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The Use of Databases in the Analysis of the Scene of Crime

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ABSTRACT

The problems of using databases in the crime scene analysis are due to changes in the structure of crime, adaptation of innovative technologies to the needs of law enforcement, and protection of human rights. The complex of these aspects determines the relevance of the topic. The aim of the study is identifying the peculiarities of using databases in the crime scene analysis and the prospects for improving law enforcement activities with a view to crime trends. The research employed logical, comparative methods, forecasting. It was revealed that the mechanism of database creation and use is aimed at the fulfilment of the tasks of working with traces at the crime scene. Correspondence of databases to the needs of law enforcement activities is assessed through criteria grouped into resource, organizational and regulatory clusters. Prospective databases should take crime trends into account. The latest methods of working with traces are the final stage of the adaptation of research in the field of criminal justice. The academic novelty of the study consists in a critical examination of the use of databases in the crime scene analysis as a complex of the issues of communications and innovations in law enforcement activities. The study opens up prospects for the development of unified algorithms for information exchange for counteraction to transnational crime

KEYWORDS: Criminal proceedings, crime scene, investigation, databases, effectiveness of evidence.

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El uso de bases de datos en el análisis de la escena del crimen

RESUMEN

Los problemas de utilizar bases de datos en el análisis de la escena del crimen se deben a los cambios en la estructura del crimen, la adaptación de tecnologías innovadoras a las necesidades de las fuerzas del orden y la protección de los derechos humanos. La complejidad de estos aspectos determina la relevancia del tema. El objetivo del estudio es identificar las peculiaridades del uso de bases de datos en el análisis de la escena del crimen y las perspectivas de mejorar las actividades policiales con vistas a las tendencias delictivas. La investigación utilizó métodos lógicos, comparativos y de previsión. Se reveló que el mecanismo de creación y uso de la base de datos tiene como objetivo el cumplimiento de las tareas de trabajo con huellas en la escena del crimen. La correspondencia de las bases de datos con las necesidades de las actividades de aplicación de la ley se evalúa mediante criterios agrupados en grupos de recursos, organizativos y regulatorios. Las bases de datos prospectivas deberían tener en cuenta las tendencias delictivas. Los últimos métodos de trabajo con huellas son la etapa final de la adaptación de la investigación en el campo de la justicia penal. La novedad académica del estudio consiste en un examen crítico del uso de bases de datos en el análisis de la escena del crimen como un complejo de cuestiones de comunicación e innovaciones en las actividades policiales. El estudio abre perspectivas para el desarrollo de algoritmos unificados de intercambio de información para combatir la delincuencia transnacional.

PALABRAS CLAVE: Proceso penal, escena del crimen, investigación, bases de datos, efectividad de la prueba.

Introduction

The crime scene inspection is the first investigative action in criminal proceedings. It is tasked to record the event and collect physical evidence (Singh, 2020). The uniqueness of each crime determines the specifics of the scene, of identifying traces, determining their relevance and withdrawing them (Turvey and Freeman, 2022; De Roo et al., 2022). At the same time, it is important to comply with the procedure of recording both the course of the inspection and the results obtained (Korzh, 2018; Khairul et al., 2021). In general, a poor inspection of the scene is the main reason for wrongful conviction and punishment (Kelty et al., 2023). These standards of fair proceedings also apply to international justice (Zarmsky, 2021).

The use of databases involves their creation from objects that were withdrawn or obtained during the scene inspection and studied by relevant experts (Fedchak, 2021; Priakhin, 2022). This identifies a number of conceptual, organizational and applied problems in the use of databases in the crime scene analysis, in particular:

- increasing volume of processed information in the field of criminal justice (Carrera et al., 2021). In particular, this is related to the use of cyberspace as a place for committing crimes, the emergence of new ways of committing illegal acts (Blahuta and Movchan, 2020);

- lack of unified methods of inspection of high-tech crime scenes and relevant databases (Lisohor, 2020);

- a biased attitude of the investigators who inspect the scene to the selection and prioritization of working with traces and with databases (Oatley et al., 2020; Lid´en and Almazrouei, 2023), which leads to the loss of a significant number of traces (Ribaux et al., 2022);

- low-quality communication between investigators and experts, overestimated expectations from expert work (Almazrouei et al., 2020; Srivastava et al., 2022);

- problems of training persons involved in the creation of databases, including specialized personnel of expert institutions (Wickenheise, 2023);

- overestimated appropriateness of using databases in the detection of serious crimes and in combating crime in general (Santos and Machado, 2017).

Forensic databases are a tool for increasing opportunities for crime investigation (Al-dhaqm et al., 2017; Senthil and Selvakumar, 2022). However, the problems of using databases directly affect the observance of human rights in criminal proceedings (Carrera et al., 2021). This determines the appropriateness of public discussion of the creation and storage of relevant databases (Pugh, 2008).

All the problematic issues of using databases during the study of the crime scene are relevant. However, only their comprehensive critical examination can lead to qualitative changes in law enforcement work and strengthening of guarantees of human rights in the field of criminal justice.

-Aim

The aim of this study is to consider the use of databases in the study of the crime scene as a complex activity that ensures the effectiveness of evidence in criminal

proceedings, and to clarify the prospects for its improvement. The aim involved the fulfilment of the following research objectives: a) determine the mechanism of creating databases that are used during the crime scene analysis; b) identify factors that affect the effectiveness of such application, and to find out the impact of these factors on human rights protection in criminal proceedings; c) outline promising directions for improving the use of databases during crime scene inspections taking into account the current crime trends.

1. Literature Review

The generalization of studies gave grounds to distinguish several aspects to which experts pay special attention:

1. Determining the types of traces and databases, which are determined by the specifics of crimes. In particular, the issues of DNA traces are investigated (Jakovski et al., 2017), it is shown that they are not universal evidence (Amankwaa and McCartney, 2021; Dela Rama, 2022). Understanding such relationships leads to recommendations on limiting work with DNA traces (De Moor, 2018).

2. Development of the latest methods of working with traces, which enables eliminating mistakes of trace detection at the scene and improve the quality of databases. In particular, it is about: a) the use of neural networks for the analysis of video data, shoe prints from the crime scene (Sahay et al., 2022; Wen et al., 2023); b) 3D-visualization, which reveals the connection between the evidence and allows to fully reconstruct the scene (Wang et al., 2019; Cunha et al., 2022; Ospina-Bohorquez´ et al., 2023), as well as provide experts with remote access to it (Yu et al., 2023).

3. Inconsistency between scientific developments and the available skills of law enforcement officers in working with traces and databases. It is noted that the imperfect analytical methods lead to a decreased probability of collecting quality samples for further examinations and databases, as well as a decreased quality of expert opinions (Kelty et al., 2023). Accordingly, law enforcement officers lack the knowledge and skills to create and update databases (Jha et al., 2019).

4. Professional deformation and stressful working conditions of investigators and experts at the scene. In particular, studies showed selective attention to traces at the crime scene, which leads to ignoring other relevant information at the crime scene (De Gruijter et

al., 2017). A biased attitude of law enforcement officers and experts towards new methods is noted, although the latter are more effective (Ribaux et al., 2022). At the same time, experts at the crime scene feel pressure because of the inflated expectations regarding the speed of making the right decisions (Almazrouei et al., 2020).

5. A separate direction is the study of the experience of different countries (Great Britain, Switzerland, Canada, India, the USA, Ukraine, etc.). Positive aspects are noted regarding: a) the creation of a wide range of databases from the objects withdrawn or obtained during the scene inspection, after conducting relevant examinations (Fedchak, 2021; Priakhin, 2022); b) modernization of national databases with a view to the current crime trends (Ribaux et al., 2022); c) joining efforts of states at the regional level to exchange information (Amankwaa, 2020). The global level of data exchange through the access of states to Interpol databases is also important (Interpol, 2022).

6. Human rights issues of the use of databases in the study of the scene mainly relate to the detection, withdrawal of DNA traces, and the use of the DNA database. Specialists draw attention to the appropriateness of adopting special laws (Office UK Government, 2023), which will enable creating a balance between traditional legal principles, human rights, and new scientific developments (Srivastava et al., 2022). At the same time, the problems of the balance of protection of public safety and human rights are urged (Amankwaa and McCartney, 2021). In particular, the limitation of the use of the DNA base (De Moor, 2018) is emphasized, which may become the subject of public discussion (Pugh, 2008).

So, the literature presents a number of conclusions regarding the use of databases in the study of the crime scene. However, they are mainly aimed at revealing certain problematic issues and fragmentarily affect the modern features of the criminal situation.
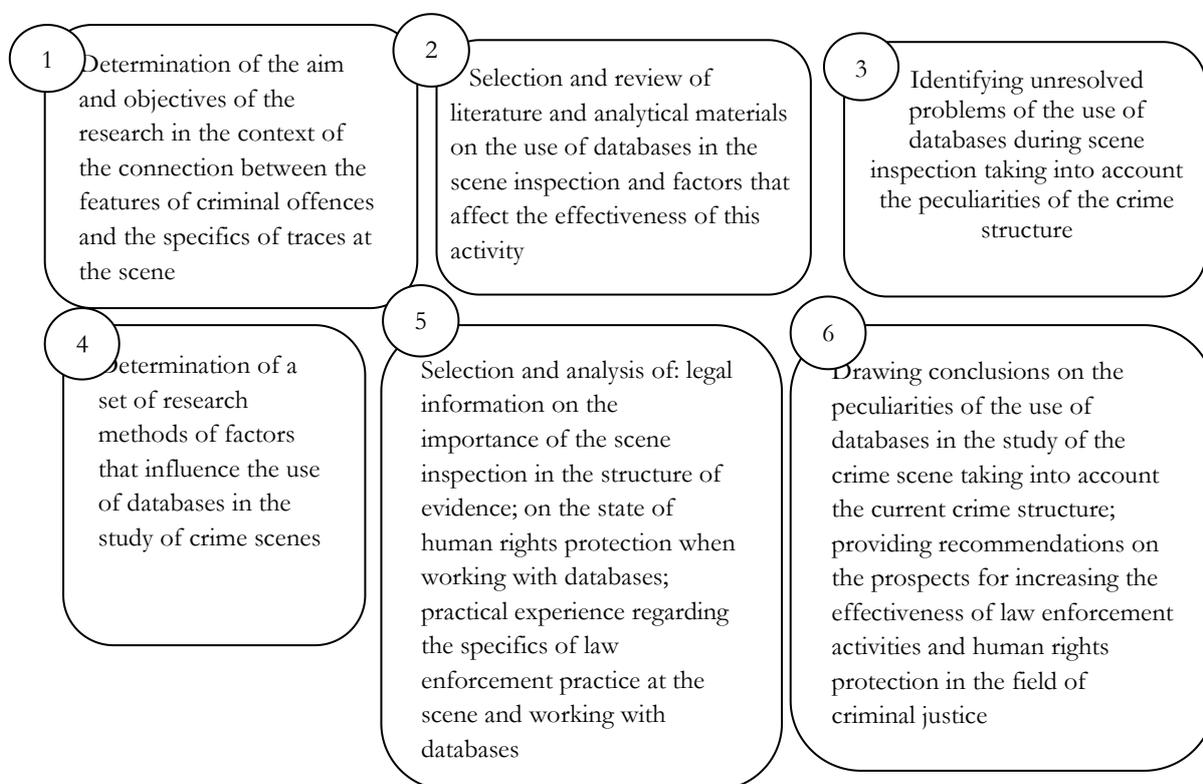
2. Methods

The aim was achieved and the research objectives were fulfilled through the selection and generalization of sources on the legal and organizational problems of using databases during the study of the scene, as well as the prospects for their solution. For this purpose, a) reports on the features of databases and analytical reports on the results of their application; b) the experience of Ukraine as a country with a transitive legal system,

Great Britain and Switzerland as stable democracies whose criminal situation reflects modern crime trends were used.

This made it possible to a) clarify the essence and mechanism of using databases during crime scene analysis; b) identify factors affecting the introduction of the latest methods of working with traces and databases at the crime scene; c) determined the prospects for improving crime scene analysis and the use of databases with due regard to the peculiarities of the crime structure. The research stages are presented in the form of a block diagram (see Figure 1).

Figure 1. Block diagram of the research design

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1 Determination of the aim and objectives of the research in the context of the connection between the features of criminal offences and the specifics of traces at the scene	**2** Selection and review of literature and analytical materials on the use of databases in the scene inspection and factors that affect the effectiveness of this activity	**3** Identifying unresolved problems of the use of databases during scene inspection taking into account the peculiarities of the crime structure
4 Determination of a set of research methods of factors that influence the use of databases in the study of crime scenes	**5** Selection and analysis of: legal information on the importance of the scene inspection in the structure of evidence; on the state of human rights protection when working with databases; practical experience regarding the specifics of law enforcement practice at the scene and working with databases	**6** Drawing conclusions on the peculiarities of the use of databases in the study of the crime scene taking into account the current crime structure; providing recommendations on the prospects for increasing the effectiveness of law enforcement activities and human rights protection in the field of criminal justice

The study employed the following methods:

- *system approach* was used to understand the essence and significance of the use of databases in the scene analysis in the course of proving taking into account threats to human rights in the field of criminal justice;

- *descriptive analysis* was applied to study the factors that influence the use of databases in the crime scene analysis;

- *the logical-legal method* was employed to identify the specifics of the legal regulation of the creation and application of databases in the context of human rights protection;

- *the comparative method* made it possible to compare the experience of Ukraine and foreign countries regarding the practice of using databases during the scene analysis;

- *the forecasting method* was used to determine the prospects for improving the study of the crime scene and the use of databases taking into account the peculiarities of the crime structure.

3. Results

The issue of using databases during the study of the crime scene is important for: a) proving in criminal proceedings; b) organization of communication between investigators and experts; c) introduction of innovations in law enforcement activities; d) protection of human rights in the field of criminal justice. Inspection of the crime scene is an urgent investigative action, the speed and completeness of criminal proceedings will depend on its quality. Therefore, it is important to understand the tasks of the scene inspection (see Figure 2).

Figure 2. The tasks for the crime scene inspection
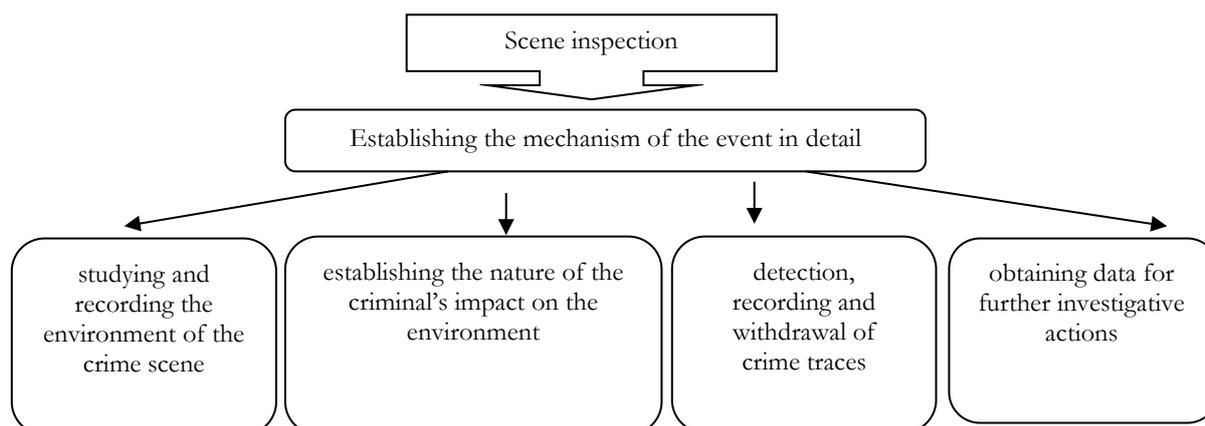
The use of such databases becomes especially important in the context of data shortage for the organization of investigation and detection of crime traces. However, investigators and experts are also active subjects in the creation of databases, as they fill them with information from crime scenes (see Figure 3).

Only those databases that are created in the prescribed manner by the proper subjects have procedural significance. Therefore, it is important to clarify the mechanism of their creation. It will be determined by the level of the base (local, national, regional, universal) and the legal regulation of its creation and application (see Figure 4).

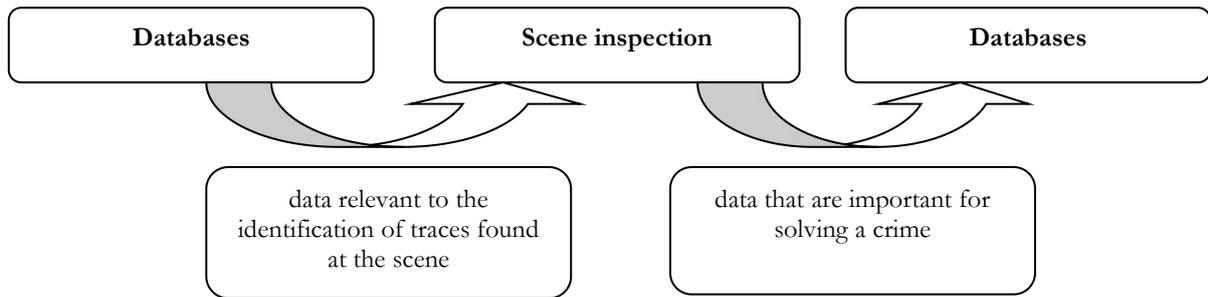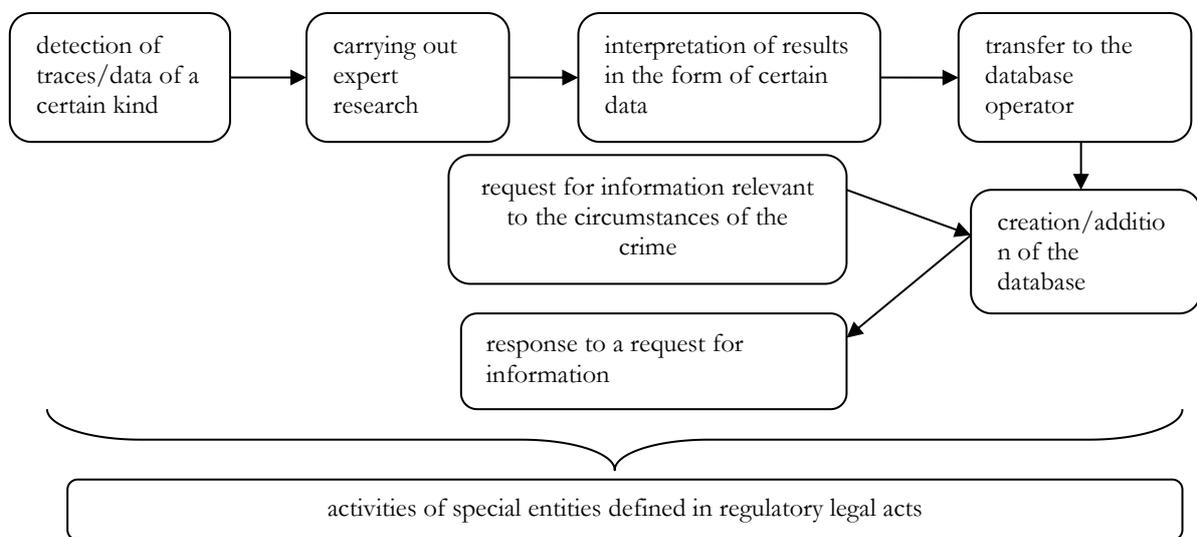**Figure 3.** Relationship between scene inspection and database performance

Figure 4. The general mechanism of database creation and its application during the crime scene analysis

National peculiarities are revealed when considering the subject composition of database creation. The experience of several states with different legal traditions - Ukraine, Great Britain and Switzerland was used as an example:

- in Ukraine, the operators of these databases are public authorities only (including law enforcement agencies). The databases are created at the national level. However, there is no single national operator of such databases;

- a special body has been created in Great Britain, the competence of which has been extended to the database of DNA profiles and fingerprints since 2016. This body is tasked to implement the strategy and policy of the most efficient and effective use of these databases (Office UK Government, 2023);

- in Switzerland, the main subject is non-specialized units that carry out an inspection of the scene and basic laboratory examinations. Unified national databases are created at the same time (Ribaux et al., 2022).

The latest developments and changes in the crime structure determine the appropriateness of forensic innovations. The similarity of the mechanism of creation and application of databases in states with different legal systems allows us to determine the main factors that limit the introduction of the latest methods of working with traces (see Figure 5).

Figure 5. Factors affecting the adoption of the latest methods of working with traces and databases at the crime scene
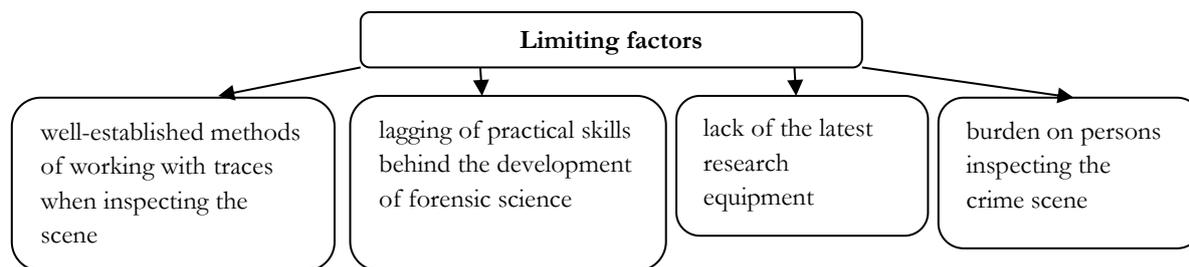
The complex of these factors has a negative effect on the psychological resistance of law enforcement officers and experts to stress factors. This, in turn, reduces interest in new work methods and willingness to learn relevant skills. Along with this, the creation and implementation of new databases is an organizationally complex task. A number of criteria are determined to assess the compliance of these databases with the needs of law enforcement activities. The experts present an approach to such criteria as having different meanings. However, it is considered appropriate to group these criteria into clusters based on their nature. At the same time, a certain cluster may acquire primary importance depending on the situation in the state (see Figure 6).

It is seen that the integration of the database into national and international data exchange systems is especially important in the international context due to the

transnationalization of crime. In general, compliance with the specified criteria will allow optimizing the work of law enforcement officers and experts in detecting and investigating a certain type of crime, first of all, when inspecting the crime scene.

The introduction of new databases will require the development of appropriate methods of work in the study of crime scenes. This involves a certain sequence of actions with the overall value of neutralizing the identified limiting factors (see Figure 7).

Figure 6. Criteria for compliance of the database with the needs of law enforcement activities
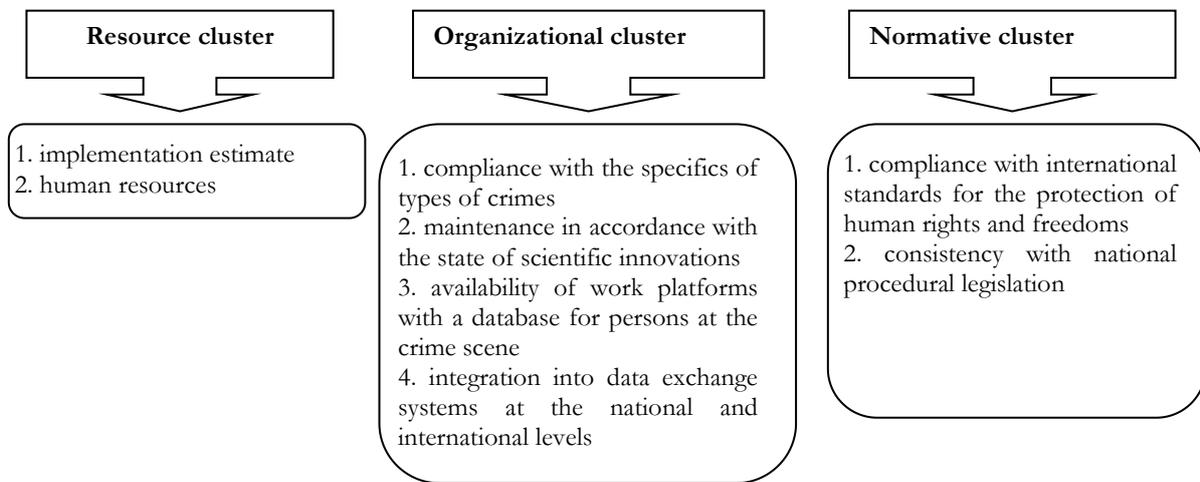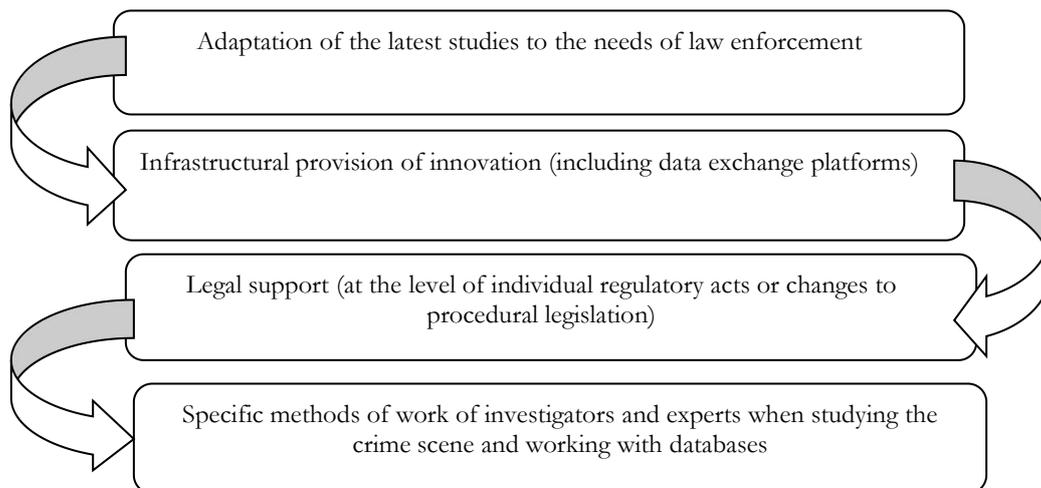

Figure 7. Stages of introduction of new methods of work at the crime scene and application of databases

In view of the foregoing, it is appropriate to identify promising directions for improving the study of the crime scene and the use of databases:

1. Creation of new databases in accordance with changes in the structure of crime taking into account the criteria of compliance with the needs of law enforcement activities.

2. Introduction of new methods of work at the scene and application of databases in accordance with the proposed sequence.

3. Improving the professional training of authorized subjects who will use high-tech means of inspecting the scene and applying databases.

Considering the transnationalization of crime, it is appropriate to discuss unified algorithms for the implementation of such directions. This will enable coordinating information exchange systems between states with different legal systems.

4. Discussion

This study confirmed the relevance of considering the problems of using databases during crime scene analysis. In particular, taking into account the experience of leading countries (U.S. Department of Justice, 2023), one should agree with the noted correlation between the specifics of crimes and the types of traces and databases. Although they were studied using the example of DNA traces (Dela Rama, 2022; Jakovski et al., 2017), given the changes in the crime structure (Amankwaa and McCartney, 2021), these patterns are of a general nature. This is revealed in the crime scene analysis as a process of interpretation of specific features of the crime and relevant contextual information (Turvey and Freeman, 2022). Therefore, the continuation of such studies is considered promising.

The statement about a connection between the discrepancy between modern scientific developments and the existing skills of law enforcement officers in working with traces and databases can be supported. This is one of the stress factors for working at the scene. At the same time, we believe that not only investigators (Tehrani, 2023), but also experts are exposed to stress. This is an important aspect, because the use of forensic examination as a tool to determine the guilt of suspects is increasing (Dela Rama, 2022). Both categories of persons at crime scenes make mistakes, which are usually associated with haste at the crime scene and lack of experience/knowledge and/or professional training (Jha et al., 2019; Kelty et al., 2023). In view of the latest approaches to working with traces, the position about a biased attitude of law enforcement officers and experts to work at the crime scene should be supported (Ribaux et al., 2022). This study emphasizes that such a combination of factors is a significant obstacle to the introduction of the latest

methods of working with traces and the creation of databases. Therefore, proposals for the inclusion of behavioural sciences in crime scene inspection methods should be supported, which will improve the work with traces (De Roo et al., 2022).

This article pays special attention to the importance of solving issues of legal regulation of the use of databases during the scene analysis. We support the adoption of special laws that enable: a) balancing traditional legal principles, human rights and new scientific developments (Srivastava et al., 2022); b) harmonizing international standards and national legislation and policy, ensure transnational exchange of information from databases (Amankwaa, 2020; Gryshchenko et al., 2022).

We support the discussion on the development of a methodology for the work of the police and experts on the collection and analysis of information (Ribaux et al., 2022), including databases. However, it should be noted that: a) the implementation of the latest databases must meet a set of efficiency criteria (Amankwaa and McCartney, 2019); b) from a technological perspective, the modern process of digital forensic research cannot effectively take into account various aspects of complex infrastructure (Rossy et al., 2013; Senthil and Selvakumar, 2022); c) digital tools do not always meet the standards of justice due to non-compliance with the requirements of confidentiality, data protection, and information security (Carrera et al., 2021). This study emphasizes the urgency of adapting the latest research to the needs of law enforcement, as well as their infrastructural support, including data exchange platforms. The policing methodology can be developed after the legal regulation of new methods of collecting evidence and creating databases.

In general, the above considerations can be the ground for legal and organizational mechanisms for the effective use of databases in crime scene investigations.

Conclusions

The academic novelty of the conducted research consists in a critical examination of the problem of using databases during the crime scene analysis as a component of the following contexts: a) provision of evidence in criminal proceedings; b) communications in the field of law enforcement at the national and international levels; c) introduction of innovations in law enforcement activities; d) protection of human rights in the field of criminal justice.

It is shown that the scene inspection is a complex action with a system of tasks, the fulfilment of which is impossible without the use of databases. The general mechanism for creating a database is presented with clarification of the features of the subject composition depending on the specifics of national legal systems. A generalization of the main factors that limit the introduction of the latest methods of working with traces is given. A cluster approach to the criteria of compliance of databases with the needs of law enforcement activities is proposed (resource, organizational and regulatory clusters are distinguished). The sequence of stages of implementation of the latest methods of work of the police and experts in identifying and withdrawing traces at the crime scene is presented.

Promising directions for improving the crime scene analysis and the use of databases are identified. Emphasis is placed on a) the creation of new databases taking into account changes in the crime structure; b) phased implementation of new methods of work at the scene and the use of databases; c) enhanced training of authorized subjects. The appropriateness of developing unified algorithms for coordination of interstate information exchange systems to combat transnational crime is argued.

The applied value of the study consists in directing recommendations to a) the improvement of professional and psychological training of investigators and experts on the use of the latest technologies; b) improvement of legal support for the use of databases containing important personal information; c) appropriateness of anticipatory development of crime scene analysis methods based on crime forecasting.

Limitations

Research on the use of databases during scene investigation is naturally limited by the number of relevant databases. Their number is constantly increasing due to the emergence of new types of crimes and methods of their investigation.

Recommendations

- in the field of organization of law enforcement activity, the improvement of training of investigators and experts on the use of the latest technologies for the detection of traces and the use of databases is considered a priority;

- in the field of legal protection, it is promising to improve the regulation of the creation and use of databases containing important personal information;

- in the research field, further study of the connections between the features of criminal behaviour and traces at the scene is necessary. It is also promising to predict the appearance of new types of crimes and to develop methods for inspecting the places where they were committed.

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