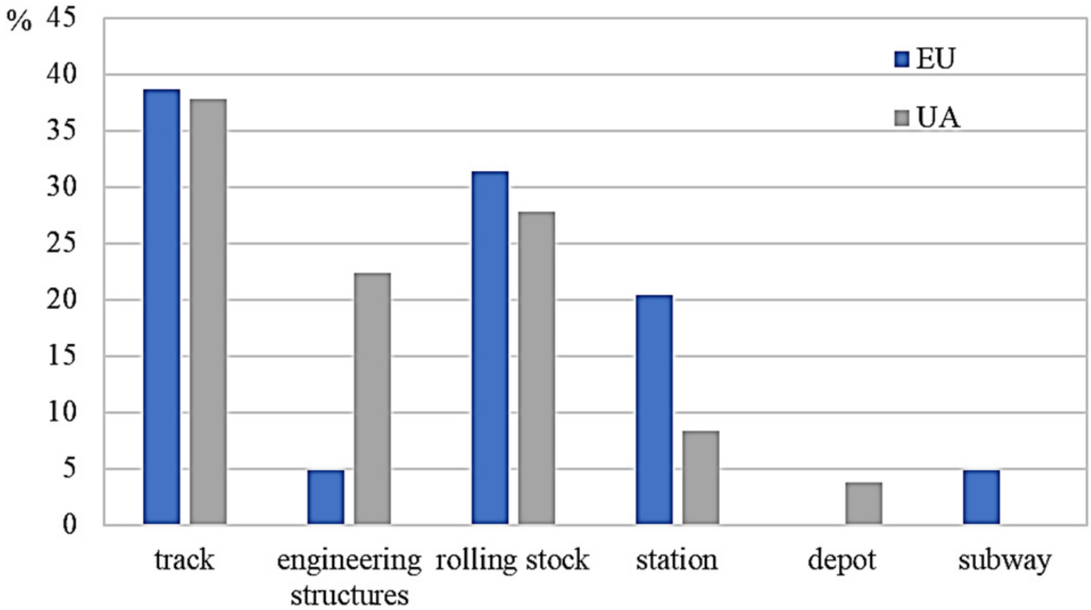

Figure 6.1. A percentage of distribution of the number of terrorist acts on the railway by place of their committing

Author's development based on data [1, 6]

As can be seen from fig. 6.1, the largest number of incidents occurred on railway tracks and in rolling stock. Separately, one should note that terrorist acts in the EU were mainly directed against civilians and passengers, as evidenced by a significant proportion of incidents at passenger stations and in the Metro. At the same time, according to statistics, a large number of attacks on Ukrainian Railways were directed at artificial structures (bridges, overpasses). Obviously, these attacks were aimed at stopping railway communication and logistics support of the Armed Forces of Ukraine in the zone of military conflict in the eastern regions of the country. Such specifics of attacks should be taken into account by risk management, in particular the risks of unauthorized interference in the operation of railway transport.

6.1.6. Railway risk management

Risk is an integral part of the production process, in particular the process of transporting passengers and goods by rail, and is a combination of the probability of damage and its severity. A set of measures aimed at minimizing possible losses that an enterprise may incur in connection with the occurrence of negative events is usually called risk management [8].

There are a significant number of risk assessment methodologies for critical infrastructures. The most common approach is linear approach [9], consisting of some basic elements: threat identification and classification, vulnerability detection, and impact assessment. In accordance with this scheme, we may formulate a general approach to risk management on the railway.

The first stage of risk management consists in identifying risks by determining the external (socio-cultural environment, political situation) and internal (organizational structure, available resources) contexts of the system's functioning. At this stage, it is determined which elements of the transportation process require risk analysis, which types of risks should be considered and risk management performers.

At the next stage, the risk value is assessed by determining the probability of occurrence of security breach incidents and the severity of their consequences. This assessment is the basis for prioritizing risk management measures.

Next, we develop risk management measures based on the following strategies [8]:

risk exclusion — completely eliminates the occurrence of risk. For example, the ban on passenger traffic on railway sections in the zone of military conflict completely eliminates the risk of injury and death of passengers from military operations.;

risk transfer — the risk is transferred to another party on the basis of an insurance contract. For example, mandatory passenger life insurance against accidents;

minimizing consequences — is aimed at reducing the damage caused by an incident, but does not reduce the possibility of this event. For example, restricting the transportation of certain types of cargo by railway sections in a military conflict zone reduces the consequences in cases of accidents on freight trains;

reducing the possibility of an incident occurring; in that connection the consequences are not minimized. For example, the organization of transportation of certain types of cargo by safer sections of Railways in the zone of military conflict reduces the possibility of accidents with them.

After developing management measures, it is necessary to determine their effectiveness by comparing the values of inherent (before management) and residual (after management) risks. As a general indicator of infrastructure protection from attacks, there is a probability of preventing a terrorist attack, which can be defined as [27]:

$$P = \frac{\sum P_1 P_2}{n}, \tag{6.1}$$

where P_1 — probability of timely detection of danger;

P_2 — probability of successful prevention of danger;

n — number of hazards.

To determine probabilities P_1 and P_2 it is necessary to determine the most likely location and method of conducting a terrorist attack and the parameters of the attacker (number, armament, level of training). To solve this problem one can use the pairwise comparison method [27].

At the last stage, a risk management plan is developed, including monitoring mechanisms, distribution of responsibility for implementing measures and evaluating their effectiveness.

This approach to risk management, unlike in Ukraine, is used on most railways in the EU, the USA, Canada, and in recent years has been introduced on the railway transport of the Russian Federation [24].

Thus, the railway transport of Ukraine is an object of critical infrastructure that performs not only passenger and cargo transportation, but also plays a significant role in ensuring the country's defense capability. In that connection, a railway is a complex technological set with a network structure that is poorly protected from unauthorized interference in its operation.

As the analysis showed, with the beginning of military aggression in the eastern regions of the country, Ukrainian Railways were subjected to mass terrorist attacks, the purpose of which was to stop railway communication and logistics support of the Armed Forces of Ukraine in the zone of military conflict. In addition, in order to destabilize the socio-political situation, terrorist acts on the railway occurred in other regions of the country (Kharkiv, Odessa, Dnipropetrovsk regions). At the same time, the most common way to commit a terrorist attack was to blow up tracks or artificial structures.

As world experience proves, an effective means of improving the safety of railway transport functioning in these conditions is the introduction of risk management methodologies and means of countering unauthorized interference in the work of its management system.

6.2. Modern challenges in the organization of international cargo transportation by road

Efficient operation of the transport industry is one of the main prerequisites for sustainable economic development of Ukraine. Domestic transport companies and logistics providers have become an integral part not only of domestic communication, but are increasingly involved in ensuring foreign trade.

Currently, the European Union is the main foreign economic partner of Ukraine. Therefore, according to the data [20] more than 42% of Ukraine's exports and 37% of imports come from trade with EU countries. In that connection, about 10% of goods by volume and 38% by cost are transported in the specified international traffic by road. As the analysis showed, there is a steady trend towards an increase in the number of truck crossings of the western part of the state border of Ukraine, especially the section adjacent to Poland (see fig. 6.2).

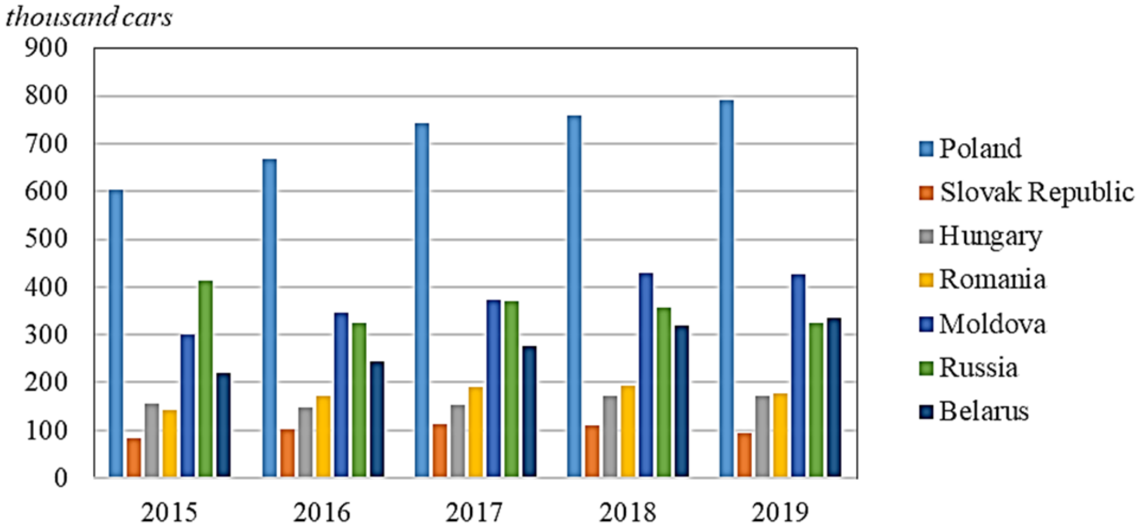

Figure 6.2. Road freight transport crossing over the state border of Ukraine

Author's development based on data [20]

In addition, activities in the field of providing transport services are one of the significant sources of filling the state budget of the country. Similar to international trade in goods, foreign economic activity includes the export-import of transport services — the performance of transportation on the territory of a foreign state, including the rental of vehicles and the provision of related and auxiliary services. The analysis showed that currently there is a gradual increase in the volume of international trade in transport services after a significant drop in 2014-2016, which was caused by the political and economic crisis in Ukraine (see fig. 6.3). It should be noted that a significant share in the total structure of foreign trade is accounted for by rail and air transport services [35].

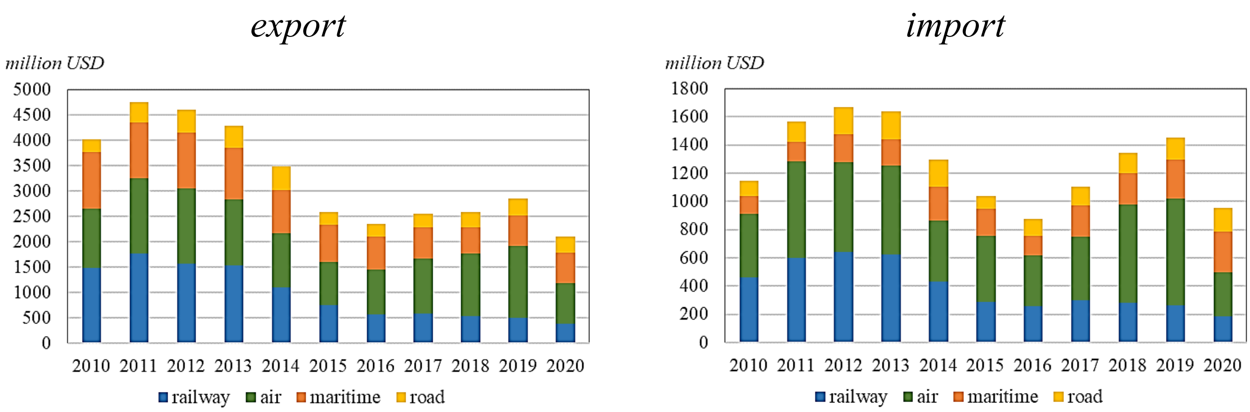

Figure 6.3. Dynamics of foreign trade in transport services

Author's development based on data [35]

At the same time, if we consider a similar distribution in trade with EU countries, the share of railway transport in the provision of these services is significantly reduced in favor of road transport (see fig. 6.4). This is due to significant technical differences between the railway systems of Ukraine and the EU countries, which considerably complicates the transportation process. In addition, road transport is more economically attractive over relatively short transport distances characterizing delivery to the EU.

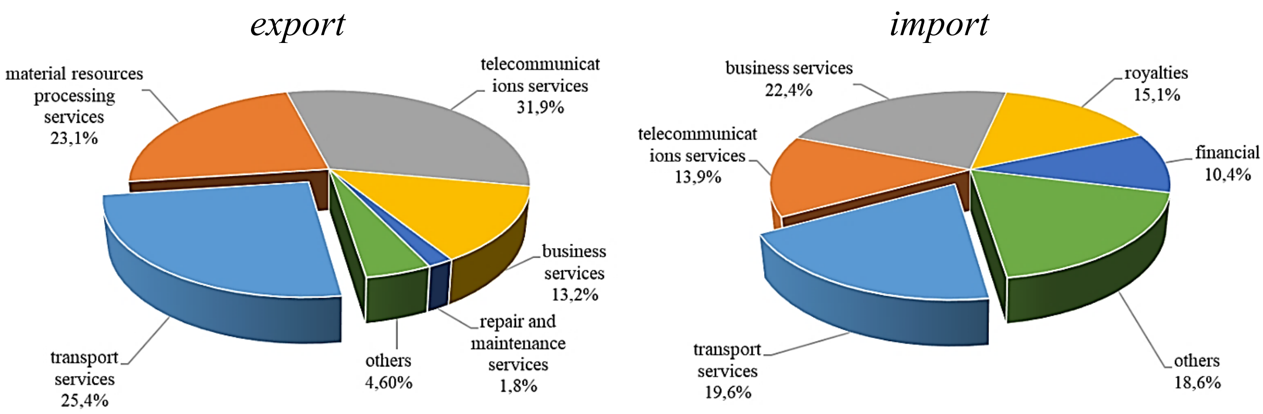

Figure 6.4. Structure of the foreign trade market in services with EU countries

Author's development based on data [35]

Transportation of goods by road in international traffic is a rather complex logistics process, which can be represented in the form of a multi-stage technological scheme. It is known that the implementation of each stage of this scheme is associated with a large number of unforeseen circumstances and random factors. Thus, in the process of international transportation, a number of risks arise that add uncertainty to the calculation of the standard duration and cost of cargo delivery [17]. At the same time, from the set of these risks at the level of persons organizing transportation, management is carried out mainly in relation to transport risks, the identification of which at different stages of international transportation is given in this article.

One of the methods of risk identification is SWOT analysis, which involves identifying strengths and weaknesses, threats and opportunities, as well as establishing links between them to form internal control and identify opportunities for developing the level of services provided. SWOT analysis of international cargo delivery services by road is given in Table. 6.2.

Table 6.2. SWOT analysis of international cargo delivery services by road

Strengths	Weakness
• Availability of the service for a wide range of consignors • Prompt execution of delivery • Possibility of organizing unimodal transportation and delivery «to the door» • Flexibility of the transportation route	• Technical condition of vehicles • Limited overall and weight parameters • Dependence on the requirements of the legislation of other countries • High level of competition • Insufficient capacity of border checkpoints

Opportunities	Threats
• Improving the safety of transportation process • Expanding the scope of additional related services • Creating a single customs zone and speeding up cargo delivery • Acceleration of customs and border control at international checkpoints	• Damage, loss or theft of cargo (road accidents, actions of third parties) • Violation of delivery terms • Lack of permits for transportation on the territory of foreign countries • A large number of participants in the transportation process and their possible incompetent actions • Political and economic risks

Author's development

Let's take a closer look at the threats and risks at the stages of transportation. The generalized scheme of cargo delivery by road in international traffic consists of the following stages:

preparation of cargo for transportation;

search and selection of a contractor for road transportation;

providing transport facility (TF) for loading;

preparation of shipping and transport documentation;

loading, placing and securing cargo in TF;

customs clearance of cargo in the country of departure (country of export);

transportation of cargo on the territory of the country of departure to the border crossing point;

passing customs and border control;

transportation of cargo through the territory of the destination country (transit countries) to the place of customs clearance;

transportation of cargo to its destination;

unloading TF.

One of the first stages where a transport risk may arise should be considered the preparatory phase of transportation, during which the cargo is packed and prepared for transportation. By Legislation of Ukraine [31] recommendations and requirements for packaging and labeling of goods in road transport have been established, so at this stage it is important to sort the cargo, as well as choose the appropriate container for its transportation. Risk factors at this stage may include the absence or choice of the wrong type of container for cargo, the use of damaged containers, careless attitude of personnel to the packaging or consolidation of cargo, etc. Therefore, research [37] has found that up to 40% of losses of perishable agricultural products are associated with the packaging of mature and diseased fruits in one container. Possible measures to reduce the amount of risks at this stage are the implementation of a system of preliminary control over the packaging and placement of goods in containers.

Direct transportation of cargo can be carried out by the shipper's own fleet (consignee) or with the involvement of third-party freight forwarding companies (outsourcing), which causes additional risk associated with the search and selection of a reliable and professional contractor. The involvement of an incompetent carrier can lead to a number of negative consequences: from non-fulfillment of obligations established by the contract to damage or loss of cargo. Economic activities related to the implementation of international road cargo transportation require mandatory licensing [32], which aims to make it impossible for unreliable carriers to enter the cargo transportation market. At the same time, as the study proved [29], the number of court cases in the field of freight forwarding activities has been steadily increasing over the past few years.

Today in Ukraine, one of the sources where you can find information about the rating and background of the transport company's activities is the All-Ukrainian online transport services exchanges: Lardi-trans, Della and others. In addition, there are now a significant number of open state registers that will additionally allow you to check the contractor's status, whether it has a tax debt, court cases, information about TF and drivers. Risk reduction at this stage is possible by implementing risk management procedures at an enterprise that attracts outsourcing companies to carry out cargo transportation.

Requirements regarding the terms and place of submission of the TF for loading, as a rule, are agreed in the application, which is an integral part of the freight forwarding contract, and their violation provides for penalties. As the analysis shows, at this stage, quite often there is a risk of late delivery of the car for loading or even refusal to load at all. The reasons for this risk may be delays of the car at the previous place of unloading, traffic jams or repairs on transport tracks at the entrance to the place of loading, irresponsibility of the driver, force majeure, etc. Obviously, the degree of risk at this stage largely depends on the level of reliability of the contractor chosen at the previous stage.

Road cargo transportation in international traffic involves the preparation of a package of shipping and transport documentation — CMR, Packing list, Invoice, Customs declaration, Certificate of Origin, Export declaration (EX-1), sanitary certificates, etc. The risk of errors, inaccuracies or lack of necessary data in the goods and transport documentation can cause significant delays in transportation, especially when crossing the state border, or even call into question its implementation.

After the vehicle is delivered to the loading point, it is received and inspected, checked for compliance with the customer's requirements and, if necessary, weighed. At this stage, there are risks associated with non-compliance of the transport facility with the customer's requirements, for example, insufficient internal dimensions of the semi-trailer, lack of a sealing cable, damage to the awning, technical malfunction of the refrigerated unit, etc.

Performing loading and unloading operations is regulated by Article 8 of the rules for the transportation of goods by road of Ukraine [31], and the requirements for placing and securing cargo in the transport facility — European standards EN 12195-1, EN 12195-2, EN 12195-3, EN 12195-4, EN 12195:2010, EN 12640. The main source of risks in cargo operations is the technical means and equipment for cargo operations, as well as the responsibility and vigilance of the personnel who carry them out. Separately, it should be noted the risks associated with the actions or omissions of the car driver. Analysis of existing practice has shown that quite often there are cases of shortage or damage to cargo due to drivers ' failure to perform their direct duties. Thus, the legislation of Ukraine establishes that the driver is responsible for placing and securing cargo within the TF, and is also obliged to control the process of loading and unloading the car.

A mandatory stage of international road transport is the implementation of customs clearance of goods. Cargo customs clearance procedures can be performed both on the territory of international automobile checkpoints and at customs terminals (posts) of regional customs offices. Depending on the cargo and the customs regime under which it is planned to be placed, a customs declaration and a package of documents for declaration established by national legislation are provided to customs in advance. When checking the documents submitted by the Declarant, the customs service applies a risk analysis method to determine the goods, including vehicles, to be checked, and the degree of such verification. It is at this stage that there are risks of car delay due to customs formalities. The increase in the duration of customs clearance may be due to incorrect processing of customs documents; incorrect calculation of customs duties and payments; lack of documents necessary for non-tariff regulation; inspection of a vehicle by a customs officer in order to compare the mass and number of cargo spaces declared in the documents with the actual one. The source of such risks is incompetent actions of the Declarant or broker when performing customs clearance of goods. Customs clearance is considered completed after the customs security (seal) is applied to the vehicle with the cargo and the mark «under customs control» is affixed in shipping and transport documents, after which international transportation begins.

The process of transportation carried out both on the territory of Ukraine and on the territory of the destination country or other third (transit) countries is the longest stage of international cargo delivery. Risks during transportation may occur for the following reasons: road accidents that may lead to damage, partial or complete loss of cargo; illegal actions of third parties that led to theft of cargo during transportation; failure to meet the delivery time of cargo due to force majeure or road conditions. Risk factors in this case may be unfavorable weather conditions; dangerous road conditions and unstable situation in the regions through which the route of transportation passes (transportation through the temporarily occupied territory of Ukraine); malfunction of individual technical systems and components of the transport facilities; lack or insignificant experience of the driver on a certain route or terrain of Transportation; insufficient awareness of the driver about the features of the cargo and the conditions of its transportation (compliance with the requirements of the temperature regime, the impossibility of delaying delivery).

In addition, during road transportation, there are stops related to food, satisfaction of the driver's natural needs, or regulated, in accordance with the requirements of the AETR [18], the driver's rest on the road. In accordance with international requirements and recommendations, long-term stopping or parking of TF with cargo should take place in certified Tir-parking facilities equipped with video surveillance equipment and an existing staff of security personnel.

Summing up this stage of transportation, it should be noted that according to international and national legislation, the responsibility for the safety of the cargo from the moment it is accepted for transportation and until it is issued to the recipient lies with the carrier, unless the latter proves that the loss, shortage, damage or damage to the cargo occurred due to circumstances that the carrier could not prevent and the elimination of which did not depend on it.

Export and import of goods by road across the customs border of Ukraine in accordance with [25] is carried out at the relevant checkpoints, the list of which is established by the Cabinet of Ministers of Ukraine. Currently, there are 100 international automobile border crossing points (IABCP) on the state border, but only 28 of them can serve cargo flow in connection with the following countries: Republic of Poland — 4, Hungary — 1, Slovak Republic — 1, Romania — 2, Republic of Moldova — 8, Russian Federation — 5, Republic of Belarus — 7. When crossing the state border, a number of checkpoints controls established by national legislation are met [28]:

control of the International Road Transportation Service (IRTS);

veterinary and sanitary, phytosanitary, environmental, radiological control;

customs control;

border control.

The total time spent by a car in the IABCP depends on the duration of the specified procedures, which is not regulated in any way, but it is established that the maximum period of stay of goods and vehicles at checkpoints can not exceed 5 days from the date of arrival at the checkpoint for customs procedures [28]. In addition, there are a number of other factors that may cause additional unpredictable downtime at the checkpoint. Thus, when exporting from Ukraine, there are cases of delay for the purpose of additional inspection of the vehicle by customs officers, due to the recommendations from automated risk analysis and management system (ARAMS) [40]. When importing goods, additional delays may occur due to the lack of prior notification of the cargo and TF in the customs information base of the point. The presence of these and other random factors gives reason to believe that the duration of stay at the checkpoint is a random value, and therefore there are risks of delay of the car with cargo at the state border of Ukraine.

The amount of risk in this case is characterized by a mathematical expectation and a standard deviation in the duration of delays. To determine these statistical characteristics, the paper analyzes the length of queues at Ukrainian border crossing points from Poland, Slovakia, Hungary and Romania by day in 2019. As the analysis showed, there are significant fluctuations in the length of the queue while waiting for the border to pass. Therefore, on the border crossing points Yahodyn-Dorohusk, the average number of cars in the queue was 178.35 cars; the standard deviation was 156.98 cars (±88%). The longest queue length at this border crossing was observed in December-January and reached 800 cars/day, and the waiting time in the queue exceeded 30 hours.

The final stage of the international transportation process is customs clearance, unloading of the transport facilities at the destination and acceptance of the cargo by the recipient. At this stage, customs formalities are performed similar to customs procedures in the country of departure, transfer of shipping and transport documents, check the number of cargo spaces and weight of cargo, inspect the cargo for signs of damage, and unload the vehicle. During these operations, there may be risks of detecting a shortage or damage to the cargo, due to inattention of the driver or unfair intentions of the recipient's personnel when unloading the cargo; technical malfunction of weighing and other equipment for unloading; unfair intentions of employees performing unloading the cargo.

Thus, as the analysis has shown, transport services in international traffic are one of the important components of economic development. The efficiency of the organization of international transportation depends not only on the economic result of the functioning of an individual transport company, but also on the indicators of foreign economic activity of industries and the country as a whole.

Research of statistical data has established that the main trading partner of Ukraine is currently the European Union. At the same time, a significant amount of cargo transportation between these parties is carried out by road, which provides attractive unimodal door-to-door delivery in a relatively short time. At the same time, the analysis showed that the organization of international transportation by road is associated with a large number of random factors and risks caused by this, which does not allow us to accurately estimate the cost and duration of such delivery. To solve this problem, the paper identifies risks at each stage of international transportation. The results obtained can be used in the risk management process to improve the efficiency of cargo transportation management by road in modern conditions.

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