

Systemy Logistyczne Wojsk
Zeszyt 63(2025)
ISSN 1508-5430, s. 75-96
DOI: 10.37055/slw/218678

Institut Logistyki
Wydział Bezpieczeństwa, Logistyki i Zarządzania
Wojskowa Akademia Techniczna
w Warszawie

Military Logistics Systems
Volume 63(2025)
ISSN 1508-5430, pp. 75-96
DOI: 10.37055/slw/218678

Institute of Logistics
Faculty of Security, Logistics and Management
Military University of Technology
in Warsaw

Challenges and threats to military road transport in the context of the contemporary geopolitical situation

Tomasz Iwan

t.iwan@law.mil.pl; ORCID: 0000-0001-5995-0404
Institute of Logistics and Transport, The Polish Air Force University, Poland

Abstract. Military road transport is essential for operational readiness, yet it increasingly operates within a security environment shaped by hybrid activities, sabotage and deliberate disruptions observed during the Russian–Ukrainian war. The research niche of this article is the integration of classic roadsafety considerations with the risk of intentional human interference in military movements conducted on civilian road infrastructure. The purpose of the article is to identify emerging threats to military road transport and to propose pragmatic riskmitigation measures. It is hypothesised that the visibility, predictability and information leakage inherent in organised movements (columns, oversize vehicles and dangerous goods transports) significantly increase vulnerability to hostile interference beyond 'typical' traffic hazards. The study applies qualitative deskbased methods: analysis of Polish legal and administrative regulations and military procedures, supported by a review of contemporary threat patterns and lessons learned from the war in Ukraine, followed by synthesis into recommendations. The analysis indicates that mandatory markings, convoy structure, route constraints and public exposure may facilitate targeting, while cyber and information operations can amplify disruption effects. The article proposes a systemic approach that combines operational security (limiting sensitive information), route and timing planning, strengthened liaison with security services, and targeted public awareness to reduce incident probability and consequences.

Keywords: logistics, road transport, transport safety, risk, hybrid activities

Introduction

In today's world, transport is a strategic component of the economy, conditioning the availability of goods and a mechanism connecting the supplier of goods with the final recipient. The growing demand for all kinds of materials is undoubtedly the result of regional development, technical progress and developing globalization. In the context of transport, economic, climatic, military, social, cultural and political

aspects are also important, which also generate the need to move people, equipment and various material means (Hajdul et al., 2015, pp. 21-23).

Transport for modern society is therefore an essential element of logistics structures, guaranteeing an adequate standard of living and the availability of various goods and services. The permanent need for wide access to the entire spectrum of material resources, in turn, results in an increase in the number and extension of supply chains, and the increase in demand for passenger and freight (logistics) transport services entails a rapid increase in the number of vehicles moving on public roads. The increase in their concentration, in turn, translated into an increased risk of negative road incidents, and with limited capacity of road sections and intersections, it led to traffic jams, increased noise intensity, environmental pollution and reduced quality of life for residents. Despite the unquestionable benefits of the development of the transport system, the likelihood of accidents and collisions caused by its structural elements has also increased. The negative effects of transport expansion can be directly measurable, in relation to the amount of pollutant emissions or noise levels, but it is much more difficult to determine the value of potential losses caused by vehicles being stopped in traffic jams. Logistics transport is undoubtedly a strategic component of the economy of every country, but its efficiency and security depend on many factors. In road transport, infrastructure, availability of the vehicle fleet, personnel and proper organisation of movement processes are crucial. This problem applies to both typical logistical and military (including operational) movements, because in practice they take place using the same road infrastructure. The issue of transport efficiency and safety concerns the whole society, but nowadays, in addition to “typical” threats, the external environment of transport processes should also be taken into account. Nowadays, complex geopolitical conditions may be important not only in the case of military movements, but also include the civilian sector. For this reason, ensuring safety in transport may become much more difficult, and all preventive and neutralization procedures should take into account the possibility of destructive human interference in the logistics system as a result of planned sabotage and hybrid activities.

Unfortunately, interference with the components of a closed set: “driver-vehicle-road infrastructure” has become quite frequent in the modern world, because their range and effects are disproportionate to small financial outlays and organisational effort. It should also be emphasized that the purpose of an attack, diversion or sabotage does not have to be the complete material destruction of means of transport, goods or road infrastructure. A measurable effect may be the mere immobilization of equipment, elimination from operation (combat), cutting off from supplies or organisational and information chaos in the economy. Military displacements have their own specificity, because in addition to direct, military consequences at the stage of relocation, any conscious, negative interference also implies secondary effects on the entire environment of the transport process, society, but also the economy.

Although organized military transports have been a natural everyday reality for most road users and the general public for years, due to the type of vehicles moving, the specificity of combat equipment and logistical means, they are often the object of special interest on transport routes. The size, weight, number and “unusualness” of military transports evoke both positive and negative emotions among other road users, due to the possibility of local traffic difficulties, significant interference in the area of security and the emotional sphere of the society. Increasing the situational awareness of road users in the context of military operational, logistical and passenger movements, taking into account contemporary geopolitical realities, seems to be indispensable. Therefore, this study focuses mainly on the issue of ensuring public security in connection with military movements in the classical sense and under “normal transport conditions”, but also touches on the issue of contemporary, new threats in the field of logistics and transport, which until recently were sporadic. The main objective of the study is therefore to identify new, potential threats in military transport and to develop proposals for rationalization and an innovative approach to transport processes, taking into account the risk of hybrid, sabotage or even terrorist activities. The research problem is formulated as the following question: “What actions, tools or systemic solutions should be implemented to reduce the risk of destructive interference in military transports and how to minimise its possible effects?” The hypothesis is that deliberate hostile interference (hybrid and sabotage activities), combined with information leakage and the high visibility of organised movements, materially increases the risk profile of military road transport and therefore requires systemic mitigation measures that go beyond standard roadsafety procedures. The scope of the considerations covers: organised military movements regulated by national procedures (columns, oversize transport and dangerous goods); and contemporary threat patterns observed in interstate conflict.

Specificity of military movements on the basis of applicable legal regulations

Organized movements of military equipment and personnel on public roads are regulated mainly in the “Road Traffic Law” and include:

- 1) Movement of single (unmarked) vehicles according to the general rules of the road,
- 2) Movement of marked military columns,
- 3) Movement of oversize vehicles,
- 4) Movement of vehicles with dangerous goods

(Act of 20 June 1997, Road Traffic Law, as amended, consolidated text, Journal of Laws of 2024, p. 1251).

The largest, direct interference with road traffic and its immediate surroundings, in particular other drivers, passengers, vehicles, road infrastructure and the natural environment, are the last three groups of displacement operations. Factors that increase the level of risk in transport are the number of pieces of equipment moved, their size or the very properties of the transported loads. These factors have a significant impact on traffic flow, the efficiency of the use of point and line elements of transport infrastructure, and obviously affect the issue of road safety. Depending on the tactical situation, manoeuvres of military equipment can take place to the areas of operational destination, training grounds or military units, places of concentration, as well as warehouses and logistic facilities. From the operational point of view, in the processes of military road transport, the primary objectives are efficiency, efficiency, reduction of the negative impact of road traffic on the natural environment and maintaining an acceptable level of safety of people moving along with the entire environment of the transport process. Therefore, an effective transport system in the military sense is an accessible, fast, simple, safe, and at the same time ecological and economical system.

Moving military columns on public roads

According to the *Road Traffic Act*, the number of vehicles with a maximum permissible weight of more than 3.5 tonnes in an organised column cannot be bigger than 5. The exceptions are columns of emergency and military vehicles. However, in the case of moving a military convoy, it is necessary to obtain an appropriate military permit, in the same way as for the passage of non-standard vehicles and vehicles carrying certain dangerous goods, and it is also required to properly mark and equip the vehicles moved in the column.

The movement of a military column of more than 20 vehicles should take place in groups with a minimum distance of 500 m, while in times of crisis or war, these vehicles may pass in one compact group. At the same time, it should always be remembered that according to the traffic regulations, it is forbidden for vehicles to drive between military vehicles driving in an organized column.

The external marking of a column of military vehicles moving on public roads consists of:

- 1) orange and black plate at the beginning and end of the column (front left of the first vehicle and rear left of the last vehicle),
- 2) blue flag (on the first vehicle of each vehicle group – on the front left, it is not required when moving a column containing up to 20 vehicles not divided into separate groups),

- 3) green flag (on the last vehicle of each vehicle group – on the front left, it is not required when moving a column containing up to 20 vehicles not divided into separate groups),
- 4) white and black flag (on the vehicle of the column commander – on the front left side),
- 5) yellow flag (on a defective vehicle or in need of technical assistance, in a place visible to other road users, after removing any other flags),
- 6) assigned number of the convoy of vehicles (number of the transport permit) – on each vehicle, applied in a contrasting colour to the colour of the vehicle, on both sides, resistant to adverse weather conditions,
- 7) mark of a special vehicle of the Polish Armed Forces or used for special purposes.

In the event of a convoy of vehicles passing on an expressway or motorway, which, due to external parameters, do not require additional escort, a yellow warning signal is placed on the first and last vehicle, visible from a distance of at least 150 m. (Regulation of the Minister of National Defence of 21 November 2012 on the manner and mode of issuing military permits for road passage and the manner of organisation and marking of vehicle columns of the Armed Forces of the Republic of Poland, consolidated text. Journal of Laws 2024, p. 1626).

Elements of external marking required for military columns are presented in Fig. 1.

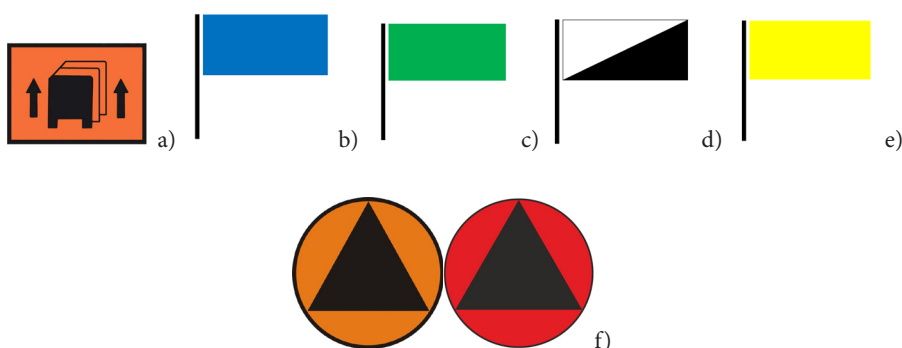


Fig. 1. Marking of military columns and vehicles

Source: Own study based on: (Rozporządzenie Ministra Obrony Narodowej z dnia 21 listopada 2012 r. w sprawie sposobu i trybu wydawania zezwoleń wojskowych na przejazd drogowy oraz sposobu organizacji i oznakowania kolumn pojazdów Sił Zbrojnych Rzeczypospolitej Polskiej)

- a) Column start and end board 400x300mm
- b) Flag of the beginning of the group of vehicles 300x450mm
- c) End of Vehicle Group Flag 300x450mm
- d) Column Commander's Flag 300x450mm
- e) Flag for a vehicle in need of technical assistance
- f) A sign of a special vehicle of the Polish Armed Forces or used for special purposes (at the front and rear of the vehicle, respectively).

Military movement of oversize vehicles

A non-standard vehicle within the meaning of the National *Road Traffic Act* is a vehicle or a combination of vehicles whose axle loads with or without load, dimensions or actual total weight with or without load are greater than the permissible values specified in the Act. Its passage on public roads requires prior arrangement of the route of transport and obtaining an appropriate permit by way of an administrative decision (categories I-V). It is issued at the request of a specific road carrier, for a specified period of time – depending on the external dimensions of the vehicle with the load and the place, route and time of the start of the journey. Permits are issued by competent administrative authorities such as: the district starost (categories I-II), the head of the customs and tax office (categories II-III) and the General Director for National Roads and Motorways (Polish GDDKiA) – categories III-V). In the case of non-standard military transports, permits are issued by the relevant troop traffic management bodies within the structures of the Support Inspectorate of the Polish Armed Forces (Polish IWsp SZ) according to the territorial scope of the planned movement, and in particular:

- 1) Chief of the Support Inspectorate of the Armed Forces (Polish IWspSZ) – for transfers between the areas of responsibility of the Regional Logistics Bases (Polish RBLog) and when crossing the Polish border,
- 2) Commander of the RBLog – in the case of journeys carried out between the areas of responsibility of the Military Transport Commands (Polish WKTr) located within the area of one RBLog,
- 3) Commandant of the WKTr – in the case of crossings running within the area of responsibility of one WKTr.

Military permits for the movement of an oversize vehicle on public roads are issued at the request of the military unit (institution) being moved, submitted each time to the WKTr competent for the place where the movement began. The specific conditions of movement are specified in the permit, as well as the need to check the designated route in advance and details of possible escort of the vehicle.

The permit is stored in the vehicle during the transfer. The parameters of oversize vehicles along with the limit values regarding the need for escort are presented in Table 1. It should also be noted that in the event of the passage of military oversize vehicles in an organized column, 2 escort vehicles should be provided: at the front and at the rear, respectively. Escorting of non-standard vehicles in the Polish Armed Forces is carried out by marked vehicles of the Military Police or military traffic regulation subunits sending flashing light signals in blue, and in the case of piloting a column of vehicles – additionally flashing light signals in red (Regulation of the Minister of National Defence of 21 November 2012 on the manner and mode of issuing military permits for road passage and the method of organizing and marking columns vehicles of the Armed Forces of the Republic of Poland, consolidated text. Journal of Laws 2024, p. 1626).

Table 1. Parameters of oversize vehicles in Poland

Width [m]	Length [m]				Height [m]	Total weight [t]
	Single vehicle	Vehicle with a trailer	Vehicle with semi-trailer	Bus		
No obligation to pilot						
2.55	12.00	18.75	16.50	15	4.00	42.0
1 escort vehicle						
3.20	23.00	23.00	23.00	23.00	4.50	60.0
2 escort vehicles						
3.60	28.00	28.00	28.00	28.00	4.70	80.0

Source: Own study based on: Rozporządzenie Ministra Obrony Narodowej z dnia 21 listopada 2012 r. w sprawie sposobu i trybu wydawania zezwoleń wojskowych na przejazd drogowy oraz sposobu organizacji i oznakowania kolumn pojazdów Sił Zbrojnych Rzeczypospolitej Polskiej, Ustawa z dnia 20 czerwca 1997 r. Prawo o ruchu drogowym

The dimensions and weight of moving oversize vehicles require drivers to have appropriate psychophysical predispositions and to exercise special caution, because the potential threats to other drivers and the surrounding infrastructure are significant. From the point of view of road safety, such a vehicle must be marked and clearly visible to other road users, who should also be characterized by appropriate situational awareness in terms of potential threats and assume that they themselves may be poorly visible. Thus, they should not perform sudden and risky manoeuvres forcing unconditional reactions of drivers of large vehicles, for whom stopping, quick change of speed or direction of travel is usually troublesome. Practical examples of military oversize vehicles in road transport are presented in Fig. 2-5.



Fig. 2. Examples of oversize transport in the Polish Armed Forces
Source: Pyszczyk, 2022



Fig. 3. Examples of oversize transport in the Polish Armed Forces
Source: Author's own materials



Fig. 4. Examples of oversize transport in the Polish Armed Forces
Source: Author's own materials



Fig. 5. Examples of oversize transport in the Polish Armed Forces

Source: Józwiak and Lesiak, 2019








Movements of vehicles transporting dangerous goods







Among the goods moved by the Armed Forces, dangerous goods deserve special attention, which are defined as materials and objects whose international carriage by road is prohibited or permitted only under certain conditions (procedures) specified in the ADR agreement (International Agreement concerning the Carriage of Dangerous Goods by Road. Edition 2025). Transport procedures for military vehicles are analogous to those for other carriers and are also regulated by the Act of 19 August 2011. *on the transport of dangerous goods* (consolidated text, Journal of Laws 2024, p. 643). The generally applicable regulations are intended to increase the level of safety and primarily concern the classification of dangerous goods, the conditions for their admission to transport, the selection of packaging and marking of shipments, the loading of goods into the vehicle, the construction and technical condition of transport units, as well as the training and qualification of personnel (Neider, 2019, pp. 143-148).

During transport, both in solid, liquid and gaseous states, hazardous substances can pose a threat to the entire environment, in particular people, the natural environment and infrastructure facilities (general and road). On the basis of chemical and physical properties and prevailing hazards, each dangerous good can be assigned to one of 13 classes, with the classification criteria together with individual identification numbers (UN) being uniform for all 54 countries – signatories of the ADR agreement. The danger of these goods may result from their explosive, flammable, oxidizing, corrosive, poisonous, infectious or radioactive properties. The intensity of the hazard posed by a given material is defined in the ADR agreement most often using packaging groups, where group I is the highest, II – medium, III – the lowest).

A synthetic list of all 13 classes of dangerous goods, the hazards they pose and the graphic warning markings (stickers) assigned to them is presented in Table 2.

Table 2. Classification of dangerous goods

Class number	Class name	Type of dominant and secondary hazards	Specimens of warning stickers for the dominant hazard
1	Explosives and items with explosives	Explosion (normal or mass), dispersal, fire, poisonous or corrosive	
2	Gases	Oxidizing, asphyxiating, poisonous, corrosive, fire, explosion, frostbite	
3	Flammable liquids	Fire, poisonous, corrosive	
4.1	Solid flammable materials, self-reactive materials, polymerizing materials and solid desensitized explosives	Fire, explosion, poisonous, corrosive, high temperature	
4.2	Substances liable to spontaneous combustion	Fire, explosion, poisonous, corrosive, high temperature	
4.3	Materials that produce flammable gases in contact with water	Fire, poisonous, corrosive	
5.1	Oxidizing substances	Fire, explosion, high temperature, strong chemical reaction when in contact with combustible materials	

Class number	Class name	Type of dominant and secondary hazards	Specimens of warning stickers for the dominant hazard
5.2	Organic peroxides	Fire, explosion, oxidizing effect, high temperature	
6.1	Toxic substances	Poisonous, fire, hazardous reaction with oxidizing activity, corrosive	
6.2	Infectious substances	Threat of a disease dangerous to life or health, asphyxiating effect, high temperature	
7	Radioactive materials	Irradiation hazard, corrosive	
8	Corrosive substances	Chemical burn hazard, corrosive action, fire, hazardous reaction with water, oxidizing effect,	
9	Miscellaneous dangerous substances and articles	Effects on health or the environment, fire and emission of harmful substances, flammable gas emissions, high temperature	

Source: Own study based on: (European Agreement Concerning the International Carriage of Dangerous Goods by Road – edition 2025, Grzegorzczuk, Buchcar, 2023, pp. 28-40)

It should be noted that each product can be assigned to only one class on the basis of the dominant threat but also have additional properties corresponding to other classes. And so, a class 3 flammable liquid material, in addition to its susceptibility to ignition, may also have poisonous properties, and then, in addition to a label describing the main hazard, it will also be marked with other warning stickers during transport. The external marking of vehicles transporting dangerous goods consists of orange plates and sometimes warning stickers. Plates with dangerous goods numbers (UN) and hazard identification numbers are placed during transport in tankers and transport in bulk in special containers. Plates without numbers (“plain”) are used for the transport of goods in pieces of consignment, as in the case of class 1 explosives and objects (combat equipment: rockets, grenades, ammunition...).



Fig. 6. Vehicle of the Polish Armed Forces transporting dangerous goods in a tanker

Source: <https://zbiam.pl/umowy-na-cysterny/>



Fig. 7. Vehicle of the Polish Armed Forces transporting dangerous goods in pieces of shipment

Source: Puzsklewicz and Piątkowski, 2018

Warning stickers placed on packaging and vehicles have a characteristic appearance, numbering and colours, which makes it possible to warn people in the vicinity, intuitively recognize the type of threat and clearly describe it to the emergency services in the event of a real threat in road traffic. In addition, any military transport unit transporting dangerous goods on public roads in the quantities above those indicated in Table 3 should be authorised to carry out transport operations, which entails agreeing in advance on the route of movement, providing the necessary means to protect the cargo and monitoring its movement. (Regulation of the Minister of National Defence of 28 September 2012 on the issuance of military permits for the road passage of vehicles transporting dangerous goods, Journal of Laws of 2012, p. 1257).

Table 3. List of dangerous goods subject to notification and authorisation

Class	Dangerous goods, the transport of which is subject to the obligation to obtain a military permit for road passage
1	explosives and explosive objects, transported in quantities which, in accordance with the ADR, require the transport unit to be marked with orange plates
2	gases of the following groups: T, TF, TC, TO, TFC and TOC, carried in tank(s) in quantities exceeding 3000 litres
3, 4.2, 4.3	goods included in packing group I, transported in tank(s) in quantities exceeding 3000 litres
5.1	goods included in packing group I, transported in tank(s) in quantities exceeding 3000 litres perchlorates, ammonium nitrate and ammonium-based fertilisers, transported in tank(s) or in bulk in quantities exceeding 3000 litres or 3000 kg
5.2	goods transported in tank(s) in quantities greater than 3000 litres
6.1	goods included in the first group of packaging, transported in tanker(s) in the amount of more than 3000 litres and goods transported in pieces of consignment in quantities requiring the vehicle to be marked with orange plates
6.2	category A infectious materials
7	radioactive materials with a total activity greater than 3000A1 or 3000A2 carried in pieces of type B(M) and type C consignments, radioactive materials carried in pieces of type B(M) consignments, fissile materials for which the sum of criticality safety indicators for pieces of consignment exceeds 50, spent nuclear fuel, radioactive materials carried under special conditions
8	goods included in packing group I, transported in tank(s) in quantities exceeding 3000 litres

Source: own study based on: Rozporządzenie Ministra Obrony Narodowej z dnia 28 września 2012 r. w sprawie wydawania zezwoleń wojskowych na przejazd drogowy pojazdów przewożących towary niebezpieczne

An essential element in the system of transport of dangerous goods in the Polish Armed Forces is the acquisition of knowledge and experience by the employed personnel. Specialist training for drivers transporting dangerous goods includes courses and state exams enabling the acquisition of skills to minimise the risk of a negative incident in road transport or, in the event of its occurrence, to reduce its tragic consequences. It includes:

- 1) Basic course (entitling to transport dangerous goods in pieces of consignment, except for classes 1 and 7),
- 2) Specialist course in the transport of dangerous goods in tankers,
- 3) Class 1 specialist course in the transportation of explosives and articles
- 4) Specialist course in the transport of radioactive materials class 7.

Specialist supervision over the observance of the necessary transport procedures and transport safety is the responsibility of the Dangerous Goods Safety Advisors (DGSA), whose employment is obligatory for any entity transporting, loading or unloading dangerous goods in quantities above which it is required to mark vehicles with orange plates.

In the technical area, the design and technical condition of transport units are extremely important. Vehicles intended for the transport of dangerous goods should undergo annual basic and additional technical inspections in order to confirm the compliance of the actual technical condition of the vehicle with the requirements of the ADR agreement. Compliance with the construction and technical requirements in Poland is confirmed in the “certificate of admission of the vehicle for the transport of certain dangerous goods” by the Transport Technical Supervision (Polish TDT), and for military vehicles by the Military Technical Supervision (polish WDT). For the transport of this type of cargo, in quantities where it is required to mark the transport units with orange plates, vehicles of the following types are used:

- 1) EX/II and EX/III – for the transport of explosive materials and objects (class 1),
- 2) MEMU – mobile transport units for the production of explosives,
- 3) FL and AT – for the transport of flammable liquids and flammable gases in tankers.

For safety reasons, another important element is the emergency equipment of transport units, necessary immediately after the occurrence of a negative and sudden event in road traffic, in particular:

- 1) 2 fire extinguishers designed to extinguish fires of groups A, B, C,
- 2) 2 chocks for locking the wheels of vehicles (to secure the immobilized vehicle),
- 3) 2 standing warning signs (to mark the place of failure),
- 4) Warning vests for crew members,
- 5) Flashlights for each crew member,
- 6) Gloves and safety glasses for each crew member,

- 7) Eye wash substance,
- 8) Escape mask for each crew member,
- 9) Shovel and container for collecting small quantities of released dangerous goods,
- 10) Cover for sewer openings.

The general scheme of the safety system in public and military road transport of dangerous goods can therefore be reduced to 4 most important areas:

1. Prevention
2. Preparation (training),
3. Neutralization (reacting),
4. Reconstruction
5. (Chruzik, 2016, pp. 11-15).



Fig. 8 Example of emergency equipment for a transport unit according to ADR

Source: European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR), 2025

Contemporary threats to road transport

However, the rapid increase in demand for transport operations, despite the unquestionable benefits, has caused many side effects for society as a whole. This is undoubtedly an increase in the number of vehicles on the roads, traffic volume and, as a result, congestion and environmental pollution. The modes of transport themselves are also exposed to different degrees of hazards from various sources and can be classified as:

- natural,
- civilization,
- terrorist (deliberate destructive actions)
- (Chruzik, 2016, pp. 7-8).

Their range can be local, regional, national or even international. The scale of terrorist attacks in the United States on 11 September 2001 forced a gradual change in the approach to displacement processes and means of transport, which can become an effective tool of asymmetric warfare or the subject of regular warfare. The Russian aggression against Ukraine on 24/02/2022 further confirmed the great impact of logistics and transport on the social, economic and military spheres of any country (Minakova et al., 2023, pp. 185-188; Sharanov, Vatchenko, 2024, pp. 266-267).

It is also important to bear in mind the unquestionable impact of energy infrastructure and logistics on the natural environment, which is also sometimes referred to as a silent victim of wars and conflicts (Hryhorczuk et al., 2024, pp. 2-6).

Unfortunately, the realities of the modern world, in addition to open armed conflicts and tensions in Europe, the Middle East and Africa, are also based on waves of illegal, uncontrolled immigration to European countries and hybrid activities carried out by modern political regimes. Hybrid warfare is a modern strategy that combines conventional, irregular, cyber, terrorism and crime, at the same time and on the same battlefield, in order to achieve political goals, often conducted without official notice and its nature is intended to allow the aggressor to avoid responsibility for it in whole or in part (Sieczka, 2023, pp. 238-247).

The whole essence of hybrid warfare is determined by many factors, such as technological progress, globalization, computerization and the asymmetric nature of modern armed conflicts. Such activities also include propaganda, disinformation, cyberattacks, destabilization, and manipulation of society (Elak et al., 2023, pp. 193-197). Modern terrorism is a specific form of violence used by organisations and states to achieve their own political goals. It is characterized by systematic planning and seeks to evoke extreme emotions and, above all, fear and uncertainty. It is calculated to cause a psychological effect and is aimed at wide circles of society. Terrorist strikes are directed at symbolic and at the same time easy targets, hence such an act of violence violates social norms and is perceived as a fearsome act (Kupryjańczyk, 2023, pp. 25-27). It also aims to increase its influence on the political behaviour of the opponent. A strike at logistical resources is, unfortunately, simple, effective and cheap, and modern threats should be considered in relation to both civilian and military logistics. According to the U.S. Army's total data, statistically, for every 24 fuel and 29 water convoys, one person from the personnel carrying out the task died during the entire mission in Afghanistan (Łukowski, Kępczyński, 2024., pp. 65-67). The primary goal is, of course, to cut off the population from basic resources, without which conducting military operations, but even the ordinary existence of some of the inhabitants will be extremely difficult.

Applying the above aspects to the military ground, an obvious thesis comes to mind that from the point of view of a potential aggressor, it becomes more rational to eliminate combat equipment from combat by liquidating the fuel or combat equipment depot that supplies it, than to selectively eliminate it in a direct confrontation

on the battlefield. It should be borne in mind that the most important features of a combat vehicle necessary on the battlefield are mobility (“mobility”), firepower and armour. Operational effectiveness in combat is ensured by all three components in total, and by cutting off the supply of fuel and combat equipment, the first two elements are quickly and effectively deprived of combat equipment. In the case of military logistics, it can be even more far-reaching that in military confrontations, these two groups of means of supply should be given absolute priority and that at no stage of the fight can there be even the slightest deficit of them. The aim of the above activities is to destabilize social life in democratic Western countries, and the direct object of interference is critical infrastructure, logistics and telecommunications with cyberspace components. In the logistics system, the focus is generally on goods (in stock or in motion) and the assumptions of the 7R principle (right: *product, quantity, value, place, time, customer, quality*) are generally applicable (Kisperska-Moroń, Krzyżaniak (eds.), 2009, pp. 21-22). However, given the current global geopolitical situation, little attention is still paid to ensuring the security of material means (stocks), both those in the storage process (e.g. warehouse) and those moved (in the transport process). Ensuring security of supply in crisis situations is a major challenge for the entire economy, the executive and entrepreneurs. Therefore, any disruption in the transport and flow of logistics stocks results in a shortage of goods at individual recipients and always has a negative impact on the economic sphere of the state in the form of an increase in various costs (Gądek-Hawlena, Heliosz, 2023, pp. 192-193).

For this reason, in addition to the aspects of road safety, nowadays it should also be borne in mind that moving forces and military resources may become an object of particular interest to a potential aggressor, the object of sabotage, a terrorist act and, consequently, a source of threat to the civilian population, infrastructure and the natural environment in the immediate vicinity. For the above reasons, the issue of the security of military transports should be considered on many levels, taking into account the potential impact on individual sectors of the economy and social life. Unfortunately, the most measurable effects in modern armed conflicts are achieved through direct or indirect impact on the civilian population, elements of the so-called “critical infrastructure”, as well as logistics and transport (Tsyrfal et al., 2024, pp. 228-230).

The catalogue of sabotage possibilities is very extensive, but it shows that a few or a dozen or so people can effectively disturb public order and the safety of hundreds or even thousands of people and cause serious disruptions in the logistics system. The source of unlawful interference in the military or civilian transport subsystem can be located outside a given unit or institution, but it can also be a current or former employee, a supplier or business partner who knows the specifics of its operation and has access to information and technology (Banasik et al., 2024, pp. 143-146).

Comprehensive protection of logistics assets has become all the more indispensable in the era of wide availability of unmanned aerial systems, image processing devices and applications enabling the location of people, stationary objects and vehicles. Therefore, the currently popular terms safe transport and safe logistics are nowadays not only a matter of road traffic, the economic aspect, effective management and availability of stocks in the right place and time, but also their monitoring and protection against damage by unauthorized persons (Kopczewski, Wiśniewski, 2024, pp. 885-887).

Currently, the issue of the security of military supply chains is largely based on the context of contemporary armed conflicts and the situation on the international arena (Grala, 2024, pp. 245-260).

Although the total risk in military transport in a hybrid war situation may be difficult to quantify, it may prove crucial on roads with heavy traffic, at intersections, in cities, near shopping malls, on viaducts, bridges and tunnels, where the impact effect is particularly extensive and immediate. The use of asymmetric and hybrid operations may also imply a number of subsequent difficulties: communication, supply and military. Military columns, non-standard vehicles or dangerous goods in road transport can become an extremely cheap, easy and effective way of fighting. The size, number and concentration of vehicles in a small space, visible and characteristic marking with warning stickers, orange plates and flags, indication of the location of the commander's vehicle in the column perfectly fulfil their warning and information functions in "normal (peaceful) conditions of transport". In a state of open or "hidden" conflict, marking means of transport to warn other road users can even provoke direct strikes, sabotage actions or terrorist acts. A moving column of vehicles, a tanker or an oversize vehicle can undoubtedly become a clearly visible, easy to locate, slow-moving and non-maneuvrable target. Attacks on military columns and vehicles are commonly used by the parties to the conflict in Ukraine, due to the good visibility of targets, the limited defence capabilities of manoeuvring forces and means, and the low military and organisational effort to carry out such a strike. In the age of digitalization, precise information about the location of such transport units can be transmitted in real time, and it is becoming increasingly difficult to stop their outflow. Currently, a lot of space is devoted to the development of intelligent transport systems that would increase the operational efficiency of means of transport and road safety by: selecting the optimal route (economical and at the same time the safest), monitoring vehicle traffic and driver's working time, and informing about traffic difficulties, dangerous points on the route or accidents. However, the condition for the effectiveness of such tools is resistance to intentional cyberattacks, which have also become a way of conducting modern operations (Hajdul et al., 2015, pp. 147-155; Garbolino et al., 2010, pp. 46-51; Nowacki, 2008, pp. 39-51).

With the current extremely tense situation in the world, including open armed conflicts, migrations of people caused by wars and deliberate provocative actions, logistics and transport are no longer only areas responsible for the material and technical security of society and military forces. There is no doubt that they are gradually becoming real participants in combat operations and effective tools for conducting operations. At the same time, unfortunately, they are extremely sensitive to the direct interference of an exposed or anonymous opponent. Undoubtedly, during movement, military non-standard vehicles, columns or transport units with dangerous goods are objects of increased risk, with limited ability to defend the moved forces and resources (firepower). Limited mobility (“mobility”) and the obvious lack of armour in logistics support vehicles effectively facilitate interference in functioning military supply chains. Obviously, it is more rational to immobilize combat equipment by eliminating the fuel tanker that supplies it, than to selectively eliminate combat equipment in direct confrontation with the enemy on the battlefield. Of course, contemporary threats should be considered in relation to both civilian and military logistics, where the primary goal may be to cut off the population from resources, without which conducting operations and even the ordinary existence of some residents will not be possible. In terms of road safety, military movements affect all road users and the general public. However, the existing catalogue of risks not only in transport, but in the entire logistics system should be expanded to include the probability of an effective impact on the material and transport subsystem, which always directly results in a deficit of specific goods.

Discussion

Both the potential damage to military transports (columns, oversize vehicles, vehicles with dangerous goods) and civilian means of logistics transport, depending on the place and time of the event, may entail a number of severe mass consequences, which include:

- social consequences (fatalities and injuries, loss of family members, friends),
- material consequences (local damage to vehicles, roads, surrounding buildings and other general infrastructure facilities),
- environmental consequences (possible local pollution of air, soil, groundwater and water intakes – which may cause a deficit of drinking water),
- logistical and economic consequences (interruption of the supply chain, e.g. of fuels, generates supply difficulties for all sectors of the economy, including food and water, and the deficit of goods and services causes a gradual increase in prices),

- psychological consequences (public perception – an explosion and fire of a vehicle with supplies or dangerous goods in a public place causes panic and long-term fear in the local community).

Despite the formally binding conditions appropriate for a state of peace, the risk of sabotage or terrorist actions aimed at the logistics system should be taken into account. Until recently, the concept of hybrid warfare was not known, and the combat security of military transports defined in doctrines generally referred to states of emergency (Instruction of the Principles of Military Road Traffic DU-4.4.4(B), 2015, pp. 9-10, pp. 61-63). Proper protection of marching groups (front, side, rear), camouflage and defence against air attacks should be a priority in the era of wide availability of unmanned aerial systems, image processing devices and applications enabling quick location of people and vehicles.

Conclusions

As a result of the analysis of the main aspects of road transport safety and the total risk associated with the situation in the international arena, it can be concluded that the direct available, compromise ways to reduce the risk of negative events during military movements and to limit the tragic consequences of a potential attack may be:

- activating the society and building vigilance and situational awareness in terms of possible infiltration and deliberate interference in the logistical processes of potential sabotage groups (informing relevant services about possible and observed threats),
- preventing third parties from accessing information about the vehicles and goods being moved, routes, places of loading and unloading (especially military, logistic and dangerous goods transports),
- successive education of the society (road users) in the field of moving columns, dangerous goods and non-standard vehicles (in particular driving techniques and rules of movement as well as protection of information about the transported vehicles from getting into publicly available networks and social media),
- organizing critical movements (military or with dangerous goods) on routes with low traffic, outside populated areas,
- introducing bans on the entry of oversize vehicles or vehicles with dangerous goods into urban areas (organizing alternative supply routes, avoiding stops and traffic jams),
- loading, moving and unloading vehicles with dangerous goods (e.g. tankers) at times with low population activity (late evening or night).

Preventing impacts on logistics and transport, minimising their severe effects, ensuring the security of stocks, diversifying them and protecting the supply network

is a gigantic challenge for both the civilian and military sectors of the modern world. Therefore, a systemic, comprehensive approach to the entire logistics area is necessary, not only through the prism of supplies and services (social and living), but also from the operational side, where logistics and transport will be an integral component of a broader national military and economic strategy.

BIBLIOGRAPHY

- [1] Banasik, M., Rogozińska, A, Daruka N., 2024. Russian Agression and European Security. The risks of insider attacks on critical infrastructure, Difin Warszawa.
- [2] Chruzik, K., 2016. Inżynieria bezpieczeństwa w transporcie, Wydawnictwa Politechniki Śląskiej Gliwice.
- [3] European Agreement Concerning the International Carriage of Dangerous Goods by Road. (Edition 2025) [online]. Available at: <https://unece.org/adr-2025-files> [Accessed: 25 May 2025].
- [4] Garbolino, E., Tkouat, M., Yankevich, N., Lachtar, D., 2010. Transport of dangerous goods. Methods and tools for reducing the risks of accidents and terrorist attack. DOI: <http://dx.doi.org/10.1007/978-94-007-2684-0>.
- [5] Gądek-Hawlena, T., Heliosz, P., 2023. The impact of supply chain disruptions on the opportunity cost of road transport companies in Poland. A case study, *Military Logistics Systems* 58(1).
- [6] Grala, D., 2024. Bezpieczeństwo wojskowych łańcuchów dostaw, Wydawnictwo ASzWoj., Warszawa.
- [7] Grzegorzczak, K., Buchcar, R., 2023. Przewóz drogowy towarów niebezpiecznych ADR 2023, AdeR Buch-Car Błonie.
- [8] Hajdul, M., Stajniak, M., Foltynski, M., Koliński, A., Andrzejczyk, P., 2015. Organizacja i monitorowanie procesów transportowych, Instytut Logistyki i Magazynowania Poznań.
- [9] Hryhorczuk, D, Barry, S, Levy, Prodanchuk, M., Kravchuk O., Bubalo N., Hryhorczuk A., Timothy B. Erickson., 2024. The environmental health impacts of Russia's war on Ukraine. DOI: <https://doi.org/10.1186/s12995-023-00398-y>
- [10] Instrukcja Zasady wojskowego ruchu drogowego DU-4.4.4(B), 2015. Ministerstwo Obrony Narodowej, Warszawa.
- [11] Kisperska-Moroń, D., Krzyżaniak, S., 2009. Logistyka, Instytut logistyki i magazynowania Poznań.
- [12] Kopczewski, M., Wiśniewski, G., 2024. The Impact of Advanced Logistics Technologies on Strengthening the Country's Defence Potential, *Transport Means 2024. Proceedings of the 28th International Scientific Conference*.
- [13] Kupryjańczyk, M., 2023. Wojsko a terroryzm, Wydawnictwo AWL, Wrocław.
- [14] Łukowski, D., Kępczyński, A., 2024. Transformacja energetyczna – wyzwania dla Sił Zbrojnych, Perspektywy logistyki wojskowej i cywilnej w kontekście zapewnienia odporności energetycznej Siłom Zbrojnym tom I, ITWL Warszawa.
- [15] Minakova, S., Volobuyeva, T., Minakov, V., Minakova, O., Tselikova, A., 2023. Peculiarities of truck transportation in wartime conditions. *Naukovyi Visnyk Natsionalnoho Hirnychoho Uniwersytetu*. DOI: <https://doi.org/10.33271/nvngu/2023-6/184>
- [16] Neider, J., 2019. Transport międzynarodowy, Polskie Wydawnictwo Ekonomiczne Warszawa.
- [17] Nowacki, G., 2008. Telematyka transportu drogowego, Wydawnictwo Instytutu Transportu Samochodowego Warszawa.

- [18] Rozporządzenie Ministra Obrony Narodowej z dnia 21 listopada 2012 r. w sprawie sposobu i trybu wydawania zezwoleń wojskowych na przejazd drogowy oraz sposobu organizacji i oznakowania kolumn pojazdów Sił Zbrojnych Rzeczypospolitej Polskiej (tekst jedn. Dz.U. 2024 poz. 1626) [online]. Available at: <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=W-DU20240001626> [Accessed: 05 May 2025].
- [19] Rozporządzenie Ministra Obrony Narodowej z dnia 28 września 2012 r. w sprawie wydawania zezwoleń wojskowych na przejazd drogowy pojazdów przewożących towary niebezpieczne (Dz. U poz. 1257) [online]. Available at: <https://www.prawo.egospodarka.pl/akty/dziennik-ustaw/2012/000/1257> [Accessed: 12 May 2025].
- [20] Sharanov R., Vatchenko O., The Crisis Management System of Ukrainian Transport Enterprises, Transport Means 2024. Proceedings of the 28th International Scientific Conference.
- [21] Sieczka R., 2023. Taktyka w wojnie hybrydowej, Menedżerska Akademia Nauk Stosowanych w Warszawie.
- [22] Tsyrfia I., Kopyika V., Minhazutdinov I., Doroshko M., Medvedieva M., 2024. Political and legal analysis of the mechanisms of providing Ukraine with resources of strategic importance in the context of increasing the national defence potential, Military Logistics Systems, 60(1).
- [23] Ustawa z dnia 19 sierpnia 2011 r. o przewozie towarów niebezpiecznych (tekst jedn. Dz. U. z 2024 r. poz. 643). [online] Available at: <https://api.sejm.gov.pl/eli/acts/DU/2024/643/text.pdf> [Accessed: 02 May 2025].
- [24] Ustawa z dnia 20 czerwca 1997 r. Prawo o ruchu drogowym z późn. zm. (tekst jedn. Dz. U z 2024 r. poz. 1251) [online] Available at: <https://sip.lex.pl/akty-prawne/dzu-dziennik-ustaw/prawo-o-ruchu-drogowym-16798732> [Accessed: 12 May 2025].
- [25] Elak L, Zieliński T, Ciekanski Z., Żurawski S., 2023. Odporność społeczeństwa, państwa na zagrożenia hybrydowe, Menedżerska Akademia Nauk Stosowanych w Warszawie.
- [26] Puskiewicz W., Piątkowski P., 2018, Wojskowy i cywilny transport drogowy towarów niebezpiecznych oraz ładunków ponadgabarytowych, Autobusy 6/2018, Instytut Naukowo-Wydawniczy „SPATIUM” Radom.
- [27] Pyszczyk K., 2022. Ciężkie ciągniki MAZ z napędem 8×8 i silnikiem V12. [online] Available at: https://40ton.net/wp-content/uploads/2022/10/ciezkie_ciagniki_maz_historia_04-1024x684.jpg [Accessed: 02 June 2025].
- [28] Józwiak A., Lesiak G., 2019. Comparative analysis of the passage of a non-standard military vehicle and a heavy vehicle on a selected example, Military Logistics Systems, 51(2).
- [29] Umowy na cysterny, 2019 [online] Available at: <https://zbiam.pl/umowy-na-cysterny/> [Accessed: 14 May 2025].