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Use of Multicriteria Analysis in Unmanned Ground Vehicle Selection

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Abstract

This article focuses on decision making to select the optimum variant of the product based on the evaluation of the criteria and the analysis of the variants of the product according to the available criteria. The introduction offers an overview of the existing method of multicriteria analysis, including a description of the principles on which the methods are based. The method of analysis was used for the optimal variant of the selection of Unmanned Ground Vehicle selection intended for military and rescue applications. Considering the properties of the described methods, the Saaty method was chosen for the intended analysis of the evaluation of the designed criteria and the determination of the weights of the groups of vehicle parameters. In addition, for the evaluation of available variants of the vehicle, the power function was applied using weights from the Saaty method for each parameter.

KEYWORDS:*multicriteria analysis, Saaty method, power function of multicriteria analysis, unmanned ground vehicle (UGV)*

1. Introduction

The decision-making process most often means a problem-solving process that has more than one solution. Solving a multi-criteria decision-making problem is a procedure that aims to find the "optimal" state of the system with respect to more than one criterion considered. This process is called multicriteria optimization.

Since the 1970s, multi-criteria decision-making (MCDM) research has developed rapidly and has become a hot research topic because many complex practical decision problems involve multiple and conflicting criteria as well as multiple objectives. Over the past few decades a number of MCDM methods [1].

The decision-making process consists of the following sub-activities (phases):

- formulating and setting the goals of the decision-making problem,
- choice of decision criteria,
- creating a file variant that is used to solve the problem,
- selection of the optimal variant that solves the given problem.

Selected methods used for multicriteria analysis:

1. Metfessel allocation – is based on the fact that the decision-maker directly enters the standardized weights of the criteria. We interpret weights here as a percentage of the sub-objective, expressed in the form of the relevant criterion, to the higher-level objectives. It is most often applied to the method of weighted average levels of fulfillment of sub-objectives, where the so-called tree of sub-objectives (or criteria tree) is used, in which the main objective is divided into sub-objectives.

2. Compensation method – uses two variants. The first option will include the worst effects on all criteria that may occur. The second option, on the other hand, will have the best possible impacts on the criteria. In the next phase, it is necessary to determine the first criterion in the sequence. This is a criterion where the most drastic change between the best and worst option. Such a criterion will gain the highest weight from the given scale. Based on this procedure, we sort all the criteria according to the significance of the changes. At this point we have non-standard weights, so it is necessary to compare them with the criterion first.

3. Scoring method – the procedure for determining the weights of criteria by this method consists in the decision-maker assigning to each criterion a certain number of points from the selected scale in accordance with how he evaluates the meaning of each criterion. Standardization is performed by determining the sum of all points allocated to all criteria. The weight of a particular criterion is then calculated as the ratio of the number of points

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of the criterion to the sum of all points. The scoring method is one of the simplest and clearest. Basic knowledge without the need for complex calculations will suffice for its evaluation.

4. Fuller's method – determination of preferences is based on a triangular matrix. This method uses pairwise comparison of variants. The advantage is that each variant is compared with each. However, the disadvantage is that the criteria of the variants are compared on a better / worse basis and the degree of preference of one variant over another cannot be taken into account.

5. PRIAM method – is based on the procedure where a set of variants is searched in a certain way in order to obtain one non-dominated solution. It works by emphasizing aspiration levels, thus gradually eliminating individual variants. As a result, only one option remains, which is then chosen as a compromise.

6. ORESTE method – it is necessary to know the ordinal information concerning variants and criteria. This information must be sorted by importance at the outset. In the next phase, a matrix of distances from the so-called fictitious beginning is created. Subsequently, the values of the matrix are sorted and evaluated on the basis of the order in which the values of preferential intensities are calculated. An indifference test is performed under certain conditions. In the last step, the comparability of variants is tested.

7. ELECTRE method – divides the set of variants into two groups, namely efficient and inefficient. To apply this method, it is necessary to know the criterion matrix, the vector of normalized weights, and the thresholds of preference and disperference. By effective variants we mean those which are preferred over at least one variant, and at the same time there is no preferred variant for them. The final output is based on the determined preference and dispreference thresholds. For preference and dispreference matrices, it is better to start from average values, which are then gradually tightened or reduced.

8. PROMETHEE method – is based on the fact that it uses preferential functions for the calculation. As a result, it is based on the same group of methods as the ELECTRE method. We know five basic types of preference functions, namely the common criterion, the quasi-criterion, the linear preference criterion, the level criterion and the Gaussian criterion. The most difficult thing for decision-makers in this method is the correct determination of the importance of the weights of the criteria and the determination of preferential functions.

9. AHP method – takes into account all elements that affect the result of the analysis. The whole decision problem is often represented as a hierarchical structure that contains several levels and each of the levels includes several elements. The relationships between the individual components can be determined similarly to Saaty's method of determining weights. Based on the calculations of the Saaty matrices, the values of the weights are divided within these matrices according to individual criteria. The values obtained in this way are often referred to as preferential indices from the point of view of all criteria. In the case where the individual preferential indices are added up from the point of view of all criteria, the evaluation is obtained from the point of view of all decision-makers and from the point of view of all criteria.

10. Saaty method – this method compares the preferential relationships of the pairs of criteria arranged in the Saaty table. However, unlike Fuller's method, in addition to the criteria preference itself, the size of this preference is also determined, ie not only if one variant is better than the other, but also how much better it is. For the Saaty method, the degree of advantage of the criteria can be taken into account.

2. Description of the Selected Saaty Method

This method uses only quantitative values, so it does not pass any qualitative values into the result and only the given values are taken into account. In this method, the criteria are compared with (each with each) other according to how they are. Comparison procedure using the Saaty method:

1. definition of variants and criteria (parameters),
2. pairwise comparison of criteria and determination of the meaning of criteria,
3. compilation of the preference intensity matrix S and determination of the weighting criteria,
4. compilation of a matrix for a given criterion and determination of the weight of variants - evaluation of criteria,
5. multiplication of the weight of the criteria with the weights of the parameters for the given variants - partial evaluation of alternatives,
6. plotting the final values in a table.

The Saaty method is used to determine the weights of criteria v_i and v_j, which is performed in two steps. First, the matrices of intensity preferences S are determined. The elements of the matrix S, which we denote as (i-th row, j-th column), are obtained by finding out how many times the criterion K_i is more significant than the criterion K_j, if it holds that K_i is more significant or as significant as K_j. This ratio of the significance of the two criteria, which is expressed by the elements s_{ij}, can also be interpreted as the ratio of their weights:

$$s_{ij} = \frac{v_i}{v_j}, i, j = 1, 2, 3, \ldots, m. \qquad (1)$$

Based on the number of times the criterion Ki is more significant than K*j*, the numbers from 1 to 9 are assigned to the elements sij of the matrix of preference intensities S, the meaning of which is given in table 1 [1][2][3][4][5].

Table 1.

Language descriptors

Weight	Descriptor
1	The elements are equally important.
2	The row element is very slightly more significant than the column element.
3	The row element is slightly more significant than the column element.
4	The row element is quite a bit more significant than the column element.
5	The row element is far more significant than the column element.
6	The row element is almost demonstratively more significant than the column element.
7	The row element is demonstratively more significant than the column element.
8	The row element is much more significant than the column element.
9	The row element is totally more significant than the column element.

If K_j is more significant than K_i, the elements s_{ij} are determined as follows:

$$s_{ij} = \frac{1}{s_{ji}}. \qquad (2)$$

If the criterion K_i is s_{ij} times more important than the criterion K_i, then the significance of the criterion K_i is $1/s_{ij}$ part of the significance of the criterion K_i. If relation (2) holds for all elements of the matrix *S*, then the matrix *S* is reciprocal.

The second step is to determine the weights themselves based on knowledge of the matrix S, for which several methods can be used, such as determining the eigenvector corresponding to the maximum eigenvalue of the preference intensity matrix S or the least squares method that minimizes expression [3]:

$$D = \sum_{i=j}^{m} \sum_{j=1}^{m} \left(s_{ij} - \frac{v_i}{v_j} \right)^2, \qquad (3)$$

on the condition

$$\sum_{i=1}^{m} v_i = 1. \qquad (4)$$

To calculate the weights of the criteria using the Saaty method, a procedure working with the geometric mean will be applied to the matrix S [3]:

$$S = \begin{pmatrix} 1 & s_{12} & \cdots & s_{1j} \\ s_{21} & 1 & \cdots & s_{2j} \\ \vdots & \vdots & \vdots & \vdots \\ s_{i1} & s_{i2} & \cdots & 1 \end{pmatrix}. \qquad (5)$$

To determine the weights, Saaty proposed several methods by which the weights v_j can be estimated. The most commonly used procedure is to calculate the weights as the normalized geometric mean of the rows of the Saaty matrix (the logarithmic least squares method). The values of bi are calculated as the geometric mean of the rows of the Saaty matrix [3]:

$$b_i = \sqrt[n]{\prod_{j=1}^{n} s_{ij}}. \quad (6)$$

The weights are then calculated by normalising the values b_i

$$v_i = \frac{b_i}{\sum_{i=1}^{n} b_i}. \quad (7)$$

The matrix is square of order n×n and expresses an estimate of the proportions of the weights of the *i*-th and *j*-th criteria. There are always values of one on the diagonal of the Saaty matrix (each criterion is equivalent to itself). The degree of consistency is measured, for example, by the consistency index, which Saaty defined as [3]:

$$C_I = \frac{\lambda_{\max} - n}{n-1}, \quad (8)$$

where $\lambda_{\max}$ is the largest eigenvalue of the Saaty matrix and *n* is the number of criteria.

To check the validity of the table, the consistency ratio C_R must be calculated according to (9). To calculate the C_R, the variable consistency index C_I according to (8), the random index R_I and the largest eigenvalue of the matrix (λ_{max}) must also be calculated. The value of R_I is freely available in the table.

$$C_R = \frac{C_I}{R_I}. \quad (9)$$

To evaluate the criteria, a single table is created with rows and columns listing all the criteria. The weights of the criteria are then assigned within the pairwise comparison according to which criterion is preferred. Then the geometric means b_i and the resulting weights v_i are calculated according to (6) and (7) respectively.

Saaty's method can be used not only to determine the preference between criteria but also between variants. Although, in case where the parameters of individual objects are described in vague terms and there are different requirements for minimum and maximum value of each parameter, the normalized geometric mean cannot be used [6].

Let $V = \{V_1, V_2, \ldots V_n\}$ be a set of variants. The optimization criterion (target) *K* is a subset of *V*, that is, the evaluation of all variants by numbers from the interval <0; 1> according to the degree of affiliation to *K*. If the criteria $K_1, \ldots K_s$ are given and to choose the variant that best suits all K_i, it is necessary to express the criterion (purpose) function $F(v)$ as the intersection of sets V_i. Two different definitions of intersection are used for this purpose [6]:

$$F(v) = \min_{1,\ldots s}\{K_1(v), \ldots K_s(v)\}; \quad (10)$$

$$F(v) = K_1(v) \cdot K_2(v) \ldots \cdot K_3(v). \quad (11)$$

The second definition of the criterion function uses the product instead of the minimum and therefore generally leads to smaller values of the criterion function. In both cases, choosing the optimal variant means choosing the one that maximizes the criterion function *F*. These entry assume that all criteria $K_1, \ldots K_S$ are equally important.

However, in practice, it must be taken into account that the criteria are of different importance. The idea of the next procedure is to use the Saaty characteristic vector method to weigh the targets as follows: We denote by $V = \{V_1, V_2, \ldots V_n\}$ the set of variants (alternatives) and optimization criteria $K_1, \ldots K_S$. That means that s sets are given:

where q_i^j are degrees of belonging to the given sets, which express the different importance of the criteria [6].

$$K_1 = \begin{pmatrix} q_1^1 & \cdots & q_n^1 \\ v_1 & \cdots & v_n \end{pmatrix}$$
$$\vdots \quad , \quad (12)$$
$$K_s = \begin{pmatrix} q_1^s & \cdots & q_n^s \\ v_1 & \cdots & v_n \end{pmatrix}$$

3. Design of Parameters for Multicriteria Analysis in UGV Selection

During the analysis, autonomous ground vehicles that meet the minimum payload conditions were assessed to be capable of being used to carry a weapon station of up to 12.7 mm caliber, to support infantry units or to evacuate wounded. To maintain the objectivity of the analysis performed, vehicles on a wheeled chassis were chosen exclusively.

Fig.1. Chosen vehicles: a) Unmanned, modular and automated robotic ground vehicle TAROS 6x6 V2;
b) Robotic vehicle SMSS (Squad Mission Support System); c) Rheinmetall Mission Master SP;
d) Multipurpose robotic UGV ROOK [7][8][9][10].

For the purposes of performing the multicriteria analysis, the parameters that influence vehicle passability, which is the ability of the vehicle to drive on damaged or disturbed roads and terrain, were selected. It consists of vehicle passability in less bearable terrain and passability in rugged terrain. This ability is also influenced especially by geometric properties of vehicle; for purposes of analysis those parameters that are available were chosen.

The second selected category of criteria were parameters affecting the driving dynamics, based on the available parameters vehicle specific power (VSP) was calculated and the maximum achievable acceleration when driving on a straight road [11].

In the third group, there are special capabilities (possibilities and abilities of vehicle) of the vehicle, which can be compared with the compared offered vehicles.

Table 2.

Language descriptors

1st group	2nd goup	3rd group
K_{11}: Vehicle Curb weight	K_{21}: Maximum speed	K_{31}: Ability to float
K_{12}: Vehicle length	K_{22}: Maximum speed of travel in water	K_{32}: Airless tires
K_{13}: Vehicle width	K_{23}: Vehicle Specific Power	K_{33}: Level of ballistic protection
K_{14}: Vehicle height	K_{24}: Driving range	K_{34}: Possible track mount
K_{15}: Effective payload	K_{25}: Acceleration (calculated)	

4. Example of UGV Selection Solution Using Saaty Method

At first, the matrices of preference intensities S for each category of criteria were assembled.

$$S_1 = \begin{pmatrix} 1 & 7 & 4 & 6 & \frac{1}{3} \\ \frac{1}{7} & 1 & \frac{1}{5} & \frac{1}{4} & \frac{1}{7} \\ \frac{1}{4} & 5 & 1 & 3 & \frac{1}{2} \\ \frac{1}{7} & 4 & \frac{1}{3} & 1 & \frac{1}{5} \\ 3 & 7 & 2 & 5 & 1 \end{pmatrix}$$

The compilation of matrices was performed for each group. For the first group, the geometric mean and weight of each criterion were calculated according to (6, 7), values are given in table 3. For the matrix of the first group λmax (8) reaches maximum value 5.456 and the CR (9), the variable consistency index is 0.114.

Table 3.

Geometric mean (Gi) and weights (vi) of criteria of the first group

	K_{11}	K_{12}	K_{13}	K_{14}	K_{15}	Geometric mean (G_i)	Weights (v_i)
K_{11}	1.00	7.00	4.00	6.00	0.33	**2.237**	**0.316**
K_{12}	0.14	1.00	0.20	0.25	0.14	**0.252**	**0.036**
K_{13}	0.25	5.00	1.00	3.00	0.50	**1.134**	**0.160**
K_{14}	0.17	4.00	0.33	1.00	0.20	**0.536**	**0.076**
K_{15}	3.00	7.00	2.00	5.00	1.00	**2.914**	**0.412**
Σ						**7.073**	**1.000**

Table 4.

Geometric mean (G_i) and weights (v_i) of criteria of all groups

Geometrical parameters K_{1j}	Parameters that influence drive dynamics K_{2j}	Special abilities K_{3j}
0.316	0.226	0.272
0.036	0.027	0.081
0.160	0.132	0.304
0.076	0.486	0.342
0,412	0,129	
Weights of main parameters		
0.484	0.349	0.168

The geometric mean and the weights were calculated for every group of criteria as can be seen in below mentioned table 4. Also, the weights of the whole K_{ij} criteria groups were determined.

Table 5 shows the input values, the target value of the requirement to which the specified parameter is to be approached, as well as the coefficient of target values of each criterion. Because the vehicles are compared with each other, the most convenient achieved value is chosen.

Table 5.

Determination of the coefficient of the target values of the criterion from the first group

Geometrical parameters	Target value [mm or kg]	UGV TAROS V2 6x6	SSMS	Rheinmetall Master SP	ROOK Multi Purpose Robotic UGV
$K_{h_{t1}} = \frac{H_{c1}}{H_{t1}}$	1100	0.786	0.638	1.000	0.917
$K_{h_{t2}} = \frac{H_{c2}}{H_{t2}}$	2700	0.985	0.750	0.915	1.000
$K_{h_{t3}} = \frac{H_{c3}}{H_{t3}}$	1500	0.847	0.833	1.000	0.938
$K_{h_{t4}} = \frac{H_{c4}}{H_{t4}}$	1200	0.588	0.571	0.857	1.000
$K_{h'_{t5}} = \frac{H_{t5}}{H_{c5}}$	1200	0.417	0.450	0.500	1.000

For estimation of parameters those for whose a lower value is desired, it is calculated using given equation:

$$K_{h_{tr}} = \frac{H_{cr}}{H_{tr}}, \tag{13}$$

and for parameters whose a higher value is desired, the bellow-mentioned equation is utilised:

$$K_{h'_{tr}} = \frac{H_{tr}}{H_{cr}}, \tag{14}$$

for t = 1, 2, …z, r = 1, 2, …. s, where H_{tr} is the value of the r criterion assigned to the variant t and H_{cr} is the value of the *r* criterion assigned to the targeted variant (target requirement), *s* is the number of criteria and *z* is the number of variants.

The equation of power criteria function applied to evaluate the variants according to the first group of criteria is stated below, and the results are given in table 6:

$$F(v_1) = K_{h_{t1}}{}^{0,316}(v) \wedge K_{h_{t2}}{}^{0,036}(v) \wedge K_{h_{t3}}{}^{0,16}(v) \wedge K_{h_{t4}}{}^{0,076}(v) \wedge K_{h'_{t5}}{}^{0,412}(v)\ , \tag{15}$$

Table 6.

Table of results of power function applied to evaluate the variants for first group of parameters

	Search direction		$(K_{ht1})^{0,316}$	$(K_{ht2})^{0,036}$	$(K_{ht3})^{0,16}$	$(K_{ht4})^{0,076}$	$(K_{h't5})^{0,412}$
	minimum	maximum					
V_1	↔	↕	0.927	0.999	0.974	0.961	0.697
V_2	↔	↕	0.868	0.990	0.971	0.958	0.720
V_3	↔	↕	1.000	0.997	1.000	0.988	0.752
V_4	↔	↕	0.973	1.000	0.990	1.000	1.000

The next step resides in determination of the optimum variant according to all five criteria, which are weighted in compliance to their importance evaluated using Saaty method. Because a power function is used, which assigns smaller values of alternatives to the more important criteria, it is necessary to select the minimum values of the coefficients of the criterion function (line by line in table 6), which belong to individual variants and correspond to aggregated criteria. The optimal alternative (given all five criteria, weighted according to their importance) is then the one that maximizes the function.

$$F(v) = \begin{bmatrix} v_1 & v_2 & v_3 & v_4 \\ 0,697 & 0,72 & 0,752 & 0,973 \end{bmatrix}. \tag{16}$$

The V_4 variant, the ROOK Multi-Purpose Robotic UGV, is optimal with regard to the specified criteria in terms of dimension and weight parameters. The V_3 variant (Rheinmetall Master SP) is the second in a row, the third is variant V_2 (SSMS), and the V_1 variant (UGV Taros V2 6x6) appears as the last one with regard to the specified geometric requirements.

The similar procedure was applied to variants according to remaining groups of criteria, and the results of the analysis can be seen below in table 7, and graphical representation of results in chart 1.

Table 7.

Table of the results of power function applied to evaluate the variants for the first group of parameters

Group of parameters	Variant			
	V_1	V_2	V_3	V_4
1st group	0.697	0.720	0.752	0.973
2nd group	0.960	0.544	0.967	0.594
3rd group	0.000	1.000	1.000	0.789
Weighted average	**0.672**	**0.612**	**0.763**	**0.734**

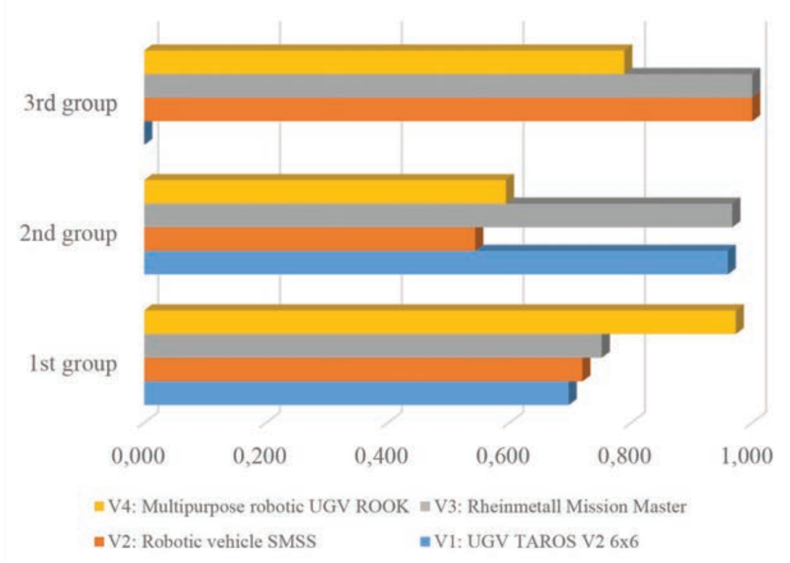

Fig. 2. The chart of complex evaluation of variants using Saaty method and power function

The least step of the proposed analysis was the evaluation of the order of the vehicles assessed according to all groups of criteria (first the geometrical parameters, the second the parameters which influence the drive dynamic and the third vehicle special abilities. The overall classification was determined using weighted average where the weights of the main parameters according to table 4 were taken into account.

The V3 variant, the Rheinmetall Master SP, is optimal with regard to the specified criteria in terms of available evaluated parameters. The V_4 variant (ROOK Multi-Purpose Robotic UGV) is the second, the third is variant V_2 (UGV Taros V2 6x6) and the V_2 variant (SSMS) appears as the last one with regard to the specified requirements.

5. Conclusions

First, the article offers an overview of existing methods of multicriteria analysis, including an introduction of the principles on which the individual mentioned methods work.

The subject of the research intention was the selection of the optimal variant of the Unmanned Ground Vehicle for military and rescue purposes based on the available parameters of the vehicle variants.

According to the mentioned principles and properties of multicriteria analysis methods, the Saaty method was chosen for this case. The method was applied mainly to evaluate the weight of individual criteria. Due to the fact that the Saaty method works only with quantitative values and in the field of vehicle passability, driving dynamics, and special capabilities of vehicles, it is necessary to decide on the basis of evaluation of individual criteria when the maximum and minimum value of various parameters is demanded, and also the decision in fuzzy environment is required. The method was supplemented by using the power function in the phase in the evaluation of individual vehicle variants.

Considering the method used, there is a certain degree of subjectivity in the phase of determining the weights of individual criteria, although it can be revised to a certain extent by calculating consistency ratio of the matrix S. Another attribute associated with the use of the power function is connected with necessity to assign smaller values of alternatives to the more important criteria, it was necessary to select the minimum values of the coefficients of the criterion function which belong to individual variants and correspond to aggregated criteria. The optimal alternative is then the one that maximizes the power function.

The evaluation of this method reveals the following facts:

- Overall accuracy, given the ability to revise inconsistent estimates.
- Applicability for performing a sufficiently large number of pairwise comparisons.
- Accuracy when using pairwise comparisons from only one expert (which, however, is not a condition, there can of course be more experts).
- Relatively easy calculations.

In Chapter 5, one of the vehicles offered was selected based on the available parameters. However, in the selection itself and eventual purchase of a vehicle, it would be necessary to take into account the financial costs, not only the price related to the acquisition, but the life-cycle cost of the vehicle.

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References

1. **Saaty T. L., Ergu D.** When is a decision-making method trustworthy? Criteria for evaluating multi-criteria decision- making methods. International Journal of Information Technology and Decision Making, vol. 14, no. 6, 2015.
2. **Bain H., Howard N., Saaty T. L.** Using the Analysis of Options technique to analyze a community conflict. Journal of Conflict Resolution, vol. 15, no. 2, 1971.
3. **Saaty T. L.** A scaling method for priorities in hierarchical structures, Journal of Mathematical Psychology, vol. 15, no. 3, 1977.
4. **Saaty T. L.** How to make a decision: The analytic hierarchy process. European Journal of Operational Research, vol. 48, no. 1. 1990, pp. 9–26.
5. **Saaty T. L.** The analytic hierarchy and analytic network processes for the measurement of intangible criteria and for decision-making. International Series in Operations Research and Management Science, vol. 233, 2016.
6. **Petříček O.** Evaluation and optimization of technical parameters of wheeled vehicles. (Ph.D. thesis). Brno:
7. University of Defence, 2003.
8. TAROS V2 Unmanned Ground Vehicle (UGV). ARMY TECHNOLOGY. [Online] 2014. [Citated: 2021-10-19]. https://www.army-technology.com/projects/taros-v2-unmanned-ground-vehicle-ugv/. Squad Mission Support System (SMSS). ARMY TECHNOLOGY. [Online] 2021. [Cited: 2021-10-25]. https://www.army-technology.com/projects/squad-mission-support-system-smss/.
9. The Rheinmetall Mission Master family. Rheinmetall Defence. [Online] 2020. [Cited: 2021-10-26]. https://www.rheinmetall-defence.com/en/rheinmetall_defence/systems_and_products/unbemannte_fahrzeuge /mission_master/index.php.
10. Elbit Systems and Roboteam Introduce ROOK. New Multi-payload 6X6 Unmanned Ground Vehicle [Online] 2021 [Cited: 2022-06-17]. Available from: https://elbitsystems.com/pr-new/elbit-systems-and-roboteam-introduce-rook- new-multi-payload-6x6-unmanned-ground-vehicle/
11. **Jiménez J. L.** Understanding and Quantifying Motor Vehicle Emissions with Vehicle Specific Power and TILDAS Remote-Sensing (Ph.D. thesis). Cambridge, Massachusetts: Massachusetts Institute of Technology, 1998.