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Methods of Extraction and Analysis of Intelligence to Combat Threats of Organized Crime at the Border

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Abstract

The article reveals the development of innovative methods of intelligence-led policing in the form of information-analytical activity (IAA) by law enforcement operational units to combat threats of cross-border organized crime. The developed methodology for extracting intelligence information contains new procedures for extracting intelligence from Internet resources and performing intelligence analysis. It allowed for a reduction in time of 1.23 times for obtaining intelligence on criminal activity. Also, the methods for identifying crimes and analyzing threats to border security were improved. It allows the development of new procedures for crime identification, the classification of organized criminal groups, the formation of scenarios of their illegal activities, and the determination of the degree of their influence on border security. The methodology is based on taxonomy, artificial intelligence, expert evaluation, and SWOT analysis. The developed mathematical model for constructing operational cover at the border takes into account the dependence of the distribution of available resources on existing cross-border crime threats. Experimental verification of the implementation of the research results indicates advantages of the results in contrast to traditional approaches in terms of "reliability" and "efficiency". Based on the developed methodological apparatus, recommendations for improving the IAA were elaborated: improving processes of obtaining intelligence information; improving processes of identifying crimes and analyzing threats to border security due to the development of criminal analysis systems; creating regional centers for detecting and analyzing threats to border security; and developing the IAA based on enhancing the capabilities of operational units. Implementation of the scientific results into the practical activity of law enforcement operational units at the border contributed to increasing the efficiency of their IAA by up to 20%.

Keywords: Information-Analytical Activity; Intelligence; Intelligence-Led Policing; Operational Units; Organized Crime; Security.

1. Introduction

Nowadays, the development of a sovereign and independent state implies constant protection of its national interests and security from external and internal threats. This is becoming particularly important for national security due to the rapid globalization and increasing imbalance of world development, the financial and economic crisis, the aggravation of international relations, the increased international competition for spheres of influence, and the escalation of conflicts. Under such conditions, organized crime is spreading, which through the use of modern information technologies and communication resources of the Internet has acquired a latent character of manifestation. As a result, the number of

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unsolved crimes increases, and through covert preparation for their commission, stable channels of cross-border organized crime are developed, for example: drug trafficking (Iran-Turkey-Ukraine-Western Europe); illegal migration; human trafficking (Central Asia-Russia-Ukraine-Western Europe; Syria-Turkey-Ukraine-Western Europe); and terrorist activities (Russia-Ukraine; Syria-Turkey-Ukraine-Western Europe).

The dynamics of a steady increase in the crime rate at the border are confirmed by statistical data from the Unified Reports of Ukraine on criminal offenses for the period from 2016 to 2021. According to the level of vulnerability of the world's countries to terrorist threats, Ukraine over the past five years has had an index in the range of 5.4–7.2 on a 10-point scale, which significantly exceeds this index for the same period before 2016 (2.3–3.3).

Based on the analysis of the results of completing tasks on countering threats of organized crime at the border, units of the State Border Guard Service of Ukraine (hereinafter – SBGSU), methodological support of their Information-Analytical Activity (hereinafter – IAA) and the requirements of the current legislation, significant inconsistencies were established between:

- Increasing volume and complexity, forms, and methods of information circulation regarding hybrid threats of organized crime and existing methods of its extraction and processing;
- The complexity of IAA processes in modern conditions of the border protection and existing tools (methods, models, methods) to ensure it;
- The dynamic development of the criminal situation due to the spread of organized crime and the lack of reasonable tools for building operational cover of the state border of Ukraine for timely obtaining reliable information about the crime.

So, the results of the activity of the Border Guard Service of Ukraine in countering organized crime under modern conditions indicate the need to develop and implement conceptual changes in the methodological foundations of information-analytical activity.

The essence of the research problem is defined as the impossibility of using existing IAA tools to ensure border security due to drastic changes and complications in the criminal situation and the hybrid nature of threats from organized crime. The need to eliminate inconsistencies and solve this problem determines the relevance of the research topic. It should be mentioned that the requirements to improve the effectiveness of information-analytical activity both for its individual processes and in general for countering organized crime are considered in the United Nations Convention Against Transnational Organized Crime, the National Security Strategy of Ukraine, the Strategy for Combating Organized Crime, and the Strategy of Integrated Border Management for the period up to 2025.

1.1. Purpose of the Research

The study aims at improving the efficiency of combating threats of organized crime at the border through the development and implementation of a methodological support apparatus for the information-analytical activity of the State Border Guard Service of Ukraine. To achieve this goal, the following tasks were defined:

- 1- Develop a method for obtaining and forming intelligence information by the units of the Border Guard Service.
- 2- Develop a method for recognizing crimes and analysing threats to border security by the units of the Border Guard Service.
- 3- Develop a method for managing the IAA of the units of the State Border Guard Service based on the results of assessing its condition.
- 4- Develop a mathematical model for constructing operational cover of the state border by the units of the Border Guard Service.
- 5- Elaborate recommendations to improve the IAA of the units of the Border Guard Service.

1.2. Literature Review and Analysis

Foreign and domestic scientists were engaged in the study of IAA issues affecting operational units of law enforcement agencies. The analysis of the events of recent years has changed the character of the border guard operational units of IAA, which has led to the improvement of the traditional methods of IAA and the reforming of the law-enforcement agency in general.

Among a number of recent scientific works, the studies of Farion (2019) consider methodology for managing information and the analytical activity of units of law enforcement agencies [1, 2]. Movchan & Taranukha (2018) analyzed the implementation of intelligence-led policing. The authors developed the mathematical apparatus and proved the efficiency of the application of new methods of criminal analysis to expand the entire analytical system of the

National Police and use analytical methods and technologies that provide efficient investigation of criminal offenses [3]. Bratko et al. (2021) studied the use of SWOT analysis in the field of national security planning [4]. Kirby & Keay (2021) discussed how intelligence is gathered to assist investigators in solving crimes. So, intelligence analysts and tactical crime analysts have to master the process of a criminal investigation in order to be in the best position to provide the kind of intelligence investigators need to close cases [5].

Also, Cope (2004) explored the integration of volume crime analysis into policing and outlined the importance of analysis for intelligence-led policing. A poor understanding of analysis amongst police officers and a lack of understanding of policing amongst analysts influenced the usefulness of analytical products for operational policing. The paper argues that training and development for both police officers and analysts are crucial to developing a productive working relationship [6]. Uzlov et al. (2018) reviewed perspectives of using data mining methods in the work of criminal analysts in the national police by the process of developing and implementing proactive police activities for the prevention and investigation crimes. It also describes tools for improving the effectiveness of the information-analytical work of the law enforcement agencies through the creation of automated, intelligent technological tools [7].

Chainey & Chapman (2013) presented a problem-oriented approach to the production of strategic intelligence assessments, which play an important role in contemporary intelligence-led policing by helping to identify strategic priorities for policing activity, crime reduction, and improvements in community safety [8]. Balendr et al. (2019 a, b) revealed the peculiarities of border guards' professional functions and training [9, 10]. Didenko et al. (2010), Balendr (2018), and Soroka et al. (2019) studied modern educational resources for training future officers of border guard units [11–13]. Guerette et al. (2021) conducted an empirical assessment of crime analysis training within a police department. The authors argue that the ability to conduct sound crime analysis has become a necessity in contemporary policing, although many law enforcement agencies struggle with the development of their own analytical abilities [14].

Rusnak et al. (2019) investigated the organization and planning in the bodies and units of the Armed Forces of Ukraine and other elements of the security and defense sector concerning the development of security and defense force opportunities [15]. Pavlikovskyi (2020) dedicated the monograph to revealing the latest approaches to the implementation of a systematic approach to defense management in the Ministry of Defense, the Armed Forces of Ukraine, and other defense forces with the aim to improve defense reform and approximate NATO standards [16]. Speaking about the combating of cross-border crime, Izcara (2017) conducted research devoted to the problem of illegal migration and drug smuggling as a significant problem for the United States on the border with Mexico [17]. Evans (2012) identified the skills and abilities required by an analyst to be recognized as effective. The findings illustrate a change from the analyst being seen as a technical specialist to a growing understanding of the analyst as part of a support structure for decision-makers. Implications of the findings for recruitment, training, and development are discussed [18].

The greatest interest in the framework of our research are the dissertations of Kyrylenko (2009) [19] considering the theoretical foundations of information and analytical support of state border protection processes (in the context of national security tasks of Ukraine in the border area) and by Kuprienko (2016) [20] - methodological foundations of the development of the border security system of Ukraine (in the conditions of a differentiated security environment). The results of these scientific works were used to conduct a comparative analysis of the existing and developed scientific and methodological apparatus of information-analytical activity used by the units of law-enforcement agencies (in Section 4 - Discussion).

The scientific works of the mentioned scientists reveal certain issues of informational and analytical support for the protection of the state border. The essence of the problem is defined as the impossibility of using the existing instrumental means of IAA to ensure border security due to changes to their use under the conditions of the complication of the criminogenic situation and threats of a hybrid nature, which necessitates the development of the methodological foundations of IAA of the law enforcement agencies. The scientific works analyzed overwhelmingly reveal certain issues of information and analytical support for the law enforcement agencies' activity; however, a comprehensive study of the methods of extraction and analysis of intelligence by the units of law enforcement agencies has not yet been conducted. Therefore, this problem requires further study, search for new methods and ways to solve it.

2. Materials and Methods

The study investigated the professional activity of the border guard operational units, which implement the function of conducting information-analytical activity to protect the state border and perform functions of search and record actual data on illegal acts of individuals and groups; receive information in the interests of the safety of citizens, society and the state; independently or in cooperation with other law enforcement agencies carry out measures to counteract crime at the state border.

The IAA study on countering organized crime was carried out in the western and eastern regions of Ukraine, and on the basis of the Higher Military Educational Institution of the Border Guard Agency at the following stages:

Stage I: analysis of the effectiveness of the IAA of the border guard operational units, its regulatory provision and methodological support;

Stage II: development of a methodological apparatus for providing IAA of the border guard operational units for countering organized crime, in particular:

- Development of methods of obtaining and forming operational-search information by the border guard operational units, in order to help them reduce the time for obtaining intelligence about criminal activity.
- Improvement of methods of crime recognition and analysis of threats to border security by operational units. The new methodology should make it possible to develop new procedures for certification of crimes, determine the types and stages of crimes, assess the possibility of committing aggregate crimes, classify organized crime groups, form scenarios for their illegal activities and determine the degree of influence on the state of border security;
- Improvement of methods of IAA management of the border guard operational units based on the results of assessing its condition using an expanded set of indicators and determining new procedures for evaluating IAA and correcting its condition in the process of management;
- Development of a mathematical model for constructing operational cover of the state border by border guard operational units, which takes into account the dependence of the distribution of available resources of operational units on the manifestation of crime at the state border;

Stage III: verification of the developed results of the IAA study of the border guard operational units and clarification of their compliance with reality, analysis of the results of experimental verification of the implementation of research results in the activity of operational units of the Border Guard Service.

Verification was carried out on the basis of a comparative analysis of the existing and developed methodological apparatus of the border guard operational divisions to find the “best” option. As a result of the analysis, it was found that none of the analyzed existing methodological apparatus provides a full solution to the current needs in IAA of operational units of the Border Guard Service of Ukraine. The methodological apparatus developed by the authors has a high level, close to the “best” option, which is 77 %, and in some positions (from 27% to 50 %) the existing IA prevails.

Experimental verification of research results was carried out with participation of the operational units in the Eastern and Western Regional Directorates, Department of Operational-Search Activity of the Border Guard Service of Ukraine and in the educational process of the Dnipropetrovsk State University of Internal Affairs and the Bohdan Khmelnytskyi National Academy of the State Border Guard Service of Ukraine. As a result, the advantages of the developed methodological apparatus over the existing one in terms of reliability were established by an average of 18.3%, and in terms of efficiency – by 23% of the existing one. For the purposes of presenting the design of the research, its logics and structure, we developed a structural-logical scheme of the scientific research (Figure 1).

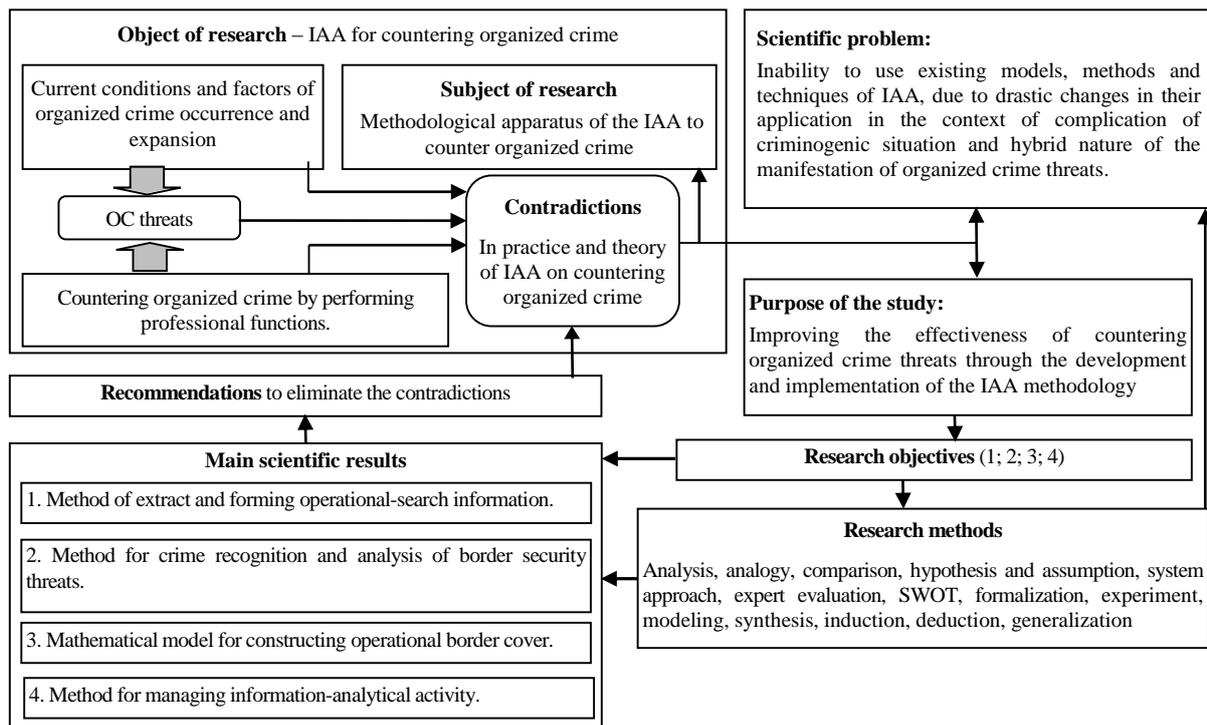


Figure 1. Structural-logical scheme of the scientific research

3. Results and Discussion

Based on the results of the analysis of the IAA of the State Border Guard Service of Ukraine, we developed methodology for obtaining operational-search information by operational units that takes into account modern conditions and opportunities for obtaining information, in particular in a special period and from Internet resources. It contains new procedures for obtaining and forming operational-search information: information-analytical intelligence of Internet information resources and intelligence analysis in a special period, and includes statistical methods and methods of artificial intelligence. The use of the methodology allowed operational units of the SBGSU to reduce the time required to obtain information about criminal activity by 1.23 times.

The components of this methodology are a partial method of extraction and formation of intelligence information using data and analytical intelligence of Internet resources and a partial method of extraction and formation of intelligence information using intelligence analysis of the situation data in a special period. A partial methodology for obtaining and forming intelligence information using information-analytical intelligence (hereinafter - IAI) of Internet resources, the structure of which is presented in Figure 2, was developed on the basis of studying the experience of law enforcement agencies of Ukraine and leading countries of the world in using the internet in the framework of measures to combat crime. Information-analytical intelligence includes searching, identifying, collecting, processing, systematizing and accumulating information and obtaining new or additional information about objects, events, facts and phenomena of operational interest based on its comprehensive analysis.

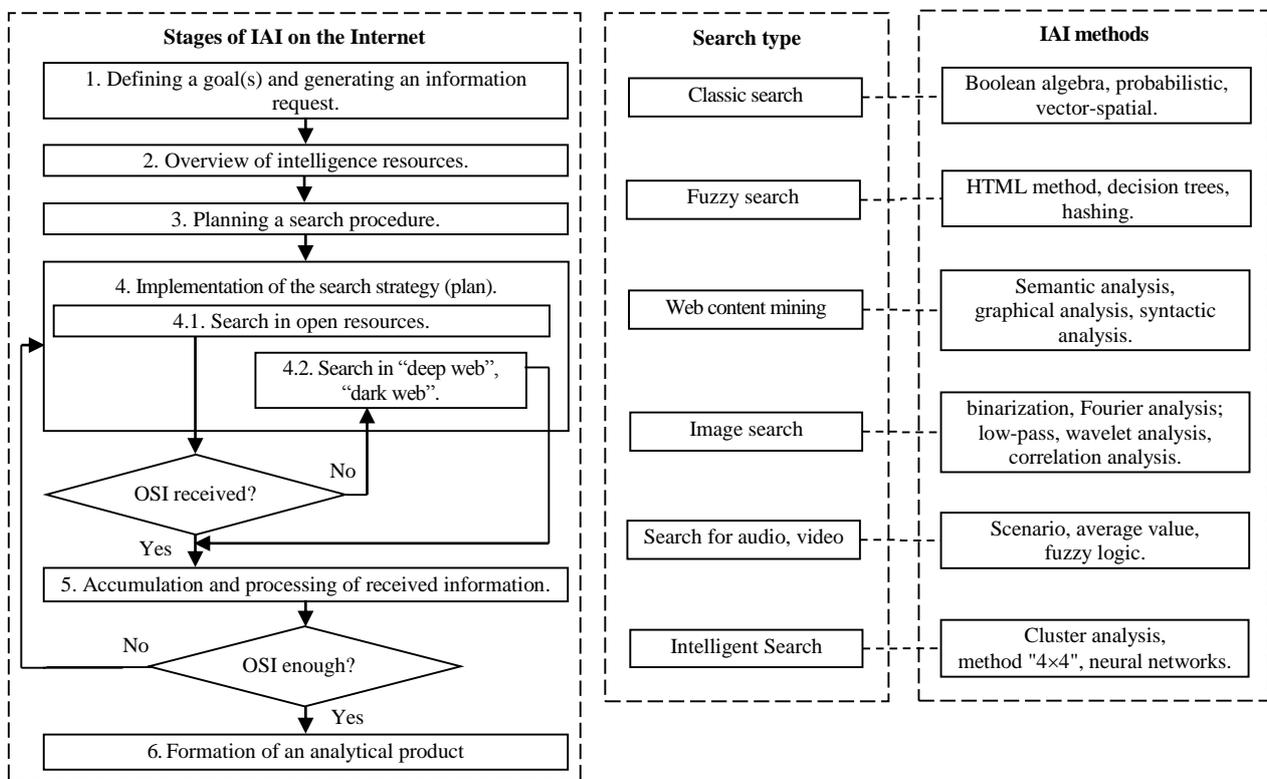


Figure 2. Structure of a partial methodology for extracting and forming operational-search information using information-analytical intelligence of Internet resources

Features of IAI of Internet resources are the extraction and formation of intelligence information from a significant volume of:

- Open (indexed) information with the use of: human intelligence (using tools "Humint" and using information exchange methods); social media analytics (using tools "Socmint", using non-intrusive tools); analysis of images, photos, drawings (using tools "Imint"); intelligent analysis of electronic signals (using tools "Sigint"); geospatial intelligence analysis (using tools "Geoint").
- Non-indexed information using special methods (techniques) and software.

Based on the analysis of the conditions and specifics of the activities of operational units of the SBGSU of Ukraine in a special period, a partial methodology for extracting and forming intelligence information using intelligence analysis of the situation data was developed, the structure of which is shown in Figure 3.

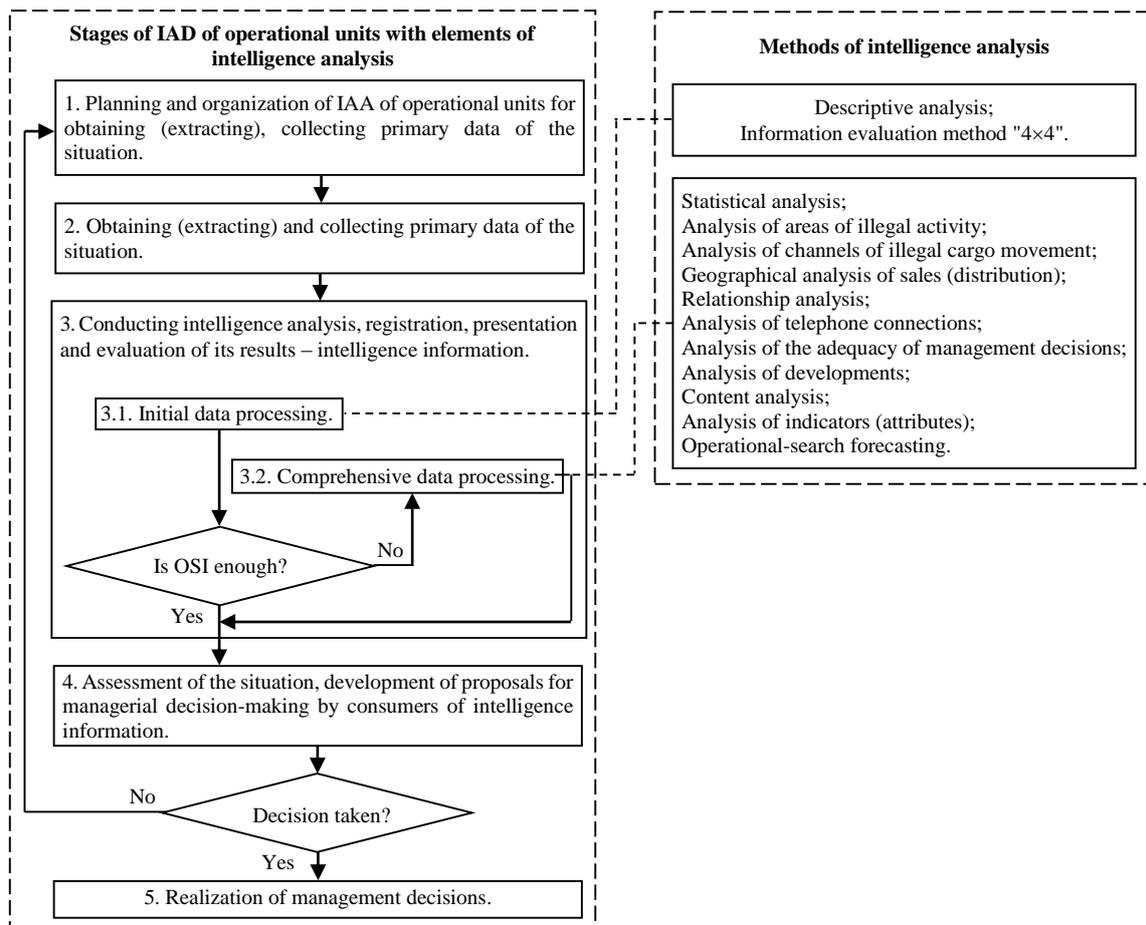


Figure 3. Structure of a partial methodology for extracting (obtaining) and forming intelligence information using intelligence analysis of situation data

In a general sense, exploratory analysis involves transformation of observational data and ways to visually represent them, allowing to identify internal patterns that manifest themselves in the data.

The use of intelligence analysis in the IAA of operational units of the SBGS of Ukraine is aimed at obtaining and forming intelligence information based on the results of analytical activities in one or two stages: the first is the initial processing of primary data; the second is the complex processing of the results obtained at the first stage.

The first stage includes: familiarization and clarification of the content of information; determination of reliability (using the “4×4” method) and the value of information; conducting a descriptive analysis of primary data to establish the specifics of illegal activity; identifying new information and comparing it with similar data from other sources; determining the need to supplement, clarify and verify primary data; classifying information by content or objects and lines of the intelligence information; systematized accounting (accumulation and registration of information in a certain order for quick search and ease of use of the necessary intelligence information). At the stage of complex data processing, the most in-depth study of available information is provided to identify its importance and significance of its essential features, obtain new data about the object of operational attention under study and its relationship with other objects. The intelligence information formed on the results of an intelligence analysis can be clarified in case of changes in the operational situation.

At the next stage of the study was improved the methodology for recognizing crimes and analyzing threats to border security by operational units of the SBGS of Ukraine. The difference between the methodology and the traditional approaches ones is the development of new procedures for certifying crimes, determining the types and stages of crimes, assessing the possibility of committing aggregate crimes, classifying organized criminal groups (hereinafter – OCG), forming scenarios for their illegal activities and determining the degree of influence on the state of border security [21]. This made it possible to increase the validity of proposals for countering criminal activity at the state border and to select priorities for forming options for the strategy of combating crime in the channels of its activities in the field of border security. The methodology is based on taxonomy, artificial intelligence, expert evaluation, and SWOT analysis methods.

This methodology contains an algorithm and methods for recognizing crimes, as well as a method for strategic criminal analysis of border security threats. So, for the recognition of crimes the methodology proposes the following procedure:

- 1- Collection (extraction) of data on the situation from various sources and through the use of IAI of Internet resources, intelligence analysis.
- 2- Study the content of the received message regarding its importance for response and sufficiency for further study.
- 3- Evaluation using empirical methods of the importance and sufficiency of the information received.
- 4- Determination of compliance of information features with the components of the crime passport by assessing the reliability of information and compliance of information features of the message with the components of the crime passport.
- 5- Determining with the help of hierarchical fuzzy Boolean output methods the specific stage of the crime in accordance with the Criminal Code of Ukraine.
- 6- Determining the availability of time for further research.
- 7- Assessment of compliance of the completeness of the information received with the necessary requirements for further processing.
- 8- Assessment of compliance of the message with a specific type of crime.
- 9- Qualification of a crime in accordance with the article and its part under the Criminal Code of Ukraine.
- 10- Assessment of the possibility of committing aggregate crimes together with the recognized crime in accordance with the qualification.
- 11- Formation of a crime model and a set of measures, in particular preventive ones, to counteract or prevent a crime.

Features of the crime recognition methodology are:

- At the stage of obtaining information, together with the methods available in operational units, the Internet IAI is used;
- When establishing the stage of the crime (preparation for a crime, attempted crime, and stage of the completed crime) using methods of hierarchical fuzzy logical output, the analysis of the received information and available data is performed and data in "iBase" based on the completeness of descriptions of "objects" – "crime". Information notification of the stage of commission of a crime is carried out through an indication by color, which allows to constantly receive messages in real time about the risk of a crime in any area of responsibility, establish the severity of the crime and form proposals for the decision of the head of the operational unit on the use of forces and means to counter such crimes;
- At the stage of forming a model for committing a crime based on the analysis of the actions of criminals, a number of hypotheses of the crime are put forward (time and place, composition of persons involved in the crime and their relationships, methods of action, directions and possible tricks), taking into account its stages. Using the method of competing hypotheses, the most correct one is determined and the corresponding model of preventing or countering a crime is worked out (purpose, tasks, areas of action, composition of forces and means, sequence and methods of action, expected results).

Separately identified crimes do not provide a complete picture of threats to border security and do not allow to develop a strategy to combat the crime which they actually manifest. Therefore, the methodology has improved the method of strategic criminal analysis (hereinafter – SCA) by operational units of the State Border Guard Service of threats to border security, the structure of which is shown in Figure 4.

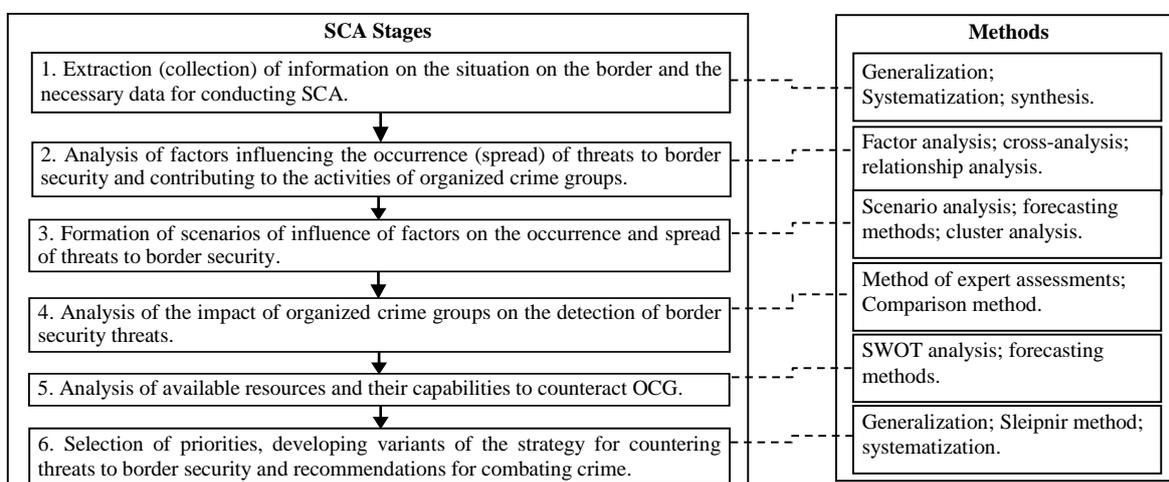


Figure 4. Structure of the method of strategic criminal analysis of border security threats by the border guard operational units

Features of the SCA method shown in Figure 4 are:

- A. At the first stage, attention is focused on the following elements: the nature of organized crime, the spheres of influence, the scale and factors of its manifestation, the composition of persons involved in illegal activities;
- B. On the basis of cross-analysis of relationships based on the values of the Matrix data (Table 1), the most significant factors that affect others and contribute to illegal activities, emergence and spread of threats to border security are identified;

Table 1. List of factors affecting the occurrence (spread) of threats to border security, and the level of their interdependence

No	Factor	Impact level	P (%)	1		2			3			...	
				Migration processes		Corruption			Economy				
				a	b	a	b	c	a	b	c		
				Increase (3%)	Level 2020	Increase	Level 2020	Reduction	Growth (4-6%)	Growth (2-4%)	Decline (<2%)		
1	Migration processes	a	Increase (3%)	70								...	
		b	level 2020	30			2	0	-2	2	0	2	...
2	Corruption	a	Increase	40	3	0				-1	0	3	...
		b	Level 2020	20	-1	1				0	1	-1	...
		c	Reduction	40	-3	2				1	0	-3	...
...	

- C. By studying the most significant factors using cluster analysis, the most important scenarios are selected (Table 2) that can contribute to the emergence (spread) of a threat to border security (OCG activities) or its reduction.

Table 2. The most significant scenarios for the influence of factors on border security threats

Factor	Scenario 1 (spreading of the threat)	Scenario 2 (Threat reduction)
Migration processes	Increase	Current level
Corruption	Increase	Reduction
Economy	Growth (4-6%)	Decline
...

- D. The degree of influence of OCG on the detection of threats to border security is determined using the parameters (P) presented by numerical value in accordance with the hierarchical classification (Table 3) in the sequence of increasing of the threat impact. In the future, in Table 4, each organized criminal group is provided with an ID code, which indicates the level of manifestation (national (N), regional (R), local (L)) and a numerical value according to the state classifier of objects of the administrative-territorial structure of Ukraine by the scale of manifestation of organized criminal group. In addition, the content of a separate parameter corresponds to OCG, where "+" – belonging. Using the Sleipnir toolkit approach, calculations are performed, for which high threat = 4 x P, medium or unknown = 2 x P, low = 1 x P, Zero = 0. The total value is the sum of points for all parameters according to each of the OCG (Table 4).

Table 3. Parameters for evaluating organized criminal groups

No	Parameter (P)
1	Number (number of people in an organized criminal group)
2	Experience of illegal activities
3	Monopolism
4	Cohesion
5	Sustainability
6	Scale (area of activity)
7	Diversification (diversity of crimes)
8	Stealth
9	Interaction with other OCG
10	Money laundering
11	Legality of activities (for example, as organizations, institutions)
12	Corruption

Table 4. General assessment of the degree of influence of organized criminal groups on the state of border security (Optional)

ID code OCG	Assessment of the degree of OCG influence	Parameter number according to Table 3 (See No)											
		1	2	3	4	5	6	7	8	9	10	11	12
N-73240-13	High threat	+	+	+	+	-	+	-	-	+	+	+	+
...													
R-56258-15	Moderate	-	+	+	+	-	+	-	+	-	+	-	+
...													
M-51247-18	Low	-	+	-	+	-	+	-	-	-	+	-	-
...													

At the next stage of the study, we improved the methodology of IAA management of the border guard operational units based on the results of assessment of its condition.

The difference between the methodology and traditional approaches is in the use of an expanded set of indicators and definition of new procedures for evaluating IAA and correcting its state in the process of management. This made it possible to assess the state and results of the IAA, identify inconsistencies in its content and technology with the needs and requirements that relate to it, and systematize measures to correct it. The methodology is based on methods for studying operations and statistics. This methodology contains a partial methodology for assessing the state of the IAA of operational units and a partial methodology for managing the IAA of operational units.

It is proposed to perform a partial methodology for assessing the state of IAA of operational units of the SBGS of Ukraine in the following sequence:

- 1- Description of the evaluation situation.
- 2- Identification of factors affecting IAA.
- 3- Justification of the requirements for IAA and conditions for its implementation.
- 4- Making decisions on IAA assessment (appropriate solutions are selected taking into account the conditions (restrictions) of the IAA assessment task).
- 5- Selection of the list of IAA properties and their corresponding indicators, the aggregate variant of which is presented in Table 5.

Table 5. A set of indicators for evaluating the information-analytical activity of the operational units of the State Border Service of Ukraine

№	Name of a comprehensive indicator	Components
I. Overall comprehensive indicator (V_1) to evaluate the process of obtaining (collecting, extracting) data (information) necessary to perform the tasks of the operational unit		
1	Comprehensive indicator ($V_{1.1}$) to assess the degree of compliance of the received information with the tasks of the operational unit	The amount of information received within the limits of operational-search case $x_{1.1}^1$
		The amount of information received within the framework of operational interaction $x_{1.2}^1$
		The amount of information received for use in the operational unit's databases $x_{1.3}^1$
...
II. General comprehensive indicator (V_2) evaluation of the process of information analysis (analytical research).		
1	Comprehensive indicator ($V_{2.1}$) to assess the quality of analytical products developed within the framework of operational search cases	Total number of analytical products developed within the operational-search case $x_{1.2}^2$
		Number of analytical products that were used as evidence of the involvement of persons in the commission of crimes $x_{1.3}^2$
		...
III. General comprehensive indicator for evaluating the IAA organization process in the operational unit (V_3)		
1	Comprehensive indicator ($V_{3.1}$) to assess the ability of the head of the operational unit to make informed decisions to complete IAD tasks	Total number of decisions and issues taken by the IAD $x_{1.1}^3$
		Number of decisions that resulted in information about crimes committed at the state border $x_{1.2}^3$
		Number of solutions based on the results of which analytical products were developed $x_{1.3}^3$
...

6- Defining (selecting) quantitative and qualitative indicators and the procedure for calculating them.

The value of these indicators can be variable over different time periods, so quantitative indicators are calculated using the expression:

$$x = \frac{1}{t} \sum_{i=1}^n \alpha_i x_i \tag{1}$$

where α_i is the weighting factor of the importance of a particular property of the IAA to meet the needs of the operational unit for a certain period of time (t).

Indicators that characterize the qualitative properties of IAA are calculated using expert evaluation methods.

- 7- Calculation of values of individual IAA indicators.
- 8- Formation of an integral indicator for evaluating IAA (Figure 5).

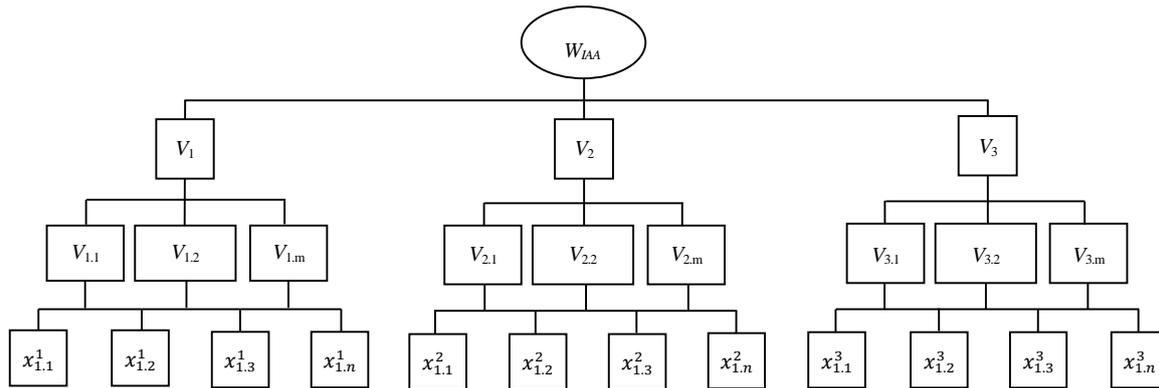


Figure 5. Procedure for forming an integral indicator for evaluating information-analytical activity

9- Performing calculations for evaluating the IAA of operational units, in particular, a comprehensive indicator (V_m) is calculated by the expression:

$$V_m = \sum_{i=1}^m \varphi_i f_i(x), \tag{2}$$

where φ_i is the weight ratio i -th objective function $f_i(x)$; m is the serial number of the complex indicator

To evaluate the processes of IAA, for example, the process of collecting and extracting data (information), the quantitative and qualitative indicators of which form the structure and range of variable values for constructing a recursive function, the following formula is used:

$$V_1 = f[V_{1.1}, \dots, V_{1.m}], \tag{3}$$

where $V_{1.1}, \dots, V_{1.m}$ are comprehensive indicators of the specified process.

Based on the calculations made a general assessment of the IAA of operational units of the SBGS of Ukraine is carried out:

$$W_{IAA} = [V_1, V_2, V_3], \tag{4}$$

where V_1, V_2, V_3 are results of evaluating each of the IAA processes.

10- Determining the state of the IAA (its level) and justification of the management decision is carried out by comparing the obtained value of the integral indicator (W) according to the numerical values given in Table 6.

Table 6. Determining the level of state of information-analytical activity

Level	Numerical value of the integral indicator
High	0.81–1.00
Sufficient	0.64–0.80
Low	0.43–0.63
Unsatisfactory	0.00–0.42

Based on the assessment of the state of IAA, a partial methodology for managing IAA of operational units has been improved, the algorithm of which is proposed to be carried out in the following sequence:

- 1- Organization of training of personnel of operational units to perform IAA tasks.
- 2- Determining the purpose of the IAA of operational units.
- 3- Getting initial data for managing IAA.
- 4- Assessment of compliance of the available initial data for the organization of IAA management with the needs for performing tasks by operational units for the protection of the state border.
- 5- Making a decision on the organization of IAA.
- 6- Planning of IAA of operational units.
- 7- Definition and setting of tasks for IAA of operational units.
- 8- Organization of interaction and coordination and comprehensive support of IAA.
- 9- Control over the implementation of IAA tasks.
- 10-Analysis of the results of performing IAA tasks.
- 11-Assessment of the IAA status.
- 12-Adjusting the goals and objectives of the IAA.

Further we developed a *mathematical model for constructing operational cover of the state border by operational units of the SBGSU of Ukraine*, which takes into account the dependence of the distribution of available resources (operational forces and means) of operational units on the manifestation of crime at the state border. This made it possible to justify the rational distribution of operational forces and resources in order to ensure timely receipt of information about changes in the criminal situation in the entire area of responsibility of operational units. The model is based on statistical methods and methods of operations research. To develop a mathematical model for constructing operational border cover, operational units of the SBGSU of Ukraine analyzed the existing state of operational cover and generalized quantitative and qualitative indicators of the secret apparatus of the State Border Guard Service.

The results of coverage of the criminal situation and the fight against crime indicate a discrepancy between the distribution of operational forces and means of operational units of the SBGSU regarding the actions of offenders, which does not ensure the effectiveness of operational cover of all sections of the state border.

In the general border protection system, operational cover is performed by operational units of the State Border Guard Service of various levels from the border guard operational search division (hereinafter – BGOSD) to the Main Operational Search Division (MOSD) and the Office of OSA of the Regional Directorate (hereinafter – OOSA of RD) (Figure 6).

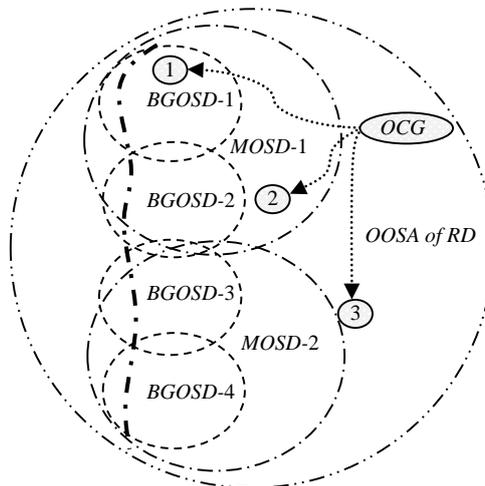


Figure 6. General scheme of construction of operational cover of the border of Ukraine in the area of responsibility of the Office of Operational-Search Activity of the SBGSU Directorate

The effectiveness of performing tasks by an operational unit to cover the state border of Ukraine is determined by the formula:

$$P_i = 1 - e^{-k_{ij}y_j} \tag{5}$$

The target function of allocating the resource of an operational unit for operational cover of the area of responsibility is the following:

$$f(y, x) = \prod_{j=1}^l P_j (y_j) x_{ij} \rightarrow \max. \tag{6}$$

If an organized criminal group operates on a section of the state border of Ukraine, it causes damage to national security or the security of the state border. Under such conditions, the target function for OCG actions is the following:

$$\bar{f}(y, x) = \prod_{j=1}^l u_m (1 - P_j(y_j)x_{ij}) \rightarrow \max. \quad (7)$$

Rational resource allocation using the Stackelberg method:

$$f(y^*, x^*) = 1 - e^{-\frac{R \sum_{0.5k_S}{k_j}}{k_j}} \quad (8)$$

$$\bar{f}(y^*, x^*) = u \left(1 - \left(1 - e^{-\frac{R \sum_{0.5k_S}{k_j}}{k_j}} \right) \right) \quad (9)$$

where R is the available resource (operational forces and means) of the operational unit; y_j is the total costs of the resource (operational forces and means) of the operational unit; j is the area of responsibility of the operational unit, $j = 1, \dots, l$; D is the distribution of offenders in the area of responsibility of the operational unit; x_{ij} is the number of offenders of i is the group that have selected j is the area for the commission of crime or refused it and did not go to the area of the committing crime; k_{ij} is the parameter for receiving information about the offender from the state border sector; u_m is the the amount of damage done by the group of offenders (organized crime groups) according to the degree of danger of the crime committed, characterized by the corresponding index (for example, the terrorist threat index).

This made it possible to justify the rational distribution of operational forces and resources in order to ensure timely receipt of information about changes in the criminal situation in the entire area of responsibility of operational units. In addition, it provided an opportunity to increase the effectiveness of work within the operational-search case; strengthen operational positions; carry out measures to adjust the agent network; increase information and analytical support for senior management.

Based on the developed methodological apparatus, a number of recommendations for improving the effectiveness of the IAA of operational units of the SBGS of Ukraine were grounded, such as:

- a. Improvement of the processes of extraction and formation of operational-search information on the border of Ukraine by operational units of the SBGS of Ukraine on the basis of:
 - Improvement of the construction of operational cover of the state border by operational units;
 - Using the potential of information-analytical interaction for the extraction and formation of operational-search information.
- b. Improvement of the processes of crime recognition and analysis of threats to border security based on the development of the criminal analysis system through the introduction of recommendations on:
 - Improvement of the organization and implementation of criminal analysis in operational units of the SBGS of Ukraine;
 - Application of criminal analysis in the system of support for managerial decision-making to counteract crime on the state border of Ukraine;
 - Selection and professional training of criminal analysts in operational units of the SBGS of Ukraine;
- c. Creation and functioning of regional centers for detecting and analyzing threats to border security, which provides an opportunity to apply at the regional and territorial levels of operational units of the State Border Guard Service of Ukraine of the institute of situational not on the staff analytical groups. This will allow to carry out constant monitoring of factors that cause threats to border security, identify them in time, analyze risks and form more reasonable proposals for countering threats;
- d. Development of the IAA on the basis of increasing the capabilities of the operational units of the State Border Guard Service of Ukraine, which provides an opportunity for each situation (certain scenario) of the development of the situation in the border security space to form a set of measures to achieve the capabilities of the forces and means of the IAA of the operational units of the State Border Guard Service to ensure border security.

4. Discussion

One of the ways to compare the obtained results of a scientific study with other (previously conducted) studies is to check their reliability and correctness, and that means carrying out their verification. For this purpose, a quantitative and qualitative analysis of the developed methods is carried out regarding their truth and determination of the degree of compliance (relevance to the "best" option). Such an option can be set by a system of requirements that, as a rule, correspond to thematic normative legal acts, the perspective vision of experts, and characterize all important aspects of a meaningful representation of the subject of research.

The verification of the obtained research results was carried out on the basis of a comparative analysis of existing and developed methods that make up the scientific-methodological apparatus (SMA) in the following sequence:

- 1- Determination and systematization of requirements for the "best" option, formation of a verification scale based on relevance (tables 7 and 8). The requirements for the IAA must correspond to the goals and tasks that the units of law enforcement agencies as a whole are obliged to fulfil.
- 2- Collection of information about previously developed SMA with which it is planned to compare the developed SMA according to the correspondingly formed system of requirements.
- 3- Expert assessment of the relevance (degree of conformity) of the analyzed SMA to each of the requirements (using the data in Table 7).

Table 7. The scale for assessing the quality of verification based on the attribute "relevance"

Qualitative assessment	The sign of the relevance of the methodological apparatus
"3" - corresponds	The aspect is fully taken into account in the SMA
"2" - mostly corresponds	The aspect is mainly taken into account, but the SMA needs minor refinement
"1" - partly corresponds	The aspect is partially taken into account, but the SMA needs significant revision or it is impossible to establish the degree of consideration of the aspect
"0" - does not respond	The aspect cannot be taken into account in the SMA

- 4- Counting the number of fulfilled and unfulfilled requirements, as well as the sum of points regarding the relevance of the analyzed SMA.
- 5- Calculation of the suitability index (K_{ni}) of the analyzed SMA.
- 6- Calculation of the relevance index (K_{pi}) of the analyzed SMAs.
- 7- Calculation of the indicator of comparative advantage (K_{ki}) of the developed SMA over the existing (previously developed) ones:
- 8- Forming a conclusion regarding:
 - The level of fulfillment of the number of requirements to the developed and existing SMA (based on the K_{pi} value);
 - The level of perfection of the developed and existing SMA (based on the value of K_{pi}), that is, how close they are to the "best" option (in percentage);
 - The level of superiority of the developed SMA over the existing ones (based on the K_{ki} value);
 - The existing potential for further development of the developed SMA.

The results of a comparative analysis of the existing and developed SMA of the units of law enforcement agencies are shown in Table 8.

Table 8. Results of a comparative analysis of the existing and developed scientific and methodological apparatus of information-analytical activity

No of the requirements	Requirements	Assessment of the "best" option	Source of origination of SMA			
			[4]	[9]	[10]	Developed SMA
			Assessment of relevance of SMA			
1	The SMA must take into account the needs of the units of law enforcement agencies in intelligence information:					
1.1	• On the possibility of extracting and forming intelligence information from the global data network (Internet resources);	3	0	0	0	2
1.2	• On the possibility of obtaining and forming intelligence information in the conditions of a special period;	3	1	1	0	3
1.3	• On the possibility of obtaining and forming intelligence in other conditions.	3	2	1	0	2
2	The SMA must take into account the needs of units of law enforcement agencies in substantiated proposals based on the results of the analysis of the situation:					
2.1	• On the possibility of instrumental means for recognizing crimes committed by cross-border crime;	3	2	0	1	3
2.2	• On the possibility of instrumental means for the analysis of threats to border security from the side of cross-border crime.	3	3	2	3	3
3	The SMA must take into account the needs of units of law enforcement agencies in managing the processes of IAA and determining the need for its correction:					
3.1	• On the possibility of instrumental means for assessing the state of IAA;	3	2	1	1	2
3.2	• On the possibility of instrumental means for managing IAA processes.	3	1	1	0	2

4	The SMA must take into account the needs of units of law enforcement agencies in ensuring the cover of the state border by an agent network from among the persons with whom confidential cooperation is carried out:					
4.1	• On the possibility of taking into account all possible variants of actions of offenders;	3	2	1	3	1
4.2	• On the possibility of making calculations regarding the distribution of forces and means	3	0	0	2	3
5	The SMA must take into account the needs of units of law enforcement agencies regarding IAA in various conditions	3	2	1	3	2
Results of calculations						
The number of fulfilled requirements for the "best" option (N_{max}) and other SMA (N_i)		10	8	7	6	10
Number of unfulfilled requirements		0	2	3	4	0
Sum of points for the "best" option (S_{max}) and other SMA (S_i)		30	15	8	13	23
Suitability indicator: $K_{ni} = N_i / N_{max}$		1	0.8	0.7	0.6	1.0
Relevance indicator: $K_{pi} = S_i / S_{max}$		1	0.5	0.27	0.43	0.77
Indicator of comparative advantage: $K_{ni} = K_{pip} - K_{picu}$, де K_{pp} , K_{picu} is the value K_{pi} for the developed and existing SMA respectively		-	0.27	0.5	0.34	0.00

For the purposes of our study, together with the developed one, was used the SMA, which provides the opportunity to take into account the requirements related to the IAA of the units of law enforcement agencies both partially and in full. The advantages of the obtained results in comparison with the already existing scientific and/or practical developments make it possible to determine the contribution of the developed scientific results to science and/or practice.

The evaluation of the SMA was carried out using the scale for assessing the quality of verification based on the attribute "relevance", the value of which is given in Table 2. Therefore, the SMA developed by the author's team has a high level, is close to the "best" option, which is 77%, and, in some positions (from 27% to 50%), prevails over the existing SMAs. This is confirmed by the results of the verification using the method of comparative analysis, which made it possible to establish that none of the analyzed existing SMAs provides a full solution to the modern needs of IAA units of law enforcement agencies.

5. Conclusions

In the framework of the study, the methodology for obtaining and developing operational-search information by operational units of the Border Guard Agency has been developed. The use of the methodology allowed operational units to reduce the time required to obtain operational-search information about criminal activity by 1.23 times. Also, the methodology for recognizing crimes and analyzing threats to border security by operational units of the Border Guard Agency was developed. The methodology is based on taxonomy, artificial intelligence, expert evaluation, and SWOT analysis methods. The methodology for managing the IAA of operational units of the Border Guard Agency based on the results of assessing their condition was developed.

The mathematical model for constructing operational cover of the border by operational units of the Border Guard Agency takes into account the dependence of the distribution of available resources of operational units on the manifestation of crime at the border. This made it possible to justify the rational distribution of operational forces and resources in order to ensure timely obtaining information about changes in the criminal situation in the entire area of responsibility of operational units. The model of this process is based on statistical methods and methods of operations research.

Experimental verification of the implementation of the results of scientific research indicates the advantages of the developed scientific results in contrast to traditional approaches to IAA in the operational units of the Border Guard Agency in terms of "reliability" by an average of 1.18 times and in terms of "efficiency" – by an average of 1.23 times. Based on the developed scientific and methodological apparatus, a number of recommendations for improving the IAA of operational units of the SBGSU were elaborated, namely: improving the processes of obtaining and forming operational-search information on the state border of Ukraine by operational units of the SBGSU; improving the processes of identifying crimes and analyzing threats to border security based on the development of the criminal analysis system of the SBGSU; creating and functioning of regional centers for detecting and analyzing threats to border security; and developing information and analytical activities based on increasing the capabilities of border guard operational units. The implementation of the obtained scientific results in the practical activity of border guard operational units contributed to increasing the efficiency of their IAA by up to 20%.

6. Declarations

6.1. Author Contributions

Conceptualization, O.F., A.M., N.P., A.B. and I.K.; methodology, O.F., A.M., N.P., A.B. and I.K.; writing—original draft preparation, O.F., A.M., N.P., A.B. and I.K.; writing—review and editing, O.F., A.M., N.P., A.B. and I.K. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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