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INNOVATIVE APPROACHES AND INFORMATION TECHNOLOGIES IN FORENSIC SCIENCE ACTIVITIES

Prevention of crime is becoming one of the most important tasks for the authorities implementing preventive measures in Ukraine. The purpose of this article is to improve crime prevention measures in the context of digitalisation of social processes. The tasks of the article are to determine the current state and prospects of forensic institutions' activities in crime prevention with the use of information technology. Forensic institutions are distinguished by their special competence among the crime prevention actors in Ukraine. The preventive activities of employees of these institutions, which are carried out at the request of the authorized bodies during the consideration of criminal proceedings, or on their own initiative on the basis of regulatory legal acts, are an important element in crime prevention. The article also identifies the areas of use of artificial intelligence in law enforcement activities involving forensic experts. This includes the analysis of satellite images to identify changes in the landscape that may be related to war crimes and the identification of victims' graves, the analysis of video and photo materials to identify objects, suspects and witnesses, the processing of audio materials to identify voices and determine the location of callers during a conversation. The authors also consider the analysis of social networks to identify links between suspects and witnesses to war crimes, analysis of data from medical institutions to determine the causes of death and identify prisoners of war and war criminals from medical records, as well as analysis of textual information and other methods. The authors note that the most

promising area of preventive activities of forensic institutions in Ukraine and the world is the introduction of Forensic Artificial Intelligence (FAI). By integrating artificial intelligence, forensic institutions can increase the efficiency of investigations and reduce the risk of subjective errors. The implementation of these measures in the activities of forensic institutions will help to increase the effectiveness of crime prevention in the context of modern digital technologies and strengthen law and order in Ukraine.

Keywords: *criminology, crime prevention, forensic examination, information techniques, crime research, innovation, artificial intelligence, cybersecurity, Forensic Artificial Intelligence (FAI).*

Statement of the problem. Crime is one of the most serious negative phenomena affecting all aspects of public life. Its development is conditioned by many factors: historical, social, political, economic and cultural peculiarities inherent in a particular society. It not only causes significant damage to interpersonal relations, but also creates obstacles to the normal functioning of state institutions and public structures.

Crime, dynamically changing and adapting to new conditions, increases its ability to cause harm, which requires special attention to preventive measures. In today's environment, this requires not only a prompt response to crime, but also a comprehensive state approach.

From the object-functional point of view, combating crime covers three areas of social relations:

1) general organisation – a set of organisational, managerial, preventive, control and other actions of various institutions that interact to achieve common results in combating crime;

2) law enforcement activity – a system of measures for the implementation of law enforcement and/or law enforcement functions by state bodies, public organisations or citizens;

3) crime prevention is the implementation by special subjects of the means of influence provided for by law in order to prevent the development of criminal unlawful intent at the preliminary stages of a criminal offence, to identify the causes and conditions of criminal offences' [1, p. 158].

According to scholars, directly or indirectly, crime is counteracted by all parts of the state and social system. Therefore, representative bodies, executive authorities and courts, the whole range of enterprises, institutions and organisations operating in various spheres of social life, public associations and individual citizens are involved in combating crime. Thus, in general terms, the system of combating crime includes bodies and organisations that determine the main directions, tasks, forms and methods of combating crime in the country; provide information and analytical support for combating crime; identify and signal criminogenic factors; directly implement measures to respond to individual criminal offences, as well as measures to eliminate, weaken or neutralise criminogenic factors, including correction of personal deformations and elimination of circumstances that form them. Thus, depending on the goals and objectives, as well as the functional responsibilities of the actors involved in combating crime, they can be divided into 'two groups – actors operating at the general social level and specialised actors. The latter include state bodies specially created to counteract crime, as well as bodies that operate outside the criminal justice system' [3, p. 83].

The subject of counteraction is characterised by occupying one of the leading positions compared to others in the system of combating crime, as well as by the decisive role of preventive measures taken by it in a comprehensive targeted impact on criminogenic factors of crime. In this regard, it should be noted that a special place in the unified system of subjects of targeted impact on criminogenic factors of crime is occupied by forensic institutions of Ukraine.

It is fair to say that, in general, a forensic expert or expert (specialist) is a person who is not interested in the outcome of the proceedings and who professionally possesses the special knowledge, skills and practical knowledge necessary to solve forensic tasks.

This 'subject of procedural relations, who has no and should not have an interest, is involved in the case to assist the court in the objective investigation of the circumstances of the case and thereby ensure that the court achieves its main goal – to protect the violated, unrecognised or disputed rights or interests of persons' [4, p. 2].

It is also worth noting that in the course of forensic activities, forensic science units

(hereinafter referred to as FSU), as well as individual specialists with appropriate professional training, receive certain powers in the field of crime prevention. Their role in this process is related not only to conducting examinations, but also to the ability to influence illegal actions at early stages, such as the formation of intent, preparation or attempted commission of a crime. In other words, forensic activities are preventive in nature, as the results of expert research and their analysis can help identify potential threats and criminal intentions before they are implemented. Thus, forensic experts become important participants in the crime prevention process, integrating into the overall crime prevention system.

Forensic expert activity not only strengthens the evidence base in criminal proceedings, but also provides additional mechanisms for monitoring compliance with the law, which helps to reduce the risk of crime. Integration of forensic instruments into a comprehensive crime prevention strategy is an important step towards strengthening law and order and security in society.

Analysis of research and publications. M. Karchevskyi, I. Fedchak, A. Babenko, O. Korystin, V. Obolentsev and other experts paid attention to the theoretical foundations of the use of information methods of crime research and prevention [5]. In his work, O. Fedorov [7] proposed options for the use of information methods for studying crime in criminological forecasting. Investigating the essence of social and ethical requirements for the use of information and communication technologies and artificial intelligence in the life of a modern person, society and the state, N. Filipenko, S. Lukashevych, O. Andreeva and K. Salaeva [8] note that the use of artificial intelligence requires special legal regulation, since it is about human life and health, even if it is about innovative approaches and information technologies for preventing and solving crimes. V. Strukov and Y. Hnusov have studied software products ('analytical tools') for data retrieval, analysis and visualisation of results based on 'artificial intelligence' [9, p. 64] RICAS [10], Shotspotter [11], Palantir Gotham [12], etc. Such scholars as S. Matuilen, V. Shevchuk, and J. Baltrunene have studied the current problems of using artificial intelligence technologies in the activities of law enforcement agencies under martial law, identified the main problems and prospects of forensic research and the use of artificial intelligence through the prism of European integration processes, and highlighted the gaps in the legal regulation of the digital technology sector [13].

Earlier, in our works [14; 15], we also considered a set of theoretical and practical issues of criminological activities of forensic institutions of Ukraine. Using various methods of scientific knowledge, we conducted a phenomenological, praxeological, historical, functional and structural analysis of the system of expert institutions, and investigated the current problems of using advanced technologies in their activities.

The aim of the article is to analyse and identify the most effective areas of artificial intelligence use in law enforcement activities involving forensic experts based on the latest research of modern Ukrainian and foreign scholars.

Summary of the main material. Criminologists note that 'the object of preventive influence is a negative phenomena of a material and spiritual nature which, interacting with the personality traits, lead to the emergence of criminal motivation, intent, decision-making to commit a crime and its implementation. In recent decades, due to the development of information technologies, more and more so-called 'virtual' objects of preventive influence have appeared. Identification and clarification of such objects with the help of expert research requires further study both at the theoretical and procedural and applied levels. Such an approach will enrich not only expert activity as such, but also the theory and practice of preventing and combating crime at all levels – general social, special criminological, individual, etc.' [14, p. 231].

Crime prevention is defined by experts in both scientific and educational literature as 'activities aimed at overcoming criminogenic and harmful contradictions in social relations in order to resolve them and gradually eliminate them (the so-called general social prevention), as well as counteracting the implementation of criminal manifestations at different stages (special criminological prevention)' [16, p. 16;] or as 'a set of various activities and measures in the state aimed at improving social relations in order to eliminate negative phenomena

and processes that generate or contribute to crime, as well as preventing the commission of crimes at different stages of criminal behaviour' [17, p. 156].

General social measures of crime prevention mean 'overcoming or limiting criminogenically dangerous contradictions in society, gradual eradication of negative phenomena created by political, economic, psychological, ideological, international and other factors of criminogenic potential in society' [16, p. 19]. The objects of general social measures to prevent criminal activity are unemployment, decline in morality, prostitution, drug addiction, alcoholism, homelessness, criminal attitudes of the population, shortcomings in regulatory regulation, and social conflict.

Special criminological crime prevention is considered to be 'the practice of implementing methods of active influence on phenomena and processes that cause or may cause activation of the criminogenic potential of society in the form of criminal manifestations, as well as anticipation of their implementation at different stages of criminal behaviour' [16, p. 21]. That is why the object of special criminological crime prevention includes two key components. Firstly, these are criminogenic phenomena and processes that can manifest themselves at the pre-criminal stage or directly during criminal activity. Secondly, it includes social values that are threatened by criminal acts. The effectiveness of crime prevention measures depends on the following factors:

– Understanding the essence of the object of preventive influence: it is necessary to take into account the nature of criminogenic processes, as well as the specifics of social values to be protected.

– Competence of the subjects of preventive activity: determination of clear powers and coordinated interaction of bodies responsible for preventive activity.

– Methods of crime prevention: implementation of modern, scientifically based instruments of influence that take into account the specifics of the object of prevention and the capabilities of the actors.

Thus, a systematic approach to crime prevention should be based on the relationship between the object, subject and methods of preventive influence, which allows to achieve the maximum level of efficiency in combating crime.

In recent decades, humanity has witnessed significant changes in crime prevention driven by the development of information technology. In particular, there are more and more 'virtual' objects of preventive influence that are characterised by a specific nature. We are talking about cybercrime and other unlawful acts, the object of which is information of particular value in the modern digital society.

Cybercrime covers a wide range of offences, including unauthorised access to information systems; data theft; distribution of malicious software; cyberbullying, fraud and other forms of abuse in the virtual space. These crimes not only cause material damage but also violate fundamental human rights, such as the right to privacy and security. In this regard, information as an object of preventive influence requires a special approach to its protection, based on innovative technological, organisational and legal mechanisms. And it is not surprising that at the 'state level, special attention is paid to cybersecurity, which determines the protection of the vital interests of a person and citizen, society and the state when using cyberspace, when sustainable development of the information society and digital communication environment, timely detection, prevention and neutralisation of real and potential threats to the national security of Ukraine in cyberspace are ensured' [18].

It is noteworthy that our country is implementing the Implementation Plan of the Cybersecurity Strategy of Ukraine [19], which provides for the development of a system of cybersecurity indicators, the creation of units with the authority to conduct armed confrontation in cyberspace, effective counteraction to intelligence and subversive activities in cyberspace and cyberterrorism, strengthening the technological and human resources of law enforcement agencies to prevent and investigate cybercrime, and ensuring the security of digital services.

The subjects of crime prevention are 'state bodies, public organisations, private institutions, social groups, officials, and individuals who direct their activities to the development and implementation of measures related to the prevention, limitation, and elimination of criminogenic phenomena and processes that generate crimes, as well as to their prevention at various stages of criminal behaviour,

and in this regard have rights and exercise responsibilities' [16, p. 62].

As N. Filipenko notes, 'among the domestic subjects of crime prevention, forensic institutions of Ukraine have always stood out for their special competence' [3, p. 87]. She also emphasises that 'expert activity in relation to crime prevention can be defined as the preventive work of employees of expert institutions during the consideration of civil, administrative or criminal proceedings, or on their own initiative on the basis of relevant regulations' [3, p. 180]. We also cannot but agree with the researcher that 'the main tasks of expert prevention of these specialised subjects of crime prevention are the development and improvement of methods for identifying the causes and conditions of criminal offences; studying the features of typical results of expert research, providing proposals and recommendations for the prevention of criminal offences on their basis; determining measures to protect objects from criminal attacks; developing measures to prevent criminal offences' [3, p. 100]. Specialists note, that "*almost every branch of science got its forensic dimension. In judicial proceedings, there was a need to engage forensic experts of various specializations, who apply modern, specific and sophisticated methods in their work*" [20, c. 26].

Due to the rapid 'digitalisation' of criminal offences, the preventive activities of forensic institutions in Ukraine are gaining new importance, focusing on ensuring effective counteraction to cybercrime. In particular, the role of such aspects as:

1) Digital forensics: experts focus on investigating digital traces, analysing data from devices, identifying and documenting facts of unauthorised access to information systems.

2) Development of innovative forensic research methods: introduction of modern technologies for analysing information flows, malware, and tracking cybercriminals.

3) Legal support: improvement of the legal framework governing the use of digital evidence and providing forensic institutions with clear powers in the field of cybercrime.

4) Education and training: training experts who specialise in digital technologies and have the necessary knowledge to analyse the latest threats.

More and more attention is being paid to the development of techniques to detect, document and evaluate digital traces of crimes related to cyberspace violations. This is becoming a key component of crime prevention, adapting traditional approaches to the requirements of the modern information society.

In this regard, computer and technical expertise (CTE) is becoming increasingly important. The main task of experts during its implementation is to 'answer questions requiring specialised knowledge in the field of forensics (computer forensics) – knowledge of methods of searching, securing and examining digital evidence in crimes related to computer information (cybercrime). CTE makes it possible to form a holistic evidence base by addressing diagnostic and identification issues, i.e. solving tasks related to the search, detection, evaluation and analysis of information contained in a computer system. As a result of the CTE, which is conducted during the investigation of crimes related to information security breaches, information is generated about the vulnerability of information processing processes in information systems' [21, p. 171].

Obviously, in the preventive activities of expert institutions, information methods of 'artificial intelligence' will be increasingly used. We agree with the opinion of scientists that 'artificial intelligence in forensic science can be applied to process and analyse large amounts of data, and the emphasis is on data interpretation. Artificial intelligence helps to overcome the shortcomings of forensic investigation and human error, but primarily in improving, speeding up and facilitating the investigation' [22; 23].

The Concept for the Development of Artificial Intelligence in Ukraine [24] defines this resource as 'an organised set of information technologies that can be used to perform complex tasks by using a system of scientific research methods and algorithms for processing information received or independently created during work, as well as to create and use its own knowledge bases, decision-making models, algorithms for working with information and determine ways to achieve the tasks set'.

Artificial intelligence technologies are increasingly influencing various spheres of public life, determining not only the level

of opportunities but also the degree of protection of social values' [25, p. 1085].

In the functional aspect, artificial intelligence is a technology for processing information using software. In fact, it is 'a data processing system formed by interconnected elementary computing nodes and having the ability to accumulate experimental knowledge, generalise it and make it available to the user in a form convenient for interpretation and decision-making' [26].

Modern research opens up wide possibilities for the use of artificial intelligence in law enforcement and preventive measures, especially with the participation of forensic experts. The main areas of application include:

1. Satellite image analysis: the use of artificial intelligence to detect changes in the landscape that may indicate war crimes (e.g., identifying mass graves). This allows for the rapid identification of areas for investigation.

2. Analysis of video and photo materials: recognition of objects, persons, suspects or witnesses using face recognition algorithms and automatic detection of details in the images. This greatly speeds up the identification of criminals.

3. Processing of audio materials: the use of technologies for voice recognition, analysis of the tone of conversations, and location of participants based on acoustic data.

4. Social media analysis: automating the process of identifying connections between suspects, witnesses or victims. This is particularly useful for identifying criminal groups or individuals involved in war crimes.

5. Working with medical data: analysing medical records to determine the cause of death, identify prisoners of war or criminals. Artificial intelligence helps to systemise and quickly process large amounts of information from medical institutions.

6. Textual information processing: the use of machine learning algorithms to analyse documents, reports, or messages to automate the search for important evidence and establish links between events.

The involvement of artificial intelligence in forensic activities is an innovative approach that can significantly increase the accuracy and speed of investigations, while reducing the human factor and the risk of errors. This contributes to a more effective response to modern challenges, including cybercrime and war crimes.

That is why one of the most promising areas of AI use for crime prevention and detection is the introduction of Forensic Artificial Intelligence. '*Forensic Artificial Intelligence (FAI) would be a software system consisting of hardware and software. It would be available to the participants in the court proceedings (judges, prosecutors, lawyers) and could be 'engaged' in court hearings like all court experts hired by the court, who were chosen from the state register of court experts. The FAI hardware would be the carrier of artificial intelligence, that is, the electronic and mechanical parts that make up the system. The software would contain the programmes used to manage the system. The FAI would collect all data from a specific forensic discipline that is available on all kinds of scientific and professional networks. In this way, through the FAI, all data that can be useful and which any party in the court proceedings would request would be available to all participants in the court proceedings and would be available in real time and space. Also, the FAI could conduct a meta-analysis of data extracted from all scientific and professional databases (monographs, textbooks, magazines, studies...), and transform the aforementioned metadata into an understandable and simplified format in the form of useful information (which is sought by judges, prosecutors, lawyers) in a very short time. Collecting and storing a large amount of information and data for forensic experts is a very difficult, extensive process that takes a long time. But FAI solves that problem with the large capacity of its database, which it uses to collect and store forensic data, its properties, research and results. By collecting and analysing a large amount of data, the FAI would be of great use when confirming or refuting certain evidence in court, and thus also when investigating various types of criminal offences*' [27, p. 19].

Conclusions. Summarising the results of the consideration of the application of innovative approaches and information technology in forensic expert activity with a view to preventing and solving criminal offences, we would like to note that:

1. The main tasks of forensic institutions of Ukraine in the prevention and detection

of criminal offences are to carry out a comprehensive analysis of the causes and conditions that contribute to their commission, develop methods for their detection, and formulate practical recommendations for eliminating these factors.

2. The results of expert research provide law enforcement agencies with tools to improve their activities, which ensures more effective investigation of crimes and at the same time helps to reduce crime by strengthening the inevitability of punishment. The effective implementation of these tasks creates the basis for more reliable protection of critical facilities, ensuring public order and reducing the level of crime in the country. Forensic institutions perform not only research, but also preventive functions, which contributes to the development of an effective crime prevention strategy.

3. Artificial intelligence techniques are an effective technological tool for forensic experts in the field of crime prevention. These methods enable the rapid analysis of large amounts of data, automation of the processes of identifying patterns in criminal activity, and forecasting potential threats. Artificial intelligence information algorithms allow for in-depth research, in particular in analysing texts, video and audio materials, identifying hidden connections between participants in crimes or establishing new evidence.

4. The most promising area of preventive activity of forensic institutions in Ukraine and the world is the introduction of 'Forensic Artificial Intelligence'. Through the integration of artificial intelligence, forensic institutions can increase the efficiency of investigations and reduce the risks of subjective errors. For example, artificial intelligence is used to analyse satellite imagery to identify war crimes or illegal burial sites. Tools are also widely used to identify voices, locate suspects and witnesses, or examine medical records to determine the cause of death.

Thus, artificial intelligence techniques are becoming an important technological resource that not only contributes to the effective detection of crimes, but also allows for the development of effective measures to prevent them, ensuring a high level of law enforcement and public safety.

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Наталія Філіпенко, Сергій Лукашевич, Александар Іванович. Інноваційні підходи та інформаційні технології у судово-експертній діяльності

Запобігання злочинності стає одним з найважливіших завдань для органів, які здійснюють превентивну діяльність в Україні. Метою цієї статті є вдосконалення заходів запобігання злочинності в умовах діджиталізації суспільних процесів. Завданнями статті є визначення сучасного стану та перспектив діяльності судово-експертних установ у сфері запобігання злочинності з використанням інформаційних технологій. Серед суб'єктів запобігання злочинності в Україні судово-експертні установи вирізняються особливою компетенцією. Превентивна діяльність працівників цих установ, яка здійснюється на вимогу уповноважених органів під час розгляду кримінальних проваджень або за власною ініціативою на підставі нормативно-правових актів, є важливим елементом запобігання злочинності. У статті також визначено напрями використання штучного інтелекту в правоохоронній діяльності із залученням судових експертів. Це включає аналіз супутникових знімків для виявлення змін ландшафту, які можуть бути пов'язані з воєнними злочинами, та ідентифікації могил жертв, аналіз відео- та фотоматеріалів для ідентифікації об'єктів, підозрюваних та свідків, обробка аудіоматеріалів для ідентифікації голосів та визначення місцезнаходження абонентів під час розмови. Автори також розглядають аналіз соціальних мереж для виявлення зв'язків між підозрюваними та свідками воєнних злочинів, аналіз даних медичних установ для визначення причин смерті та ідентифікації військовополонених і воєнних злочинців з медичної документації, а також аналіз текстової інформації та інші методи. Автори зазначають, що найбільш перспективним напрямом превентивної діяльності судово-експертних установ в Україні та світі є впровадження криміналістичного штучного інтелекту (Forensic Artificial Intelligence, FAI). Інтегруючи штучний інтелект, судово-експертні установи можуть підвищити ефективність розслідувань і знизити ризик суб'єктивних помилок. Впровадження цих заходів у діяльність судово-експертних установ сприятиме підвищенню ефективності запобігання злочинам в умовах сучасних цифрових технологій та зміцненню правопорядку в Україні.

Ключові слова: *кримінологія, запобігання злочинам, судова експертиза, інформаційні технології, дослідження злочинів, інновації, штучний інтелект, кібербезпека, криміналістичний штучний інтелект (КШІ).*