

Comprehensive methodology for evaluating the effectiveness of measures to increase the survivability of troops (forces) and objects in the defense operation of the group of troops

Mykola Pidhorodetskyi * ^{1 A}; Oleksandr Ivashchuk ^{2 A}

*Corresponding author: ¹ Candidate of Military Sciences, e-mail: nickpidhorodetskyi@gmail.com, ORCID: 0000-0003-4807-8635

² PhD student, e-mail: sashik-ivashchuk84@ukr.net, ORCID: 0000-0002-8189-6472

^A National Defence University of Ukraine named after Ivan Cherniakhovskiy, Kyiv, Ukraine

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Abstract

In the context of a significant increase in the capabilities of intelligence and data transmission, the rapid development of means of destruction, and, accordingly, the change of views on operations (combat operations), measures to increase the survivability of troops (forces) and objects in operations occupy a leading place in achieving the success of any operation of a group of troops. At the same time, it is obvious that the inconsistency of traditional approaches to determining the nature and scope of the complex of measures to increase the survivability of troops (forces) and objects in operations and insufficient capabilities for their timely implementation leads to significant losses. The existing scientific and methodological apparatus used to assess the effectiveness of measures to increase vitality is not comprehensive, which does not allow to qualitatively assess the effectiveness of a set of measures to increase the survivability of troops (forces) and objects in operations and to substantiate the relevant recommendations and the expediency of their implementation.

That is why, to assess the effectiveness of measures to increase the survivability of troops (forces) and objects in the defense operation, the article based on the analysis of ways to increase the survivability of troops (forces) and objects in armed conflicts of recent decades, and modern approaches to determining the impact of measures to increase survivability based on a systematic approach using probability theory, proposed a methodology for assessing the effectiveness of measures to increase the survivability of troops (forces) and objects in the defense operation.

The method in assessing the effectiveness of measures to increase the survivability of troops (forces) and objects in the operation takes into account the heterogeneous impact of certain measures on the survivability of military facilities, depending on their place, role, and contribution to the overall survivability of the group of troops.

The use of the proposed methodology will allow assessing the survivability of troops (forces) and objects at a certain time interval of preparation and conduct of defense operations and will provide an opportunity to substantiate recommendations for the implementation of a set of measures to increase the survivability of troops (forces) and objects in the operation.

Key words: survivability, equipment, increase, defense, calculating.

Introduction

The realities of today show that the world maintains many political, economic, international, and other contradictions, which is not always possible to solve peacefully, and military force remains one of the most

important means of implementing the policy of states. This requires the constant maintenance of armed forces in combat capability, which is the basis of their combat readiness to reliably ensure the security of the state and achieve

certain goals during the war (armed conflict). At the same time, the experience of local wars and armed conflicts in recent decades indicates that the emergence of new more advanced means of intelligence and destruction has led to a change in the forms and methods of armed struggle. Based on this, the military and political leadership of the leading countries of the world is trying to increase the combat potential of the armed forces, while not trying to increase their number, but by increasing their combat capabilities by equipping them with the latest types of weapons, and the issue of increasing the survivability of troops (forces) and objects in operations becomes extremely relevant. According to the given above causes a need to develop a comprehensive methodology for evaluating the effectiveness of measures to increase survivability. For further substantiation of recommendations to increase the survivability of troops (forces) and objects in operations to a level that will ensure the implementation of certain tasks.

The issues of assessing and improving the survivability of troops (forces) and objects are devoted to a significant number of works, including Voloshchenko O.I., Chernykh I.V., 2017, Kotsiuruba V.I., Cherevko R.M., Ivashchuk O.A., 2019. However, the analysis of existing approaches to the evaluation of survivability, indicates that today the scientific apparatus

used, due to significant changes caused by the modern development of intelligence, data transmission, and destruction, does not allow to qualitatively determine the necessary set of measures to increase the survivability of troops (forces) and objects in specific conditions. In addition, the existing scientific and methodological apparatus is adapted only to assess the effectiveness of individual components and elements of the grouping of troops (brigades, control systems, recovery systems, rear support, etc.) and does not allow to comprehensively assess the effectiveness of measures to increase the survivability of troops (forces) and objects in the defense operation or the level of survivability of the group of troops. The work Voloshchenko O.I., Chernykh I.V., 2017 considers the impact only of fortification equipment on the survivability of troops (forces) and objects, Zagorka O.M., Koval V.V., Zagorka I.O., 2017, Pechorin O.M., 2017 – considers the assessment of survivability depending on the probabilities of reconnaissance and destruction (not damage) of a certain object by the enemy, in Chernykh I.V., Kotsiuruba V.I., Phil V.M. and other, 2016, Karshen A.M., Kolos O.L., Galushka O.M. and other, 2020 – it is determined that the greatest increase in survivability of military facilities gives fortification equipment and considers an increase in survivability due to rational fortifications.

Material and methods

The purpose of the article is to highlight the main provisions of the methodology for evaluating the effectiveness of measures to increase the survivability of troops (forces) and objects in the defense operation of the group of

troops, which will determine and justify recommendations for the implementation of a set of measures to increase survivability in the defense operation in conditions adequate to the requirements of our time.

Results and discussion

Survivability, in the broad sense of the word, is the ability to remain alive. However, considering the concept of survivability using a systematic approach, it becomes obvious that the survivability of troops (forces) and objects of any army in the world is not only the ability to remain alive but also to maintain their ability to perform tasks for their intended purpose under

any conditions of the situation. That is why, under the survivability of troops (forces) and objects in operations, it is proposed to understand their properties to counteract the enemy, to preserve and restore their combat capability on time.

The analysis of the influence of factors and ways to increase survivability Polovenko V.,

2019 allows us to highlight the following components of the properties (Fig. 1), which have a direct and significant impact on achieving

the required level of survivability of troops (forces) and objects in the operation.

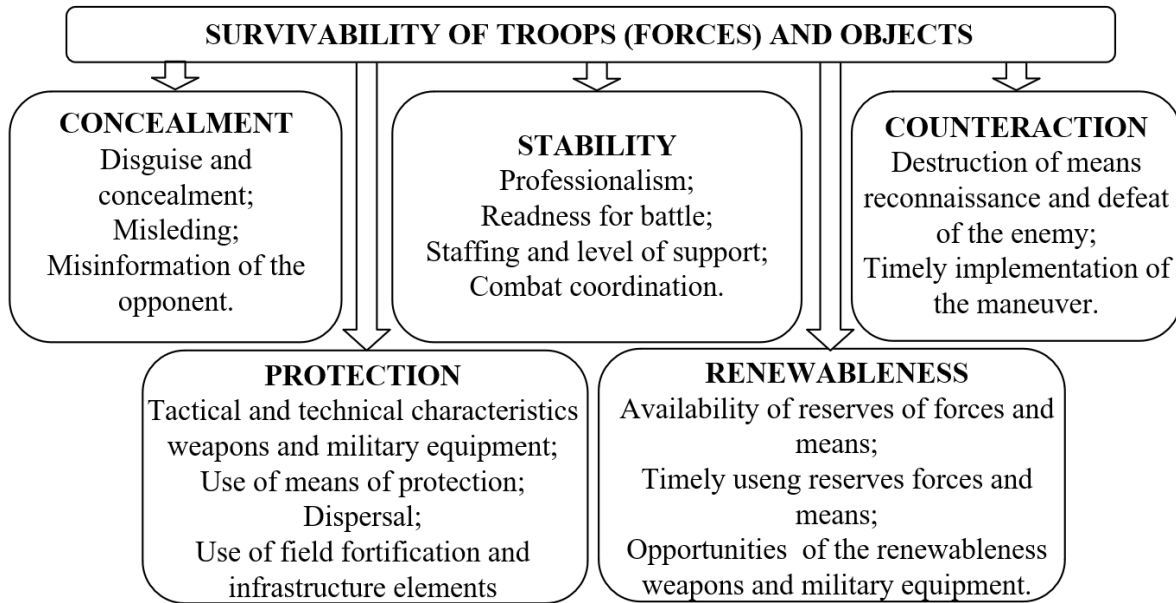


Figure 1 – The main components of the properties of survivability of troops (forces) and objects in the operation

For a comprehensive consideration of the indicators of components of survivability, taking into account their importance in the defense operation, it is proposed to use a comprehensive

methodology for evaluating the effectiveness of measures to increase the survivability of troops (forces) and objects in the defense operation of the group of troops (Fig. 2).

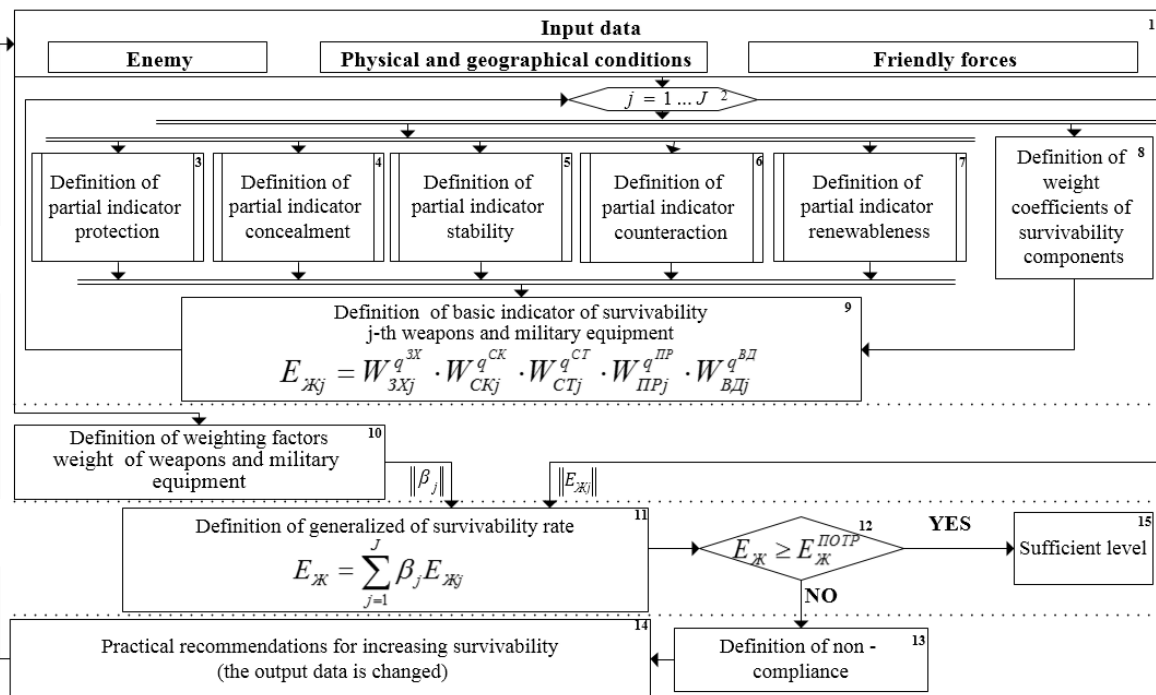


Figure 2 – Structural and logical scheme of a comprehensive methodology for evaluating the effectiveness of measures to increase the survivability of troops (forces) and objects

The essence of the methodology is that the survivability of troops (forces) and objects is considered in the complex as a set of sequential stages.

In unit 1, input data for calculations is formed, and with the help of a cycle (block 2) provides calculations for all military objects (MO).

In blocks 3 – 7, partial indicators are calculated.

Protection (unit 3), as part of the survivability of troops (forces) and objects, is a property for weakening the action of means of defeating the enemy. Analysis of security components (Fig. 1) indicates that one part of them requires the implementation of certain measures, and the other becomes part of personnel or material means. Components that become part of personnel or weapons and military equipment (WME) provide protection only from certain impressive factors and are mandatory elements in the conditions of modern hostilities. Therefore, in the course of the study, the main attention is paid to the implementation of measures to increase vitality, and the achieved level of security will depend on the capabilities of the WME regarding timely field fortification (FF) in specific conditions of combat situation, which can be expressed in an expression:

$$B_{\Phi O}(t) = M_{\Phi O}, \quad (1)$$

where $B_{\Phi O}(t)$ – WME capabilities regarding individual units for a specified time;

$M_{\Phi O}$ – number and types of fortification installation.

The physical content of the protection indicator W_{3X} consists in determining stochastic values of mathematical expectation of the share of adversary losses at the expense of individual equipment and units $W_{3X} = f(M_{\Phi O})$, calculating according to Chernykh I.V., Kotsiuruba V.I., Phil V.M. and other, 2016 the formula:

$$W_{3X} = Q_j^{3B} Q_j^{BT3}, \quad (2)$$

where Q_j^{3B} – an indicator of protection of WME elements due to the use of fortification installation ($M_{\Phi O}$), from the defeat of conventional weapons of the enemy;

Q_j^{BT3} – an indicator of protection of weapon and military equipment elements due to the use of field fortification such as shelters and installations ($M_{\Phi O}$), from the defeat of the enemy's high-precision weapons.

The next component of survivability (unit 4) is secrecy, which is the property of troops (forces) and objects to prepare and conduct combat operations with minimal disclosure for the enemy's intelligence means of their intention for further actions. Secrecy of troops (forces) and objects W_{CK} directly depends on the means of reconnaissance of the enemy, so it can be described by the expression:

$$W_{CK} = 1 - P_{\text{вияв}}, \quad (3)$$

where $P_{\text{вияв}}$ – probability of detection of WME in one reconnaissance cycle Pechorin O.M., 2017.

Stability (unit 5) is a property of personnel to overcome difficulties and successfully perform combat missions in conditions of enhanced enemy influence. The stability indicator is proposed to be determined in accordance with the level of readiness of personnel to conduct combat operations, taking into account the importance of the components of stability proposed in the method of G. Davydov – Krivoruchko P.P., Khmilyar O.F., Shpak R.A., Vasilchenko S.V., 2004, according to the expression:

$$W_{CT} = U_{63} \cdot \frac{1,0 \cdot U_{\Pi} + 0,9 \cdot U_{\text{рот}} + 1,1 \cdot U_{y3}}{3}, \quad (4)$$

where U_{63} – indicator of combat of the MO;

U_{Π} – professionalism indicator, which takes into account the experience of participation in hostilities, the level of education, the degree of awareness of personnel about the state of affairs in the state and the purpose and objectives of the operation;

$U_{\text{рот}}$ – readiness indicator, takes into account the functional state of personnel, faith in the success (operation) of hostilities and the effectiveness of the functioning of management bodies;

U_{y3} – indicator of staffing and comprehensive support as a percentage of all types in general.

Counteraction to the enemy (unit 6), as a

component of survivability, involves active or passive obstruction of the influence of means of defeating the enemy at a certain time in order to maintain combat capability at the appropriate level.

Active counteraction is considered measures that involve the destruction of enemy defeat means by inflicting fire damage and, accordingly, reducing its combat capabilities. Based on this, the influence of active counteraction can be expressed through the enemy's fire damage, namely due to the probable attainable degree of damage Zagorka O.M., Polishchuk S.V., Zagorka I.O., 2020, which makes it possible to determine the mathematical expectation of reducing the combat potential.

In contrast to active counteraction, passive measures do not provide for influencing the enemy and are aimed at avoiding losses by timely withdrawal of WME from fire damage. At the same time, according to Kotsiuruba V.I., Cherevko R.M., Ivashchuk O.A., 2019 the probability of timely maneuvering of the P_{CM} depends on the distance and speed of the MO movement, the delay time on obstacles and the time of the maneuver.

Taking into account that in the considered situation, the MO acts in accordance with the defense operation plan and does not carry out active and passive counteraction with maximum efficiency at the same time, the effectiveness of counteraction measures is determined by the weighted average indicator by expression:

$$W_{\Pi P} = (W_{\Delta Cj} + P_{CMj})/2, \quad (5)$$

where $W_{\Delta Cj}$ – reducing the enemy's combat potential due to the achievable degree of enemy fire damage in the defensive operation.

Renewableness (unit 7) – the property of troops (forces) and objects to restore their combat capability, after the influence of enemy forces and means, to the required level in a certain time. That is why, after the enemy strikes, measures are being taken to restore combat capability in a timely manner. The forces and means involved in the implementation of combat capability recovery measures have

limited capabilities, so the recovery rate is to possibly reduce losses in the defense operation by returning to the combat-capable state of the corresponding number of affected objects:

$$W_{B\Delta} = \frac{\sum_{i=1}^n C_i^{B\Delta} t_i^{B\Delta}}{N_{yp}}, \quad (6)$$

where n – the number of units (groups) carrying out recovery measures in accordance with the current situation and composition of the group;

i – types of relevant bodies (groups) performing recovery measures;

$C_i^{B\Delta}$ – capabilities of organs (groups) of i -th type to restore (return to combat-capable condition) of affected (damaged) objects per unit time;

$t_i^{B\Delta}$ – time of combat capability restoration measures;

N_{yp} – the total number of affected objects, the number of which is determined in accordance with the combat capabilities of the enemy.

The described properties and measures that provide them will have a heterogeneous effect on the survivability of the MO and will depend on the place and role of this object in the preparation and conduct of the operation. This requires an appropriate determination of the weight coefficients of the components of survivability on different levels of MO, so in Unit 8, the method of expert evaluation determines the importance of survivability components for the overall process of increasing the survivability of the MO. The total weight of the coefficients will be equal to 1.

In unit 9, the value of the main survivability indicators of j -th of MO is calculated $E_{\mathcal{X}j}$, which characterize the degree of achievement of the goal of increasing vitality due to efficiency in the implementation of certain measures and are quantized using a multiple convolution according to the expression:

$$E_{\mathcal{X}j} = W_{3Xj}^{q_{3X}} \cdot W_{CKj}^{q_{CK}} \cdot W_{CTj}^{q_{CT}} \cdot W_{\Pi Pj}^{q_{\Pi P}} \cdot W_{B\Delta j}^{q_{B\Delta}}, \quad (7)$$

W_{3Xj} , W_{CKj} , W_{CTj} , $W_{\Pi Pj}$, $W_{B\Delta j}$ – the value of indicators of components of vitality (protection, secrecy, stability, counteraction,

renewableness) j -th MO;

$q^{3X}, q^{CK}, q^{CT}, q^{PP}, q^{BD}$ – weight indicators of the contribution of components of survivability (protection, secrecy, stability, counteraction, renewableness) to the general process of increasing the survivability of MO.

In the future, in unit 10, the coefficients of importance of the MO are calculated taking into account their contribution to achieve the goal of the defense operation. The calculation of the importance of MO is carried out according to the total capabilities of their forces and means for fire damage to the enemy, rank, direction (strip) of actions in accordance with the periods of operation and the importance of tasks performed by the J -th MO.

In unit 11, a generalized indicator of the survivability of troops (forces) and objects in the defense operation is determined by expression:

$$E_{\text{Ж}} = \sum_{j=1}^J \beta_j E_{\text{Ж}j}, \quad (8)$$

β_j – importance indicator value of the j -th MO;

J – the number of MO created in the group of troops for the defense operation.

Achieved generalized performance indicator $E_{\text{Ж}}$ measures to increase survivability reflects the level of survivability of troops (forces) and objects in the defensive operation of the group of troops.

In the future, in unit 12, the sufficiency of the generalized survivability indicator is checked $E_{\text{Ж}}$ by comparing it with the desired value, respectively, the selected evaluation criterion by expression:

$$E_{\text{Ж}} \geq E_{\text{Ж}}^{\text{ПOTP}}, \quad (9)$$

In case of inconsistency, the reasons are determined and practical recommendations are provided to improve the effectiveness of measures to increase survivability, change the initial data taking into account the defined recommendations and recalculate in accordance with the specified sequence. Upon reaching the required indicator, a relative increase in the efficiency of measures to increase survivability is determined, which reflects the contribution of the developed recommendations to the effectiveness of measures to increase the survivability of troops (forces) and facilities.

Conclusions

Thus, the proposed comprehensive methodology allows assessing the effectiveness of measures to increase the survivability of troops (forces) and objects in the operation of the grouping of troops. At the same time, the proposed indicators are sensitive to changes, have clear physical content, provide ease of

calculations, their analysis and consideration of random processes.

The use of this integrated approach is aimed at determining and justifying the necessary set of measures to increase the survivability for the MO created for the defense operation of the group of troops.

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