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Road transport of dangerous goods – challenges and innovations

Drogowy transport towarów niebezpiecznych – wyzwania i innowacje

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Abstract

The transportation of dangerous goods by road is an important part of global logistics, but its development poses challenges in terms of safety, regulatory compliance and transportation efficiency. This article presents an analysis of key developments in ADR transportation, taking into account such aspects as multimodality, the use of artificial intelligence (AI) for vehicle identification, the Internet of Things (IoT) and computer modeling of hazards. The harmonization of transportation regulations was discussed, pointing out barriers to the full integration of the various modes of transportation. The potential benefits of using ALPR/OCR systems to recognize ADR plates and IMS sensors that could monitor the presence of hazardous substances in real time were also analyzed. The use of ALOHA® software in conjunction with GIS to model the effects of accidents and optimize transportation routes was also an important element of consideration. The analyses undertaken indicate that the future of ADR transportation will be determined by digitization, integration of intelligent analytical systems and improvement of safety procedures, which will allow for more effective and predictable risk management.

Keywords: ADR transportation, multimodality, artificial intelligence, IoT, computer modeling, ALOHA®, GIS, ALPR/OCR systems, transportation safety

Streszczenie

Transport drogowy towarów niebezpiecznych jest istotnym elementem globalnej logistyki, jednak jego rozwój wiąże się z wyzwaniami w zakresie bezpieczeństwa, zgodności z regulacjami oraz efektywności przewozów. W artykule przedstawiono analizę kluczowych kierunków rozwoju transportu ADR, uwzględniając takie aspekty jak multimodalność, wykorzystanie sztucznej inteligencji (AI) do identyfikacji pojazdów, Internet Rzeczy (IoT) oraz modelowanie komputerowe zagrożeń. Omówiono harmonizację regulacji transportowych, wskazując na bariery w pełnej integracji różnych gałęzi transportu. Przeanalizowano również potencjalne korzyści wynikające z zastosowania systemów ALPR/OCR do rozpoznawania tablic ADR oraz czujników IMS, które mogłyby monitorować obecność niebezpiecznych substancji w czasie rzeczywistym. Istotnym elementem rozważań było także wykorzystanie oprogramowania ALOHA® w połączeniu z GIS do modelowania skutków awarii i optymalizacji tras przewozu. Podjęte analizy wskazują, że przyszłość transportu ADR będzie determinowana przez cyfryzację, integrację inteligentnych systemów analitycznych oraz doskonalenie procedur bezpieczeństwa, co pozwoli na bardziej efektywne i przewidywalne zarządzanie ryzykiem.

Słowa kluczowe: transport ADR, multimodalność, sztuczna inteligencja, IoT, modelowanie komputerowe, ALOHA®, GIS, systemy ALPR/OCR, bezpieczeństwo transportu

Introduction

Road transport of dangerous goods plays a key role in global logistics, enabling the delivery of essential materials for industry, energy, and the chemical sector. At the same time, their transportation involves numerous challenges, both in terms of safety and compliance with international regulations. Modern regulations, based on UN Model Regulations (*Recommendations on the transport of dangerous goods. Model Regulation. Volume I*, 2023), are constantly being developed to keep pace with growing requirements for environmental protection, public health, and transport infrastructure. This article focuses on the challenges and development directions of ADR transport in the context of technological progress and regulatory changes. The analysis covers the issue of multimodality, which is an important element of optimizing the transport of dangerous goods, the use of artificial intelligence (AI) in identifying ADR vehicles, as well as the application of the Internet of Things (IoT) and computer hazard modeling in risk minimization.

Introduction to dangerous goods issues

The Model Regulations of the United Nations, which form the basis for updates to the ADR Agreement, IMDG Code, ICAO-TI Technical Instructions, ADN European Agreement, and RID Regulations, do not contain a definition of dangerous goods, but indicate that their transport is regulated to ensure the maximum level of safety (2023: 1):

> The transport of dangerous goods is regulated in order to prevent, as far as possible, accidents to persons or property and damage to the environment, the means of transport employed or to other goods. At the same time, regulations should be framed so as not to impede the movement of such goods, other than those too dangerous to be accepted for transport.

Although the basic regulatory principles (i.e., Model Regulations) apply to all modes of transport, the characteristics of road, sea, air, inland waterway, and rail transport necessitate the use of separate approaches and safety measures. Hence, documents such as ADR, IMDG, ICAO-TI, ADN, and RID adapt requirements to the specifics of a given mode of transport, taking into account, among other things, infrastructural and operational differences, as well as the level of risk associated with the transported materials and items.

Therefore, a natural consequence was further work related to the creation of regulations that led to the development of formal definitions of dangerous goods in individual legal acts. For example, according to the definition contained in the ADR Agreement and RID Regulations, dangerous goods are materials and items whose carriage under ADR [and respectively RID] is prohibited or allowed only under the conditions specified in these Agreements (ADR, 2023: 1.2; RID, 2023: 1.2). A similar approach was applied in the IMDG Code, in which dangerous goods were defined as substances, materials, and items covered by the provisions of the IMDG Code (IMDG, 2020: 5). In turn, in the ICAO-TI Technical Instructions, dangerous goods are defined as articles or substances that may pose a risk to health, safety, property, or the environment, and which are included in the list of dangerous goods in these regulations or which have been classified in accordance with these regulations (ICAO-TI, 2023: 1.0). An approach analogous to ADR and RID was adopted in the ADN Agreement, according to which dangerous goods are materials and items whose international carriage is prohibited on the basis of the regulations annexed to this agreement or allowed only under specified conditions (AND, 2023: 1.2).

To summarize the argument so far: despite some differences in wording, all the above definitions are based on a common principle: dangerous goods are materials and items whose transport requires special precautions or which, due to their properties, should be subject to restrictions in national or international transport.

To better illustrate the importance of the topic related to the transport of dangerous goods, the author decided to refer to statistical data found in Eurostat. These data cover road transport only, with a particular focus on operations conducted in accordance with the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). The availability of detailed information for other transport modes – such as maritime, inland waterways, and air – is significantly limited. Nevertheless, the analysis of this dominant sector offers a reliable basis for inferring broader patterns and systemic tendencies within the logistics of hazardous materials.

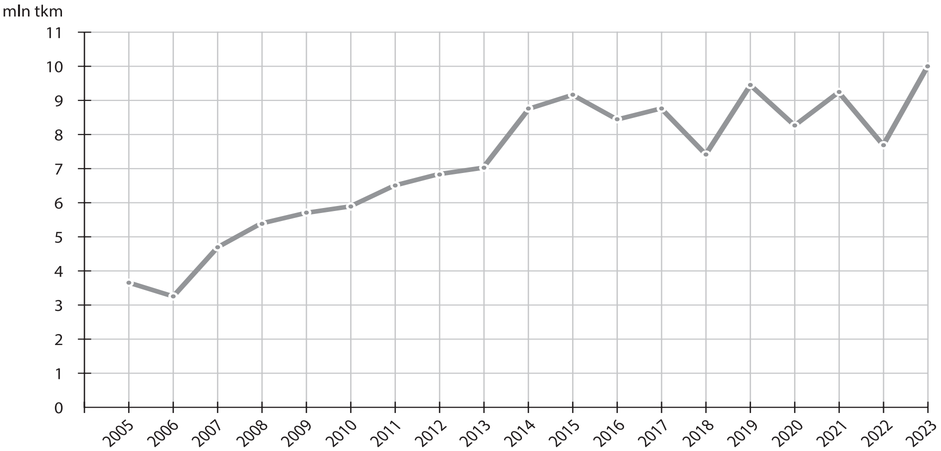

Fig. 1. Road transport of dangerous goods in Poland from 2005 to 2023 (in million tkm)

Source: *Road freight transport of dangerous goods by type of dangerous goods and territorial coverage (tkm, vehicle-km, basic transport operations) – annual data*, 2023.

The analysis of the chart shows a clear upward trend in the transport of dangerous goods by road in Poland between 2005 and 2023, though not without short-term variations. After a slight drop in 2006, the volume steadily increased until 2010. Between 2010 and 2013, moderate year-on-year growth continued, followed by a significant surge in 2014 and 2015. From 2016 onward, the trend becomes more volatile, with noticeable drops in 2017 and 2022. Despite these fluctuations, the overall trajectory remains positive, culminating in a record-high 10 million tkm in 2023.

Multimodality in the transport of dangerous goods

Currently (as of 2025), legal acts regulating the transport of dangerous goods are constantly evolving due to scientific progress and an increasing number of new substances finding practical applications, which also increases their volume. The latest significant invention, the transport of which is beginning to be gradually regulated, is the sodium-ion battery (Kociemba, 2025). As a result, each of the legal acts currently consists of over 1,000 pages. One of the biggest challenges resulting from this situation is the issue of multimodality, which is gaining importance year by year. For this reason, the author decided to direct further considerations towards this issue.

According to Stankiewicz (2011: 14), multimodal transport itself is closely related to combined transport, understood as the movement of cargo using several means of transport within one branch or using different transport branches. According to the EU directive, the initial and final section of the route should be carried out by road transport, while the main part of the transport should take place using rail, inland waterway, sea, or air transport. Hapanionek and Ślączka (2017: 1505), attempting to define multimodal transport, refer to the Convention on International Multimodal Transport, according to which it is transport carried out using at least two different branches of transport, based on one multimodal transport contract, within a route leading from one country to another, with the goods being in the custody of the transport operator throughout. The authors distinguish two key forms of multimodal transport:

- intermodal transport – uses different branches of transport, but the cargo remains in the same loading unit (e.g., container, trailer, swap body) throughout the route;
- combined transport – also involves different means of transport, but delivery to the recipient and collection from the sender is always carried out by road transport, which refers to the so-called first and last mile problem.

The essence of multimodal transport forced action to unify procedures and eliminate administrative barriers so that these transports could take place in a smooth and efficient manner. The best examples of progress in this field are ro-ro type rail platforms, enabling the transport of (semi-)trailers (and vehicles) on railway wagons, containers compliant with the ISO standard, which can be transported by various means of transport without the need to reload cargo, and the unification of transport documentation, which significantly reduces formalities at borders and in transshipment terminals.

In addition to progress in the previously mentioned areas, it is reasonable to draw attention to the harmonization and interoperability of regulations regarding the transport of dangerous goods. For this purpose, the author conducted an analysis which indicates that:

1. ADR – allows the carriage of packages equipped with marks and warning labels in accordance with IMDG and ICAO-TI regulations. Containers, bulk containers, portable tanks, tank-containers, and MEGCs that are not marked in accordance with ADR may be marked in accordance with IMDG (ADR, 2023: 1.1.4.2.1).
2. IMDG and ICAO-TI – do not provide for any compatibility with other regulations regarding the transport of dangerous goods. This means that goods transported by sea or air must be marked and prepared in accordance with IMDG or ICAO-TI regulations, regardless of the earlier or later stage of transport.
3. ADN – allows the carriage of packages marked in accordance with IMDG and ICAO-TI. Portable tanks, tank-containers, and MEGCs that are not marked

in accordance with ADN may be marked in accordance with IMDG (ADN 2023: 1.1.4.2.1).

4. RID – allows the carriage of packages equipped with markings in accordance with IMDG and ICAO-TI. In addition, containers, bulk containers, portable tanks, tank-containers, MEGCs, and wagons that are not marked in accordance with RID may be marked in accordance with IMDG (RID, 2023: 1.1.4.2.1). Additionally, wagons carrying road vehicles do not have to be marked in accordance with RID, provided that the vehicle is marked in accordance with ADR or benefits from a partial or total exemption from the regulations.

The above argument was presented in the form of a clear table 1:

Tab. 1. Compatibility of marking and packaging of dangerous goods in multimodal transport

		Transport within a multimodal chain involving:				
		Road	**Maritime**	**Air**	**Inland**	**Rail**
Packaging and marking in compliance with:	ADR (road)	X				
	IMDG (maritime)	X	X		X	X
	ICAO TI (air)	X		X	X	X
	ADN (inland)				X	
	RID (rail)					X

Source: own elaboration.

The analysis shows that harmonization of regulations and interoperability has been largely achieved. Means of transport used in the last stage of transport, such as rail and road transport, accept loads marked in accordance with IMDG and ICAO-TI. However, there are still some areas requiring optimization, especially in the context of differences resulting from the possibility of tightening regulations. An example occurring in Poland is the need to indicate the owner of the dangerous goods in the transport document (which was introduced in Art. 13 of the Act of August 19, 2011, on the transport of dangerous goods – Journal of Laws of 2011, item 1367). Analysis of available legal acts in countries neighboring Poland did not indicate the existence of such an obligation there.

Use of AI in identifying vehicles transporting dangerous goods

Artificial intelligence (AI) is a field of computer science involved in creating systems capable of performing tasks requiring human intelligence, such as pattern recognition, data analysis, or decision-making. Modern solutions in this field are based primarily on machine learning (ML), which allows algorithms to improve themselves based on processed data.

One of the key tools of machine learning is artificial neural networks (ANN), inspired by the structure of the human brain. As Kurowski (2023: 3–9) points out, their greatest advantage is the ability to learn adaptively and analyze complex relationships in data, which makes them widely applicable in image recognition, natural language processing, or predictive analysis.

It is the ability of neural networks to analyze images and extract key information that finds practical application in transport systems. The dynamic growth of transport, especially using road vehicles, has forced the implementation of systems ensuring transport efficiency and improving its safety. As Kamiński and Bułatowa (2016: 242) point out, one such solution is the Automatic License Plate Recognition (ALPR) system, which has found application, among others, in section speed measurements, detection of traffic offenses, and electronic toll collection systems.

ALPR is closely related to Optical Character Recognition (OCR) technology, enabling the conversion of a raster image to text. As Musiał and Szczepaniak (2014: 41–44) point out, modern OCR systems are based not only on classic pattern matching algorithms but also on advanced artificial intelligence methods such as neural networks. This allows for precise detection and interpretation of characters even in difficult conditions, e.g., with low contrast, poor lighting, or partial obstruction of the plate.

In the context of ADR transport, ALPR systems can be expected to play a key role in identifying vehicles transporting dangerous goods, which could be done by checking for the presence of orange warning plates, used in accordance with the requirements of the Agreement. These plates have a rectangular shape, orange color, and a black frame, as shown in figure 2:

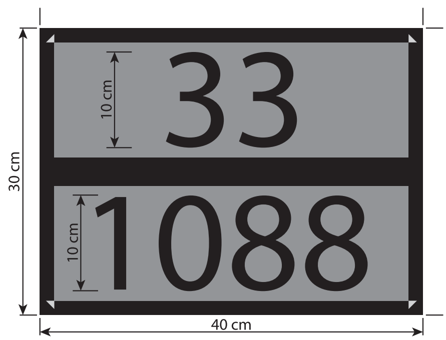

Fig. 2. Orange-colored plate template with black border

Source: ADR, 2023: 5.3.2.2.3.

In most cases, the ADR plate contains two numbers placed in separate sections:

– upper part – the hazard identification number is a two-digit or three-digit code that informs about the type of hazard posed by the transported material.

Individual digits indicate specific properties of the substance, such as gas emission (2), flammability (3, 4), oxidizing action (5), toxicity (6), radioactivity (7), corrosivity (8), or risk of violent chemical reaction (9). Repetition of a digit in the code indicates an intensification of a specific hazard, while adding a zero means that the number fully describes the risk associated with the material. A special case is a number preceded by the letter "X", which signals that the substance reacts dangerously with water and its use requires consultation with specialists. Additionally, in the case of explosive materials of class 1, a classification code is used, consisting of the subclass number and the letter of the compatibility group, which enables precise determination of their properties.

– lower part – the UN number, i.e., a four-digit code assigned to a specific dangerous substance, in accordance with UN classification.

However, there is not always a need to use plates containing identification numbers – in some cases, transport on so-called "smooth plates", which have a uniform orange surface and do not contain classification numbers or UN numbers, is allowed. This means that in such a case, ALPR/OCR systems can only confirm that a given vehicle is transporting dangerous goods but will not be able to determine their type or level of hazard.

Despite this, supervisory services will gain access to live data on the number of ADR vehicles on a given section of the route and the type of materials they carry (if the plate contains this information). As a consequence, it will be possible to react more quickly in the event of incidents, analyze the flow of dangerous goods, and more effectively manage ADR vehicle traffic in real time.

One of the key applications of the ALPR/OCR system could also be verification of compliance with administrative requirements resulting from the ADR Agreement. Thanks to the integration of monitoring systems with databases on the transport of dangerous goods, it will be possible to automatically check whether the vehicle owner has submitted the annual report required by law for the previous year. In addition, the system will be able, by design, to retain the information obtained, allowing for later verification of whether the report will be submitted in the following year. This mechanism will allow for the identification of companies operating in the "gray zone" that avoid obligations resulting from ADR regulations, thereby endangering the safety of transport and the environment. The author's professional practice indicates that enterprises operating in the "gray zone" equally often do not fulfill the assumptions resulting from legal provisions regarding counteracting acts of terrorism (including through the lack of a protection plan for high-risk dangerous goods), and do not meet basic requirements regarding employee safety.

IoT and chemical sensors

The Internet of Things (IoT) is an idea that redefines the way objects function in the world around us. In the era of technological progress, IoT creates an intelligent network of connected devices that can independently collect, process, and exchange information without the need for direct human interaction. Thanks to this, the boundary between the physical and digital worlds is increasingly blurring, and objects – from temperature sensors to intelligent city management systems – are becoming active participants in information processes (Smarzyńska, Stanisławska, 2019: 267–268).

The foundation of IoT is the ability of devices to communicate, which enables not only automation and monitoring but also advanced data analysis. Sensors, processors, and software embedded in everyday objects allow for collecting information about the environment, analyzing it in real time, and taking actions based on the collected data. As Adamczewski (2015: 286–287) points out, according to Kevin Ashton, who first used the term *Internet of Things* in 1999, the future of this technology is based on the full integration of intelligent systems with social and economic infrastructure, which will enable even more efficient resource management and increase process efficiency.

IoT is not just a concept of the future – today it finds application in countless areas, such as building automation, the aforementioned smart cities, healthcare, Industry 4.0, as well as logistics and transport systems. Some researchers consider IoT to be a catalyst for the third wave of economic transformation, pointing to its ability to optimize processes, minimize losses, and improve operational efficiency (Adamczewski, 2017: 286–287).

Three distinguishing features of the Internet of Things are (Adamczewski, 2017: 286–287):

- **context** – intelligent devices can interpret the environment, adapting their operation to changing conditions;
- **ubiquity** – the number of objects connected to the network already exceeds the number of people, and in the future, IoT will become an integral element of almost every product and process;
- **optimization** – the Internet of Things enables intelligent data management, which leads to increased efficiency and the development of new technologies.

The basis for the operation of IoT is also integration with other digital systems, such as big data, artificial intelligence, or cloud computing, which further increases its analytical and adaptive capabilities. Forecasts indicate that the development of the Internet of Things will be one of the key factors driving the future of innovation and the economy, leading to accelerated productivity growth and the implementation of innovative data management models (Adamczewski, 2017: 286–287).

The Internet of Things, although often associated with advanced industrial systems, is increasingly finding application in everyday life. The simplest example is mobile applications that enable remote control of light, its color, or intensity, which is already today a standard in modern solutions for smart homes.

In the context of transport, IoT is gaining increasing importance. Some technologies are already being implemented in vehicles, bearing the hallmarks of the Internet of Things. An example can be geofencing, a system limiting the possibility of restarting the engine after stopping the vehicle outside the designated zone. This solution is particularly important for the transport of high-value cargo. Another example is the eCall system, which is based on sensors monitoring vehicle parameters such as overload or moment of inertia. In the event of an accident detection, the eCall system automatically sends information to the emergency center, thus shortening the response time of services. As estimates in the literature indicate, its implementation allows for improving response time by 40% in rural areas and up to 60% in cities (Dworzecki, Gudzbeler, 2016: 122). Also, GPS systems, which were initially expensive and limited to military applications, have today become common and inexpensive, constituting one of the key elements of IoT in transport. Thanks to them, it is possible to track vehicles in real time, optimize routes, and analyze transport efficiency.

The use of the Internet of Things in transport and logistics is not limited only to fleet management or vehicle safety. One of the potential applications is the introduction of chemical sensors capable of detecting in real time the release of transported dangerous substances. This is not a concept detached from reality – similar solutions are already used in the case of transporting self-reactive materials and organic peroxides requiring strict temperature control. The introduction of sensors analyzing the presence of dangerous gases or chemical leaks could significantly improve transport safety, as well as enable early detection of potential hazards. Instead of developing new, costly technologies, adaptation of existing devices used by customs services and law enforcement agencies will likely be made. Portable spectrometers and chemical analyzers, used to detect drugs and explosive substances, could be modified in such a way as to serve as sensors for the detection of gases, vapors, or liquids posing a hazard.

As Sczurek (2015: 151–152) points out, one of the most effective tools for this purpose is Ion Mobility Spectrometry (IMS). IMS works on the principle of analyzing the mobility of ions formed as a result of chemical reactions. An air sample, potentially containing dangerous substances, is ionized and then introduced into an electric field, in which molecules move depending on their mass, shape, and charge. A classic IMS spectrometer consists of two main parts: a reaction chamber and a drift chamber, separated by a dosing grid. In the reaction part, ionization of the sample takes place, most often using a radioactive Ni-63 isotope that emits beta particles. The resulting ions pass through the dosing grid to the drift chamber, where they are separated in an electric field according to their physicochemical properties. Depending on the nature of the analyzed substance, positive or negative ions may form in the system, which determines the method of their detection. The ion mobility spectrum generated by the spectrometer allows for the identification of present substances and determination of their concentration. Characteristic peaks in the spectrum indicate specific chemical compounds, and their area is a measure of the amount of detected substance. This enables quick and effective detection of trace amounts of dangerous substances, making IMS an ideal tool for monitoring the transport of dangerous goods.

The application of this technology in the transport of dangerous goods could significantly increase the level of safety. IMS sensors, placed directly in ADR vehicles could analyze the air in real time for the presence of dangerous leaks. Thanks to this, surveillance systems could immediately detect potential hazards, trigger alarm procedures, and minimize the risk of environmental contamination or threat to people.

Computer modeling of hazards posed by dangerous goods

In order to minimize risk, as well as for better route planning, computer modeling methods are increasingly used, which allow for simulation of possible incidents and assessment of their consequences. It enables, among others:

- estimation of the effects of leaks, explosions, and fires of dangerous substances in various environmental conditions;
- analysis of the impact of substance release on the surroundings, including people, infrastructure, and the environment;
- optimization of transport routes, taking into account both safety and logistical aspects.

One of the most commonly used tools in failure modeling is the ALOHA® (Areal Locations of Hazardous Atmospheres) program, developed by NOAA and EPA, which enables simulation of chemical substance release and determination of hazard zones. This program allows for the analysis of various incident scenarios, such as:

- immediate or continuous release of substance (direct leak)– simulation of liquid or gas leak as a result of damage to a tank or installation;
- formation of substance pools – modeling the spread of spilled liquid materials on the surface;
- pipeline leaks – analysis of the effects of a pressurized pipeline failure;
- damage to a tank or transport container – determination of the impact of a failure on the surroundings, including assessment of the radius of impact of toxic or flammable substances.

The program also enables the export of results in .KML format, which allows for their visualization in a geospatial environment (e.g., in Google Earth Pro). Thanks to this, it is possible to precisely determine the area of hazard and analyze the impact of a potential failure on the surrounding infrastructure. The color scheme of hazard zones in the ALOHA® program corresponds to the level of risk:

– red (area in the very center) – critical zone (fatal threat in less than 60 seconds);
– orange (second circle) – high-risk zone (possibility of second-degree burns);
– yellow – area of residual impact (health hazard, e.g., irritation of the respiratory tract).

The study by Damjanvić et al. (2024: 264) indicates that the integration of real-time vehicle tracking systems with ALOHA® software constitutes a strategic approach to more effective risk management in the transport of dangerous goods. The authors emphasize that the use of these technologies allows for quick detection of hazards and their analysis, which is crucial in emergency situations. Further integration would involve the application of advanced data processing algorithms that would take into account in real time environmental variables and transport parameters, such as vehicle speed, weather conditions, or traffic density (in short: spatial data denoted by the English acronym GIS). The cooperation of the ALOHA® system with GIS tools would enable immediate visualization of hazard zones, which would allow for quick transmission of information to emergency services and transport management bodies. Additionally, the researchers point to the need for statistical analyses of road accidents involving vehicles transporting dangerous goods, which would allow for better forecasting of potential hazards and development of more effective preventive strategies. Such an approach would not only increase transport safety but also enable better coordination of actions in crisis situations and optimization of routes for transporting dangerous materials.

Summary

The transport of dangerous goods requires constant adaptation to changing technological and regulatory conditions. Analysis of trends in ADR transport indicates that a key role in the further development of the sector will be played by digital technologies, enabling better monitoring, risk prediction, and increased transport efficiency. The application of modified license plate recognition systems (ALPR/OCR) to recognize ADR vehicles and IMS sensors can significantly improve supervision over the transport of dangerous goods, and the integration of the Internet of Things (IoT) will allow for ongoing analysis of transport conditions and early detection of potential hazards. Computer modeling, especially with the use of ALOHA® software and GIS tools, opens new possibilities for route optimization and planning preventive actions in case of failure. The considerations taken in the article indicate that the future of dangerous goods transport will depend on further digitization, integration of analytical systems, and implementation of modern safety procedures. Further research should focus on the development of interoperable IT systems that will enable more comprehensive risk management and adaptation of ADR transport to the requirements of the 21st century.

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Law Acts

ADN – Oświadczenie rządowe z dnia 31 maja 2023 r. w sprawie wejścia w życie zmian do Przepisów załączonych do Umowy europejskiej dotyczącej międzynarodowego przewozu śródlądowymi drogami wodnymi towarów niebezpiecznych (ADN), zawartej w Genewie dnia 26 maja 2000 r., obowiązujących od dnia 1 stycznia 2023 r. (Dz.U. z 2023 r., poz. 1167).

ADR – Oświadczenie rządowe z dnia 13 marca 2023 r. w sprawie wejścia w życie zmian do załączników A i B do Umowy dotyczącej międzynarodowego przewozu drogowego towarów niebezpiecznych (ADR), sporządzonej w Genewie dnia 30 września 1957 r. (Dz.U. z 2023 r., poz. 891).

ICAO TI – Instrukcje Techniczne Bezpiecznego Transportu Towarów Niebezpiecznych Drogą Powietrzną.

IMDG – Międzynarodowy morski kodeks towarów niebezpiecznych Międzynarodowej Organizacji Morskiej (IMO), stanowiący załącznik do Międzynarodowej konwencji o bezpieczeństwie życia na morzu, 1974, sporządzonej w Londynie dnia 1 listopada 1974 r. (SOLAS) (Dz.U. z 2016 r., poz. 869 oraz z 2017 r., poz. 142) wraz z Protokołem z 1978 r. dotyczącym Międzynarodowej konwencji o bezpieczeństwie życia na morzu, 1974, sporządzonym w Londynie dnia 17 lutego 1978 r. (Dz.U. z 1984 r., poz. 320 i 321).

Recomendations on the transport of dangerous goods. Model Regulations. Volume I (2023), New York – Geneva: United Nations, https://unece.org/sites/default/files/2023-08/ST-SG-AC10-1r23e_Vol1_WEB.pdf [accessed: 11.03.2025].

RID – Oświadczenie rządowe z dnia 13 marca 2023 r. w sprawie wejścia w życie zmian do Regulaminu międzynarodowego przewozu kolejami towarów niebezpiecznych (RID), stanowiącego załącznik C do Konwencji o międzynarodowym przewozie kolejami (COTIF), sporządzonej w Bernie dnia 9 maja 1980 r. (Dz.U. z 2023 r., poz. 789).

The Act of August 19, 2011, on the transport of dangerous goods – Journal of Laws of 2011, item 1367 [Ustawa z dnia 19 sierpnia 2011 r. o przewozie towarów niebezpiecznych (Dz.U. z 2011 r., poz. 1367)].

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