Application of the AHP and PROMETHEE II individual decision-making methods and the Condorcet group decision-making method in the selection of a multipurpose armored wheeled combat vehicle

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Abstract:

Introduction/purpose: Wheeled armored combat vehicles are combat systems that are increasingly present in modern armed conflicts, especially in operations against asymmetric threats. The global wheeled armored vehicle market is constantly growing, which reflects their application in a wide range of missions and tasks of armed forces. The existence of numerous models of these vehicles with different technical and exploitation characteristics, along with the possibility of adaptation to specific needs, further complicates the choice of the most suitable alternative. The paper presents the case of solving the problem of selecting the most suitable multi-purpose medium-class wheeled armored vehicle with a 4x4 drive formula when choosing one of the four alternatives, using individual and group multi-criteria decision-making methods.

Methods: In the paper, the methods of multi-criteria decision making were applied to solve problems in the field of complex combat systems selection. Experts from the field of tactics with weapon systems have ranked the alternatives following the defined criteria using the AHP (Analytic Hierarchy Process) and the PROMETHEE II (Preference Ranking Organization Method for Enrichment Evaluations II) methods. The results obtained by individual decision making were subjected to the Condorcet method of group decision making to make a final decision.

Result: Selection of the most suitable vehicle by the defined criteria.

Conclusion: Solving the problem involves taking into account the views of military experts regarding the optimization of multiple criteria to provide the best performance vehicle suitable for use in various missions. The choice of a multi-purpose wheeled armored combat vehicle is a complex process influenced by numerous factors that cannot be analyzed objectively without the application of adequate mathematical models.

Keywords: armored combat vehicles, multi-criteria decision making, AHP, PROMETHEE II, Condorcet method.

Introduction

Armored combat vehicles are special motor vehicles considered for performing various tasks in the operations of armed forces. Their basic characteristics are mobility, protection, and firepower (the ability to transport personnel and cargo).

Today, there is a tendency for wheeled armored vehicles of all types to dominate in equipping armed forces in the world, compared to tanks and tracked infantry fighting vehicles, which are significantly more expensive and more demanding in terms of maintenance. In support of this, the constant growth of the world market of wheeled armored vehicles, especially those belonging to the light and medium class, is evidenced, with estimates that this trend will continue (Kurtay, 2024). Multi-purpose armored combat vehicles with a 4x4 wheel drive formula are suitable for carrying out various tasks, such as reconnaissance, territory control, transport and support of infantry units, and fire support, but also for command and control and medevac.

The choice of a wheeled armored combat vehicle is a challenge even for experts in that field and requires a certain level of compromise in requirements and respect for the specific needs of military or police units, as well as for the spectrum of threats to which the vehicle and its users may be exposed.

The paper presents one of possible models for the application of various multi-criteria decision-making methods to provide support to decision makers in the preliminary selection of a 4x4 wheel drive armored combat vehicle. For this purpose, two individual decision-making methods are described and practically applied - AHP and PROMETHEE II and the Condorcet group decision-making method. It was noted that choosing between vehicles with similar performance is complex when there are conflicting criteria to consider.

The mentioned methods were applied in the case of solving a specific problem - ranking and choosing the most optimal variant among the four offered models of armored combat vehicle wheel drive 4x4: BOV M16 Miloš-2, Despot, Tatra 815-7 Patriot II and Zetor-Gerlach. The mentioned vehicles were chosen for two basic reasons: the availability of data on technical and exploitation characteristics and similarity in essential characteristics, whereby there is no intention of the author to single out a specific vehicle as the absolute best. The offered vehicles belong to the middle class of armored vehicles from 10 to 20 t and in certain aspects have similar performance, which can make the choice even more difficult for experts.

For the purposes of this research, military experts were hired. The use of expert evaluation in the development of a multi-criteria decision-making model proved to be necessary (Kizielewicz & Sałabun, 2024; Puška et al, 2018). In this case, the experts defined three main criteria, namely: mobility, protection, and the ability to transport personnel and cargo (payload capacity), while firepower and command and control criteria were omitted, bearing in mind that with all four offered alternatives there are numerous options for equipping with different combat and other systems depending on the need, which exceeds the scope of this research. Also, the problem is viewed from the aspect of combat vehicle capabilities, without considering the value aspect (purchase price, maintenance, etc.). The ranking of the alternatives based on the defined criteria, which are explained below, was carried out based on the subjective opinion of four military experts in the field of tactics with weapons systems. Considering the medium level of complexity of the problem and the chosen decision-making methods, a model of the participation of a smaller number of experts was chosen. In this research, performing a high level of expertise in the field of wheeled armored unit tactics was essential for valid individual decision making. The interview was conducted with a total of 12 Infantry branch officers, and four of them met the set criteria regarding the necessary professional experience and knowledge in wheeled armored vehicles.

The first two experts performed the ranking using the AHP method, while the third and the fourth applied the AHP-PROMETHEE II model. The results obtained by the individual decision making of four experts were subjected to the Condorcet method of group decision making, to make a final decision.

The AHP method was chosen because it requires the active participation of military experts for adequate comparison by pairs and determining the weight of the criteria, and because it provides good results for the given number of criteria. Also, based on the analyzed literature, the AHP method is useful for structuring the problem of choosing vehicles and combat systems. On the other hand, the PROMETHEE II method is very easy to use by experts and provides additional precision by defining the preference parameters on each criterion. The Condorcet method was chosen because it is more representative than models of simple majority voting in group decision making, as it takes into account all possible comparisons of the ranks of alternatives obtained by experts through individual decision making.

The analysis of the literature leads to the conclusion that multi-criteria decision-making methods have been applied in many areas of military activity, individually or in a variant of the combination of two or more methods, to make the best use of their capabilities in support of finding an optimal solution to the problem. In the field of combat system selection, there is a large number of scientific works in which the subject methods were used: Kurtay (2024) applies the Fuzzy EDAS method for the selection of an armored vehicle; Genc (2015) applies the ELECTRE III and PROMETHE II methods, while Gazibey et al. (2015) apply the DEMATEL method for criteria analysis and tank selection; Radovanović et al. (2023) ranks Unmanned Combat Air Vehicle for military needs using multiple methods (DIBR, FUCOM, LMAW, and EDAS); Starčević et al. (2019) apply the AHP-DEA model to the selection of military vehicles for use in multinational operations; Tešić & Marinković (2023) perform the selection of complex combat systems using several methods and aggregators; Jokic et al. (2024) apply the DEX method to select the optimal caliber for an automatic rifle; Radovanović et al. (2019) apply the AHP method, and Pamučar & Dimitrijević (2021) the TOPSIS and MABAC methods for the selection of anti-armor missile systems; Santos et al. (2021) apply the AHP method in the selection of a warship; Sun et al. (2013) apply the Fuzzy-AHP method, and Furch & Švásta (2022) integrate a number of multi-criteria decision-making methods for the selection of unmanned ground platforms; Radovanović et al. (2024) select an assault rifle using the LMAW - gray EDAS hybrid model. In the study of the UN working group, the AHP method was used to rank the importance of the capabilities of armored personnel carriers and wheeled and tracked vehicles (UN Department of Operational Support, 2023).

The analyzed literature unequivocally indicates that the authors are interested in the application of various mathematical methods when choosing complex combat systems.

The work is conceived in several parts. In the next part, a description of armored combat vehicles was given. Furthermore, the methods used in the creation of the model were presented, in order to finally give a detailed description of the criteria and a presentation of the results obtained through the application of the model.

Basic characteristics of armored vehicles

The development of armored combat vehicles took place following the reached level of technological progress in the world and changes in the physiognomy of armed conflicts, constantly adapting to new threats. The first armored vehicles were used during the First World War in the form of transporters with light armor protection and were intended for the transport of infantry units to support tanks on the battlefield (Radetić, 2001). Regarding the vehicle type, originally half-tracked combat vehicles were used while later tracked vehicles were dominant, and wheeled vehicles were rarely used. After the Second World War, the intensive development of infantry fighting vehicles began to ensure a higher speed of maneuver of infantry units, at the same time providing better armor protection and firepower. After the period of the Cold War, a more intensive development of wheeled armored combat vehicles of all types began, under new - asymmetric threats and in the conditions of increasingly frequent conflicts in the urban environment (Kurtay, 2024). Such a situation required the use of vehicles of smaller dimensions and high maneuverability, but also with adequate protection, suitable for carrying out tasks such as reconnaissance, territory control, operations of special military and police forces, and for conflicts of lower intensity.

The key capabilities of armored vehicles are traditionally contained in the so-called "iron triangle" which implies mobility, protection, and firepower (Dean, 2024). In addition to the mentioned universal characteristics, for wheeled armored combat vehicles that are essentially intended to carry out the transport of combat formations and assets to the desired location, the ability to transport personnel and cargo, i.e. the vehicle's carrying capacity, is very important, and the efficiency of this type of vehicle is often considered through three main characteristics: mobility, protection and payload capacity (Giurgiu et al, 2023).

In a 2023 United Nations task force study, an expanded list of criteria for the classification of armored fighting vehicles (APVs) was proposed and included protection, mobility, firepower, payload capacity, and command and control systems. Also, the necessity of considering new capabilities by the requirements of the modern combat environment, such as survivability, adaptability, connectivity, surveillance, threat detection, identification in combat, etc., has been increasingly discussed recently (Giurgiu et al, 2023). The essence of such tendencies is to ensure a high degree of situational awareness on the battlefield to quickly react in terms of eliminating or avoiding the threat.

Mobility is very important for the efficiency of vehicle use in different terrain conditions, but also from the aspect of force protection, thanks to the reduced exposure of the vehicle to potential threats. Mobility largely depends on the combat weight of the vehicle, because it affects the acceleration, i.e., the agility of the vehicle in combat, as well as the power of the engine and the suspension system (Muždeka, 2012). As the mass of the vehicle directly affects the maneuverability of the vehicle, there must be a balance concerning armored protection and transport capacity (Kamel, 2017). On the other hand, the number of crew members and the mass of additional cargo are related to the self-protection capability. Namely, the greater mass with which it is possible to load the vehicle is an indicator of the possibility of implementing different weapons systems - greater firepower and for acting on different targets (anti-armor means, for acting on targets in the airspace, etc.), but also a larger number of combat-formation members, which protects the vehicle itself in battle, among other things. Also, in terms of additional protection, the greater carrying capacity of the vehicle provides the possibility of using various modular elements for the protection of the vehicle for protection against light anti-armor systems of less penetration (Dean & Cazalet, 2024).

In terms of firepower, modern wheeled armored combat vehicles are not far behind other combat vehicles and can be equipped with different combat stations with light and heavy machine guns, cannons of caliber up to 30 mm, but also with secondary weapons such as anti-armor systems, grenade launchers, light anti-aircraft systems, etc.

From the above, it can be concluded that there is a high degree of interdependence among the characteristics, and it is necessary to have an adequate balance to achieve greater efficiency in combat. This is especially important in terms of the use of multi-purpose vehicles. In order to choose the most optimal variant of the vehicle, it is necessary to first decompose the main criteria into an optimal number of sub-criteria, and then carry out their evaluation to ensure a compromise in the level of the vehicle's capabilities, according to the specific requirements of use.

Description of the methods

The work used the AHP and PROMETHEE II methods of individual multi-criteria decision making and the Condorcet method of group multi-criteria decision making. The presentation of the model is given in Figure 1. As it can be seen from the figure, the model has four phases. In the first phase, criteria and sub-criteria specific to the presented problem are defined. Through the second phase, the experts compare the criteria, and after that, the weight coefficients of the criteria are calculated for each expert. The obtained values represent the input to the third phase of the model where the ranking of the alternatives is performed using the AHP and PROMETHEE II methods. Finally, in the fourth stage, the final values for the ranking of the alternatives are obtained by applying the Condorcet method. A brief description of the applied methods in the model is given in the following sections.

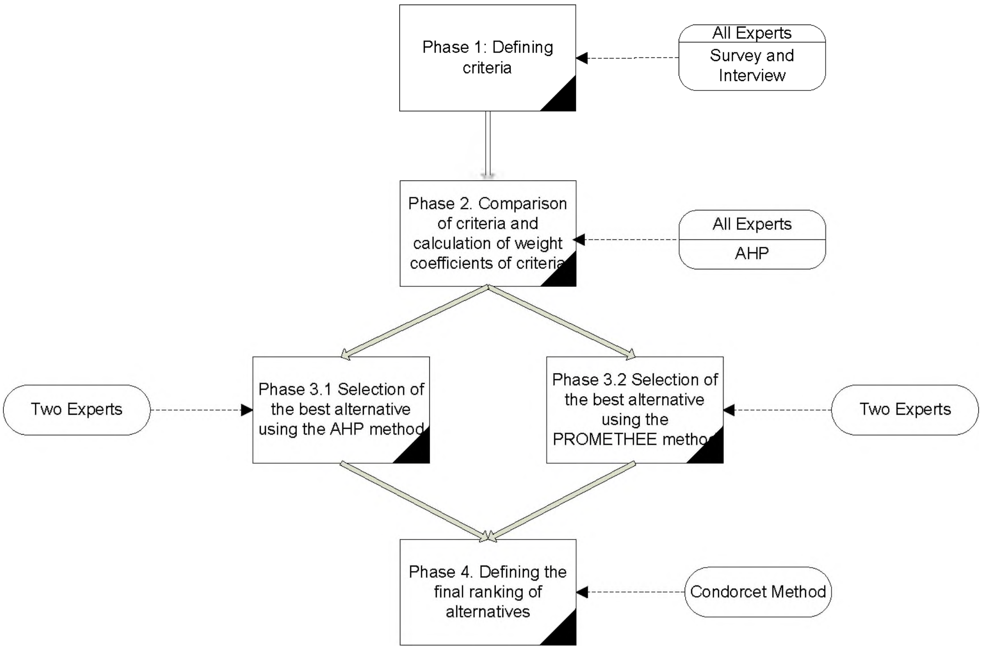


Figure 1 – Flowchart of the AHP - PROMETHEE - Condorcet model

Description of the Analytic Hierarchy Process (AHP) Method

The Analytical Hierarchical Process Method was developed by Saaty (1980) and it is based on a pairwise comparison of decision elements (criteria, sub-criteria, and alternatives). For pairwise comparisons, the values given in the scale of mutual importance in Table 1 are applied.

Table 1 – Saaty's scale of relative importance (Saaty, 2008)

Definition	**Intensity of Importance**
Equal importance	1
Moderate importance	3
Strong importance	5
Very strong importance	7
Extreme importance	9
Intermediate values	2, 4, 6, 8
Reciprocal values of the above numbers	1/2, 1/3, ... 1/9
If the activities are very close	1.1 – 1.9

The basic features of the AHP method are the ability to work with numerical and non-numerical data (Elraaid et al, 2024), the ability to determine the weights of the criteria, and the assessment of consistency, i.e., checking the quality of the given assessments.

The procedure for applying the AHP method includes several steps. The first step involves defining the problem that needs to be solved and presenting it through the structuring of the hierarchy of goals, criteria, sub-criteria, and possible alternatives (Saaty, 2008). This step is the most demanding for experts, but it is also the most creative (Kovačević et al, 2024; Biswas et al, 2025). In addition to the knowledge about the problem being investigated, experts must also be familiar with the way of applying the Saaty scale when making comparisons.

The second step of the method is the formation of a set of matrices for the mutual comparison of all criteria (sub-criteria) by pairs and defining their weights.

The next step is to calculate the consistency ratio (CR), the value of which must be less than 0.1 to be acceptable. The consistency ratio is calculated according to the formula:

$$CR = \frac{CI}{RI} \quad (1)$$

where CI is the consistency index and RI is the randomness index (Random Index - RI).

The random index (RI) is determined empirically and depends on the number of criteria, i.e., on the dimensions of the assessment matrix - n (Table 2).

Table 2 – Random indices according to Saaty (Saaty, 1988)

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

The consistency index is calculated according to the formula:

$$CI = \frac{\lambda_{max} - n}{n-1} \qquad (2)$$

λ_{max} is the eigenvalue calculated for each criterion by the formula:

$$\lambda_{max} = \frac{Aw*w}{w*w} \qquad (3)$$

where A is the criteria comparison matrix, and w is the eigenvector for the criteria, i.e., the degree of confidence in the criteria (weight of the criteria).

The comparison matrix A is multiplied by a vector by multiplying w (corresponding to a particular criterion) by the value of each cell in the same row, and the resulting products are summed. The procedure is repeated for all rows in the matrix. Finally, if the obtained CR consistency ratio is less than 0.1, the matrix is consistent, and the alternatives are compared according to each criterion. A ratio value greater than 0.1 indicates that the criteria comparison matrix is inconsistent and that it is necessary for the participants to correct their assessments in solving a specific problem or to structure the hierarchy of the problem in another way (or formulate questions differently when comparing elements).

Then the weighted sum is calculated, which is obtained by multiplying the matrix of alternatives with the eigenvector w. By comparing them, a conclusion is reached about the most favorable variant and it is possible to rank them. A higher value of the difficult sum for a certain alternative indicates that it is more favorable.

Description of the PROMETHEE II method

The PROMETHEE method is a prominent multi-criteria decision-making method that evaluates alternatives depending on the preferences of decision makers (Brans & Mareschal, 2005; Oubahman & Duleba, 2021). Many authors highlight the simplicity of its application as the main advantage of this method compared to others, as well as the possibility of solving complex problems in conditions where the criteria are mutually opposed (Oubahman & Duleba, 2021; Taherdoost & Madanchian, 2023). The PROMETHEE I method was created in 1984 (Brans et al, 1984), while the PROMETHEE II method was first presented in the work of Brans & Vicke (1985), and since then it has been used in a large number of research related decision making cases. Also, later, new modifications of the PROMETHE method - PROMETHEE III, IV, V, as well as the GAIA graphic representation of the optimal solution were developed.

Here, a brief overview of the PROMETHEE II method will be given, bearing in mind that it provides a complete comparison and ranking of alternatives, unlike PROMETHEE I which allows only a partial comparison of alternatives. It can be used for single-criteria and multi-criteria decision analysis.

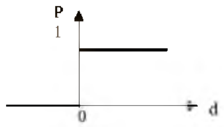
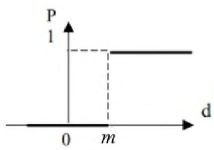
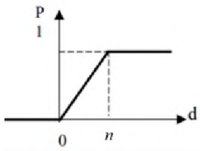
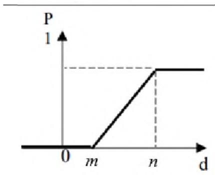
This method requires defining a preference function for the mutual comparison of alternatives, as well as the parameters of that function. The parameters of the preference function are the indifference parameter (m) which indicates up to which limit of the difference between two alternatives according to a certain criterion there is no preference, and the preference parameter (n) which indicates that above a certain difference in value between the two alternatives there are certain preferences (Suknović et al, 2021). Thus, the preference function identifies the existence and then describes the value of the difference between the two alternatives, which goes from 0 to 1 for each criterion.

Six general types of preference functions can be used to express a preference, namely: simple type; "U" type, "V" type, stepped type, linear type, and Gaussian type (Brans et al, 1986). Which of the mentioned functions will be used primarily depends on the characteristics of each of the criteria (Oubahman & Duleba, 2021). The linear type of preference is general and is most often applied in practice because it can cover the largest number of problems (Suknović et al, 2021). Table 3 describes the types of functions that will be applied in the paper.

The first step in the application of the PROMETHEE method is the calculation of preferences by pairs for all criteria, using the appropriate preference function and the type of extremization (minimization/maximization). Previously, by applying some of the methods, weights are determined for each criterion because PROMETHEE does not have a mechanism for determining weights.

The second step involves multiplying the received preferences of the pairs of alternatives with the corresponding weights of the criteria while in the third step the weighted sum of preferences is calculated.

Table 3 – Description of the PROMETHEE method function types (Brans et al, 1986; Brans & Mareschal, 2005)

Graph function	Definition	Parameters
	*I type (ordinary):* p(d) = 1, $d > 0$ (strict preference) p(d) $= 0, d \leq 0$ (indifference)	-
	*II type („U“):* p(d) = 1, $d > m$ (strict preference) p(d) $= 0, d \leq 0$ (indifference)	*m*
	*III type („V“):* p(d) = 1, $d \geq n$ (strict preference) p(d) = d/n, $0 < d < n$ (weak preference) p(d) =0, $d \leq 0$ (indifference)	*n*
	*V type (linear):* p(d) = 1, $d \geq n$ (strict preference) p(d) = $(d-m)/(n-m)$, $m < d < n$ (weak preference) p(d) $= 0, d \leq m$ (indifference)	*m, n*

In the fourth step, the positive, negative, and net flow of alternatives are determined (Suknović et al, 2021). A positive flow indicates how preferred an alternative is on average compared to other alternatives, while a negative flow indicates how preferred other alternatives are compared to the observed one. A net flow (T) can be represented mathematically as the difference between the positive flow (T^+) and the negative flow (T^-): $T = T^+ - T^-$.

The overall ranking of alternatives is based on the highest net flow value.

Description of the Condorcet method

The Condorcet method is among the most prominent and oldest methods of group decision making. In practice, it was most often applied in the political election process, but also in other areas, such as product procurement. It is specific in that it requires mutual comparison of alternatives by pairs to determine how many times a certain alternative was ranked better than the others (Suknović et al, 2021). By applying that simple rule, the Condorcet method ensures that the choice of a certain alternative is based on the opinion of the majority of people participating in the decision. It can be applied in its original form or in combination with the Borda method (Herrero & Villar, 2021) and other methods (Green-Armytage, 2011; Brandt et al, 2021).

The procedure for applying this method implies the formation of a matrix of the order of alternatives. Alternatives are compared in pairs and the number of times one alternative dominates over the other among all decision makers is entered in the appropriate cell of the matrix. Then the value of the vector W is calculated by adding all the dominances in one row of the matrix for the first alternative and then for the others. The most acceptable alternative is the one that has the highest value of the vector W.

However, the Condorcet method also has its limitations, i.e., it does not always allow to determine the best alternative. This situation in which alternatives are offered in the same rank is called the "Condorcet paradox" (Suknović et al, 2021). One of possible solutions implies that one of the decision makers reconsiders and changes the order of alternatives, but in that case the equality of decision-making participants is violated (Tomczak et al, 2019).

In this case, group decision making will be carried out based on the decisions of four military experts, which were made independently, without influencing each other.

Description of the alternatives and the criteria

The process of multi-criteria decision making using the presented model was carried out in the case of a preliminary selection of one of four alternatives according to three main criteria and several sub-criteria within them.

For alternatives, four models of multi-purpose armored wheel drive 4x4 models were selected: (A1) BOV M16 Miloš 2; (A2) Despot; (A3) Tatra 815-7 Patriot II and (A4) ATV Zetor Gerlach, between which the optimal solution was chosen. For that purpose, data on technical and operational characteristics, available on the official websites of their manufacturers (Table 4), were collected.

All the listed alternatives (Figure 2) have a similar purpose, ie., they are suitable for carrying out military and police tasks, such as reconnaissance, territory control, transportation and support of special units, command, fire support, medical evacuation, etc.

Table 4 – Basic technical and operational characteristics of the vehicles

Data type	Vehicle model - Alternatives			
	Miloš-2	*Despot*	*Patriot II*	*Zetor Gerlach*
Maximum engine power (kW)	252	240	300	240
Vehicle specific power (kW/t)	14	17.1	16.7	16.5
Maximum speed (km/h)	100	120	110	117
Maximum climb (%)	60	50	45	60
Maximum side slope (%)	30	30	32	57
Vertical obstacle (m)	0.5	0.5	0.5	0.5
Trench width (m)	0.8	0.8	0.9	1
Water obstacle depth (m)	0.9	1.1	1.2	1.2
Total mass (t)	18	14	18	14.5
Load capacity (t)	2.5	3	4.5	2.3
Number of crew members	2+8	2+8	2+6	2+4
Autonomy of movement (km)	600	700	700	600
Ballistic protection level (STANAG 4569)	3	2	2	3
Mine protection level (STANAG 4569)	2a/2б	2a/2б	2a/2б	3a/3б

Figure 2 – Alternatives: a. Miloš-2 (Yugoimport, 2024), b. Despot (TRB, 2024), c. Patriot II (Excaliburarmy, 2024), d. Zetor Gerlach (Zetorengineering, 2024)

Based on the relevant scientific and professional literature and the views of experts in the field of construction and use of wheeled armored combat vehicles, and by the available data on the vehicles, the following basic criteria were defined based on which the alternatives will be ranked:

Criterion 1 (K1): Mobility - represents the vehicle's ability to move and maneuver in different terrain conditions. In this paper, it will be considered through the following sub-criteria: vehicle specific power (K_{11}), autonomy of movement (K_{12}), and passability (K_{13}). The specific power of the vehicle is the ratio of engine power to the total mass of the armored combat vehicle and is expressed in kW/t. The value of this criterion directly indicates the performance of the vehicle such as acceleration, maximum speed, and agility, which is very important from the aspect of quick reaction in various combat situations (Muždeka, 2012). Autonomy of movement implies the maximum distance that the vehicle can move with one filling of the fuel tank and is important from the point of view of the so-called operational mobility, i.e., planning logistical needs in operations. The vehicle's passability implies the ability of an armored vehicle to overcome a space with different characteristics (slope of the terrain), as well as certain obstacles. Different parameters describe the vehicle's passability, and in this case, it will be considered through the ability to overcome the front and side slopes, vertical obstacles, trenches of a certain width, as well as water obstacles of a certain depth (without prior preparation).

Criterion 2 (K2): Protection - refers to the resistance of the armored vehicle to the effects of various types of weapons and the explosion of mines and the possibility of protecting people and key equipment and systems in the vehicle, and is expressed by a certain level of ballistic (K_{21}) and anti-mine protection (K_{22}), most often according to the NATO standard STANAG 4569. The level of protection for which the vehicle is certified indicates specifically the type and caliber of the projectile/amount of explosives that the vehicle's armor can withstand, as well as the type of weapon/tools, the distance, and the angle at which the projectile was fired.

Criterion 3 (K3): Transport of people and cargo (payload capacity) - represents the total number of people - members of military or police units with complete combat equipment, for which adequate space is provided in the front and rear part of the vehicle, as well as the mass of useful cargo that can be loaded or additionally equip the vehicle with certain systems.

Ranking results

The first decision maker (DM1) will rank the combat vehicles using the AHP method based on the hierarchy of criteria presented in Table 5.

Table 5 – Criteria and sub-criteria

Goal	Criteria		Sub-criteria			
The selection of a multipurpose armored combat vehicle 4x4	K_1	Mobility	K_{11}	Specific power		
			K_{12}	Cruising range		
			K_{13}	Obstacle crossing capabilities	K_{131}	Overcoming front gradient
					K_{132}	Side slope overcoming
					K_{133}	Overcoming vertical obstacle/Trench/Fording capability
	K_2	Protection	K_{21}	Ballistic protection		
			K_{22}	Antimine protection		
	K_3	Payload capacity	K_{31}	Number of crew members		
			K_{32}	Mass of additional cargo		

By applying Saaty's scale (Table 1), DM1 performed a comparison of the criteria/sub-criteria by branches of the hierarchy, whereby a total of 5 matrices were formed (Tables 6-10, under a), and then the matrices were normalized and the value of the vector w was determined (Tables 6 -10, under b).

Table 6 – Ranking of the main criteria in relation to the set goal

a)	K_1	K_2	K_3
K_1	1	1.2	1.4
K_2	0.83	1	1.1
K_3	0.71	0.91	1
Σ	2.55	3.11	3.50

б)	K_1	K_2	K_3	**w**	CR
K_1	0.393	0.386	0.400	**0.393**	0
K_2	0.327	0.322	0.314	**0.321**	
K_3	0.280	0.292	0.286	**0.286**	
Σ				1	

Table 7 – Ranking of the sub-criteria concerning vehicle mobility

a)	K_{11}	K_{12}	K_{13}
K_{11}	1	3	1
K_{12}	0.33	1	0.33
K_{13}	1	3	1
Σ	2.33	7	2.33

б)	K_{11}	K_{12}	K_{13}	**w**	CR
K_{11}	0.429	0.429	0.429	**0.429**	0
K_{12}	0.143	0.143	0.143	**0.143**	
K_{13}	0.429	0.429	0.429	**0.429**	
Σ				1	

Table 8 – Ranking of the sub-criteria concerning vehicle passability

a)	$К_{131}$	$К_{132}$	$К_{133}$
$К_{131}$	1	1	1.5
$К_{132}$	1	1	1.5
$К_{133}$	0.67	0.67	1
Σ	2.67	2.67	4

б)	$К_{131}$	$К_{132}$	$К_{133}$	w	CR
$К_{131}$	0.375	0.375	0.375	**0.375**	
$К_{132}$	0.375	0.375	0.375	**0.375**	0
$К_{133}$	0.250	0.250	0.250	**0.250**	
Σ				1	

Table 9 – Ranking of the sub-criteria concerning the level of vehicle protection

a)	$К_{21}$	$К_{22}$
$К_{21}$	1	1.4
$К_{22}$	0.71	1
Σ	1.71	2.40

б)	$К_{21}$	$К_{22}$	w	CR
$К_{21}$	0.583	0.583	**0.583**	
$К_{22}$	0.417	0.417	**0.417**	0
Σ			1	

Table 10 – Ranking of the sub-criteria concerning the payload capacities

a)	$К_{31}$	$К_{32}$
$К_{31}$	1	2
$К_{32}$	0.5	1
Σ	1.5	3

б)	$К_{31}$	$К_{32}$	w	CR
$К_{31}$	0.667	0.667	**0.667**	
$К_{32}$	0.333	0.333	**0.333**	0
Σ			1	

The matrix consistency check (Tables 6, 7, 8, 9, and 10) was performed using formulas (1), (2), and (3) and it was found that all values of the CR consistency index are less than 0.1, i.e., the matrices are consistent.

In this way, the relative weight values of the criteria and sub-criteria were obtained, based on which the absolute weight values are calculated by multiplying the relative weight of each sub-criterion with the weight value of all super-criteria in the displayed hierarchy. The absolute values of the weights for the subcriteria of the leaves of the tree hierarchy are shown in Figure 3 (bold numbers in shaded boxes).

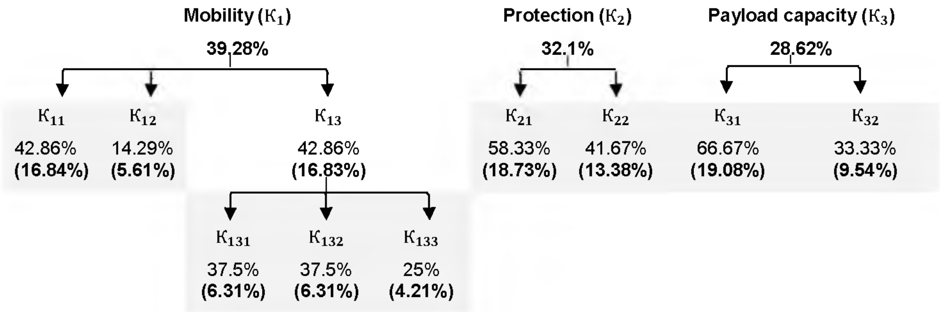


Figure 3 – Relative and absolute weights (in bold) of the criteria and sub-criteria

The results of the comparison of the alternatives according to each criterion of the hierarchy tree leaf (the criteria and sub-criteria which are the last in the hierarchy tree) are shown in Tables 11-19.

Table 11 – Comparison of the alternatives according to the specific power

K_1	A1	A2	A3	A4	Average
A1	1	0.20	0.25	0.25	0.071
A2	5	1	1.5	1.6	0.393
A3	4	0.67	1	1.20	0.282
A4	4	0.63	0.83	1	0.254
Σ	14	2.49	3.58	4.05	1

Table 12 – Comparison of the alternatives according to the autonomy of movement

K_2	A1	A2	A3	A4	Average
A1	1	0.2	0.2	1	0.083
A2	5	1	1	5	0.417
A3	5	1	1	5	0.417
A4	1	0.2	0.2	1	0.083
Σ	12	2.40	2.40	12	**1**

Table 13 – Comparison of the alternatives according to overcoming the climb

K_{131}	A1	A2	A3	A4	Average
A1	1	5	7	1	0.421
A2	0.2	1	3	0.2	0.106
A3	0.14	0.33	1	0.14	0.052
A4	1	5	7	1	0.421
Σ	2.34	11.33	18	2.34	1

Table 14 – Comparison of the alternatives according to overcoming the side slope

K_{132}	A1	A2	A3	A4	Average
A1	1	1	0.83	0.13	0.087
A2	1	1	0.83	0.13	0.087
A3	1.2	1.2	1	0.13	0.100
A4	8	8	8	1	0.726
Σ	11.2	11.2	10.67	1.38	1

Table 15 – Comparison of the alternatives according to the obstacles overcoming

K_{133}	A1	A2	A3	A4	Average
A1	1	0.50	0.25	0.20	0.082
A2	2	1	0.50	0.33	0.156
A3	4	2	1	0.67	0.313
A4	5	3	1.50	1	0.449
Σ	12	6.50	3.25	2.20	1

Table 16 – Comparison of the alternatives according to the ballistic protection level

K_{21}	A1	A2	A3	A4	Average
A1	1	7	7	1	0.437
A2	0.14	1	1	0.14	0.062
A3	0.14	1	1	0.14	0.062
A4	1	7	7	1	0.438
Σ	2.29	16	16	2.29	1

Table 17 – Comparison of the alternatives according to the mine protection level

K_{22}	A1	A2	A3	A4	Average
A1	1	1	1	0.14	0.100
A2	1	1	1	0.14	0.100
A3	1	1	1	0.14	0.100
A4	7	7	7	1	0.700
Σ	10	10	10	1.43	1

Table 18 – Comparison of alternatives according to the number of crew members

K_{31}	A1	A2	A3	A4	Average
A1	1	1	5	7	0.413
A2	1	1	5	7	0.413
A3	0.20	0.20	1	5	0.128
A4	0.14	0.14	0.2	1	0.047
Σ	2.34	2.34	11.2	20	1

Table 19 – Comparison of the alternatives according to the mass of additional cargo

K_{32}	A1	A2	A3	A4	Average
A1	1	0.50	0.14	1.20	0.090
A2	2	1	0.20	3	0.178
A3	7	5	1	7	0.656
A4	0.83	0.33	0.14	1	0.076
Σ	10.83	6.83	1.49	12.2	1

Finally, by inserting the mean values from the normalized matrices for all alternatives according to each criterion of the hierarchy list (from Tables 11-19 under b) into the new matrix (Table 20) and multiplying with the absolute weights, the weighted sum value and the final ranking of the alternatives are obtained (Table 21).

Table 20 – Normalized decision-making table

	K_{11}	K_{12}	K_{131}	K_{132}	K_{133}	K_{21}	K_{22}	K_{31}	K_{32}
A1	0.071	0.083	0.421	0.087	0.082	0.437	0.100	0.413	0.090
A2	0.393	0.417	0.106	0.087	0.156	0.062	0.100	0.413	0.178
A3	0.282	0.417	0.052	0.100	0.313	0.062	0.100	0.128	0.656
A4	0.254	0.083	0.421	0.726	0.449	0.438	0.700	0.047	0.076
w	**0.168**	**0.056**	**0.063**	**0.063**	**0.042**	**0.187**	**0.134**	**0.191**	**0.095**

Table 21 – Ranking of the alternatives

Alternatives	Weighted sum	**Rank**
A1	0.2347	**2**
A2	0.2291	**3**
A3	0.2056	**4**
A4	0.3306	**1**

Based on the analysis performed by DM1, the following ranking of the alternatives was obtained: A4, A1, A2, and A3. The most favorable alternative is A4, and the least favorable is A3, with alternatives A1 and A2 having similar values of the weighted sum.

The second decision maker (DM2) applies the AHP method, in the same way as DM1, whereby the value of the absolute weights of the main criteria is obtained as follows: mobility 35.29%, protection 35.29%, and carrying capacity 29.41%. Table 22 shows the normalized decision matrix, and Table 23 shows the ranking of the alternatives.

Table 22 – Normalized decision-making table

	K_{11}	K_{12}	K_{131}	K_{132}	K_{133}	K_{21}	K_{22}	K_{31}	K_{32}
A1	0.071	0.083	0.421	0.087	0.082	0.437	0.100	0.413	0.090
A2	0.393	0.417	0.106	0.087	0.156	0.062	0.100	0.413	0.178
A3	0.282	0.417	0.052	0.100	0.313	0.062	0.100	0.128	0.656
A4	0.254	0.083	0.421	0.726	0.449	0.438	0.700	0.047	0.076
w	**0.137**	**0.060**	**0.055**	**0.055**	**0.046**	**0.206**	**0.147**	**0.166**	**0.128**

Table 23 – Ranking of the alternatives

Alternatives	Weighted sum	**Rank**
A1	0.2313	**2**
A2	0.2155	**4**
A3	0.2190	**3**
A4	0.3343	**1**

The decision maker (DM2) received the following ranking of the alternatives: A4, A1, A3, and A2, where it is evident that in this case the alternatives A1, A2 and A3 have close values of the difficult sum.

The third decision-maker (DM3) applies the AHP method to determine the weights of the criteria and in that procedure the following values of the absolute weights of the main criteria were obtained: mobility 36.45%, protection 33.24%, and carrying capacity 30.31%. It then applies the PROMETHEE II method in the final ranking of the alternatives. The decision maker fills in Table 24, based on the available data on the vehicles, in which he evaluates the value of the subcriterion K_{133} based on the width of the trench and the depth of the water obstacle that the vehicle can overcome, and the value of the anti-mine protection level is expressed by a unique number, bearing in mind that the values a and b do not differ (the level of explosion protection under the center of the armored body and under the wheels of the combat vehicle is the same).

Table 24 – Data for vehicle selection

	K_{11}	K_{12}	K_{131}	K_{132}	K_{133}	K_{21}	K_{22}	K_{31}	K_{32}
A1	14	600	60	30	0.8/0.9	3	2а/2б	10	2.5
A2	17.1	700	50	30	0.8/1.1	2	2а/2б	10	3
A3	16.7	700	45	32	0.9/1.2	2	2а/2б	8	4.5
A4	16.5	600	60	57	1/1.2	3	3а/3б	6	2.3

Then, for each criterion, the appropriate type of the preference function (chosen from Table 3), the parameters of preference and indifference, and the type of extremization were determined (Table 25). The type of extremization is the same for all criteria because a higher value is preferred.

After calculating the difference in the value of the criteria for all mutual pairwise comparisons (Table 26), the preferences of the pairs of the alternatives were obtained by applying the defined functions (Table 27).

Table 25 – Weights and the parameters of the preference functions

	К_{11}	К_{12}	К_{131}	К_{132}	К_{133}	К_{21}	К_{22}	К_{31}	К_{32}
w	0.158	0.063	0.051	0.051	0.042	0.205	0.128	0.227	0.076
Tip f-je	lin.	lin.	lin.	lin.	lin.	lin.	lin.	simpl.	lin.
m	0.25	25	4	3	0.1	0.5	0.5	0	0.3
n	0.75	70	8	6	0.2	1	1	0	0.8
min/max					max				

Table 26 – Differences in the value of criteria by all pairs of the alternatives

	К_{11}	К_{12}	К_{131}	К_{132}	К_{133}	К_{21}	К_{22}	К_{31}	К_{32}
A1A2	-3.1	-100	10	0	-0.1	1	0	0	-0.5
A1A3	-2.7	-100	15	-2	-0.2	1	0	2	-2
A1A4	-2.5	0	0	-27	-0.25	0	-1	4	0.2
A2A1	3.1	100	-10	0	0.1	-1	0	0	0.5
A2A3	0.4	0	5	-2	-0.1	0	0	2	-1.5
A2A4	0.6	100	-10	-27	-0.15	-1	-1	4	0.7
A3A1	2.7	100	-15	2	0.2	-1	0	-2	2
A3A2	-0.4	0	-5	2	0.1	0	0	-2	1.5
A3A4	0.2	100	-15	-25	-0.05	-1	-1	2	2.2
A4A1	2.5	0	0	27	0.25	0	1	-4	-0.2
A4A2	-0.6	-100	10	27	0.15	1	1	-4	-0.7
A4A3	-0.2	-100	15	25	0.05	1	1	-2	-2.2

Table 27 – Preferences of the pairs of the alternatives according to all criteria

	К_{11}	К_{12}	К_{131}	К_{132}	К_{133}	К_{21}	К_{22}	К_{31}	К_{32}
A1A2	0	0	1	0	0	1	0	0	0
A1A3	0	0	1	0	0	1	0	1	0
A1A4	0	0	0	0	0	0	0	1	0
A2A1	1	1	0	0	0	0	0	0	1
A2A3	0.3	0	0	0	0	0	0	1	0
A2A4	0.7	1	0	0	0	0	0	1	1
A3A1	1	1	0	0	1	0	0	0	1
A3A2	0	0	0	0	0	0	0	0	1
A3A4	0	1	0	0	0	0	0	1	1
A4A1	1	0	0	1	1	0	1	0	0
A4A2	0	0	1	1	0.5	1	1	0	0
A4A3	0	0	1	1	0	1	1	0	0

By multiplying the preferences in Table 27 with the weights of the criteria w, the so-called "weighted preferences" were obtained for each pair of comparisons (A1A2, A1A3...), which are then entered into a weighted preference matrix to calculate positive, negative and net flows (Table 28).

Table 28 – Matrix of the weighted preferences of the alternatives with the positive and negative flow values

	A1	A2	A3	A4	T^{+}	T	Rank
A1	*	0.2555	0.4828	0.2273	0.322	-0.016	**3**
A2	0.2959	*	0.2746	0.4759	0.349	0.087	**1**
A3	0.3384	0.0758	*	0.3656	0.260	-0.137	**4**
A4	0.3789	0.4555	0.4343	*	0.423	0.067	**2**
T^{-}	0.3380	0.2620	0.3970	0.3560		0.001	

Based on the value of the net flow, DM3 established the following order of alternatives: A2, A4, A1, and A3, where it is noticeable that the difference between the value of the net flows of the first-ranked alternative A2 and the second-ranked alternative A4 is insignificant. Therefore, the alternatives A2 and A4 are almost equally good in this case.

The fourth decision maker (DM4) applies the same model as the previous one. When evaluating the criteria using the AHP method, the following weight values of the main criteria were obtained: mobility - 36.29%, protection 27.85%, and transport of people and cargo - 35.86%, which indicates that DM4 favors the mobility and transport capabilities of vehicles, in relation to protection. By applying the PROMETHEE II method, DM4 performs the final ranking of alternatives. Due to the limitations of this work and the procedure already described, the tables with the values of the criteria weights, the parameters and the types of the preference function are presented as well as the matrix of the weighted preferences with the flow values (Tables 29 and 30).

Table 29 – Weights and the parameters of the preference functions

	K_{11}	K_{12}	K_{131}	K_{132}	K_{133}	K_{21}	K_{22}	K_{31}	K_{32}
w	0.141	0.062	0.061	0.047	0.053	0.162	0.116	0.239	0.120
function	lin.	lin.	lin.	lin.	lin.	„U“	„U“	„U“	lin.
m	1	40	6	4	0.1	0.5	0.5	1	0.2
n	2	80	12	8	0.2	0	0	0	0.7
min/max					max				

Table 30 – Matrix of the weighted preferences of the alternatives with the positive and negative flow values

	A1	A2	A3	A4	T^+	T	**Rank**
A1	*	0.2031	0.4624	0.2390	0.302	-0.033	**3**
A2	0.2739	*	0.2390	0.4202	0.311	0.073	**1**
A3	0.3750	0.1195	*	0.4202	0.305	-0.057	**4**
A4	0.3564	0.3923	0.3860	*	0.378	0.018	**2**
T^-	0.3350	0.2380	0.3620	0.3600		0.001	

Based on the analysis performed by DM4, the same ranking of the alternatives was obtained as in the previous case.

Application of the Condorcet method

The ranking results obtained by individual decision-making methods by four decision makers are entered in Table 31 in order to determine the optimal solution using the Condorcet method under the conditions of group decision making.

Table 31 – Result of the group decision making

Ranking of alternatives by each decision maker					Matrix					Vektor w
Rank	DM1	DM2	DM3	DM4	Alternatives	A1	A2	A3	A4	Σ
1	A4	A4	A2	A2	A1	*	2	4	0	**6**
2	A1	A1	A4	A4	A2	2	*	3	2	**7**
3	A2	A3	A1	A1	A3	0	1	*	0	**1**
4	A3	A2	A3	A3	A4	4	2	4	*	**10**

In the table, a matrix was formed for the purpose of mutual comparison of the alternatives by pairs and determining how much one alternative dominated in all individual rankings in relation to the other. Then the value of the vector W is calculated by adding the values of all dominances in one row of the matrix, for the alternative A1, and then for the others.

By applying the Condorcet method, it was found that the most acceptable alternative is A4 (the highest value of the vector W=10), and the most unfavorable is A3 (the lowest value of the vector W=1). The alternatives A1 and A2 are of similar value.

Conclusion

The application of multi-criteria decision-making methods is indispensable when deciding between a number of alternatives and when the entire spectrum of characteristics of a complex combat system is taken into account. This is especially pronounced when striving to achieve a balance between the criteria that belong to the so-called "iron triangle" of the multipurpose combat armored vehicle. The paper presents a model of the application of the AHP and PROMETHEE II methods on the specific case of ranking four alternatives according to nine criteria/sub-criteria, in two cases using the AHP method and in two cases using the AHP-PROMETHEE II model. Group decision making aimed at the final selection of the most favorable alternative was carried out using the Condorcet method.

In the results of the evaluation of the criteria by military experts, uniformity is evident in determining the weights of the main criteria, whereby in three cases priority was given to vehicle performance, i.e., vehicle mobility, and in one case the mobility and protection criteria were equal. In the first two cases, in which priority was clearly expressed on the criteria of mobility and force protection, the first ranked alternative was A4, i.e., the Zetor Gerlach vehicle. In the third case, in which the value of the transport capacity criterion was slightly lower compared to the mobility criterion, and in the fourth case, in which the highest degree of uniformity of all three criteria was present, a different result was obtained, the first-ranked alternative was A2, i.e., the Despot vehicle. Finally, by applying the Condorcet method, it was found that the most favorable alternative is A4.

The obtained results indicate that the final ranking of the alternatives depends significantly on the experts' clear vision of the solution to the problem, expressed primarily through the evaluation of criteria using the AHP method. Bearing in mind that the subsequent comparison depends a lot on specific, clearly measurable differences in characteristics from alternative to alternative. This certainly supports the claim that for the purposes of use in modern combat operations, high-performance vehicles are needed in terms of agility, the ability to maneuver in a limited space and passability. The subject methods can be effectively applied for the ranking of armored vehicles by defining different scenarios that can be presented through an adequate ratio of the values of the key criteria.

The defined criteria can serve as one of the models for the preliminary ranking of vehicles of this type because they require data that is generally available. Normally, the value aspect has an important influence on the final decision and therefore there must be an adequate balance between capabilities, procurement price, and costs throughout the vehicle's entire lifecycle.

Proper hierarchical structuring of problems on multiple levels ensures simpler evaluation of elements and helps experts to achieve consistency, i.e., to be consistent in grading. In order to express small differences between the elements of the comparison, the experts used very small values of relative importance from the Saaty scale.

Multi-criteria individual and group decision-making methods are an effective tool that can contribute to making objective decisions when choosing a specific combat system; therefore, it is necessary to know the possibilities of each of the methods in order to fully exploit their possibilities.

Further research steps should be focused on incorporating the consideration of value aspects and the application of Fuzzy logic into the selection of wheeled armored vehicles in the conditions of uncertainties and various scenarios.

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Aplicación de los métodos de decisión individual AHP y PROMETHEE II y del método de decisión grupal Condorcet en la selección de un vehículo blindado de combate polivalente sobre ruedas

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CAMPO: ciencia de la decisión, ciencias militares
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Resumen:

Introducción/objetivo: Los vehículos blindados de combate sobre ruedas son sistemas de combate cada vez más presentes en los conflictos armados modernos, especialmente en operaciones contra amenazas asimétricas. El mercado mundial de vehículos blindados sobre ruedas está en constante crecimiento, lo que refleja su aplicación en una amplia gama de misiones y tareas de las fuerzas armadas. La existencia de numerosos modelos de estos vehículos con diferentes características técnicas y de rendimiento, junto con la posibilidad de adaptación a necesidades específicas, complica aún más la elección de la alternativa más adecuada. El artículo presenta el caso de solución del problema de selección del vehículo blindado sobre ruedas de clase media polivalente más adecuado con una fórmula de tracción 4x4 al elegir una de las cuatro alternativas, utilizando métodos de toma de decisiones multicriterio individuales y grupales.

Métodos: En el presente trabajo se han aplicado los métodos de toma de decisiones multicriterio para resolver problemas en el ámbito de la selección de sistemas de combate complejos. Expertos en el campo táctico con sistemas de armas han clasificado las alternativas siguiendo los criterios definidos utilizando los métodos AHP (Analytic Hierarchy Process) y PROMETHEE II (Preference Ranking Organization Method for

Enrichment Evaluations II). Los resultados obtenidos mediante la toma de decisiones individual se sometieron al método Condorcet de toma de decisiones grupal para tomar una decisión final.

Resultados: Selección del vehículo más adecuado según los criterios definidos.

Conclusión: Solucionar el problema involucra tomar en consideracionn las opiniones de los expertos militares en cuanto a la optimización de múltiples criterios para ofrecer el vehículo de mejor rendimiento adecuado para su uso en diversas misiones. La elección de un vehículo blindado de combate sobre ruedas polivalente es un proceso complejo en el que influyen numerosos factores que no pueden analizarse objetivamente sin la aplicación de modelos matemáticos adecuados.

Palabras claves: vehículos blindados de combate, toma de decisiones multicriterio, AHP, PROMETHEE II, método Condorcet.

Применение индивидуальных методов принятия решений AHP и PROMETHEE II, а также группового метода принятия решений Condorcet при выборе многоцелевого боевого колесного бронетранспортера

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РУБРИКА ГРНТИ: 27.47.19 Исследование операций,
28.17.31 Моделирование процессов управления,
73.47.12 Организация управления и автоматизированные системы управления транспортом,
78.21.53 Исследования и разработки в области эффективности, надежности и боевого использования вооружения и военной техники

ВИД СТАТЬИ: оригинальная научная статья

Резюме:

Введение/цель: Боевые колесные бронетранспортеры − это боевые системы, которые все чаще используются в современных вооруженных конфликтах, особенно в операциях против асимметричных угроз. Мировой рынок колесных бронированных машин постоянно растет, что отражается на их применении в широком спектре миссий и задач вооруженных сил. Существование многочисленных моделей этих транспортных средств с различными техническими и *эксплуатационными характеристиками наряду с возможностью адаптации к конкретным потребностям усложняет выбор наиболее соответствующей альтернативы. В данной статье представлен пример решения задачи выбора наиболее подходящей многоцелевой колесной бронированной машины среднего класса с формулой привода 4x4 при выборе одной из четырех альтернатив с использованием индивидуальных и групповых многокритериальных методов принятия решений.*

Методы: В данной статье применялись методы многокритериального принятия решений в решении задач в области выбора сложных боевых систем. Эксперты в области тактики и систем вооружения оценивали альтернативы в соответствии с определенными критериями, используя методы AHP (Analytic Hierarchy Process) и PROMETHEE II (Preference Ranking Organization Method for Enrichment Evaluations II). Результаты, полученные в ходе индивидуального принятия решений, были обработаны методом группового принятия решений Condorcet для принятия окончательного решения.

Результаты: Был сделан выбор наиболее подходящего транспортного средства по утвержденным критериям.

Вывод: Решение проблемы предполагает учет мнений военных экспертов относительно оптимизации множества критериев для обеспечения наилучших характеристик транспортного средства, используемого в различных миссиях. Выбор многоцелевой колесной бронированной боевой машины является сложным процессом, на который влияют многочисленные факторы, не поддающиеся объективному анализу без применения подходящих математических моделей.

Ключевые слова: боевые бронетранспортеры, многокритериальное принятие решений, AHP, PROMETHEE II, метод Condorcet.

Примена метода индивидуалног одлучивања AH и PROMETHEE II и методе групног одлучивања Condorcet при избору вишенаменског оклопног борбеног возила точкаша

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Сажетак:

Увод/циљ: Оклопна борбена возила точкаши су све присутнији у савременим оружаним сукобима, нарочито у операцијама против асиметричних претњи. Тржиште ових возила је у константном порасту у свету, што је одраз њихове примене у широком спектру мисија и задатака оружаних снага. Постојање бројних модела оклопних возила точкаша различитих техничких и експлоатационих карактеристика, са могућношћу прилагођавања специфичним потребама, додатно отежава избор најпогодније алтернативе. У раду је представљен случај решавања проблема избора најпогоднијег вишенаменског оклопног возила точкаша средње класе и формуле погона 4x4. Изабрана је једна од четири понуђене алтернативе, применом метода индивидуалног и групног вишекритеријумског одлучивања.

Методе: Примењене су методе вишекритеријумског одлучивања при решавању проблема из области сложених борбених система. Експерти из области тактике са системима наоружања су применом метода AHP (Analytic Hierarchy Process) и PROMETHEE II (Preference Ranking Organization Method for Enrichment Evaluations II) извршили рангирање алтернатива у складу са дефинисаним критеријумима. Резултати добијени индивидуалним одлучивањем подвргнути су методи групног одлучивања Condorcet ради доношења коначне одлуке о оптималном решењу.

Резултати: Изабрано је најопогодније возило у складу са дефинисаним критеријумима.

Закључак: Решење проблема подразумева узимање у обзир ставова војних експерата у погледу оптимизације више критеријума ради обезбеђења возила најбољих перформанси погодног за употребу у различитим мисијама. Избор вишенаменског оклопног борбеног возила точкаша је комплексан процес на који утичу бројни фактори које није могуће анализирати објективно без примене адекватних математичких модела.

Кључне речи: оклопна борбена возила, вишекритеријумско одлучивање, AHP, PROMETHEE II, метод Condorcet.

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