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НОРМАТИВНО-ПРАВОВЕ ЗАБЕЗПЕЧЕННЯ СТАЛОГО РОЗВИТКУ ТРАНСПОРТНО-ЛОГІСТИЧНИХ СИСТЕМ

Актуальність. Наукова стаття присвячена дослідницькому аналізу особливостей правового регулювання та побудови інформаційної архітектури транспортних систем, які працюють на засадах сталості. Транспортні комунікації об'єднують компанії по всьому світу та є необхідною передумовою для цілісності країни та її інтеграції у світову економіку через зовнішньоекономічну діяльність. У зв'язку з цим транспортна система має безпосередне відношення до економіки та соціальної сфери, та через застосування принципу сталості, й до екологічної безпеки країни. Транспортна політика будь-якої держави характеризується національними приоритетами на мікро- та макрорівнях. Конкурентоспроможна транспортна система повинна мати такі характеристики: бути економічно, екологічно та соціально стійкою; бути спроможною ефективно відновлюватися після стихійних лих; мати розвинену та надійну IT-інфраструктуру.

Використання інформаційних систем в управлінні дорожнім рухом пов'язане з бурхливим розвитком сучасних міст, збільшенням кількості рухомого складу на вулицях, новими маршрутами та іншими особливостями. У результаті, обсяг інформації, необхідної для аналізу та прийняття оперативних рішень, значно зріс. Інформаційна складова стає невід'ємною частиною міського життя. А для ефективнішого використання всіх можливостей інтелектуальних транспортних систем (ІТС) необхідне правове регулювання, яке охоплює захист даних, стандартизацію, правила застосування досягнень ІТС та їх подальший розвиток, інформаційних ресурс реалізації екологічних пріоритетів.

Мета та завдання. Мета дослідження – дослідження правових засад концепції сталого розвитку транспортно-логістичних систем.

Матеріали і методи. Методологію дослідження побудовано на засадах законодавчо-правових методів забезпечення транспортно-логістичних потоків, економіко-правового аналізу і використання загальнодержавної бази та специфічних нормативно-правових актів, які регламентують діяльність транспортно-логістичних систем. Проблем інтелектуалізації природоохоронної діяльності розглядаємо як через структурні зміни в міжнародній економіці, через сучасні процеси розвитку національних транспортно-логістичних систем, а також через дослідження складної мережевої структури глобальних логістичних ланцюгів, де обидві підходи доповнюють один одного.

Результати. Бурхливий розвиток сучасних міст, збільшення транспортних засобів на вулицях, розвиток нових маршрутів збільшує обсяг інформації, необхідної для аналізу та прийняття оперативних рішень. Це своєю чергою стимулює активне використання інформаційних технологій, які забезпечать їх реалізацію, і створення правових стимулів для розвитку сталого транспортно-логістичної системи є одним з факторів зміцнення економіки та підвищення добробуту населення.

Висновки. Проведені дослідження включали проведення аналізу правового регулювання та дозволяло ефективно використовувати інструменти стимулювання розвитку сталого транспортно-логістичних систем. Основними необхідними елементами зміцнення інтелектуальних транспортних систем є стандартизація на міжнародному рівні, для того щоб була можливість створити глобальну систему для більш ефективного використання транспорту і досягнення глобальних цілей в безпеці пересування та зниження впливу транспорту на навколишнє середовище.

Ключові слова: інтелектуалізація, логістичні процеси, сталий розвиток, інтелектуальні транспортні системи, стандартизація, директива, дорожня карта.
REGULATORY AND LEGAL ENSURING THE SUSTAINABLE DEVELOPMENT OF TRANSPORT AND LOGISTICS SYSTEMS

Topicality. The scientific article is devoted to the research analysis of the peculiarities of legal regulation and the construction of the architecture of the intellectualization of transport systems. Transport communications unite companies around the world and are a necessary prerequisite for the integrity of the country and its integration into the world economy through foreign economic activity. In this regard, the transport system is directly related to the economy and the social sphere. The transport policy of any state is characterized by national priorities at the micro and macro levels. A competitive transport system must have the following characteristics: be economically, ecologically and socially sustainable; to be able to recover effectively after natural disasters; have a developed and reliable IT infrastructure.

The use of information systems in traffic management is associated with the rapid development of modern cities, an increase in the number of rolling stocks on the streets, new routes and other features. As a result, the amount of information needed for analysis and making operational decisions has increased significantly. The information component will become an integral part of city life. And for more effective use of all the possibilities of intelligent transport systems (ITS), legal regulation is necessary, which includes data protection, standardization, rules for the application of ITS achievements and their further development.

Aim and tasks. The purpose of the research is to study the legal foundations of the concept of transport and logistics systems sustainable development.

Materials and Methods. The research methodology is based on the analysis of legislative and legal methods of ensuring transport and logistics flows, economic and legal analysis using the general legal framework and special legal acts that regulate the activity of transport and logistics systems. The problem of intellectualization of environmental protection activities is considered both through structural changes in the international economy, through modern processes of development of national transport and logistics systems, as well as through the study of the complex network structure of global logistics chains, where both approaches complement each other.

Research results. The rapid development of modern cities, the increase of vehicles on the streets, the development of new routes increases the amount of information necessary for analysis and making operational decisions. This, in turn, stimulates the active use of intelligent information technologies. And the creation of legal incentives for the development of the intellectualization of the transport and logistics system is one of the factors of strengthening the economy and improving the welfare of the population.

Conclusion. The conducted research made it possible to conduct an analysis of legal regulation and stimulation of the development of intelligent transport systems (ITS). In particular, at the international and regional levels. The main necessary elements of the comprehensive application of intelligent transport systems are standardization at the international level, in order to be able to create a global system for more efficient use of transport and achieving global goals in the safety of movement and reducing the impact of transport on the environment.

Keywords: intellectualization, logistics processes, sustainable development, intelligent transport systems, standardization, directive, road map.
for the development of the transport and logistics system intellectualization is one of the factors of strengthening the economy and improving the welfare of the population (Matvieieva et al., 2020).

Intellectualization of environmental protection activities of transport and logistics systems plays a particularly important role in the processes of urbanization and development of cities. ITS contribute to the improvement of traffic flow, for example, the use of signalized intersection controllers. Also, urban traffic management and control can enable police, local authorities and public transport operators to share information and contribute to a truly integrated and more efficient transport system. ITS contribute to the improvement of road traffic safety through control cameras, intelligent traffic lights that can increase the time available for people crossing roads, where and when necessary.

Also, ITS technology stimulates the improvement of public transport. In particular, VMS can provide information on current traffic conditions, availability of parking spaces or public transport information in real time, operators can improve their services by having accurate information about the location and movement of vehicles, traffic information services can improve the quality of information available to travelers.

Another important benefit of the spread of ITS is the increase in the efficiency of freight transportation, as improved traffic flow and more accurate location information will lead to faster and more reliable movement of goods. And ICS also contribute to reducing the negative impact on the environment. For example, reduced congestion, a more efficient transport network together with more informed travelers and greener transport can help tackle climate change and reduce air pollution (UNEC for Europe, p. 53).

The main trend at today's stage of the modern transport and logistics system development is the complexity and variety of objects. The transport system consists of complex, multifactorial, non-stationary flows (passenger, material, information, financial) that require research, description and further optimization. And since the system of such interconnected objects is becoming more and more complicated, new methods of information processing are needed, and here the intellectualization of transport and logistics systems becomes an important aspect. (Dorokhovskii, 2012).

The intellectualization of the transport and logistics system means the continuous process of obtaining knowledge, its increase, transformation and processing in order to find an effective solution in the management of the system at a given moment in time.

Intelligent transport systems are considered as a part of solving current and future transport tasks. They are widely recognized as an effective tool for achieving efficient, safe and sustainable mobility. Intelligent transport systems help to significantly increase road safety, efficiency and driving comfort, helping transport users to make the right decisions and adapt to the road situation. They also help increase the use of multimodal options, improve travel and traffic management, contribute to the preservation of natural resource potential and ensuring the quality of life of the population.

**Analysis of recent publications on the problem.** Mangiarasina R., Perego A., Salvadori G., Tumino A. review the role of ITS in supporting smart mobility in cities and note that accuracy of information and speed of decision-making are of paramount importance in managing the mobility of goods and people in cities. Intelligent Transportation Systems (ITS) can provide road users with up-to-date information and forecasts about traffic and weather conditions. The result of using ITS in this direction will be higher efficiency of resource use and better management of physical flows (Mangiaracina et al., 2016).

Sushchenko R. and Zhang, Yu and his co-authors studied innovative practices of providing transport and tourist flows by various types of urban transport. The authors claim that the most striking example in this context is Germany. The study also determined that an integrated urban intelligent transport system includes a traffic management system, a public transport management system, a parking management system and a logistics flow management system, taking into account the impact of tourism. With the development of ITS in cities, nearby rural areas will also be actively developed (Sushchenko et al., 2022; Zhang et al., 2021).

Kashif Nasir Qureshi and Abdul Hanan Abdullah review the wide variety of applications of intelligent transportation system, technology and its various fields. The authors talk about the need for integration and synthesis of some areas and applications, technologies, discussion with all perspectives of the use of IT technologies in various areas (Qureshi & Abdullah, 2013).

Mandzhuka S., Zhura M., Horvat B., Mitsakis V. analyze the current guidelines of the European Union regarding the deployment of an intelligent transport system and its application to optimize environmental protection activities. The needs and potential for the development of the regional ITS architecture of South-Eastern Europe were also
investigated (Mandžuka et al., 2007).

Cherednichenko O. and Valatskene A. consider the possibilities of ITS in the management of traffic flows. The authors investigated and identified four groups of main problems of urban transport systems. We analyzed the level of implementation of systems for monitoring and managing traffic flows in Ukrainian cities. And researched the legal framework regulating the issue of mobility (Cherednichenko & Valatskene, 2022). Kostyuchenko L.V. researched models of safe supply chain management using digitalization achievements (Kostyuchenko, 2022). Hryhorak M.Yu. and Trushkina N.V. study the development of the logistics system of the economic region “polissya” in the context of the green economy: environmental problems and prospects (Hryhorak & Trushkina, 2020).

Butler L., Yigitkanlar T. and Paz A. claim that innovative technologies of intelligent mobility can contribute to the improvement of the transport system. According to the results of the study, the main innovations in the field of intelligent mobility are demand-responsive transport, public transport, intelligent transport systems, electric mobility, autonomous vehicles designed on the modern basis of the application of the concept of zero emissions, and mobility as a service. Smart mobility innovations can benefit urban areas by improving accessibility, efficiency, coverage, flexibility, safety and overall integration of the transport system (Butler et al., 2020).

A. Matveeva and co-authors research the legal regulation of the transport and logistics system of Ukraine and the countries of the European Union in general. The main priorities and problems that need to be solved by the transport and logistics system have been determined. The prospects of transport and logistics integration of Ukraine into international networks were also analyzed (Matvieieva et al., 2020).

Allocation of previously unsolved parts of the general problem. Today, obtaining the right information at the right time and in the right place is crucial for the development and effective use of transport and logistics systems. And in modern conditions, it is impossible to create a flexible, high-quality and environmentally safe system without the deployment of IT. The use of ITS in the urban transport system is crucial for improving standards. The most popular achievements of the intellectualization of transport systems are applications that track and transmit information before or during a trip on city public transport (WAP, SMS, etc.): electronic scoreboards, information desks for obtaining information about routes, ticket prices, schedules, announcements about the road situation, etc.; on-board screens in city vehicles, ticket vending machines (TVM), electronic tickets; security systems and other information services for passengers (UNECE for Europe, 2012, p. 53).

All these achievements in the transportation of goods and passengers are the result of the construction of intelligent transport systems. And today there are significant differences between approaches to the design of ITS architecture in the world. The US ITS architecture is based on the physical operation point of view, the European architecture is mainly based on user needs and the functional point of view, while Japan's national ITS architecture uses an object-oriented methodology (Mandžuka et al., 2013).

Formulation of research objectives (problem statement). The purpose of the research is to form the legal foundations of the concept of environmental protection activities intellectualization in transport and logistics systems.

Materials and Methods. The organization of the research process was built through the review of scientific and professional sources, the selection of cities for survey, the formation of a research methodology and a direct understanding of the factors that have an impact on transport in the urban sphere, environmental protection measures for the use of transport by the population and the industrial sector, the quality of life and the ecological state of the environment cities. Summarizing research results, forming conclusions and providing recommendations.

The study itself included the application of the methodology of content analysis, with the use of text evaluation methods with the acquisition of understanding and insight into the ecologically clean transport of smart cities in order to form rational and reproducible assumptions of legislative significance, the literature review involved the analysis of Internet sources by entering keywords such as "sustainable transport", "smart transport for modern cities" and "smart cities" in popular search engines, scientific databases such as Web of Science, Scopus and ScienceDirecta.

An outline of the main results and their justification. Advances in technology are giving transport administrations around the world the opportunity to change the way they manage and operate their transport and logistics networks. Their possibilities are practically limitless.

In order to fully investigate the legal regulation of the intellectualization of the transport and
logistics system, we consider it expedient to give an interpretation to the concept of intelligent transport systems (ITS).

The term "intelligent transport systems" (ITS) was introduced in transport and road engineering in the 1990s and can be defined as a holistic, control, information and communication modernization of classic transport systems, which allows to significantly improve productivity, transport flow, efficiency of passenger and cargo transport, transport safety, reduction of environmental pollution and others.

The concept of intelligent transport systems is used all over the world. Almost all countries have developed strategies or concepts dedicated to the implementation of ITS. So, for example, Article 4 of the European Commission Directive 2010/40/EU dated July 7, 2010 defines that "ITS is a system that uses information and communication technologies in the field of road transport, including infrastructure, vehicles, users, road management traffic, as well as interaction with other modes of transport" Directive 2010/40/EU, 2010 (Dmitrieva et al., 2020).

"Intelligent transport systems are a system for collecting, storing and providing information about road traffic in real time to maximize the efficiency of use, ensure convenient and safe transport and reduce energy consumption due to the use of advanced electronics, information and telecommunication technologies on roads, cars and transport means" (CEN/TC 278, 2023).

The UN Economic and Social Commission for Asia and the Pacific (ESCAP) report on Intelligent Transport Systems for Sustainable Development in Asia and the Pacific defines ITS as a combination of technologies to improve the efficiency of road traffic (ESCAP, 2019).

In terms of the overall scheme, ITS can be an overall system that includes technologies, policies, plans, strategies and regulations to improve transport systems to solve transport-related problems.

There is also an interpretation of ITS as a system that uses computers, communications, positioning and automation technologies in combination to improve the safety, management and efficiency of ground transportation (Intelligent transport systems, 2021).

As you can see, there are many variations in the definition of ITS and their interpretation can also differ by country and region. For example, some definitions of ITS may emphasize the perspective of traffic operations (Andersen & Sutcliffe, 2000), which may be enhanced by ITS, or the perspective of traffic information that may be provided by ITS. Because of different priorities in each country to solve their transport problems, approaches to ITS development differ and need to be coordinated to maximize the benefits of ITS. And in view of such dynamics and the UN Agenda in the field of sustainable development for the period until 2030, ITS defines as "Intelligent transport systems are a set of various technologies that increase the sustainability of transport systems in a safer, more rational and ecological way" (ESCAP, 2019).

Thus, ITS can be defined as the application of computer, information and communication technologies to manage vehicles and networks in real time, including the movement of people and goods. ITS covers all functional components: traffic management, commercial transport management, vehicle monitoring and control, transit management, emergency and rescue services, driver and passenger services, electronic payment services, data archiving, maintenance and construction management.

ITS applications and services are diverse and include trip planners, travel information services, intelligent traffic lights, real-time traffic information, traffic management and others. And today, Intelligent Transport Systems (ITS) can revolutionize mobility, changing everything from the way we move and communicate to the tools we use in transport legislation, to check compliance for vehicle certification and as a means of implementing environmental protection measures.

The origins of intelligent transportation systems date back to the 1960s, when the Electronic Route Navigation System was developed in the United States. However, the ITS World Congress in Paris in 1994 accelerated the development and deployment of intelligent transportation systems to improve traffic management systems worldwide. Since then, numerous ITS applications have been developed by various organizations around the world and customized according to specific needs. It has become a global phenomenon that has attracted the attention of both the automotive industry, transport experts and policy makers (Gritsenko S.I. Vinichenko I.A., 2020).

The high-quality application of the Intelligent Transport System is primarily based on the coordination and possible integration of individual solutions into integrated systems. Achieving this is related to the design of the basic system, the so-called ITS architecture, and the definition of the necessary standards by official organizations.

The initial standardization of ITS services was initiated by the International Organization for Standardization (ISO). The first reference model for ITS included 8 functional areas and 32 services
Transport information and control systems – Reference model architecture for the ITC sector (International Standard ISO 14813-1, 2015). Since 1999, reference models for IT architecture have been continuously improved. The current ISO 14813-1 standard defines the main services and applications that can be provided to users of an intelligent transport system. Those that share a common purpose may be grouped together in ITS service domains, and may have multiple ITS service groups for specific parts of the domain. ISO defines 11 service domains, within which numerous groups are then defined. The taxonomy includes 11 functional areas: Information for travelers; Traffic management and operations; Vehicles; Freight transport; Public transport; Emergency situation; Electronic payment related to transport; Personal safety related to road transport; Weather and environment monitoring; Disaster response management and coordination; National security. Each functional direction consists of interdependent services (Mandžuka et al., 2013).

Also, in addition to the International Organization for Standardization for Standardization at the international level, the Economic Commission for Europe of the United Nations (UNECE) occupies a significant position in the regulation of ITS, dealing with domestic transport issues, offering a unique platform for forming the legal framework and ensuring the safe implementation of future technologies. The main results of the work are reflected in more than 50 international agreements and conventions, which provide an international legal framework and technical regulations for the development of international road, rail, inland water and intermodal transportation, as well as transportation of dangerous goods and vehicle construction using ITS achievements (UNECE for Europe, 2013).

The Transport Division and other UNECE bodies contribute to ITS by facilitating coordination activities and preparatory studies for legal instruments aimed at the application and deployment of ITS. Today, the main task of the Division is to investigate, understand and respond to new transport problems and to promote the implementation of existing conventions and agreements by all its member countries. UNECE’s strategy is to take an integrated approach to transport, focusing not only on innovative new ways of working, but also on ways to combine traditional, well-functioning legal instruments with new technologies. Intelligent transport systems are part of this holistic vision of the transport system. And realizing this, in 2004, the first UNECE ITS Round Table was organized, and the first ITS Coordinator was appointed. At the same time, the Division intensified the work and promotion of ITS inside and outside the UN. UNECE working groups are committed to implementing the strategies of the Division, taking into account their competence and mandate, they consider the various aspects of IT and their compliance with legal instruments and technical provisions of the UN. Activities in this direction are regulated by the "ITS Road Map". The ITS Roadmap identified areas and listed actions that UNECE could take to remove obstacles to wider and faster deployment of ITS applications. At the 2020 session of the Inland Transport Committee, it was noted that the ITS Roadmap for 2012–2020 encourages ITS activities related to infrastructure and all modes of transport and promotes an integrated solution to ITS challenges (UNECE for Europe, 2013).

Since this card expired in 2020, the committee renewed it in 2021. And the UNECE Roadmap for Intelligent Transport Systems for 2021–2025 was adopted. The updated publication of the Roadmap contains an action plan with 20 global actions to promote the use of ITS aimed at: harmonisation, security and accountability, environment and climate change mitigation, all modes of transport, promotion of key technologies and capacity building needs (including analytical work) (UNECE ITS Road Map, 2012–2020). And it is clear that technological innovation is leading to legal and institutional change and that governments and policymakers must catch up with current trends and even accelerate their actions. The main objective of the UNECE ITS Strategy is to lobby for new actions and policies in which ITS improve the quality of life and enable sustainable mobility across borders.

ITS has been the focus of a number of political and legislative initiatives not only at the international level, but also at the regional level. The main example here is the development of ITS in the EU. The European Commission has laid the legal framework for accelerating the implementation of innovative transport technologies across Europe. The development of the European ITS architecture is the result of two projects funded by the European Commission: the KAREN project, which laid the foundation for the development and standardization of ITS in the 90s of the last century, and the FRAME project. The FRAME project includes the early ideas of the European ITS infrastructure architecture with the following documentation:

1. European functional architecture of ITS;
2. European ITS physical architecture;
3. European ITS communication architecture;
4. European analysis of the effectiveness of ITS costs;
5. Studying the use of ITS in Europe;

The FRAME project continues as a new E-FRAME (Extend FRAME work) architecture for cooperative systems. This new EU standard is necessary for interoperability and the ITS Architecture for Cooperative Systems should be used to explore possible standardization requirements and create a set of recommendations for relevant organizations (Mandžuka et al., 2013, p. 274).

Also, every year the European Commission with the Multilateral Platform for ICT Standardization develop the Action Plan for the implementation of ICT (The Rolling Plan for ICT Standardisation), it can be considered as a document that initiated a more active and purposeful development of ICT in the European Union (European Commission, 2019).

The implementation of the Action Plan was associated with three main problems: congestion and congestion costs (congestion costs the EU economy more than 1 % of GDP per year due to time lost by citizens and workers, as well as unreliable and inefficient logistics that feed the economy); CO₂ emissions and fatalities (accidents). The main policy objectives arising from these challenges are to make transport and travel more frequent, more efficient, safer and more reliable. ITS is a possible solution and the goal of the Action Plan is to accelerate and coordinate the implementation of ITS. The potential of ITS can be realized only if its deployment in Europe transforms from a limited and fragmented implementation to a pan-European one (EC. Revision of the Directive on ITS, 2021).

The action plan envisages six priority directions:
1. Optimal use of road, traffic and trip data;
2. Continuity of ITS services for traffic and freight management on European transport corridors and in urban agglomerations;
3. Traffic safety;
4. Integration of the car into the transport infrastructure;
5. Data security and protection, as well as liability issues;
6. European cooperation and coordination of ITS.

In total, 24 types of activities were identified within six priority areas. Later, priority areas were partially transferred in Directive 2010/40/EU (Dmitrieva et al., 2020).

Directive 2010/40/EU is a joint document on the coordination of IT development in the European Union. Like other directives, it is not directly applicable in every member state. However, member states are obliged to adapt their national legislation to achieve the objectives set by the directives. An integral part of the document is a list of priority directions and priority actions, as well as plans with established deadlines. The main objective of the Directive is to create a basis for future activities that will eventually lead to the harmonization of IT development in Europe. The ITS Directive addresses transnational aspects that cannot be satisfactorily addressed by Member States alone, such as the common definition of key data sets to be made available for the development of ITS services, the interoperability of equipment, as well as the strengthening of the internal market for ITS services at a global level (thereby contributing to job creation and growth)(Mandžuka S. et al., 2013; EC. Revision of the Directive on ITS, 2021).

Comprehensive principles and enabling conditions for the deployment of ITS are implemented through common EU-level specifications developed with the active participation of subject matter experts appointed by Member States, industry and all relevant stakeholders. Specifications of priority areas are the first step on the way to coordinated development. Specifications are developed individually and, depending on the area covered, may include different types of provisions: functional provisions describing the roles of different stakeholders and the exchange of information between them; technical means that provide technical means of performing functional provisions; organizational provisions that describe the procedural obligations of the various stakeholders, and service provisions that describe the different service levels and their content for ITS applications and services. The directive also pays special attention to data protection and states that member states are obliged to ensure fundamental rights and freedoms of the individual. National IT legislation must ensure the protection of personal data against misuse, including unlawful access, alteration or loss. For these reasons, the use of anonymous data is recommended.

The Directive's tasks are supported by the European ITS Committee (EIC) and the European ITS Advisory Group, which were established to provide advice on the business and technical aspects of ITS implementation and deployment. The advisory group includes service providers, users, manufacturers, professional associations and
local authorities (Mandžuka et al., p. 278).

In 2021, the European Commission conducted an assessment of the effectiveness and implementation of the provisions of the Directive. Based on the results of the inspection, the Commission concluded that the Directive had a positive impact on the deployment of ITS in the EU. The Directive remains a suitable tool to solve problems such as the lack of coordination in the deployment of ITS in the EU and the slow, risky and economical deployment of ITS (Proposal for a Directive of the European Parliament, 2021).

The assessment also notes that the use of ITS is increasing, but despite improvements, the deployment of ITS is still often limited by geographic coverage. As before, there is a clear need for further action to ensure interoperability, cooperation and data sharing to ensure smooth and uninterrupted operation of ITS in EU countries (Proposal for a Directive of the European Parliament, 2021). Although the current specifications address data availability, where it exists, they do not yet address the issue of network-wide availability of key types of data, which is important to support new services such as advanced driving assistance systems (e.g. Intelligent Speed Assistance). In addition, new ITS topics and challenges are emerging, such as connected and automated mobility and mobile platforms (e.g. Mobility as a Service – MaaS), as well as insufficient collaboration between private and public stakeholders. Moreover, the ITS Directive initially focused heavily on the core and comprehensive TEN-T network. More attention should be paid to more efficient and sustainable multimodal transport solutions (EC. Revision of the Directive on ITS, 2021). And in order to solve these problems and solve the set goals, the European Commission initiated a revision of the Directive in order to: increase the interoperability and cross-border continuity of ITS applications, systems and services, create effective coordination and monitoring mechanisms between all ITS stakeholders and solve problems related to with the availability and exchange of data supporting ITS services. But despite of the revision in the baseline scenario, the current ITS Directive remains in place and the Commission will implement the existing work program and possible further work programs after 2023, using common specifications, optional measures and standards in existing priority areas where appropriate.

ITS services and applications can create clear benefits in terms of transport efficiency, sustainability, accessibility, safety and security, while contributing to the objectives of the EU's single market and competitiveness, as well as the Green Deal. To develop these directions, in December 2020, the European Commission adopted the Communiqué on the strategy for sustainable and intelligent mobility (the "strategy") 2, which proposes a significant transformation of the European transport system to achieve the goal of sustainable, intelligent mobility. Digitization is an indispensable driver of this transformation. Digitization will make the entire transport system more integrated and more efficient. It will also increase the level of safety, security, reliability and comfort. The strategy identifies the deployment of intelligent transport systems (ITS) as a key action in creating a connected and automated system of multimodal mobility. The latter combines new developments such as Mobility as a Service (MaaS) and Shared, Connected and Automated Mobility (CCAM) (Proposal for a Directive of the European Parliament, 2021).

In addition, the European Commission asked European standardization organizations to develop and adopt European standards to support the legal framework. Not surprisingly, the standardization organizations CEN, CENELEC and ETSI are very active in this area (CEN/TC 278).

In the next fig. the scheme of greening of intelligent transport systems of cities and the creation of an urban transport ecosystem developed by (Hazem et al., 2022) is presented, which is built using regulatory tools divided into traditional (blue) and innovative (beige).

Important instruments of state management of the transport sector are: normative acts regulating the interrelationships of the transport industry and ensuring effective interaction of various types of transport on the basis of logistics and joint competition; national and regional programs for the development of modes of transport and their interaction; system of taxation of transport activity; development of national and regional transport balances related to plans for the development of productive forces. (Braginsky, 2011, p. 110). So, for example, the European ITS infrastructure architecture is designed to provide a flexible structure that individual countries can adapt to their requirements. Thus, national ITS architecture
Demand

Modes of mobility/B2C and B2B offerings

Mobility-as-a-Service
- Routing
- Air mobility
- Goods mobility
- Smart Parking
- Advanced ticketing
- Micromobility

Bus
- Public bus

Supply

infrastructure
- EV charging
- 5G, IOT sensors
- Intermodal mobility hubs
- Parking infrastructure
- Waterways

Mobility assets
- EVs, AVs
- Hyperloop Flying taxis
- Cars, vans, buses, trucks
- Delivery drones, robots
- Flying taxis
- Boats, ferries

Aviation assets
- Parking infrastructure

Foundational

Governance, regulations and standards
- Mobility assets policies
- Urban planning
- Training certifications
- ESG policy

Financing and insurance
- Cybersecurity policies
- Standard setting bodies
- Aviation, transit authority
- Overall transit strategy
- Public–private sponsorship
- Monetizing mobility data
- Tolls and fines
- Private sponsorship
- Government sponsorship
- Usage-based charges

Innovation ecosystem
- Corporates
- Centers of excellence
- Startups
- Research institutes

Fig. 1 – Ecosystem of Smart Cities

projects based on the European ITS structure architecture, such as ACTIF (France), ARTIST (Italy), TTS-A (Austria) and TEAM (Czech Republic), have a common approach and method, but so that each country can focus on aspects of local importance and develop them in more detail.
The 2023–2026 U.S. ITS Development Plan states that the U.S. government supports the large-scale adoption of innovative transportation technologies through policy, thought leadership, and workforce development.

Goals and strategies for 2023–2026:
- Expand offers for participants of the transport system
- To ensure the development of card potential
- Support procurement innovation and resources to obtain federal funding.
- Promote large-scale deployment to expand the implementation of committees and members that involve ITS

Conclusions and perspectives of further research. Based on the analysis, it can be said that ITS is an automated system that combines a variety of modern technologies, which allows for efficient and safe movement of goods, people, as well as management and control of the road situation, ensuring reliable and stable interaction between vehicles, as well as with transport infrastructure.

Intelligent transport systems (ITS), due to their advantages, can make a significant contribution to the creation of a cleaner, safer and more efficient transport system. The advantages of ITS include: reducing the impact of road traffic on the environment, increasing energy efficiency and reducing dependence on fossil fuels; reducing congestion and optimizing the use of existing infrastructure; improve road safety and security; increasing the convenience of transport; ITS also make better use of existing infrastructure, expand multimodality and improve traffic management.

Despite the fact that the intellectualization of transport and logistics systems is an urgent issue today, the active development of ITS is hindered by the following key problems: lack of functional compatibility and continuity of applications, systems and services; lack of alignment and effective collaboration between stakeholders and unresolved issues related to the availability and sharing of data supporting ITS. In order for ITS to actively develop and function effectively at the national, regional and international levels, it is necessary to: further improve coordination in the field of data availability, take into account the emergence of new topics and tasks of ITS and improve the availability of key types of data throughout the road and transport network.

Year-on-year transport demand and improved information exchange through further digitization will remain a key factor in addressing congestion, traffic accidents, air pollution and CO2 emissions, as well as transport sustainability. And the improvement of the legislative framework at all levels will contribute to the satisfaction of the needs for vehicles and the accelerated development of ITS. But experts note that the huge potential and advantages can be obtained only if IT solutions are implemented as coordinated as possible at the international level.

REFERENCES


CEN/TC 278. Intelligent transport systems. (2023) URL: https://www.itsstandards.eu/


Sustainable Mobility.pdf