ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

DIGITAL TRANSFORMATION IN TRAFFIC MANAGEMENT AND THE PREVENTIVE EFFICACY OF ITS: AN ANALYSIS OF NATIONAL AND INTERNATIONAL EXPERIENCE

University of Public Safety, independent researcher Captain Zafar Komiljonovich Kuvondikov

***Abstract**: The article examines modern mechanisms for ensuring road safety within the framework of transport sector digitalization and the "Smart City" concept. The author analyzes the strategic role of Artificial Intelligence, Big Data, and Intelligent Transport Systems (ITS) in preventing traffic violations and reducing road fatalities. Based on international concepts such as "Vision Zero" and "Safe System," the study highlights gaps in the national legislation of Uzbekistan, specifically regarding the procedural status of digital evidence and data integration issues. Finally, the author proposes original recommendations for enhancing ITS infrastructure.*

***Keywords**: Digital transformation, ITS, preventive monitoring, Artificial Intelligence, Vision Zero, digital evidence, Big Data, transport safety.*

ЙЎЛ ҲАРАКАТИ БОШҚАРУВИДА РАҚАМЛИ ТРАНСФОРМАЦИЯ ВА ИТТНИНГ ПРЕВЕНТИВ САМАРАДОРЛИГИ: МИЛЛИЙ ВА ХАЛҚАРО ТАЖРИБА ТАҲЛИЛИ

Жамоат хавфсизлиги университети, мустақил изланувчиси капитан Кувондиков Зафар Комилжонович

***Аннотация**: Мақолада транспорт соҳасини рақамлаштириш ва "Ақлли шаҳар" концепцияси доирасида йўл ҳаракати хавфсизлигини таъминлашнинг замонавий механизмлари тадқиқ этилган. Муаллиф томонидан сунъий интеллект, катта маълумотлар (Big Data) ва ИТТ (Интеллектуал транспорт тизимлари)нинг ҳуқуқбузарликлар профилактикаси ҳамда ўлим ҳолатларини камайтиришдаги стратегик роли таҳлил қилинган. Тадқиқотда "Vision Zero" ва "Safe System" каби халқаро концепциялар асосида Ўзбекистон миллий қонунчилигидаги ҳуқуқий бўшлиқлар, хусусан, рақамли далилларнинг процессуал мақоми ва маълумотлар интеграцияси масалалари ёритилган. Якунда ИТТ инфратузилмасини такомиллаштириш бўйича муаллифлик таклифлари илгари сурилган.*

Калит сўзлар: *Рақамли трансформация, ИТТ, превентив мониторинг, сунъий интеллект, Vision Zero, рақамли далил, Big Data, транспорт хавфсизлиги.*

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ В УПРАВЛЕНИИ ДОРОЖНЫМ ДВИЖЕНИЕМ И ПРЕВЕНТИВНАЯ ЭФФЕКТИВНОСТЬ ИТС: АНАЛИЗ НАЦИОНАЛЬНОГО И МЕЖДУНАРОДНОГО ОПЫТА

Аннотация: *В статье исследуются современные механизмы обеспечения безопасности дорожного движения в рамках цифровизации транспортного сектора и концепции «Умный город». Автором проанализирована стратегическая роль искусственного интеллекта, больших данных (Big Data) и интеллектуальных транспортных систем (ИТС) в профилактике правонарушений и снижении смертности на дорогах. На основе международных концепций, таких как «Vision Zero» и «Safe System», освещены пробелы в национальном законодательстве Узбекистана, в частности, процессуальный статус цифровых доказательств и вопросы интеграции данных. В завершение выдвинуты авторские предложения по совершенствованию инфраструктуры ИТС.*

Ключевые слова: *Цифровая трансформация, ИТС, превентивный мониторинг, искусственный интеллект, Vision Zero, цифровое доказательство, Big Data, транспортная безопасность.*

In the development strategy of modern Uzbekistan, the value of the individual and the protection of their rights and legitimate interests have been firmly established as a priority direction of state policy. This conceptual foundation also requires a fundamental transformation of the road traffic safety system, in particular the introduction of the “Safe Road and Safe Pedestrian” principle advanced by President Sh. M. Mirziyoyev as a strategic criterion[1]. Today, road traffic safety is interpreted not only as an element of the transport infrastructure but also as a fundamental guarantee for the realization of citizens' constitutional rights to life and health[2].

In recent years, the volume of financial resources allocated for the modernization of the sector has increased significantly. In particular, since 2017, the 61 trillion won allocated to improving roadways and infrastructure is 3.5 times greater than in previous periods[3]. However, the sharp increase in the country's level of motorization (the number of vehicles per 100 people has increased from 6–7 to 12) is reducing the effectiveness of traditional management methods and creating a need for the rapid digitization of the system.

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

2025, the “Year of Environmental Protection and the Green Economy” in conjunction with the declaration of 2025 as the “Year of Environmental Protection and the Green Economy” [3], the issues of reducing harmful gas emissions and ensuring environmental safety through the intelligent management of traffic flows have also begun to be considered an integral part of the intelligent transportation system concept [4]. This, in turn, requires analyzing road traffic safety not only as a legal issue but also as a factor of environmental and socio-economic stability.

In this context, a number of national legal scholars and industry experts assess the role of digital technologies in ensuring road traffic safety not only as a punitive measure, but also as a preventive (preventive) mechanism," they argue. In particular, experts such as Olim Saidov[5], Anvar Abdullajanov[6], and Kamol Roziев[7] classify intelligent transport systems as the highest level of prevention. In their view, the intelligent transportation system, by automatically recording violations without human intervention, instills in drivers a sense of “inevitability of punishment,” which in turn serves to raise legal culture. Similarly, R.A. Gulyamov, in his research on the theoretical foundations of intelligent transportation systems, emphasizes that its primary goal is to optimally organize traffic flows, reduce congestion, and thereby improve the environmental situation.

[8]. The following digital prevention directions are being proposed by representatives of the National School. These include:

Ø Theory of procedural transparency! According to this theory, the implementation of the “E-ma'muriy ish” system minimizes human involvement in the processing of administrative violation cases, which eliminates the risks of corruption and increases citizens' trust in the internal affairs agencies[9].

Ø Victimological prevention and digital education! According to this, researchers are substantiating the necessity of using mobile applications and interactive maps to raise the legal culture of road traffic participants, especially pedestrians[10].

Ø data integration and forecasting! Accordingly, national scientists propose organizing data exchange between the Ministry of Internal Affairs, the Ministry of Transport, and the Ministry of Health on the principle of a “single window.” This, in turn, makes it possible to forecast in advance the likelihood of road accidents on specific road sections and to take prompt measures[11].

According to this national theory, the intelligent transport system is viewed not only as a technical system but also as a means of humanizing law enforcement practice. For example, notifying drivers about hazardous road sections via a digital alert (push-notifications) system before imposing fines increases the preventive effect.

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

In the global scientific community, several major schools of thought have emerged regarding the concept of an intelligent transport system and its impact on safety. In particular, Purnendu S. M. Tripathi and his co-authors in their In his paper, “An Overview of Intelligent Transport System (ITS) and its Applications,” he defines the intelligent transport system as a synergy of modern communication, control, and electronics technologies, emphasizing that its primary function is to automate the control functions traditionally performed by humans. [12]. Furthermore, in his view, the system consists of three main stages: data acquisition, data processing, and distribution of information.

Abdulaziz Aldegheishem[13] and his co-authors propose their concept of VANET (Vehicular Ad-hoc Networks). According to his theory, vehicles communicate with each other in real-time (V2V – Vehicle-to-Vehicle) and with road infrastructure (V2I – Vehicle-to-Infrastructure) constant and automatic data exchange makes it possible to reduce the probability of unexpected collisions by up to 80 percent.

Also, Professor Mohamed M. Ahmed[14], director of the Transportation Center at the University of Cincinnati, USA, has conducted research on modeling driver behavior using Big Data and artificial intelligence. His “Adaptive Speed Limits” (Variable Speed Limits – VSL) argues that safety is ensured not by merely penalizing drivers, but by offering a safe mode of travel based on road conditions.

Furthermore, according to Australian Monash University researchers M. Fitzharris & S. Newstead, studying the impact of intelligent transport systems on the human factor, technologies should not only prevent collisions, but also that they should reduce the severity of injuries in the event of an accident (for example, through an automatic emergency braking system—AEB)[15].

These theoretical perspectives indicate that intelligent transport systems are not just a collection of technical devices, but a complex socio-technical system for ensuring the safety of road users.

In this regard, the experience of the world's leading countries shows that the widespread implementation of intelligent transportation systems is the most effective way to drastically reduce road fatalities.

In particular, the countries of Singapore, Japan, and Germany are recognized as benchmarks in this area.

For example, Singapore was one of the first in the world to create an economic-technological model for managing congestion and speed.

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

The ERP (Electronic Road Pricing) system not only manages traffic flow but also regulates the flow of vehicles entering the city[16]. Currently, Singapore is transitioning to the ERP 2.0 system, which is based on Global Navigation Satellite System (GNSS).

The key features of this system include:

● On-Board Unit (OBU): A device installed in each vehicle informs the driver in real-time about traffic congestion, roadwork, and school zones[17].

● Remote control: Instead of physical gantries, virtual control points are used, which allows preserving the city's architecture[18].

Studies on the A99 autobahn near Munich, Germany, have shown that the uneven distribution and sharp changes in speed are one of the main factors causing traffic accidents in the country. In addressing this problem from an organizational and legal standpoint, Germany's Active Traffic Management system on its highways demonstrates high efficiency. In particular, according to the conclusions of fundamental research conducted on the A99 autobahn near Munich, the VSL that manages the traffic flow (Variable Speed Limit – VSL) system was active, the average travel time for vehicles was reduced by 4 percent. The most significant criminological finding is that the system's use led to a 12–20 percent reduction in speed dispersion (standard deviation).

This organizational solution not only ensures the uniform and stable flow of traffic but also serves to significantly prevent situations of abrupt braking or overtaking violations by drivers, i.e., the number of collisions.

[19].

Above, we studied the positive experience of developed countries; now, it is appropriate to address the universally binding norms on road traffic safety regulated by international organizations.

In particular, it is no secret that the UN General Assembly's 2020 resolution declared the years 2021–2030 the “Second Decade of Action for Road Safety”[20].

Additionally, the World Health Organization (WHO) and the UN's Global Plan promote the “Safe System” approach. According to this approach, road safety is based on five key pillars. These are: safe governance, safe users, safe vehicles, safe roads, and post-crash care[21]. The “Vision Zero” strategy, based on the Swedish experience, prioritizes human life over economic gain and holds system designers responsible for safety[22].

Furthermore, standards developed by the ISO/TC 204 technical committee are crucial for ensuring the technical interoperability of intelligent transport systems[23]. These standards allow the systems of different countries to be integrated with each other. These include:

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

● ISO 21217, which defines the station and communication architecture for intelligent transport systems and provides the technical foundation for the V2X (vehicle-to-everything) system [24].

● ISO 14816, which regulates Automatic Vehicle Identification (AVI) and its data structure[25].

This serves as the legal basis for the new Uzbekistan's integration into the global safety system.

Despite reforms to implement intelligent transportation systems, the existing legislation and infrastructure of the new Uzbekistan contain a number of serious legal gaps that limit the effectiveness of digital prevention.

First, there is the problem of terminological and conceptual gaps, namely, the current Law "On Road Traffic Safety" lacks legal definitions for "Intelligent Transport System," "Autonomous (driverless) vehicle," modern concepts such as "Digital Road Infrastructure" are not legally defined[26]. This is causing legal inconsistencies in the design, certification, and implementation of these systems.

Secondly, there is a problem with the procedural status of digital evidence, namely, that currently only violations recorded by photo and video recording devices are recognized. However, the sensors of complex intelligent transportation systems, There are no clear regulations for the use in court as evidence of metadata collected by LiDAR[27] and artificial intelligence algorithms (for example, algorithmic conclusions about driver fatigue or failure to maintain a safe distance).

In order to eliminate the systemic problems identified in the field of road traffic safety and to raise the effectiveness of preventive measures to a new qualitative level, the following scientific-practical proposals are put forward. Specifically:

First, in order to align the normative and legal framework with modern technological trends and to systematize the sector's legal definitions,

It is considered necessary to supplement Article 3 of the Law "On Road Traffic Safety," titled "Basic Concepts," with the following new terminological concepts:

· "Intelligent Transportation System (ITS)

— *a set of high-tech solutions that integrate the exchange of information among vehicles, road infrastructure, and users to manage traffic flow, ensure traffic safety, and enhance mobility and environmental sustainability.*

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

· "Cooperative Intelligent Transport System (C-ITS) — 'vehicle-to-vehicle' *($V2V$) and "vehicle–road infrastructure" ($V2I$) formats, providing real-time data exchange aimed at increasing the situational awareness of road users.*

· Digital Twin of the Road (Digital Twin) — a high-accuracy digital model that reflects the state, dynamics, and functional characteristics of real-world road infrastructure objects in a virtual environment, enabling the prediction of potential events and the modeling of management decisions."

The systematic introduction of the innovative concepts and technological systems analyzed above into national legislation and legal practice will make it possible in the future to achieve the following strategically significant results:

a) will contribute to the formation of a "digital legal environment" in the field of ensuring road traffic safety.

This, in turn, creates the groundwork for prioritizing legal mechanisms based on intelligent and high-tech solutions, moving away from traditional methods of regulating relationships in the sector.

b) High efficiency is achieved in preventing road traffic accidents by minimizing the impact of the human factor in the process of managing traffic flow. Defining the legal status of Cooperative Intelligent Transportation Systems (C-ITS) and "digital twin" technologies expands the possibility of implementing preventive measures in the field in real-time and based on prognostic analysis.

c) ensures the scientific basis for resource-saving and management decisions in the processes of designing, constructing, and operating road infrastructure.

The use of digital models to simulate in advance the factors that threaten traffic safety in a virtual environment, the targeted allocation of state budget funds, and the extension of the service life of infrastructure facilities.g) The creation of a legal framework aligned with international standards enhances our country's transport and logistics potential and its position in international rankings (e.g., the Logistics Performance Index). This, in turn, guarantees that the transport system will become a safe, efficient, and environmentally sustainable network during the digitalization of the national economy.Secondly, the draft resolution of the Cabinet of Ministers of the Republic of Uzbekistan "On establishing the national 'Safe Road' data platform and launching its operation" and the relevant regulatory -legal document, the following strategic directions for the digital transformation of the road traffic safety management system are proposed: 1. Creation of an integrated "Multimodal Digital Registry." This includes:· Based on the UN and WHO's

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

international recommendations for road traffic safety management, create a single platform that consolidates all data in the field. Within this registry, road traffic incidents (RTIs) that have occurred,

integrate databases on geometric and technical indicators of road infrastructure, drivers' violation histories (penalty points), and their health status (medical indicators).

Implement an inter-agency automated data exchange regulation to ensure the accuracy and transparency of the data.

2. Implement an AI-based “Predictive Monitoring and Risk Analysis” module. It will:

· Implement an automated system for identifying “accident black spots” by applying artificial intelligence algorithms on the data platform. The system not only records statistical events but also, by analyzing road conditions and traffic intensity, forecasts potential accident hotspots in advance and proposes scientifically based solutions for their mitigation.

3. The “Directive and Automatic Tasks” mechanism of execution control:

· Legally codify the system for sending mandatory “digital assignments” (directives) to responsible government agencies and road owners to address the systemic deficiencies and hazardous sections identified by the platform. The execution status of the directives is monitored in real time on the platform, and if measures are not taken within the specified deadlines, legal mechanisms are activated to pursue the administrative liability of the responsible persons.

Third, digital standards for road infrastructure (O'z DSt) to develop and integrate into sectoral technical regulations; the Ministry of Transport, in cooperation with the Ministry of Internal Affairs and the “Uzstandard” Agency, proposes to adopt the following standards: 1. Intelligent Transportation Systems (ITS)

It is proposed to adopt the following standards in cooperation with the Ministry of Internal Affairs and the “Uzstandard” Agency:

1. Adoption of unified technical standards for the design and construction of Intelligent Transportation Systems (ITS) facilities. This includes:· for newly constructed and reconstructed Category I and II public highways, during the design phase, V2X

(Vehicle-to-Everything) communication systems, intelligent sensors and detectors, and data transmission networks, and to introduce mandatory regulatory requirements that explicitly include the necessary engineering and communication channels. In this regard, establishing the “Digital Readiness” index as one of the main criteria for the state commission for road acceptance.

2. Implement a digital identification system for traffic management devices. This includes:

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

· Approve digital identification codes for road signs, traffic signal units, and road markings (based on international ISO 14816 and ISO 15628 standards). The implementation of this system will ensure that autonomous and highly automated vehicles can recognize road infrastructure objects in real time without error and maintain a virtual inventory of objects in the "Digital Twin Road" system.

Fourth, it is proposed to introduce the following amendments and additions to the Administrative Liability Code of the Republic of Uzbekistan and the relevant procedural normative acts to legally legitimize the mechanisms for detecting traffic violations using digital technologies: the following amendments and additions are proposed to the Code on Administrative Liability of the Republic of Uzbekistan and the relevant procedural normative legal acts:

1. Article 171 of the Code of Administrative Offenses, entitled "Administrative Liability of Persons for Violations of Traffic Rules Recorded by Specialized Automated Photo and Video Recording Devices," is supplemented with the following ninth paragraph:

"The procedure provided for in the first part of this article, as well as intelligent transport systems (ITS) based on artificial intelligence algorithms and video -analytics software, shall also apply to cases of complex violations (dangerous maneuvering, failure to maintain a safe distance, failure to observe traffic priority) detected by the artificial intelligence system. In this case, the analytical report (trajectory map, distance measurement, and situational simulation) generated by the artificial intelligence system, which describes the dynamics of the violation, is mandatory to be attached to the administrative protocol."

2. It is proposed to supplement Article 276 of the Code of Administrative Offenses, "Evidence," with the following fourth part:

"As evidence in an administrative case, analytical data, digital models, and situational forecasts generated by artificial intelligence and high-tech hardware-software complexes may be admitted. *The authenticity of this information must be substantiated by the certification of the technical means and the integrity of the data contained therein."*

3. It is proposed to introduce a new Article 2831 into the Code of Administrative Offenses, titled "Features of proceedings on violations recorded by artificial intelligence systems."Article 2831. Features of proceedings for violations recorded by artificial intelligence systems

In administrative proceedings for traffic violations detected by means of artificial intelligence systems:1. Documents generated by the algorithm shall have the force of circumstantial evidence;

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

2. If there is doubt as to the fact of the violation, the competent authority shall verify the algorithm's operating parameters in the presence of an expert specialist;

3. The owner of the vehicle has the right to appeal the artificial intelligence's conclusion through the courts and to request a technical expert analysis to prove an algorithm error."

Fifth, in order to ensure the sustainable development of Intelligent Transport Systems (ITS) and digital infrastructure, and to promptly resolve problems at the regional level, It is proposed to optimize the system for allocating funds from the Safe Roads and Safe Pedestrians National Fund (or relevant targeted funds) as follows:

1. Introduce a quota-based system for targeted allocation of funds. This would establish a legal mechanism to direct at least 20 percent of the fund's resources strictly toward developing digital infrastructure at the district and city levels.

These funds are designated for the following specific purposes:

o installation and modernization of local-level ITS elements (intelligent traffic signals, sensors, and cameras);o Ensuring the technical maintenance and software stability of existing digital devices;

o Updating the database of local roads for the “Digital Road Twin” system.

2. “Investment Refinancing”

(Re-investment) principle: creating a system that redirects a portion of the fines collected from violations detected by digital systems in a specific area back into digitizing that area's road safety infrastructure. This “self-financing” model increases the interest of local authorities in implementing innovations.

3. Financial transparency and digital oversight. This involves establishing a system to monitor the expenditure of allocated funds through the national “Safe Road” platform. Implement a KPI (Key Performance Indicator) system that links the degree of digitalization and the reduction in road traffic accidents with the funding amount for each district/city.

Based on research and analysis, it was determined that the role of intelligent transportation systems in ensuring road traffic safety in the New Uzbekistan is indispensable. The reforms initiated by President Shavkat Mirziyoyev have created a solid political and financial foundation for transitioning the sector from repressive control to technological and humane prevention.

Scientifically, it can be concluded that the ITS system is not just a technical tool, but a complex socio-technical system that legally and practically guarantees the principle of “human life is the supreme value.”

ISSN: 2775-5118 VOL.3 NO.11 (2024) I.F. 9.1

The theoretical perspectives of foreign scholars and the experience of developed countries (Singapore, Japan, Germany) successful experience confirms that road fatalities can be reduced by up to 50 percent only by harmonizing digital technologies with legal norms.The main task for Uzbekistan is to fully implement the “Safe System” approach by filling existing legal gaps, implementing international ISO standards into national legislation, and ensuring inter-sectoral data integration. Intelligent transportation systems serve not only to maintain order but also as a high-tech guarantee for saving human lives. This, in turn, further enhances the reputation of the new Uzbekistan as a safe and stable state on the global stage.

REFERENCES:

[1] Mirziyoyev S.M. Additional measures to ensure road traffic safety have been established. — URL: https://gov.uz/uz/news/view/67332

[2] UNECE. Road Safety Performance Review Uzbekistan. United Nations Economic Commission for Europe, 2024. // https://unece.org/sites/default/files/2024-05/Road%20Safety%-20Performance%20Review%20Uzbekistan.pdf.

[3] Mirziyoyev S.M. Materials of the videoconference meeting on reforms in the road economy and issues of improving road construction quality. — July 9, 2024 // https://president.uz/uz/lists/view/7363.

[4] Decree of the President of the Republic of Uzbekistan No. PF–16 of January 30, 2025 “On the State Program for the Implementation of the ‘Uzbekistan — 2030’ Strategy in the Year of ‘Environmental Protection and the Green Economy’” //
National Legal Information Base // https://lex.uz/ru/docs/7369703

[5] Saidov O.N. “Improving the Organizational-Legal and Criminological Aspects of Ensuring Road Traffic Safety.” Dissertation submitted for the degree of Doctor of Science (DSc) in Law. – Tashkent: Ministry of Internal Affairs Academy, 2021.
Pages 118–125.

[6] Abdullajanov A.A. Improving the Prevention of Administrative Offenses in the Field of Road Traffic Safety: PhD Dissertation in Legal Sciences. – Tashkent: Academy of the Ministry of Internal Affairs, 2019. – 160 pp.

[7] Roziев K.T. Improving the Organizational and Legal Foundations of Road Traffic Safety Activities: A Textbook. – Tashkent: Ministry of Internal Affairs Academy, 2020. – 120 p.

[8] Gulyamov R.A. The Role and Importance of Digital Technologies in Managing Traffic Flows // Modern Problems of Information and Communication Technologies and Telecommunications. – Tashkent, 2021. – No. 2. – Pp. 45-52.

[9] Ziyodullayev M.Z. Problems of Ensuring Procedural Transparency in the Adjudication of Administrative Offenses // Bulletin of Legal Sciences. – Tashkent, 2022. – No. 4. – P. 34-39.

[10] Ismailov I., Ziyodullayev M.Z. The Role of Digital Technologies in Organizing the Victimological Prevention of Offenses // Analysis of Uzbek Legislation. – Tashkent, 2023. – No. 2. – P. 41-46.

[11] Tojibaev A.A. Information-Analytical Support for the Forecasting and Prevention of Road-Transport Incidents (Criminological and Organizational Aspects): PhD Dissertation in Law. – Tashkent, 2021.

– p. 46.

[12] Tripathi P.S.M., Kumar A., Chandra A. An Overview of Intelligent Transport System (ITS) and its Applications // Journal of Mobile Multimedia. – 2021. – Vol. 17, Issue 1-3. – P. 79-114. (DOI: 10.13052/jmm1550-4646.17134).

[13] Aldegheishem A., Yasmeen H., Maryam H. et al. Smart Road Traffic Accidents Reduction Strategy Based on Intelligent Transportation Systems (TARS) // Sensors. – 2018. – Vol. 18, Issue 7. – P. 2091-2105. (DOI: 10.3390/s18072091).

[14] Ahmed M. M. Evaluating the Safety Impacts of Variable Speed Limits (VSL) and Driver Behavior using Big Data Analytics // Journal of Transportation Engineering / Accident Analysis & Prevention. – 2021. – Vol. 147. – P. 112-128.

[15] Fitzharris M., Newstead S. Evaluation of Autonomous Emergency Braking Systems in Australasian Light Vehicles / Monash University Accident Research Centre (MUARC) Report. – Melbourne: Monash University, 2022. – P. 45-62.

[16] Goh M. Congestion pricing in Singapore: the Electronic Road Pricing system // Journal of Transport and Statistics. – 2002. – Vol. 5, No. 1. – P. 29-41

[17] Singapore Land Transport Authority (LTA). Next-generation Electronic Road Pricing (ERP 2.0) system and On-Board Unit (OBU) implementation guidelines. – Singapore: LTA Official Report, 2023. – P. 12-18.

[18] Zheng M. GNSS-based Road Charging Systems: Assessment of Vehicle Location Determination. Ph.D. dissertation. – Technical University of Denmark (DTU), 2020. – P. 45-52.

[19] Weikl S., Bogenberger K., Bertini R.L. Traffic Management Effects of Variable Speed Limit System on a German Autobahn // Transportation Research Record: Journal of the Transportation Research Board. – Washington, DC, 2015. – Vol. 2380. – P. 45-53.

[20] Resolution of the United Nations General Assembly “Enhancing Global Road Safety” (A/RES/74/299), adopted on August 31, 2020. – URL: https://undocs.org/ru/A/RES/74/299

[21] Global Plan for the Decade of Action for Road Safety 2021–2030. WHO and the United Nations Regional Commissions. – URL: https://www.who.int/ru/publications/i/item/9789240035140

[22] Swedish Parliament. Road Traffic Safety Bill “Vision Zero” (Prop. 1996/97:137). Stockholm, 1997. – URL: https://www.government.se/articles/2016/10/renewed-commitment-to-vision-zero

[23] ISO/TC 204 - Intelligent transport systems. Technical Committee standards and projects. International Organization for Standardization. – URL: https://www.iso.org/committee-/54706.html

[24] International Standard ISO 21217:2020 Intelligent transport systems. Station units and communication architecture. General principles. – URL: https://www.iso.org/standard/71555.html

[25] International Standard ISO 14816:2005 Telematics for road transport and traffic. Automatic identification of vehicles and equipment. Numbering and data structure. – URL: https://www.iso.org/standard-/38154.html

[26] Law of the Republic of Uzbekistan No. 348-I “On Road Traffic Safety” of April 10, 2013 // https://lex.uz/docs/2153434.

[27] Note: LiDAR (Light Detection and Ranging) is a technology that uses laser beams to measure distance and create three-dimensional (3D) models of objects. In the context of intelligent transportation systems and autonomous driving, this technology serves as the vehicle's “eyes.”