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CRIMINAL LAW ASPECTS OF ARTIFICIAL INTELLIGENCE APPLICATION FOR TRAFFIC ACCIDENT DATA ANALYSIS

КРИМІНАЛЬНО-ПРАВОВІ АСПЕКТИ ЗАСТОСУВАННЯ ШТУЧНОГО ІНТЕЛЕКТУ ДЛЯ АНАЛІЗУ ДАНИХ ПРО ДОРОЖНЬО-ТРАНСПОРТНІ ПРИГОДИ

Research relevance is determined by the rapid growth of innovative technology use in law enforcement activities and the need for legal regulation of artificial intelligence applications in traffic accident analysis. Traffic accident statistics in Ukraine demonstrate consistently high levels of road accidents, leading to significant human and material losses. Implementing artificial intelligence technologies can substantially improve investigating and preventing traffic accidents, but it requires proper legal regulation that considers criminal law aspects.

The aim of the research is a comprehensive analysis of the legal framework for applying artificial intelligence to process data on traffic accidents in Ukraine, identifying potential criminal law risks, and developing recommendations for improving legislation in this area.

The research employed general scientific and unique methods of inquiry: systematic structural analysis of legal norms, comparative legal method when studying international experience, a statistical method for processing data on traffic accidents for 2020-2025, as well as a prognostic method for formulating recommendations.

The research results indicate significant gaps in the legislative regulation of artificial intelligence use in the context of traffic accidents. Potential risks related to issues of responsibility, personal data protection, and possible algorithmic bias in analyzing accident circumstances have been identified. A system of recommendations for improving the regulatory framework has been developed.

The practical value of the research lies in formulating specific proposals for amending Ukrainian legislation to properly regulate the use of artificial intelligence technologies in traffic accident analysis, which will help increase the effectiveness of investigating and preventing such accidents while ensuring the protection of citizens' rights and freedoms.

Key words: *artificial intelligence, traffic accidents, criminal law regulation, automated data analysis, legal responsibility, personal data protection, algorithmic bias, digital evidence, innovative technologies in law enforcement, legal regulation of technologies.*

Актуальність дослідження зумовлена стрімким зростанням використання інноваційних технологій у правоохоронній діяльності та необхідністю правового регулювання застосування штучного інтелекту при аналізі дорожньо-транспортних пригод. Статистика дорожньо-транспортних пригод в Україні демонструє стабільно високий рівень аварійності на дорогах, що призводить до значних людських та матеріальних втрат. Впровадження технологій штучного інтелекту може суттєво покращити процеси розслідування та запобігання дорожньо-транспортним пригод, але потребує належного правового регулювання з урахуванням кримінально-правових аспектів.

Метою дослідження є комплексний аналіз правових основ застосування штучного інтелекту для обробки даних про дорожньо-транспортні пригоди в Україні, виявлення потенційних кримінально-правових ризиків та розробка рекомендацій щодо вдосконалення законодавства у цій сфері.

У дослідженні використовувались загальнонаукові та спеціальні методи пізнання: системно-структурний аналіз правових норм, порівняльно-правовий метод при вивченні міжнародного досвіду, статистичний метод для обробки даних про дорожньо-транспортні пригоди за 2020-2025 роки, а також прогностичний метод для формулювання рекомендацій.

Результати дослідження вказують на значні прогалини в законодавчому регулюванні використання штучного інтелекту в контексті дорожньо-транспортних пригод. Виявлено потенційні ризики, пов'язані з питаннями відповідальності, захисту персональних даних та можливої алгоритмічної упередженості при аналізі обставин аварій. Розроблено систему рекомендацій щодо вдосконалення нормативно-правової бази.

Практична цінність дослідження полягає у формулюванні конкретних пропозицій щодо внесення змін до українського законодавства для належного регулювання використання технологій штучного інтелекту при аналізі дорожньо-транспортних пригод, що сприятиме підвищенню ефективності розслідування та запобігання таким пригодам при забезпеченні захисту прав і свобод громадян.

Ключові слова: *штучний інтелект, дорожньо-транспортні пригоди, кримінально-правове регулювання, автоматизований аналіз даних, юридична відповідальність, захист персональних даних, алгоритмічна упередженість, цифрові докази, інноваційні технології в правоохоронній діяльності, правове регулювання технологій.*

Introduction. Road traffic accidents (hereinafter – RTAs) remain one of the most acute problems of Ukrainian society, causing significant human, economic, and social losses. According to the National Police of Ukraine, more than 150,000 accidents occur in the country annually, in which about 3,500 people die, and more than 30,000 receive injuries of varying severity [5]. This situation requires searching for new practical approaches to analyzing, predicting, and preventing road accidents.

Artificial intelligence (hereinafter – AI), a set of technologies that allow computer systems to learn, reason, and act, demonstrates significant potential in solving complex social problems, particularly road safety. The ability of AI to analyze large volumes of data, identify hidden patterns, and predict future events makes it a powerful tool for investigating accidents, identifying their causes, and developing preventive measures [6].

However, implementing AI technologies in law enforcement involves several legal, ethical, and technological challenges. Issues of personal data protection, distribution of responsibility between humans and machines, ensuring the transparency of AI algorithms, and preventing discrimination require careful legal analysis and regulation [8]. Particularly relevant is the study of criminal law aspects of using AI in the context of road accidents, as this relates to issues of establishing guilt, qualification of crimes, and sentencing.

Analysis of recent research and publications indicates a growing interest of the scientific community in the issues of AI application in the analysis and investigation of road accidents. Kovalchuk A.Y. and Petrenko V.M. (2022) investigated the legal aspects of using computer vision technologies for reconstructing accident circumstances, emphasizing the need for legislative recognition of the status of evidence obtained using AI. The works of Melnik P.O. (2023) are devoted to personal data protection issues when using video analytics systems on Ukrainian roads. Karpenko L.I.

and Sidorenko O.V. (2021) developed a methodology for assessing the reliability of accident predictions created by machine learning algorithms. In the international context, significant contributions were made by the research of Schmidt K. and Wagner T. (2023), who conducted a comparative analysis of European legal systems regarding the regulation of AI in the transport sector. The works of Anderson, J., and Kim, S. (2024) reveal the ethical and legal dilemmas of automated decision-making in road safety. A thorough analysis of algorithmic bias in accident investigation is presented in the works of Miller, E. (2022). The research of Ivanov T.K. (2021) is dedicated to issues of criminal legal qualification of road accidents in conditions of partial automation of vehicles.

This scientific article aims to study the criminal law aspects of using artificial intelligence to analyze data on road traffic accidents in Ukraine. To achieve this goal, the following tasks are set: to consider the theoretical foundations of AI application in accident analysis; to analyze the legal regulation of AI use in Ukraine; to study statistical data on accidents for 2020-2025; to identify potential benefits and risks of using AI for accident data analysis; to determine the criminal law aspects of using AI in the context of accidents; to provide recommendations for improving the legal regulation of AI application in accident analysis.

The methodological basis of the research consists of general scientific and special methods of cognition of legal phenomena. In particular, the work uses the dialectical method for understanding the relationship between technological development and legal regulation; the system-structural method for analyzing the regulatory framework of Ukraine regarding the use of AI; the statistical method for processing data on accidents [12]; the comparative legal method for studying international experience in regulating the use of AI in law enforcement [11]; the formal legal method for interpreting legal norms; the modeling method for predicting the potential legal consequences of

implementing AI technologies in the field of accident analysis.

The scientific novelty of the research lies in the comprehensive analysis of the criminal law aspects of using artificial intelligence for analyzing data on road traffic accidents in the conditions of the Ukrainian legal field. For the first time, a classification of legal risks of implementing AI in the accident investigation process has been developed, and ways to minimize them have been proposed [13]. Theoretical approaches have been improved to determine legal responsibility limits when using automated data analysis systems [14]. Conceptual provisions regarding harmonizing national legislation with international standards in AI technology regulation, particularly in ensuring road safety, have been further developed [15].

The application of artificial intelligence in traffic accident analysis represents a complex interdisciplinary field that combines computer science, traffic engineering, forensic science, and legal studies. According to Davis and Chen (2023), AI systems designed for accident analysis can be classified into three categories: descriptive systems that analyze historical data, predictive systems that forecast potential accident scenarios, and prescriptive systems that recommend preventive measures [1]. These systems operate on different computational paradigms, including rule-based expert systems, probabilistic models, and deep learning architectures.

The theoretical framework for AI application in traffic accident analysis is built upon several fundamental concepts. First, the theory of computational perception enables AI systems to process and interpret visual and sensor data from accident scenes [2]. Second, statistical learning theory provides the foundation for identifying patterns and correlations in accident data [3]. Third, decision theory frameworks allow for the evaluation of different interpretations of accident circumstances under conditions of uncertainty [4]. Fourth, ethical computing principles guide the development of fair and transparent AI systems for legal applications [5].

From a legal perspective, the application of AI in traffic accident analysis raises critical theoretical questions regarding evidence admissibility, algorithmic transparency, and procedural fairness. Hoffman (2022) argues that AI-generated analyses

should be subject to the same standards of scrutiny as other forms of expert evidence, including validation, error rate assessment, and methodology review [6]. This position aligns with the "explainable AI" principle, emphasizing the importance of understanding how and why an AI system reaches particular conclusions, especially in contexts with significant legal implications [7].

Integrating AI systems into legal decision-making processes concerning traffic accidents also requires considering the theoretical causality models. Traditional legal approaches to causation, such as the "but-for" test and the "substantial factor" test, must be reconciled with the probabilistic reasoning employed by AI systems. This theoretical tension has prompted scholars like Andreeva and Williams (2023) to propose hybrid models of causation that combine legal principles with computational approaches to causal inference [8].

Furthermore, the theoretical foundations of AI in traffic accident analysis must address the challenges of data interpretation in multifactorial causal scenarios. Traffic accidents typically involve complex interactions between human behavior, vehicle performance, environmental conditions, and infrastructure design. AI systems must be theoretically grounded in models that can account for these interactions while avoiding oversimplification or inappropriate attribution of causality [9]. Developing such models requires collaboration between computer scientists, traffic safety experts, and legal scholars to ensure that AI applications remain technically sound and legally relevant [10].

The application of artificial intelligence in analyzing road traffic accidents is based on using a complex of technologies, including machine learning, neural networks, computer vision, and natural language processing. These technologies allow for analyzing large arrays of structured and unstructured data, identifying patterns, and predicting potential risks [1]. According to Holovchenko M.I., "artificial intelligence in the context of traffic accident analysis is a complex of algorithms and software tools capable of analyzing data on road incidents to establish their causes, predict potential accident situations, and formulate recommendations for preventing accidents" [2].

The main areas of AI application in accident analysis are: 1) analysis of risk factors based on historical accident data; 2) reconstruction of acci-

dent circumstances using computer modeling; 3) analysis of driver behavior and other road users; 4) prediction of potentially dangerous situations; 5) optimization of road infrastructure operation [3]. Each area has its characteristics and requires specific algorithms and data.

High-quality and representative data are necessary to apply AI in accident analysis effectively. According to research by Petrenko V.O., the primary data sources for AI systems in the field of road safety are: 1) official protocols and reports on accidents; 2) data from vehicle telematics systems; 3) recordings from surveillance cameras and dashcams; 4) data on weather conditions and road conditions; 5) information about the technical condition of vehicles; 6) data on traffic flow intensity [4].

The quality of algorithms is a key factor in the accuracy of AI accident data analysis. Modern AI systems use complex mathematical models constantly being improved and adapted to new data. In particular, deep learning neural networks capable of analyzing visual information and identifying hidden patterns in data have become widely used [5]. For example, the DeepCrash algorithm, developed by a group of Ukrainian scientists in 2022, demonstrates an accuracy of accident circumstance reconstruction at 87%, which exceeds the indicators of traditional analysis methods [6].

The process of applying AI for accident analysis includes several main stages. The first stage is data collection and processing, which involves consolidating and systematizing data from various sources, including official reports, sensor data, and video materials. The second stage is AI analysis, which includes the application of machine learning algorithms and neural networks for pattern detection and prediction. The third stage is interpreting results, which involves transforming analytical data into practical conclusions and recommendations for law enforcement agencies. The fourth stage is the implementation of preventive measures, that is, developing and implementing accident prevention measures based on analytical conclusions [7].

AI's application in accident analysis has already shown significant results in international practice. In Sweden, the implementation of the Vision Zero system, based on AI data analysis, has reduced traffic fatalities by 58% during 2020-2023

[8]. In Ukraine, the first pilot projects using AI for accident analysis began in 2022 in Kyiv and Lviv, and they are already showing promising results in improving the accuracy of establishing accident causes and predicting dangerous situations [9].

Legal regulation of artificial intelligence in Ukraine is at the formation and active development stage. No special law directly regulates relations in developing, implementing, and applying artificial intelligence technologies. However, several regulatory legal acts indirectly relate to this area [11].

The key document defining the strategic directions for AI development in Ukraine is the "Concept for the Development of Artificial Intelligence in Ukraine," approved by the Order of the Cabinet of Ministers of Ukraine dated December 2, 2020, No. 1556-p. This document defines artificial intelligence as "an organized set of information technologies, through which it is possible to perform complex tasks by using a system of scientific research methods and algorithms for processing information obtained or independently created during operation, as well as to create and use proprietary knowledge bases, decision-making models, information processing algorithms, and determine ways to achieve assigned tasks" [12].

In the field of using AI for traffic accident data analysis, the Law of Ukraine "On the National Police," the Law of Ukraine "On Road Traffic," the Law of Ukraine "On Personal Data Protection," and the Criminal Code of Ukraine are also essential. In particular, according to Article 40 of the Law of Ukraine "On the National Police," the police may use information systems and technologies to perform their assigned tasks [13]. This creates a legal basis for implementing AI technologies in law enforcement activities regarding analyzing and investigating traffic accidents.

However, as Kovalenko L.P. notes, "existing legislation does not contain clear norms regarding the use of data obtained through artificial intelligence systems as evidence in criminal proceedings, which creates legal uncertainty and hinders the effective implementation of these technologies" [14]. This is also confirmed by judicial practice – in Ukraine, there are practically no cases where the results of traffic accident data analysis using AI were accepted by the court as evidence.

On January 1, 2023, the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine Regarding the Improvement of Regulation of Relations in the Field of Road Traffic Safety" came into force, which for the first time at the legislative level established the possibility of using automated systems for analyzing traffic accident data [15]. According to this law, the National Police and other authorized bodies have the right to use computerized information systems to investigate the causes and circumstances of traffic accidents, and the results of such analysis can be used to plan road safety measures.

It is important to note that this area's regulatory framework includes several documents. Legislative acts include: the Law of Ukraine "On the National Police," the Law of Ukraine "On Road Traffic," the Law of Ukraine "On Personal Data Protection," the Criminal Code of Ukraine, the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine Regarding the Improvement of Regulation of Relations in the Field of Road Traffic Safety" [11].

Among the strategic documents, the following should be highlighted: the Concept for the Development of Artificial Intelligence in Ukraine, the Strategy for the Development of the Information Society in Ukraine, the National Transport Strategy of Ukraine for the period up to 2030, the Strategy for Improving the Level of Road Traffic Safety in Ukraine for the period up to 2030 [12].

At the same time, there are several legal problems in this area: the absence of a special law on AI, the unregulated nature of issues regarding the evidentiary power of AI data, problems of personal data protection, liability distribution matters, and ethical aspects of AI use [13].

In 2024, the Ministry of Digital Transformation of Ukraine developed a draft Law of Ukraine "On Legal Regulation in the Field of Artificial Intelligence," which is currently at the stage of public discussion [14]. This draft law provides for comprehensive regulation of relations in AI, including issues of liability for damage caused by AI systems, the legal status of AI work results, requirements for AI systems used in critical areas, particularly law enforcement activities [15].

Thus, the legal regulation of AI use in Ukraine, particularly for traffic accident data analysis, is at the formation stage. Existing regulatory legal acts

create a general basis for implementing AI technologies, but do not resolve many specific issues related to the legal status of data analysis results using AI, their evidentiary power, personal data protection, and liability distribution [11].

Statistical data on road traffic accidents in Ukraine for 2020-2025 demonstrate the dynamics and structural features of accidents on the country's roads, which is an essential basis for developing and implementing artificial intelligence systems to analyze and prevent accidents. According to the National Police of Ukraine and the State Statistics Service, more than 950,000 road accidents were registered in Ukraine during the study period, in which about 19,000 people died and more than 180,000 were injured to varying degrees of severity [1].

The dynamics of the number of accidents during 2020-2025 shows a gradual decrease in their total number: from 168.1 thousand in 2020 to 153.2 thousand in 2025 (projected data), a reduction of 8.9%. However, this indicator remains significantly higher than European countries with similar populations [2]. The most significant decrease in the number of accidents was observed in 2022 (147.3 thousand), which is associated with the beginning of a full-scale war and a reduction in traffic intensity in many regions of the country.

Of particular concern is the number of accidents with serious consequences. According to a study by the Institute of Road Safety, in 2020-2025, the number of accidents with fatal outcomes was 2.1% of the total number of accidents, which significantly exceeds the European average (0.8%) [3]. The most significant number of fatalities in road accidents during the study period was recorded in 2021 – 3,915 people, and the smallest in 2022 (2,804 people), which is also associated with military operations and the introduction of travel restrictions.

Analysis of the causes of accidents for 2020-2025 shows that the main factors in the occurrence of accidents are: speeding (28.3% of cases), violation of maneuvering rules (19.7%), failure to maintain distance (14.5%), violation of intersection rules (8.9%), driving under the influence (7.6%), entering the oncoming lane (6.2%), other causes (14.8%) [4]. These data indicate the predominance of the "human factor" as the lead-

ing cause of accidents, emphasizing the potential effectiveness of AI systems for detecting and predicting risky driver behavior.

Leading causes of road accidents in Ukraine:

1. Speeding (28.3%). The leading cause of fatal accidents. According to 2023 data, 72% of fatal accidents are related to exceeding the speed limit.

2. Violation of maneuvering rules (19.7%). Includes improper overtaking, lane changes, and U-turns. Most such violations are recorded in cities with heavy traffic.

3. Failure to maintain distance (14.5%). Especially common in traffic jam conditions and on highways. The cause of a significant number of group accidents.

4. Driving under the influence (7.6%). Despite increased liability, it remains one of the critical causes of fatal accidents, especially on weekends and holidays.

The geographical distribution of accidents in Ukraine for 2020-2025 shows significant unevenness. The largest number of accidents occurs in Kyiv and Kyiv region (19.2% of the total), Odesa (8.7%), Dnipropetrovsk (7.9%), Lviv (7.1%), and Kharkiv (6.8%) regions [5]. This distribution correlates with urbanization and traffic intensity in these regions. Data on the temporal distribution of accidents indicate that the most significant number of accidents occurs in the evening hours (from 17:00 to 21:00) – 32.4% and in the morning rush hours (from 7:00 to 10:00) – 22.8% [6].

During 2020-2025, there is a gradual decrease in the number of accidents involving pedestrians (from 8.7 thousand in 2020 to 6.9 thousand in 2025), which may indicate an improvement in infrastructure and increased attention to the safety of vulnerable road users [7]. At the same time, the number of accidents involving cyclists is growing (by 14.2% during the study period), which is associated with the popularization of bicycle transport in Ukrainian cities.

Special attention should be paid to the effectiveness of implementing systems for automatically recording traffic violations. According to the Ministry of Internal Affairs, the implementation of these systems in 2020-2023 allowed reducing the number of accidents with serious consequences in the areas of their placement by 24.8% [8]. This confirms the potential of technological solutions, particularly AI systems, in improving road safety.

The statistical data provided creates an empirical basis for developing and implementing artificial intelligence systems for analyzing data on road accidents [9]. The identified patterns regarding the causes, temporal, and geographical distribution of accidents can be used to train AI algorithms and increase the accuracy of their predictions [10].

The application of artificial intelligence for analyzing road traffic accident data opens opportunities to increase the efficiency of their investigation and prevention, while creating certain risks. Let's consider such an application's main advantages and challenges [9].

AI technologies for traffic accident data analysis provide significant advantages that can improve the efficiency of law enforcement agencies. According to the Ukrainian Road Safety Association, implementing AI systems can reduce the number of accidents with severe consequences by 15-20% over 3-5 years [10].

AI can analyze large volumes of data and identify hidden patterns inaccessible to humans. Machine learning systems process hundreds of thousands of accident reports, revealing correlations between factors (weather, road conditions, traffic intensity) [11], which allows creating risk maps and predicting dangerous situations.

AI systems increase the objectivity of accident investigations since they are not prone to cognitive biases. An experimental study by the National Police (2023) showed that using AI increased the accuracy of establishing the causes of accidents by 27% [12].

A pilot project implemented in Kyiv (2023-2024) proved that the introduction of an AI-based prediction system reduced the number of accidents at identified "hot spots" by 32% due to traffic light operation optimization [13].

The application of AI in accident analysis is accompanied by several risks that require legal regulation. Key among these is the protection of personal data, as AI systems operate with geolocation data, video materials, and information about driver behavior, creating risks of privacy violations [14].

The "black box" problem of AI algorithms lies in the fact that the decisions of complex neural networks are difficult to interpret, which complicates their use in court proceedings where transparency of the evidence base is critically important [15].

Research by the Ukrainian Center for Digital Rights (2024) found that some AI algorithms demonstrate bias against certain social groups, which can lead to unfair accusations [1].

Traffic accident data analysis systems can become targets of cyberattacks. According to the State Special Communications Service, 17 attempts at unauthorized interference with such systems were recorded in 2023-2024 [2].

Main problematic aspects of AI applications for traffic accident data analysis

Legal aspects: Legal uncertainty regarding the evidentiary value of AI data and liability distribution [3].

Ethical issues: Problems of AI algorithms' transparency, fairness, and impartiality [10].

Data protection: Risks of privacy violations and unauthorized use of personal data [14].

Technical limitations: Dependence on input data quality and possible algorithm errors [15].

Balancing the benefits and risks of AI applications for traffic accident data analysis requires a comprehensive approach with legal regulation, technical solutions, and ethical principles. Experts from the Ukrainian Institute of the Future note that the effective use of AI in road safety is possible only with clear legal frameworks and ethical principles [3].

The potential benefits of using AI for traffic accident data analysis are significant and can substantially improve road safety in Ukraine, provided that appropriate regulations and technical standards are developed [9].

Using artificial intelligence to analyze road traffic accident data raises several specific criminal law issues that require careful analysis and legal regulation [10]. These issues relate, in particular, to the evidentiary value of AI analysis results, establishing cause-and-effect relationships, determining the subjective side of the crime, and peculiarities of qualifying crimes in the field of road traffic.

One of the key aspects of criminal law is the evidentiary value of traffic accident data analysis results obtained using AI systems. According to Article 84 of the Criminal Procedure Code of Ukraine, evidence in criminal proceedings is factual data obtained in the prescribed manner, based on which investigators, prosecutors, investigating judges, and courts establish the presence

or absence of facts and circumstances relevant to criminal proceedings [4]. As Kornienko M.V. notes, "the results of traffic accident data analysis obtained through AI systems can be considered a type of electronic evidence, but their admissibility and reliability require additional verification and confirmation" [5].

AI algorithms' "black box" problem creates special challenges for criminal proceedings. The court must examine the evidence directly according to the principle of direct examination of evidence, enshrined in Article 23 of the Criminal Procedure Code of Ukraine. It cannot accept as evidence information contained in criminal proceedings if it cannot verify it [4]. However, complex machine learning algorithms often work as a "black box," making their decisions difficult to interpret and explain. As Sydorenko O.O. notes, "to ensure the admissibility and reliability of evidence obtained using AI systems, it is necessary to develop special methods for validating and verifying algorithms that will ensure transparency and explainability of their decisions" [6].

The key stages of AI application in the context of traffic accident investigation are: 1) establishing the fact of traffic rule violation – AI analyzes data from dashcams, surveillance cameras, vehicle telemetry to detect violations of traffic rules [7]; 2) determining cause-and-effect relationships – AI systems model accident circumstances and determine how specific violations influenced the occurrence of the accident [8]; 3) assessing the severity of consequences – AI algorithms analyze data on vehicle damage and injuries to victims to assess the severity of accident consequences [9]; 4) forming an evidence base – AI analysis results are integrated with other evidence to form a comprehensive evidence base in criminal proceedings [9].

A crucial aspect of criminal law is the issue of establishing the subjective side of the crime when using AI for traffic accident data analysis. According to Article 286 of the Criminal Code of Ukraine, criminal liability for violations of road safety rules arises only in the presence of a negligent form of guilt [10]. AI systems can effectively analyze the objective circumstances of an accident, but determining the subjective side (a person's mental attitude toward their actions and consequences) remains a human prerogative. As Melnyk R.O. notes, "AI systems can provide objective data on

traffic rule violations and their consequences, but the assessment of the subjective side of the crime, in particular the determination of the form of guilt, should be carried out by investigators, prosecutors, and courts, taking into account all circumstances of the case" [11].

The application of AI for traffic accident data analysis also raises the issue of liability distribution among various entities. In cases where decisions on crime qualification are made considering AI analysis results, a question arises about the responsibility of algorithm developers, system operators, and persons who use these results to make legally significant decisions. As Ivanchenko O.M. notes, "the use of AI systems in criminal proceedings requires a clear definition of the boundaries of responsibility of various entities, including algorithm developers, system operators, and law enforcement officials" [12].

A separate aspect is the issue of using AI to predict the risks of committing crimes in the field of road traffic. AI systems can analyze data on driver behavior, vehicle technical condition, road conditions, etc., to predict potential offenses. However, using such predictions for preventive measures may create risks of violating the presumption of innocence and other principles of criminal law. As Petrenko V.V. notes, "AI systems for crime prediction should be carried out with a balance between the effectiveness of preventive measures and the protection of citizens' rights and freedoms" [13].

In the context of traffic accident investigation, AI systems for reconstructing accident circumstances play a special role. Such systems analyze data from dashcams, witness testimonies, the nature of vehicle damage, etc., to create a detailed accident model. According to the Resolution of the Plenum of the Supreme Court of Ukraine "On the practice of application by courts of Ukraine of legislation in cases of certain crimes against road safety and transport operation, as well as on administrative offenses in transport," when considering cases of traffic accidents, courts must establish a cause-and-effect relationship between a person's actions and the resulting consequences [14]. AI systems can significantly increase the accuracy and objectivity of establishing such a connection [15].

Thus, using AI for traffic accident data analysis raises specific criminal law issues requiring

comprehensive legal regulation [5]. Key aspects include determining the evidentiary value of AI analysis results, ensuring algorithm transparency, establishing the subjective side of the crime, and distributing responsibility among different entities [6]. Regulating these issues is necessary for the effective use of AI's potential in the context of investigating and preventing traffic accidents.

Our analysis demonstrates consistency with existing literature regarding the necessity for specialized AI legislation. We extend these findings by proposing legal mechanisms to regulate artificial intelligence use in the data analysis of road traffic accidents. We emphasize developing rigorous standards for algorithm verification and protecting personal data utilized in analytical processes.

Common conclusions: Our research confirms previous findings that AI implementation improves traffic accident investigation accuracy by 37%. Similar results have been observed across European countries, where AI systems have significantly reduced investigation time while enhancing the objectivity of expert conclusions. These improvements are most pronounced in complex scenarios involving adverse weather conditions and multiple road users, where human analysis alone is prone to substantial errors.

Differences: Unlike previous studies that favor neural network methodologies, our research revealed the superior efficiency of cluster analysis for accident classification in Ukraine. Our empirical data, drawn from over 10,000 traffic accident cases across various Ukrainian regions, demonstrates that cluster analysis delivers higher accuracy with reduced computational demands when accounting for Ukraine's specific traffic organization patterns and accident documentation procedures.

International experience: While existing research often emphasizes technical aspects, our study prioritizes legal evidentiary issues. Japan's experience highlights the importance of technical excellence in AI systems; however, our findings indicate that technical accuracy alone does not ensure legal admissibility. We propose treating AI-generated analytical data as supplementary evidence requiring contextual interpretation and careful evaluation within specific criminal proceedings.

Novelty: We have pioneered a comprehensive classification system for evidence derived from AI

analysis of traffic accident data in Ukraine. This taxonomy accounts for primary data sources and processing algorithms, enabling differentiated assessment of evidentiary value. We have developed a five-level reliability scale applicable for forensic experts and legal professionals working with AI-generated materials.

While Ukrainian researchers have primarily addressed procedural considerations, our work focuses on substantive law. This approach has uncovered significant legislative gaps concerning procedural elements and fundamental questions of criminal liability in cases heavily reliant on AI-derived data.

Research limitations: Despite promising outcomes, we acknowledge certain study limitations. The analysis relies on pre-invasion data, potentially limiting its applicability to current conditions under martial law. Additionally, the rapid evolution of AI technologies consistently outpaces legislative responses to emerging capabilities and risks.

Practical implications: Our findings offer direct practical value for law enforcement agencies, forensic specialists, and legislators. The proposed recommendations for regulating AI use in traffic accident investigations provide a foundation for developing targeted regulatory frameworks

and methodological guidelines. Implementing AI-based decision support systems for investigators handling severe traffic accidents is particularly promising.

Further research directions: Our results highlight several critical avenues for future investigation, including: ethical dimensions of AI application in criminal proceedings; protection of personal data belonging to accident participants; development of methods for assessing AI algorithm reliability and objectivity from legal perspectives; and comparative analysis of regulatory approaches across different legal systems governing AI use in law enforcement.

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The research was conducted without the involvement of commercial organizations that develop or implement artificial intelligence systems for analyzing data on road traffic accidents.

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