

Methodical apparatus for risk assessment in decision-making to combat illegal migration at the state border of Ukraine

 Ihor Bloshchynskiy^{1*},  Oleksandr Meiko²,  Victor Zalozh³,  Volodymyr Andrushko⁴,

 Olena Voitiuk⁵

^{1,2,3,4,5} Bohdan Khmelnytskyi National Academy of the State Border Guard Service of Ukraine, 46 Shevchenka Street, 29000 Khmelnytskyi, Ukraine; i.bloshch@gmail.com (I.B.), dachia_75@ukr.net (O.M.), v زالozh@gmail.com (V.Z.), avzzet@icloud.com (V.A.), o.a.voitiuk@gmail.com (O.V.).

Abstract: This study proposes a methodical apparatus for risk assessment when making decisions on combating illegal migration at the state border of Ukraine. This apparatus includes a risk assessment methodology, a set of risk assessment indicators and criteria for combating illegal migration, a model of illegal migration risk assessment and a model for choosing the processing method. The goal that was set during the methodology development involves the following main stages: forming a set of indicators and criteria for risk assessment, assessment of the threat impact level (assessment of the threat probability level and the level of the threat's negative consequences), vulnerability assessment, determining the risk level and the processing method. An expert survey of analysts from the Ukrainian Border Guard Agency was carried out to develop this set of risk assessment indicators and criteria. The proposed set includes new indicators, mathematical assessment models, quantitative values of assessment criteria and considers the influence weight of the main factors on the threat and vulnerability levels. This provides an opportunity to bring the qualitative characteristics of the risk level indicator to the provisions of modern risk management theory to obtain the quantitative value of the risk level, to exclude a subjective factor in assessment and to determine the risk level more accurately. The improved methodical apparatus allows developing of an action strategy aimed at minimizing the negative consequences of risk when making management decisions to combat illegal migration to assess a risk management result using an economic effect indicator.

Keywords: *Combating illegal migration, Indicators and criteria, Management decision, Methodical apparatus, Risk analysis, Risk assessment model, State border, Threat impact level.*

1. Introduction

One of the directions of the state's security policy in Ukraine's integration into the European Union (EU) is the transition of the State Border Guard Service of Ukraine (henceforth referred to as the border guard agency) to the standards of law enforcement agencies of the EU member states. These standards cover nearly every aspect of activity from staff procedures to the type of fuel for weapons and equipment.

All of the previous discussions relate entirely to the execution of information-analytical assistance for management activities including the process of conducting risk analysis in accordance with the EU Member States' Common Integrated Risk Analysis Model.

The analysis results of the management activity implementation by the authorities of the border guard agency allow us to assert the existence of a contradiction in the theory and practice of management decision-making between the need to make informed decisions on combating illegal

migration and the lack of an adequate methodical risk assessment apparatus. Therefore, the issue of risk assessment is still relevant and requires further research.

Recently, the problem of internal and external risk management has been developed in many scientific studies by domestic and foreign scientists. The analysis of scientific works on risk management enables us to draw the following conclusions:

Many scientists devoted their studies to the conceptual issues of risk management where they structured the concept of “risk management” by types, substantiated the minimum requirements for implementing a risk management model based on a decision-making matrix formed a risk management mechanism in the organization’s management system summarized approaches to the formation of modern risk management strategies and tactics and revealed the main formation features of a complex risk management system at production enterprises.

Thus, scientists Kaplan and Mikes devoted their work to the development of a new concept for risk management [1]. In this paper, the scholars present a classification of risks that helps managers understand the qualitative differences between the types of risks faced by organizations and proposed approaches to managing internal and external (strategic) risks. The authors reached the conclusion that organizations may use techniques such as scenario analysis and war games to foresee and mitigate the effects of significant external threats.

The issues of risk assessment in project management were analyzed by Jiang, et al. [2], Fetaji [3] and Ivashkov, et al. [4]. The purpose of their research is to develop practical recommendations for assessing and managing project risks. The scholars studied the relationship between critical actions, critical ways and risk scenario management which are applied to project planning from start to completion.

The analysis of political risk, its classification and the main problematic aspects of political risk management are given in the work by Coplin and O’Leary [5].

A sufficient number of scientific works are devoted to issues of customs and border control. Csaba [6] identifies in his work indicators that pinpoint the dangers specific to a specific border region. Risk factors serve as the basis for creating a risk profile but they can also be used for risk analysis at regional or national levels.

Androshchuk [7] proposes a fuzzy inference model for risk assessment of offenses that take place during border control. The use of models provides an opportunity to use qualitative indicators taking into account inaccurate and approximate information as well as to use the experts’ knowledge which is presented in the form of vague rules.

The recommendations on the risk analysis used to form a border management system were elaborated in the work by Lee, et al. [8]. The specific feature of this work lies in the fact that it is aimed at reviewing approaches to risk analysis at the border during the COVID-19 pandemic.

Risk management and the application of risk-oriented selectivity in a single window environment are examined in Part VIII of the World Customs Organisation Compendium [9]. It is crucial for ensuring the simplification of not only trade procedures but also effective and coordinated border control through standardized information and timely receipt of cargo information for risk management and standardized data sharing leading to effective real-time communication and collaborative actions.

The United States–Canada Joint Border Threat and Risk Assessment [10] provides an analysis and assessment of risks on the international border between the USA and Canada. This assessment provides U.S. and Canadian policymakers, resource planners and other law enforcement officials with a strategic overview of significant cross-border threats to make appropriate decisions.

In their scientific work, Rosenblum, et al. [11] provide a model for understanding risks at US borders and assess model border threats in their research.

The researcher uses models to classify threats as a relatively high or low risk for certain planning and budgeting activities as well as for the implementation of certain border security programs.

Ylönen and Aven [12] reveal the issue of intelligence and risk management in the context of customs and border control. In this research, a new perspective on the integration of intelligence and risk management in this context is presented. The guidelines provide customs and border service

management with new ideas and tools for organizing, solving risk and intelligence-related issues and conducting research.

Some issues of economic examination as a means of investigation and counteraction of economic crimes in East Europe were studied by [Khalymon, et al. \[13\]](#). A criminological profile examination of corrupt border guards was presented in the work by [Kuryliuk, et al. \[14\]](#).

The socio-psychological peculiarities of a person who confidentially provides assistance to the operational unit have been substantiated by [Khalymon, et al. \[15\]](#).

Topical aspects of combating the illegal movement of radioactive materials and objects across the state border of Ukraine were presented in the article by [Nikiforenko \[16\]](#). An effective system implementation to minimize harm from drug use in health and public safety has been revealed by [Kuryliuk, et al. \[17\]](#).

At the same time, it is feasible to claim that there are very few studies that address risk analysis in some way based on the study of research on the topic of ensuring state border security beyond border crossing locations. The methodological documents [18-21] reflect the experience and recommendations of the EU Frontex agency regarding risk assessment and its analysis in the field of border security and clarify the general scheme of risk analysis based on current regulations and the operational and service activities of the state border protection bodies.

Thus, there are still insufficient research papers that address risk assessment in the context of Ukraine's state border security on a comprehensive basis. A significant place in these works is devoted to the empirical description of risks. Theoretical generalizations mainly address only partial aspects of the risk analysis especially in the context of the methodological apparatus for assessing the risk level in the illegal migration field which ensures that an adequate decision is made to counteract it.

Therefore, the need to develop a methodological apparatus for risk assessment when making decisions on combating illegal migration at the state border is still urgent.

2. Methodology

The purpose of the paper is to improve the methodological apparatus of risk assessment when making decisions on combating illegal migration at the state border.

The main purpose of risk analysis is to provide information and analysis results that facilitate decision-making regarding the reduction and mitigation of its impact. Three major factors can be used to assess risk: threat, vulnerability to threat and threat impact. The above conclusion is supported by a review of regulatory texts, methodological suggestions and real-world risk analysis experience. This approach is aimed at emphasizing risk analysis as a key tool for ensuring adequate decision-making regarding threat counteracting and risk management.

The development of a methodological apparatus for risk assessment in the field of combating illegal migration should be based on the comprehensive use of the entire arsenal of modern research methods. At the same time, special attention should be paid to the formation of a set of indicators and assessment criteria that reflect the threat impact and draw quantitative and qualitative conclusions about the risk level and the expediency of conducting certain countermeasures.

A model for evaluating the risk of illegal migration, a model for selecting the processing method, a set of risk assessment indicators and criteria and the assessment methodology itself comprise the methodical apparatus for risk assessment in decision-making on combating illegal migration at the state border all of which are in line with the established goal.

The risk assessment methodology in the field of combating illegal migration is regarded as a set of rules for the formalized processing of information about illegal migration threats in order to determine the risk level and an adequate countermeasure mechanism.

3. Results

The goal set during the development of the methodology implies the following main stages: forming a set of risk assessment indicators and criteria, assessment of the threat impact level (assessment of the

occurrence probability and the level of threat negative consequences), vulnerability assessment, determination of the risk level and the method of processing.

1. *Formation of a set of risk assessment indicators and criteria.* This stage is at the center of risk analysis because structured information processing and analysis will be the basis of threat, vulnerability and consequence assessment.

The input and output parameters of this stage and the methods (means) of their achievement will be as follows:

The input parameters are the purpose of risk analysis, a risk analysis plan, experience and results of operational activities, sources of statistical, information-analytical, empirical and archival data and formalized documents of information-analytical activities.

Output parameters: Arrangement of information in order to establish relationships between its components, elaboration of conclusions and forecasts, trends and regularities, indicators and criteria for threat, vulnerability and risk assessment.

Methods and means: A system for collecting and processing situational data (informative model), methods related to organizational events (briefings, meetings, etc.), procedures and methods of information-analytical activities (SWOT analysis, PEST analysis, scenario method), procedures and methods for risk analysis (expert survey, brainstorming, nominal group technique and Delphi technique).

It is essential to provide a comprehensive overview of the development of a set of risk assessment indicators and criteria due to the significance and complexity of this stage.

The complexity of the situation at the state border is characterized by a large list of threats and the factors that shape them. Therefore, analysts face the task of choosing the most significant threats among them. Certain factors will be relevant to our study in relation to a threat such as illegal migration while other factors will be uncommon. The level of their impact on the probability of the threat occurrence, possible negative consequences and the risk level may be different too.

In addition, the effectiveness of operational and service activities and their final result depends mostly on the ability of the state border protection system to counteract the threat quickly and adequately.

The conducted research (methodological recommendations), the experience in combating illegal activities on the state border and expert assessment and the list of factors that have a great influence on the illegal migration level were compiled by analyzing the content of the main regulatory documents that determine the risk analysis procedure.

The number of factors was minimized by excluding insignificant factors taking into account the objectives of the study. Those factors that do not significantly affect the dynamics of the illegal migration threat and those about which information is not available to the analytical units of the border guard agency.

A survey was conducted among the analytical officers of the border guard agency in accordance with their functional duties, assess and predict threats and risks at the state border to fulfil this task. The scientific and pedagogical staff of the National Academy of the State Border Guard Service of Ukraine was also involved in the survey. The sample size was 29 people which is sufficient to determine the weight of the factors.

The expert assessment was conducted in several stages.

In the first stage, each expert was asked to create a list of risk assessment indicators. After summarizing their opinions, a general list of indicators was compiled and it was provided to the experts for analysis of each indicator. The analysis was conducted according to the following procedure: First, it was necessary to leave the indicator on the list. Then clarify this indicator or reformulate it. Combine it with another indicator. Remove it from the list (with the full agreement of all group members).

As a result, the following indicators remained in the list: an integral indicator the risk level and partial indicators – the threat probability level, the level of negative consequences, the threat impact

level (threat index) and the vulnerability level. The obtained result allows for forming the criteria for their assessment in the future taking into account the degree of influence of the most important factors.

At the second stage, the group of experts was required to form a list of factors affecting the impact level of the illegal migration threat (threat probability level, level of negative consequences), vulnerability level and range of them. The assessment was carried out in secret which increased the objectivity of the approach to determining priorities. Since the experts were familiar with the opinions of others, this contributed to the unification of the participants' positions.

The results of the expert survey are presented in Tables 1-3 and Figures 1-3.

Table 1.

Factors affecting the probability level of the illegal migration threat and their weight.

No.	Factors	Factor weight (q_i)
Y ₁	<i>Foreign policy factor:</i> The state of the socio-economic and military-political situation in the countries that are the main suppliers of illegal migrants transiting through Ukraine to EU member states.	0.204
Y ₂	<i>Social factor:</i> The activity level of criminal groups that specialize in the transportation of illegal migrants and human trafficking, the state of complicity among border area residents.	0.194
Y ₃	<i>Economic factor:</i> The unemployment level in the border areas, the living standard of the local population and the state of the labour market infrastructure.	0.185
Y ₄	<i>Corruption factor:</i> Attempts to involve the personnel of the border guard agency in illegal activities or facilitation of them.	0.041
Y ₅	<i>Complicit factor:</i> The presence of family ties between people engaged in illegal activities and military personnel of the border guard agency.	0.043
Y ₆	<i>Technical factor:</i> The availability of high mobility vehicles among the local population in the border area, thermal imaging and optical devices, modern aircraft (Drones), information about the area.	0.105
Y ₇	<i>Physiographic (epidemiological) factor:</i> The state of the geographical relief of the state border area, road infrastructure, terrain relief, the presence of access roads, routes and settlements in the immediate vicinity of the state border.	0.111
Y ₈	<i>Administrative and legal factor:</i> The mechanism for the deportation of illegal migrants.	0.117

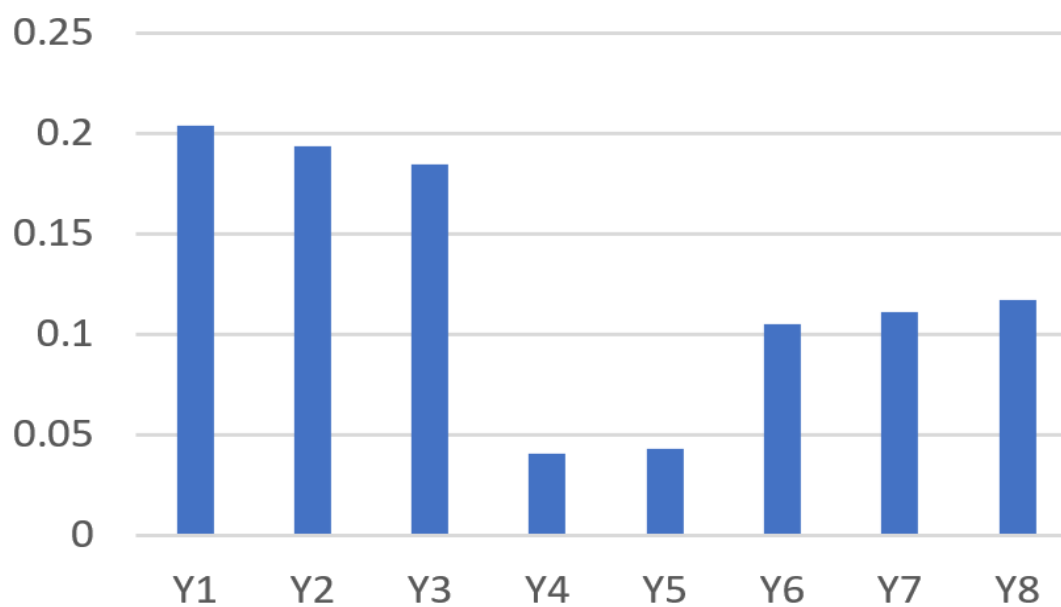


Figure 1.
The weight of factors affecting the probability level of the illegal migration threat.

Table 2.
Factors affecting the level of negative consequences of the illegal migration threat and their weight.

No.	Factors	Factor weight (g_i)
X_1	<i>Foreign policy factor</i> : The level of negative impact on the international security environment.	0.187
X_2	<i>Social factor</i> : The level of negative impact on the image of the border guard agency.	0.090
X_3	<i>Economic factor</i> : The level of damage caused to the state budget.	0.175
X_4	<i>Corruption factor</i> : The level of direct negative influence on military personnel of the border agency.	0.148
X_5	<i>Complicit factor</i> : The level of negative impact on border guard service personnel due to family ties.	0.144
X_6	<i>Technical factor</i> : The level of negative impact on the border infrastructure.	0.045
X_7	<i>Physiographic (Epidemiological) factor</i> : The level of negative impact on the epidemiological situation.	0.036
X_8	<i>Administrative and legal factor</i> : The level of illegal migration (Its increase or decrease compared to the previous period).	0.176

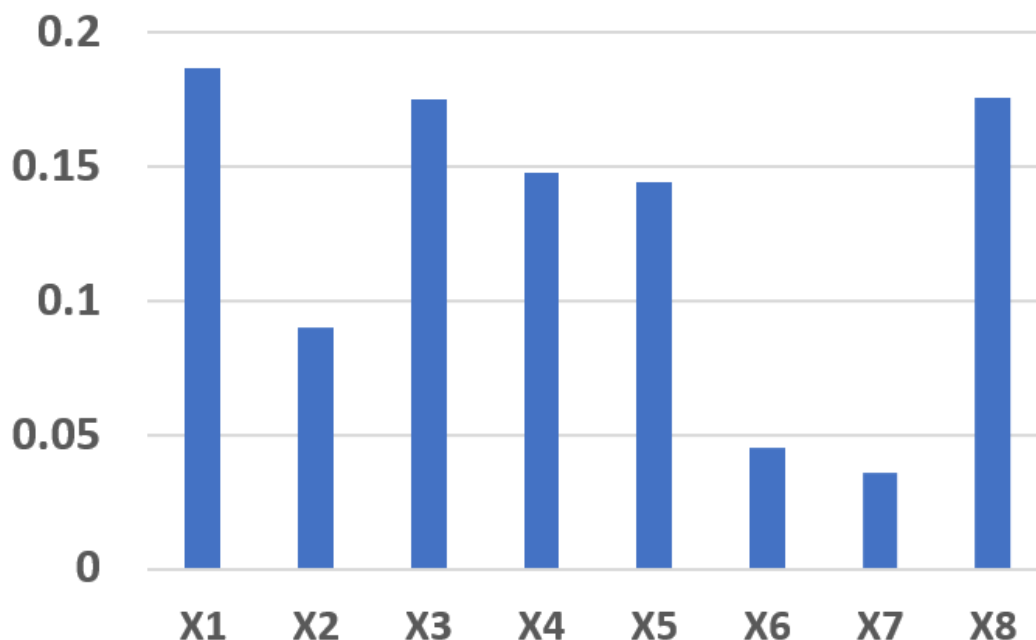


Figure 2.
Weight of factors affecting the level of negative consequences of the illegal migration threat.

Table 3.
Factors affecting the vulnerability level of the state border protection system and their weight.

No.	Factors	Factor weight (w_i)
U ₁	The infrastructure condition of the border section between border crossing points (BCPs).	0.144
U ₂	The number of BCPs across the state border.	0.136
U ₃	The type and intensity of traffic at BCPs.	0.131
U ₄	The staffing state of the border guard units protecting the border beyond the BCPs.	0.126
U ₅	The staffing state of the border guard units protecting the border at the BCPs.	0.103
U ₆	The state of rear, engineering and technical support.	0.086
U ₇	The state of operational-service activity results from the threat counteraction.	0.079
U ₈	The state of cooperation with the border guard of the neighboring state.	0.067
U ₉	The state of professional training and experience of personnel.	0.049
U ₁₀	The state of legislation regarding liability for aiding and abetting illegal migration.	0.038
U ₁₁	The level of society's tolerance for illegal activities.	0.026
U ₁₂	The state of the geographical surface of the state border section and road infrastructure.	0.015

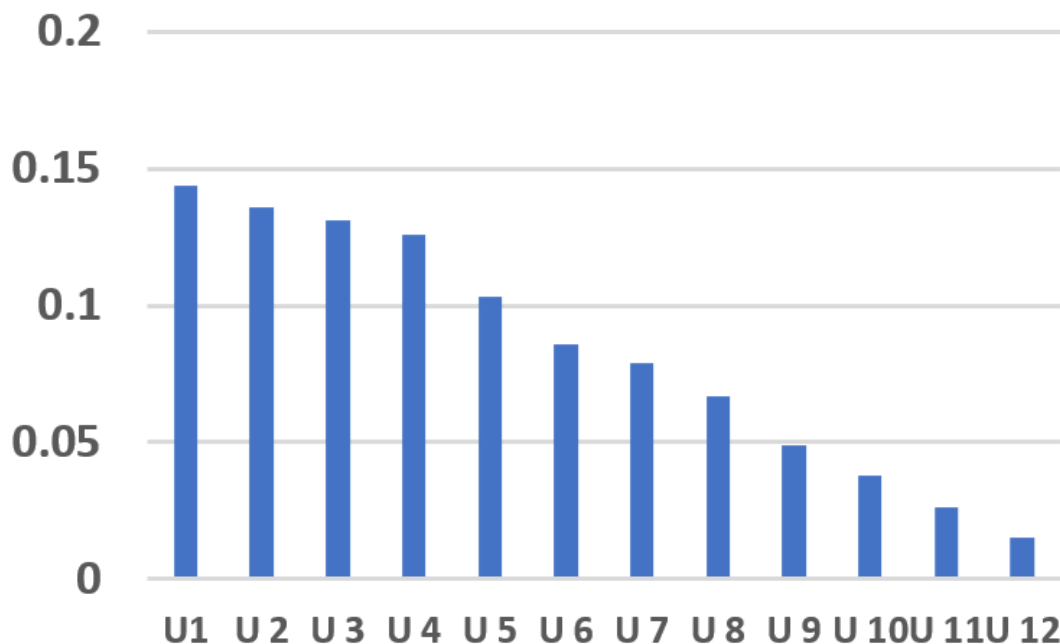


Figure 3
Weight of factors affecting the vulnerability level of the state border protection system.

At the third stage, the group of experts was asked to form qualitative and quantitative criteria for assessing indicators of the probability level, the level of negative consequences and the vulnerability level of the illegal migration threat. The criteria were formed by the “brainstorming” method which allowed identifying and comparing the individual judgments of experts regarding the specified issue. In all the cases, a verbal-numerical scale was used.

The general gradation and quantitative values of the partial level indicators (probability, negative consequences, level of threat impact and vulnerability) are given in Tables 4-7.

Table 4.
General gradation and quantitative values of the indicator of the probability level of the illegal migration threat.

Probability level	The interval in which the value of $P1$ is located	Quantitative value of indicator $P1$
Almost possible	(4,50...5,00)	5
Very likely	(3,50...4,50)	4
Likely	(2,50...3,50)	3
Unlikely	(1,50...2,50)	2
Almost impossible	(1,00...1,50)	1

Table 5.
General gradation and quantitative values of the indicator of the negative consequence level of the illegal migration threat.

The level of consequences	The interval in which the value of $P2$ is located	Quantitative value of indicator $P2$
Maximum	(4,50...5,00)	5
High	(3,50...4,50)	4
Average	(2,50...3,50)	3
Insignificant	(1,50...2,50)	2
Minimum	(1,00...1,50)	1

Table 6.
General gradation and quantitative values of the impact level indicator.

Impact level	Threat index(<i>T</i>)
Critical	(20 ... 25)
Substantial	(12 ... 16)
Moderate	(9 ... 10)
Insignificant	(5 ... 8)
Ignored	(1 ... 4)

Table 7.
General gradation and quantitative values of the vulnerability level indicator.

Vulnerability level	Vulnerability index(<i>V</i>)
Critical	(20 ... 25)
High	(12 ... 16)
Average	(9 ... 10)
Insignificant	(5 ... 8)
Minimum	(1 ... 4)

The criteria for assessing the integral indicator the risk level (*R*) were determined on the basis of the conducted research results at the fourth stage of the work. When evaluating the risk level, the assessments of the description for the indicators of the impact levels of the illegal migration threat and the vulnerability level were used. A variant of the gradation of the integral indicator risk level is given in [Table 8](#).

Table 8.
General gradation of the risk level.

Risk level	Outline of the risk level	Interpretation(<i>R</i>)
High	The vulnerability level outweighs the threat impact level ($V > T$).	Unacceptable risk
Average	The vulnerability level corresponds to the threat impact level ($V = T$).	Tolerable risk
Low	The threat impact level outweighs the vulnerability level ($T > V$).	Acceptable risk

Therefore, the obtained result allows for the formation of a generalized information potential for the risk assessment model in the field of combating illegal migration.

2. *Assessment of the threat impact level (assessment of the threat probability level and the level of the threat's negative consequences).* The purpose of the threat assessment is to identify, describe and measure it in terms of magnitude and probability.

2.1. *Assessment of the threat probability level (*P1*).* Risk assessment is based on identifying threats, real or potential and the probability of their impact. The detection of the threat probability is conducted based on the summary of data and information collected by analysts. The mathematical model for calculating the threat probability level (*P1*) has the following form:

$$P_1 = \sum_{i=1}^8 Y_i \cdot q_i \quad (1)$$

Where Y_i is the i^{th} -factor affecting the probability level of the illegal migration threat, q_i is the weight factor.

2.2. *Assessment of the level of the threat negative consequences (*P2*).* The first step in assessing the threat's magnitude is determining the threat measurement unit.

It is essential to select the most practical indications for additional monitoring in order to convey the risk level. The mathematical model for calculating the level of negative consequences (P_2) has the following form:

$$P_2 = \sum_{i=1}^8 X_i \cdot g_i \quad (2)$$

Where X_i is the i^{th} -factor affecting the level of negative consequences of illegal migration; g_i is the weight factor.

Assessment of the threat impact level (threat index) (T). The level of threat impact (threat index) makes it possible to judge the impact level and the threat level. The mathematical model for calculating the level of negative consequences is as follows:

$$T = P_1 \cdot P_2 \quad (3)$$

According to the study results, it is proposed to assess the impact level of the illegal migration threat, its occurrence probability and the level of negative consequences based on the indicators and assessment criteria highlighted in the first stage of the methodology.

Therefore, the input and output parameters of this stage and the methods (means) of their achievement are:

Input parameters include experience, operational-service activity results, conclusions and forecasts, trends, regularities and recommendations on the threat, risk analysis of previous activities, factors that affect the threat occurrence probability and the scale of the negative consequences, their weight and formalized risk analysis documents.

Output parameters include quantitative values of indicators, the level of threat probability, the level of threat negative consequences and the threat index.

Methods and tools: Procedures and methods of risk analysis (expert survey, brainstorming, nominal group technique and Delphi technique).

3. Vulnerability assessment. Vulnerability should be understood as the factors in the state border security system that can increase or decrease the threat magnitude or probability. Geographical aspects of the border region are among the primary elements influencing vulnerability. Vulnerability analysis also includes the analysis of measures, including threat mitigation capabilities such as the number of personnel and their qualifications, equipment placement and management of priorities and policies. The mathematical model for calculating the vulnerability level (V) has the following form:

$$V = \sum_{i=1}^{12} U_i \cdot w_i \quad (4)$$

Where U_i is the i^{th} -factor affecting the vulnerability level and w_i is the weight factor.

The assessment of the vulnerability level is also proposed to be conducted according to the indicators and assessment criteria highlighted in the first stage of the methodology.

Therefore, the input and output parameters of this stage and the methods (means) of their achievement are:

Input parameters: Experience, operational-service activity results, conclusions and forecasts, trends, regularities and recommendations on the threat, risk analysis of previous activities, analysis of strong and weak points of the organization, factors that affect vulnerability and their weight formalized risk analysis documents.

Output parameters include quantitative values of the vulnerability level indicator.

Methods and tools: SWOT analysis, PEST analysis, procedures and methods of risk analysis (expert survey, brainstorming, nominal group technique and Delphi technique).

4. Determination of the risk level and the method of processing. Quantifying the risk level is usually difficult because impact modelling requires large datasets and efforts to collect critical information and it often takes a long time to perform validation. In most cases, when assessing risk, it is recommended to use qualitative assessments in the form of described levels of risk and their classification.

However, in practice, it is important to fulfil a risk assessment in quantitative terms. For this reason, the model that is schematically shown in [Figure 4](#) is proposed to be used. Subsequently, the method of

processing a risk is determined based on its level of risk (see Figure 5) in order to simplify the adoption of an appropriate management decision.

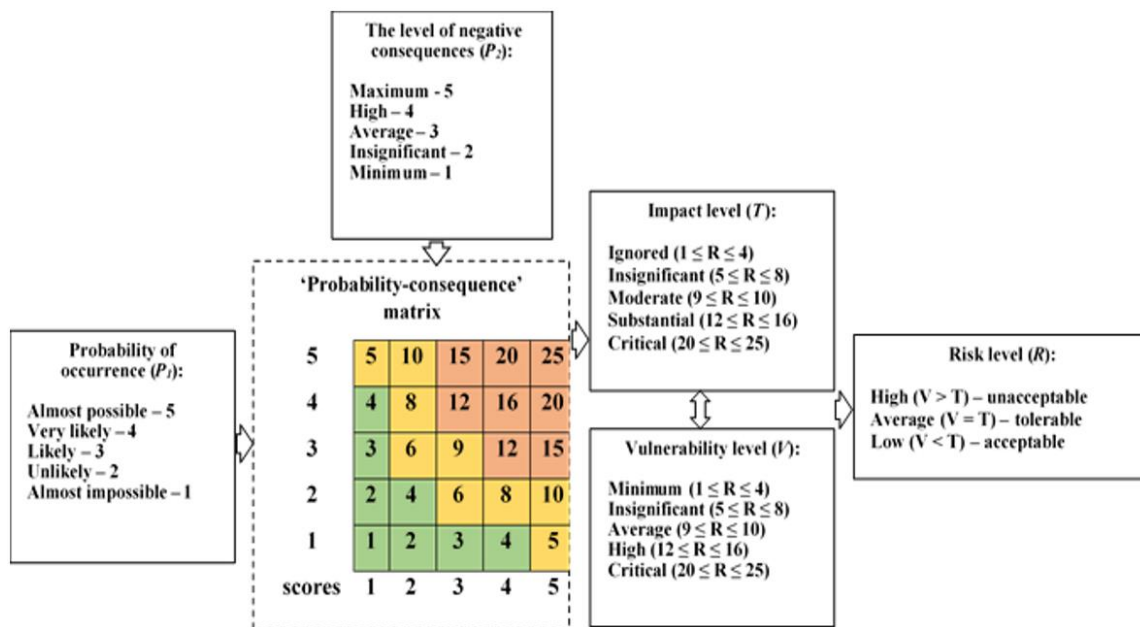


Figure 4. Model for assessing the illegal migration risk.

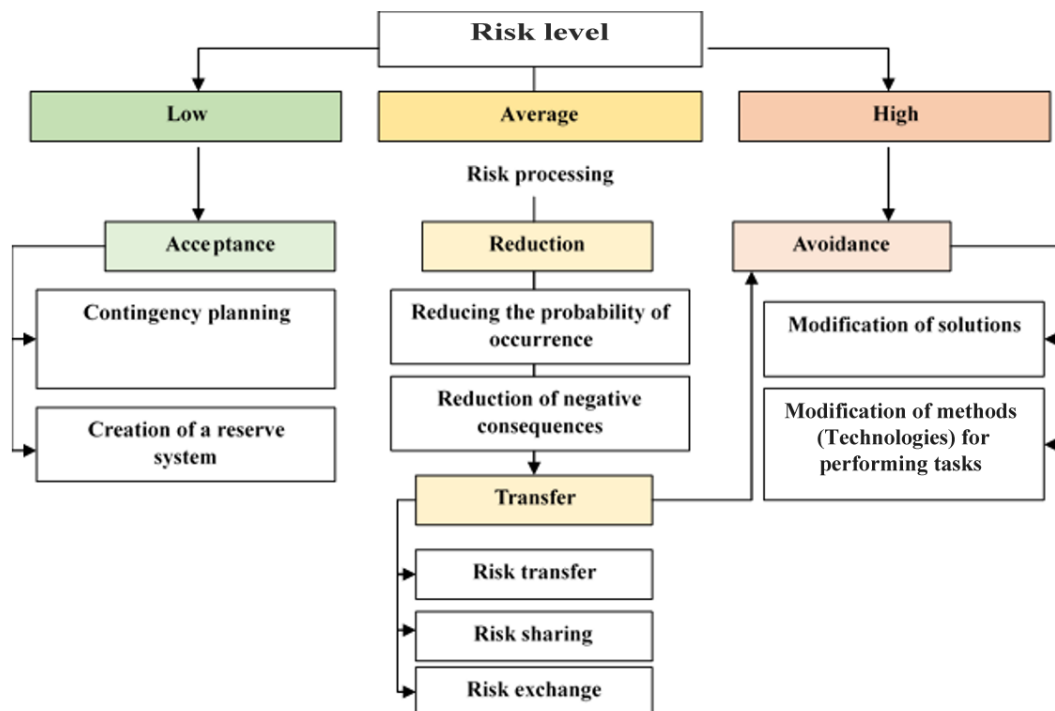


Figure 5. Model for choosing a method for risk processing.

A generalized risk assessment is proposed to be conducted according to the indicators and assessment criteria given in the content of the first stage of the methodology.

Therefore, the input and output parameters of this stage and the methods (means) of their achievement are:

Input parameters: The indicators and criteria for assessing the threat occurrence probability and the scale of negative consequences, the level of threat negative consequences, the threat probability level, the threat impact level the vulnerability assessment indicators and criteria and the vulnerability level.

Output parameters: Risk level and risk processing methods.

Methods and tools: Procedures and methods of risk analysis (expert survey, brainstorming, nominal group technique and Delphi technique).

The economic effect indicator can be used to calculate the financial indicators and the risk management outcome after the completion of processing procedures, if necessary. This indicator will characterize the excess of risk management results over costs in the management process.

$$P_{UR} = \sum_{i=1}^N M_{0i} - \sum_{i=1}^N M_i \quad (5)$$

Where P_{ur} is the risk management result (predicted reduction in the risk impact degree), M_{0i} – probable losses from the i -th risk manifestation (without processing), M_i – probable losses from the i -th risk manifestation (after processing), N is the number of identified risks.

The introduction of an improved methodical apparatus for risk assessment in decision-making on counteracting illegal migration into the practical activities of the state border protection bodies made it possible to obtain the following advantages compared to existing approaches:

Reduce the work time of analysts during risk analysis by 1.2 times.

Increase the assessment objectivity of all indicators of the illegal migration threat and the risk level in general by 1.9 times.

Increase the reliability of decisions by 1.31 times while the efficiency of their adoption gets improved by 1.17 times.

4. Conclusion

The new indicators and mathematical models of their assessment, the quantitative values of the assessment criteria and the consideration of the impact weight of the primary factors on the level of threat and vulnerability are therefore characteristics of the improved set of indicators and assessment criteria which differ from the previous ones.

This made it possible to apply the qualitative characteristics of the risk level indicator to the provisions of modern risk management theory to exclude the subjective factor in the assessment due to the introduction of quantitative criteria and to determine the risk level more accurately.

The improved risk assessment technique unlike the known ones includes a risk assessment model and a model for choosing a method of its processing. This allows unifying the work procedures of analysts for risk assessment to develop a strategy of actions aimed at maximizing the positive and minimizing the negative consequences of risk and to assess the risk management result using the economic effect indicator.

The results of their practical implementation in the daily activities of the state border protection organizations give evidence to the authenticity and dependability of the results produced under the conditions described in the study. In addition, the results of verification and comparative analysis made it possible to establish that the improved methodical apparatus fully meets all the mandatory requirements defined by experts, the level of its approximation to the 'ideal' option is 93% which is 37% higher than existing approaches.

We consider the development of software-algorithmic support for the scientific- methodological apparatus of risk assessment and its implementation into the information and telecommunication systems of the border guard agency as prospects for further research.

Funding:

This study received no specific financial support.

Institutional Review Board Statement:

Not applicable.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Competing Interests:

The authors declare that they have no competing interests.

Authors' Contributions:

All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

Copyright:

© 2024 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

References

- [1] R. S. Kaplan and A. Mikes, "Managing risks: A new framework," *Harvard Business Review*, vol. 90, no. 6, pp. 48-60, 2012.
- [2] J. J. Jiang, G. Klein, and T. S. Ellis, "A measure of software development risk," *Project Management Journal*, vol. 33, no. 3, pp. 30-41, 2002. <https://doi.org/10.1177/875697280203300305>
- [3] B. Fetaji, "Devising new software project risk management model: MARUNA," *TEM Journal: Journal of Association for Information Communication Technology Education and Science*, vol. 1, no. 4, pp. 302-307, 2012.
- [4] Y. Ivashkov *et al.*, "Project management risk assessment methodology in the state border guard service of Ukraine," *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, vol. 12, no. 1, pp. 343-362, 2021. <https://doi.org/10.18662/brain/12.1/186>
- [5] W. D. Coplin and M. K. O'Leary, *Introduction to political risk analysis*. New York: Policy Studies Associates, 1983.
- [6] Z. Csaba, "Border traffic risk assessment," *Academic and Applied Research in Military Science*, vol. 11, no. 2, pp. 273-285, 2013.
- [7] A. S. Androshchuk, "Risk assessment of offences at state border using fuzzy hierarchical inference," *Reliability: Theory & Applications*, vol. 6, no. 23, pp. 72-78, 2011.
- [8] K. Lee, J. Piper, and J. Fang, *Using risk analysis to shape border management: A review of approaches during the COVID-19 pandemic*. Washington, DC: Migration Policy Institute, 2023.
- [9] Integrated Risk Assessment, "Part VIII, vol. 2, 21," Retrieved: <https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/single-window/compendium/swcompendiumvol2partviii.pdf>. [Accessed 28 August 2023], 2019.
- [10] United States-Canada Joint Border Threat and Risk Assessment, "United States-Canada joint border threat and risk assessment," Retrieved: <https://www.dhs.gov/united-states-canada-joint-border-threat-and-risk-assessment>. [Accessed 28 August 2023], 2010.
- [11] M. R. Rosenblum, J. P. Bjelopera, and K. Finklea, "Border security: Understanding threats at U.S. borders, Risk Management of National Security Threats: Select Issues and Topics, pp. 1-40," Retrieved: <https://www.everycrsreport.com/reports/R42969.html>. [Accessed 01 September 2023], 2013.
- [12] M. Ylönen and T. Aven, "A new perspective for the integration of intelligence and risk management in a customs and border control context," *Journal of Risk Research*, vol. 26, no. 4, pp. 433-449, 2023. <https://doi.org/10.1080/13669877.2023.2176912>
- [13] S. Khalymon, P. Vadym, K. Oleg, M. Oleksandr, and O. Strilets, "Forensic economic examination as a means of investigation and counteraction of economic crimes in East Europe (Example of Ukraine)," *Journal of Legal, Ethics and Regulatory Issues*, vol. 22, no. 3, pp. 1-8, 2019.

- [14] Y. Kuryliuk, S. Khalymon, S. Filippov, H. Shvedova, V. Zolka, and A. Vikhtiuk, "Criminological profile of corrupt border guard (Ukrainian experience)," *Journal of Legal, Ethics and Regulatory Issues*, vol. 24, no. SpecialIssue, pp. 1-7, 2021.
- [15] S. Khalymon, V. Polovnikov, and P. Volynets, "Socio-psychological profile of a person who confidentially provides assistance to the operational unit," *Yearbook of Legal Psychology*, vol. 30, pp. 13-20, 2020. <https://doi.org/10.5093/apj2019a10>
- [16] V. Nikiforenko, "Combating illegal movement of radioactive materials and objects across the state border of Ukraine," *Nuclear and Radiation Safety*, vol. 1, no. 89, pp. 30-35, 2021. [https://doi.org/10.32918/nrs.2021.1\(89\).04](https://doi.org/10.32918/nrs.2021.1(89).04)
- [17] Y. Kuryliuk, V. Nikiforenko, S. Filippov, H. Shvedova, and V. Vazhynskyi, "Current state of drug crime control in Ukraine," *Pharmacologyonline*, vol. 2, pp. 1020-1025, 2021.
- [18] Frontex Common Integrated Risk Analysis Model, "Summary booklet. Version 2.0," Retrieved: https://frontex.europa.eu/assets/CIRAM/en_CIRAM_brochure_2013.pdf. [Accessed 05 September 2023], 2013.
- [19] A European Border and Coast Guard to Protect Europe's External Borders, "European commission – press release," Strasbourg, Retrieved: https://ec.europa.eu/commission/presscorner/detail/en/IP_15_6327. [Accessed 04 September 2023], 2015.
- [20] K. F. Aas and H. O. Gundhus, "Policing humanitarian borderlands: Frontex, human rights and the precariousness of life," *British Journal of Criminology*, vol. 55, no. 1, pp. 1-18, 2015. <https://doi.org/10.1093/bjc/azu086>
- [21] The Implementation of the Hotspots in Italy and Greece A Study, "The European council for refugees and exiles. Amsterdam," Retrieved: <https://www.ecre.org/wp-content/uploads/2016/12/HOTSPOTS-Report-5.12.2016..pdf>. [Accessed 02 September 2023], 2016.