Védelem Tudomány 2024. különszám - Természeti Katasztrófák Csökkentésének Világnapja
Nemzeti Közszolgálati Egyetem nemzetközi tudományos konferencia
Konferenciaközlemény

Investigation of Road Transport Incidents involving Dangerous Goods

Közúti veszélyes áru szállítási káresemények vizsgálata

Almási Csaba tű. őrnagy
Nemzeti Közszolgálati Egyetem, Katasztrófavédelmi Intézet,
tanársegéd
Email: almasi.csaba@uni-nke.hu
ORCID: 0000-0002-3031-0515

Dr. Cimer Zsolt PhD
Nemzeti Közszolgálati Egyetem, Víztudományi Kar
dékán, egyetemi docens
Email: cimer.zsolt@uni-nke.hu
ORCID: 0000-0001-6244-0077

Dr. habil. Kátai-Urbán Lajos tű. ezredes
Nemzeti Közszolgálati Egyetem, Katasztrófavédelmi
Intézet, tanszékvezető egyetemi docens
Email: katai.lajos@uni-nke.hu
ORCID: 0000-0002-9035-2450

Bevezetés

A veszélyes áruk szállítása során bekövetkező rendkívüli események megelőzése és kezelése a hivatásos katasztrófavédelmi szerv egyik alapfeladata. Feltételezem, hogy ez a bekövetkezett események gyűjtésével, elemző érékelésével és a releváns következtetések rendszerezésével valósítható meg.

Jelen publikáció célkitűzése elemző és rendszerező vizsgálatok útján képet alkotni a magyarországi közúti veszélyes áru szállítási veszélyeztetettségről, valamint a balesetek bekövetkezési mintázatáról. A publikációban a Magyarországon 2012 és 2022 között bekövetkezett, közúti veszélyes áru szállítási balesetek elemző, értékelő és rendszerező vizsgálati részeredményeinek közlése történik meg.

Introduction

The prevention and management of incidents during the transport of dangerous goods is one of the basic tasks of the professional emergency services. I assume that this can be achieved by collecting and analysing the incidents that have occurred and systematically drawing the relevant conclusions.

The objective of this publication is to provide a picture of the road transport of dangerous goods in Hungary and the pattern of accidents by means of analytical and systematic studies. The publication presents the partial results of analytical, evaluative and systematic investigations of road transport accidents involving dangerous goods in Hungary between 2012 and 2022.

Kulcsszavak: közúti közlekedés biztonsága, fenntartható közlekedés, veszélyes áru, ADR

Keywords: road safety, sustainable transport, dangerous goods, ADR

1. Legal regulation

The *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)* was signed in Geneva on 30 September 1957 and entered into force with its Annexes on 29 January 1968. Hungary acceded to the Agreement in 1979. As regards the domestic application of the ADR Agreement, the *Government Decree 284/2023 (VI. 30.) on the promulgation of Annexes A and B to the Agreement on the International Carriage of Dangerous Goods by Road* and on certain aspects of its domestic application, and the *ITM Decree 39/2021 (VII. 30.) on the domestic application of Annexes A and B to the Agreement on the International Carriage of Dangerous Goods by Road (ADR)* are in force in Hungary today.

The prevention and management of incidents during the transport of dangerous goods is one of the basic tasks of the professional emergency services. I assume that this can be achieved by collecting and analysing the incidents that have occurred and systematically drawing the relevant conclusions. The objective of this thesis is to provide a picture of the road transport of dangerous goods in Hungary and the pattern of accidents by means of analytical and systematic studies. The method of investigation is based on the study of documents and the analysis of open sources, which have been generated during the investigation of the causes and circumstances of incidents and which are managed by the National Directorate General for Disaster Management, Ministry of the Interior (NDGDM).

When processing the data, particular attention should be paid to identifying and evaluating information on the causes of accidents, critical road sections, critical periods and risky goods, which will subsequently allow the definition of an appropriate risk analysis methodology and the development of effective risk reduction measures.

2. Trends in dangerous goods transport and chemical production in the European Union

The requirements of *Regulation (EU) No 70/2012 of the European Parliament and of the Council of 18 January 2012 on statistical returns in respect of the carriage of goods by road (recast)* provide a good picture of trends in the transport of dangerous goods and the production of chemicals in the European Union.

In Hungary, we comply with the requirements of Regulation (EU) No 70/2012 in accordance with the provisions of *Annex 13 of Government Decree 388/2017 (XII. 13.) on the mandatory data provision of the National Statistical Data Collection Programme.*

In the European Union, the share of road transport of dangerous goods was 3.5% in 2022 and 3.4% in 2023, while in Hungary it was 2.5% in 2022 and 3.3% in 2023. At EU level, 73.2% of the transport of dangerous goods takes place within national borders. For most countries, the share of international transport of dangerous goods in tkm in 2023 is equal to the share of international transport of all types of goods in tkm. This means that, in general, countries with a high share of international transport of all types of goods in tkm tend to have a higher share of international transport of dangerous goods in tkm. The notable exceptions are Bulgaria, the Czech Republic, Estonia, Hungary, Portugal and Romania: although in these countries international transport of all types of goods accounted for more than half of road transport, the majority of dangerous goods transport was domestic. (Figure 1) [1].

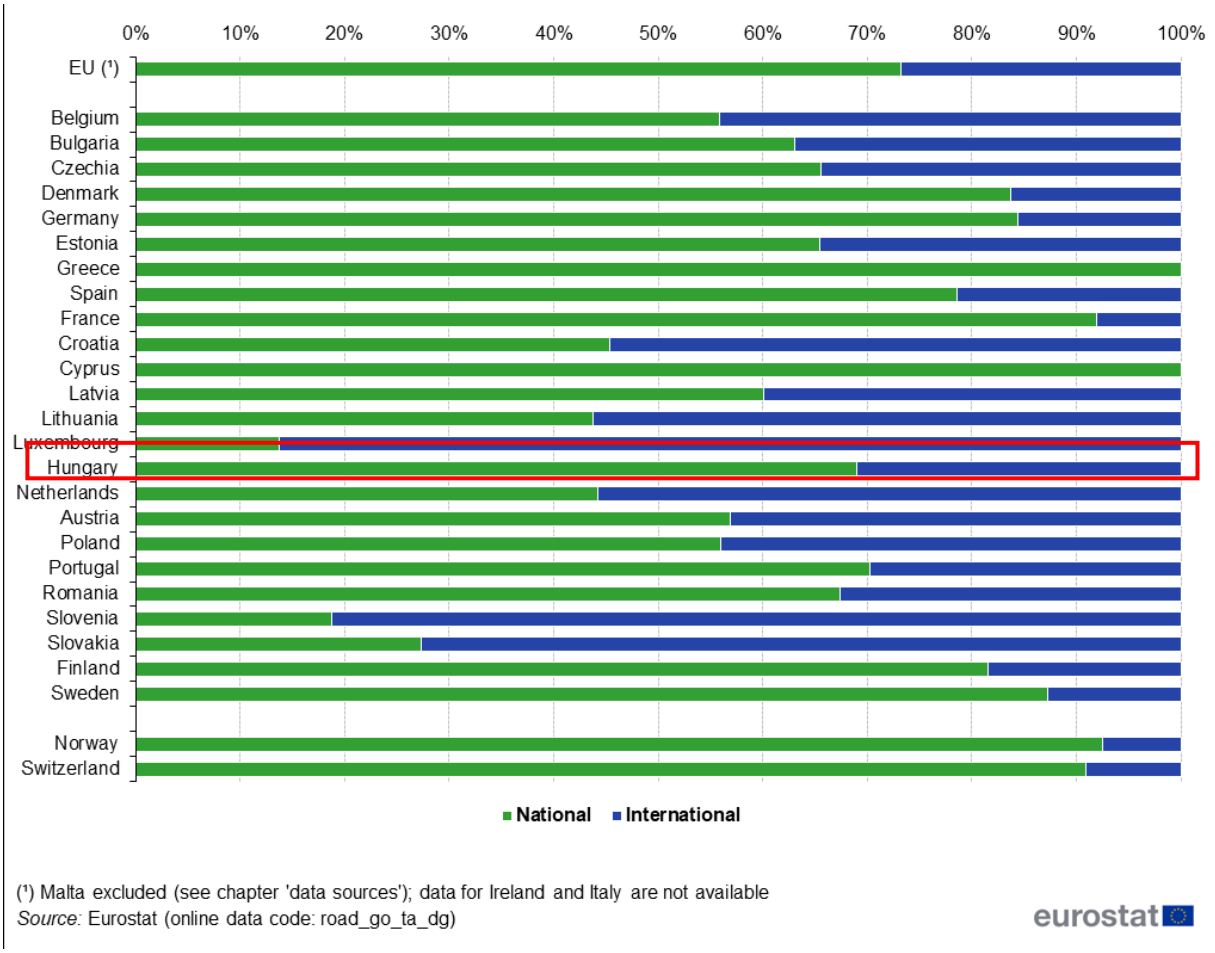

Figure 1: Road freight transport of dangerous goods by type of operation, 2023 (% share in tonne-kilometres). EU, 2023. Source: Eurostat, 2024 [1].

Total production of chemicals in the EU increased between 2004 and 2007, by around 4% overall, reaching a peak of 314 million tonnes in 2007. During the financial and economic crisis, production fell back in 2008 and bottomed out in 2009. In 2011, EU chemical production fell again, and then only slightly between 2011 and 2015, but still below its pre-crisis peak in 2007. Chemical production in 2022 was almost as low as the 2009 minimum. Industrial chemical production is largely concentrated in Western Europe (Figure 2) [2].

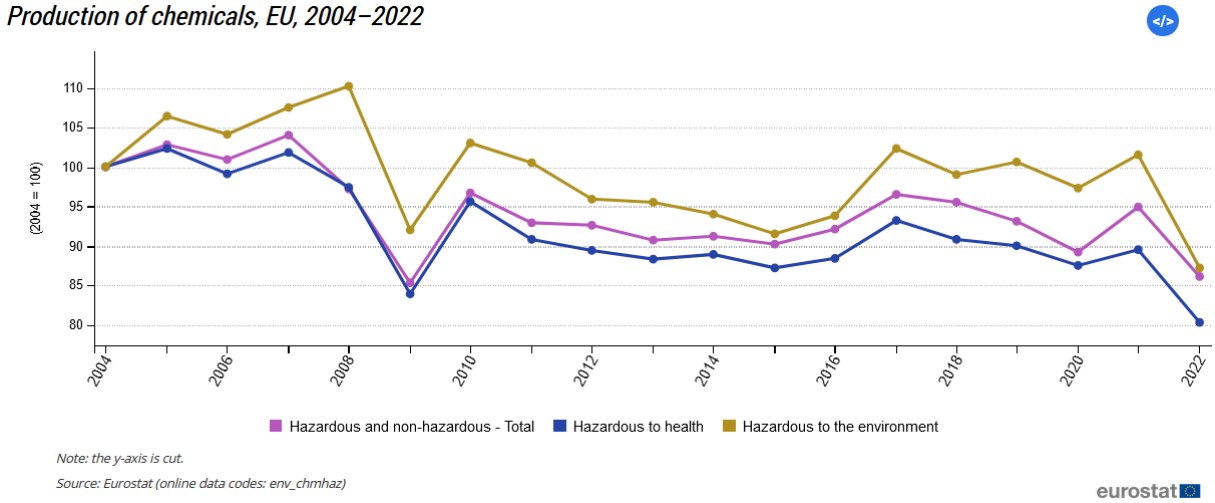

Figure 2: Production of substances hazardous to health, the environment and general substances (2004=100). EU, 2023. Source: Eurostat. [2].

3. Analytical investigation of road transport accidents involving dangerous goods

Open access databases on dangerous goods transport accidents are incomplete and often outdated. EU statistical reports cover rail and inland waterway accidents involving the transport of dangerous goods, while data on the road transport sector are difficult or impossible to find. The EU last published a report for all Member States in 2015, which showed that in 2013 there were 48 rail dangerous goods accidents, 67% of which involved a release of material. In the same report, only 3 inland waterway dangerous goods accidents occurred in 2013 (one in Bulgaria, one in Austria and one in Hungary) [3]. Information on the road sector is therefore incomplete, but rail and river data are not updated.

Given the distribution of freight transport performance and the dynamics of the EU chemical trade, and the incomplete and outdated databases on dangerous goods transport accidents, primarily on the road, a continuous investigation into the causes, consequences and frequency of accidents in the transport of dangerous goods by road is warranted.

The international regulatory framework for the carriage of dangerous goods (ADR, RID, ADN, IMDG Code and IATA DGR) sets out, among other things, the technical requirements for classification, packaging or vehicles, the quantities that can be carried, the training of personnel or the requirements for transport document entries. The provisions of *Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances ("Seveso III" Directive*) set out strict risk management requirements that do not cover transport or temporary storage. The ISO 39001 standard, *Road Traffic Safety Management System* (RTSMS), sets out guidelines for road risk reduction. Improving road safety is a strategic issue for improving quality of life [4].

Nancy P. Button and Park M. Reilly (2000) investigated the predictability and recurrence of spills and fires during road transport of dangerous goods. In the study, an attempt was made to determine the number of events expected per billion vehicle-km [5]. Ohtani and Masayuki Kobayashi (2005) investigated the causes of the increasing number of dangerous goods transport accidents in Japan. No explanation was found for the increasing trend in the number of accidents, the main reason for which was attributed to the quality and reliability of the accumulated data [6].

The causes of incidents involving the transport of dangerous goods by road can be identified and classified.

The analytical study and classification of road transport accidents involving dangerous goods in Hungary between 2012 and 2022 was made possible by the database of the NDGDM and open sources.

67% of the transport incidents investigated were the result of human error unrelated to technical failure or non-compliance with ADR rules (Figure 3). However, it would be wrong to concentrate solely on monitoring the driver's readiness, mental and physical fitness and effectiveness. Driver error can only be interpreted and reduced by taking into account and examining risky road sections and periods together. The application of artificial intelligence can also offer the possibility of replacing the driver and significantly reducing risk in road freight transport, but because of the cultural embeddedness, the human factor will never be excluded from road transport.

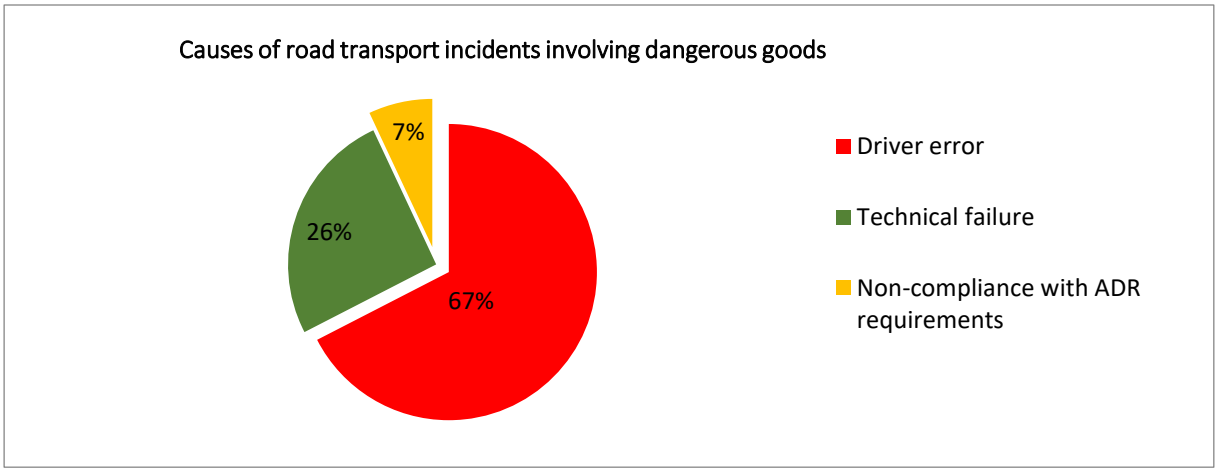

Figure 3: Documented causes of adverse events in the period under review (2012-2022). Source: own ed.

26% of the incidents that occurred were the result of technical failures, in which case no ADR violations and no human error were involved. Such incidents can only be avoided by regular, possibly unscheduled, on-site inspections of vehicles and parcels.

Incidents related to non-compliance with ADR rules account for only 7% of all incidents, all of which were investigated as cargo securing failures. These types of incidents can also be prevented by an on-site inspection of the preparation of the transport.

From the point of view of the risk of a road accident involving the transport of dangerous goods, it is possible to identify the road sections where there is a risk of recurrence of incidents and the county emergency management directorates that are more frequently involved in serious incidents involving the transport of dangerous goods.

Roads and motorways are the road sections on which there were repeated (more than one) serious accidents during the period under review. The results show that on sections 80-171 km of the M3 motorway and 54-156 km of the M7 motorway, increased enforcement or speed restrictions for vehicles carrying dangerous goods are justified.

Routing road vehicles carrying dangerous goods in transit, organising intermodal freight transport or making better use of the railways also offers risk mitigation solutions today.

In terms of the risk of an accident involving the transport of dangerous goods by road, it is also possible to identify the periods where there is a risk of recurrence.

It can be concluded that the occurrence of each event does not show a marked difference in favour of any season or month, but that February and June stand out slightly in terms of months.

28% of all the events examined occurred on a Monday and 23% on a Tuesday. The risk of intestinal accidents is therefore highest at the beginning of the week and decreases steadily towards the end of the week (Figure 4).

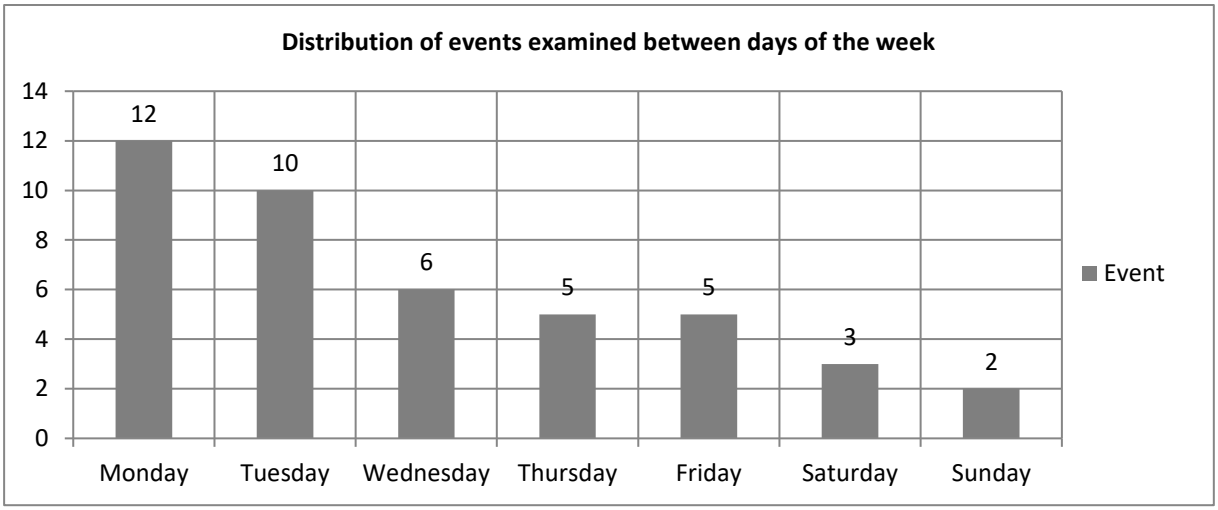

Figure 4: Distribution of events by day of the week (2012-2022). Source: own ed.

The morning and mid-morning period (06.00-14.00) is a particularly high risk period for accidents involving the transport of dangerous goods by road. 65% of incidents occurred during this period of the day.

In terms of the risk of a road transport accident involving dangerous goods, the materials most affected by transport incidents can be identified.

During the period under investigation, 48 dangerous goods of various types (UN numbers) were involved, 46% of which were flammable liquids, 12.5% corrosive (Class 8), 10-10% gas and Class 9 materials. Only about 36% of the total flammable liquids involved in each incident belonged to the more dangerous packing group II. It can also be noted that flammable gases also have lower accidental exposure compared to transport rates.

It is important to monitor the fact that 74.4% of the hazardous substances released are hazardous to the aquatic environment. Given the importance of water for agricultural and national economic strategy and nature conservation, and the need to protect the aquatic environment, the frequency of this type of accident should be reduced. Consideration should be given to including environmentally hazardous substances transported in large quantities, not in parcels, such as gas oil (UN 1202) and environmentally hazardous liquids and solids (UN 3082 and UN 3077) under the scope of public safety requirements.

A risk assessment for the transport of dangerous goods by road can be developed and carried out for specific road sections. A risk assessment is proposed for specific routes where there is a risk to the public, specific installations (tunnels, bridges, critical infrastructure, monuments, etc.) or environmental sites. A multi-step methodology is proposed to assess the risk for the transport of dangerous goods by road. The first step of this multi-step methodology is the identification of the road section to be assessed, the second step is the performance of a risk analysis.

On the basis of an analytical assessment of the events that occurred, we examined current practices for responding to incidents.

Nijolė Batarlienė (2008) pointed out that the safety of transport of dangerous goods is based on the development of transport technologies and the application of modern information technology methods, which should cover the whole process of the transport chain [7].

Accidents in the road transport of dangerous goods may require the involvement and cooperation of several bodies and authorities involved in the rescue, therefore, the continuous and timely exchange of information is essential for the effective organization and solution of each of the tasks [8].

Examining prevention issues affecting the safety of dangerous goods logistics

One of the important areas of prevention of dangerous goods logistics accidents is the prevention of the release of flammable dangerous substances into the open air, the most important technical basis of which is the installation of signaling systems. In addition to property protection systems, fire protection signaling systems installed for fire prevention purposes [9], which perform their assignments together with widely used fire protection extinguishing systems [10]. In addition to fire protection signaling systems, it is also particularly important the application of monitoring systems for the detection of dangerous substances that are primarily flammable and toxic in industrial environments. These systems can be installed inside buildings, such in the case of commercial and logistics warehouses, or outside the building in the technological and natural environment [11]. In recent years, as a result of technological development, the simplification of these systems and the harmonization of their application with systems serving other purposes have come to the fore. The latter supporting technical system can also be camera systems installed for property and occupational safety purposes [12].

Finally, we can learn important practical lessons for the development of fire protection authority activity when dealing with the policing issues of event order security [13].

4. Summary

An analytical study of the causes, consequences and frequency of serious road transport accidents involving dangerous goods in Hungary between 2012 and 2022 is continuously needed to reduce the frequency of serious accidents and to identify risk reduction measures, with particular attention to critical road sections, periods and goods.

It is also reasonable to recommend that individual test results are published in open databases, possibly in several languages, and that they are continuously updated.

The study of the documents generated by the investigation of serious accidents involving the transport of dangerous goods by road leads to the conclusion that the causes of the incidents are well defined and distinguishable. Almost two thirds of the transport incidents in the period under review were the result of driver error, which can be clearly distinguished from technical failure and non-compliance with ADR rules. Only about a quarter of the incidents were the result of a technical failure. Non-compliance with ADR rules was identified as the cause of only a small proportion of the incidents examined.

By examining the locations where incidents occur, it is possible to identify road sections where a serious incident is likely to recur. The results of the analysis also allow the identification of the county emergency management directorates most involved in the management of major incidents and the periods when a recurrence of a major accident is expected.

Almost half of the incidents investigated involved flammable liquids, and three quarters of the hazardous substances released were hazardous to the aquatic environment.

It is justified and appropriate to carry out a risk analysis for the transport of dangerous goods by road on routes where there is a risk to the public, special installations (tunnels, bridges, critical infrastructure, monuments, etc.) or environmental sites.

5. Bibliography

[1] Eurostat (2024a): Road freight transport of dangerous goods. [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_by_type_of_goods#Road_freight_transport_of_dangerous_goods (24.10.2024.)

[2] Eurostat (2024b): Chemicals production and consumption statistics. [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Chemicals_production_and_consumption_statistics (24.10.2024.)

[3] Eurostat (2024c): Transport accident statistics. [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Transport_accident_statistics (24.10.2024.)

[4] Andrea C. – Chiara R. – Enrico S. (2016): A risk assessment for road transportation of dangerous goods: a routing solution. *Transportation Research Procedia*, Vol 14. 2890-2899.

[5] Nancy P. B. – Park M. R. (2000): Uncertainty in incident rates for trucks carrying dangerous goods. *Accident Analysis & Prevention*, 32, 6. 797-804.

[6] Hideo O.– Masayuki K. (2005): Statistical analysis of dangerous goods accidents in Japan. *Safety Science*, 43, 5–6. 287-297.

[7] Nijolė B. (2008): Dangerous Goods Transportation: New Technologies and Reducing of the Accidents. *Journal of KONBiN*, 5 (8) ISSN 1895-8281.

[8] Érces, Gergő ; Rácz, Sándor ; Vass, Gyula ; Varga, Ferenc: Fire safety in smart cities in Hungary with regard to urban planning. *Journal of Integrated Disaster Risk Management*, 13 : 2 pp. 104-128. (2023)

[9] Érces, Gergő – Vass, Gyula (2018), 'Veszélyes ipari üzemek tűzvédelme ipari üzemek fenntartható tűzbiztonságának fejlesztési lehetőségei a komplex tűzvédelem tekintetében'. *Műszaki Katonai Közlöny,* 28, no 4 , 2–22.

[10] Mészáros, István; Bognár, Balázs. Üzletmenet-folytonossági tervezés kórházi környezetben II.: Kockázatértékelés és hatékonyságmérés. *Hadmérnök*, 17(3), 153–168. (2022) [Online]. Available: https://doi.org/10.32567/hm.2022.3.10 (24.10.2024.)

[11] Tóth, Levente: Limitation in the Application of High Resolution Image Sensors. *National Security Review*. 2 108-122. (2016)

[12] Tóth, Levente (2023) Közterületi térfigyelő rendszerek eltérő fejlődése Európában. *Belügyi Szemle*, 71(6), 1041-1057. [Online]. Available: https://doi.org/10.38146/BSZ.2023.6.6 (24.10.2024.)

[13] Kanyó Ferenc; Vásárhelyi-Nagy Ildikó: Research for New Physical Ability Testing Method for Firefighters in the V4 Countries. 29(1) 161–166. (2019) [Online]. Available: doi: 10.32562/mkk.2019.1.13 (24.10.2024.)

[14] Tóth Nikolett Ágnes. Technological Innovations in the field of Sports Policing. (2021) *Часопис Національного університету "Острозька академія"* 2021. 23 1-24.