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Certain Problems in Infrastructure Management of the Armed Forces of the Czech Republic on Military Bases in Foreign Operations

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Abstract:

This article is devoted to certain infrastructure management options of the Armed Forces of the Czech Republic and designing military bases in foreign operations. In connection with the Defence Research Project, software architecture based on databases is projected, which is designated for special requirements of the Engineering Corps. At some level there must be coherence within the All-military Logistics Information System; moreover, to increase the efficiency of the process of base design, it is possible to use other options and software tools. To select the optimal base design option the multi-criteria decision-making may be used, whose principles are elaborated on in the article.

Keywords:

Military base, base design, variant, multi-criteria decision-making

1. Introduction

The Defence Research Projects are addressed at the University of Defence, which is based in the city of Brno in the Czech Republic. One of these projects is titled "Technical support of design, building, maintenance and cancelling of Czech military bases in operations abroad, using the REACH-BACK concept (RUCH)". Because the content of the project relates to the activity of the Engineering Corps, it is quite natural that this project is addressed by teachers, doctoral students and students in the Department of Engineer Technology at the Faculty of Military Technology in collaboration with experts from the civilian sector. One of the objectives of this project is to design tools to facilitate the activities listed in the project name,

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designated to those who are directly involved in the activities, as well as the commanders responsible for fulfilling orders in a given area.

The process of design, construction, maintenance and the cancellation of military bases in foreign operations is a process that synthesizes multiple fields. It incorporates various sub-tasks of a heterogeneous nature performed using a number of tools. For example to suitably design a base, it is necessary to combine a purely building aspect with the military tactical, economic and logistical aspects, bearing in mind also the requirements of environmental protection and many other disciplines. Similarly, in any of the listed and also those not listed disciplines involved in the activities relating to military bases, it is necessary to take into account the requirements of the engineers. For this reason, the knowledge, methodologies and experience of all the disciplines should be used and the addressed issues should be approached comprehensively.

In addressing the issue of military buildings at bases on foreign operations, among others, the tools providing the infrastructure management of the Armed Forces of the Czech Republic are used. This infrastructure management is based on databases which contain information on assets and infrastructure. The collected data can be used in various ways and for different purposes. An appropriate database performs more extensive features than just providing a register of each item. It is a tool used in the design, construction, maintenance and cancellation of military bases. The Armed Forces of the Czech Republic use software called Logistics Information System. In this computer program, among many other functions, it is possible to find military property databases, including assets on bases on foreign operations. Engineers, as well as other kinds of troops, use the Logistics Information System (further LIS); however, they also need other special technical data for their work; in addition, they have to be able to incorporate such data into their activities in a straightforward manner (e.g. into the base design process). For this reason, it appears to be very useful to create a tool that would enhance the competency of the Engineering Corps Brigade in the design of bases. For example, such a tool can be catalogue sheets containing partial items of infrastructure with their detailed technical specifications and software working with digital database records. The database would have to meet the special requirements of the Engineers; therefore, LIS cannot be directly used to the full. Nevertheless, the co-ordination between the LIS and the described tool of engineers needs to be ensured in some ways.

The article is firstly concentrated on the engineers' view of military bases. It is followed by the part that concerns the Logistics Information System. Following that, the issues of multi-criteria decision making are addressed. The paper also outlines a possibility how the new tools in the property management of the Armed Forces of the Czech Republic could be used to increase the competence of Engineering Corps in the design of bases.

2. Military Bases in Foreign Operations

A properly built military base is one of the basic pre-requisites in the success of a foreign operation. Construction of bases may vary significantly from each other. It is influenced by factors such as the duration of the operation, the number and composition of teams, cultural, climatic, logistical and geological conditions. Engineer troops, which also provide engineer support to multi-national joint combat and non-combat operations, are responsible for the construction of a base. To analyze engineer security operations and support the activities of a group of troops, it must be clear what kind of activity it is, what tasks, in what order and how they should be implemented during their operation. To carry this out, it is necessary to have the required documents, information about engineering measures, commander's envisaged activities, formulated similarly as for example in the regulations or military publications [5].

Each base goes through its life cycle. It includes a course of stages of the base from its design, through its construction and operation up to its cancellation. Engineering units enter into the process as early as in the design stage. The design stage deals with the issues of the implementation of the project in technical, economic, legal, security and other terms. Engineering professionals need an access to the current information and technical data of infrastructure. To meet the required tasks, there is modern information technology.

Within the structure of the Czech Armed Forces, the Engineering Corps together with other unspecified departments belong to the so-called Joint Set Assistance Force. Engineering Corps are heavily involved in the performance of tasks and engineer security measures (sum of the planned and implemented measures in the area of corps activities of operating clusters), in the form of combat and general engineer support of the corps activities. The aim of engineer security is to create conditions for the timely transfer into the operating area and safe movement in the areas of their activities during carrying out the tasks of the defined mandate [12].

In the preparation of an operation it is necessary to specify the threats and analyze risks. Based on their specifications, it is possible to plan and then implement engineering measures to protect the troops and base. Within non-combat operations, the engineer support in protecting troops is carried out in the form of advice (counsel, guidance), designs, material security, and the building of bases [12].

Problems related to specific activities of the units were theoretically developed in the use of units and departments of engineer troops in current military operations. LIS is used for any material accountancy managed by the Armed Forces of the Czech Republic, its movements, disposal etc. It plays a crucial role in the planning of the Czech Army building bases in foreign operations. Therefore, the following part of the article briefly introduces the software.

3. Logistics Information System

Infrastructure management of the Armed Forces of the Czech Republic on bases during foreign operations requires managing large amounts of infrastructure data. Most of the data is of purely engineering character; nevertheless other data falls into the area of logistics, economics, management, etc. If possible, an information system introduced in the Army of the Czech Republic is used. If the data must be kept separately, it is necessary to co-operate with this system to the maximum possible extent. Therefore, the following paragraphs briefly deal with the mentioned information system, which forms the backbone of all stored information.

Logistics information system is a software product that originated as a response to the need to effectively work with data and thereby secure military activity. An integrated information system was created, which gives the opportunity to work in a broad environment; it uses resources, it is able to transmit important data and achieve synergy effect in the overall logistics chain. It was essential that the information system was fully compatible within the multinational environment [7].

The Logistics Information System can be described as a functional, unified and integrated information system for military logistics. Its creation was also one of the basic assumptions of the involvement in the NATO logistics system. It supports military logistics in all relevant areas and provides a unified logistical support for all components of the armed forces [1]. Currently the Logistics Information System is used by the Ministry of Defence and the Armed Forces of the Czech Republic for the purpose of asset management at all military units, including military groups in peace, rescue and foreign operations. The system provides management with a continuous overview of property conditions, from its acquisition until its disposal and de-commissioning [7].

The Logistics Information System aims to have efficient and effective promotion of property management and all logistics activities. Among other things, it communicates with NATO logistics (i.e., there is an electronic data exchange via the NATO Mail BOX System, which connects 28 countries), with other information systems of the Ministry of Defence through data interfaces, as well as with the sectors which follow (e.g. defence industry, information system for the administration of state material reserves, etc.) [8].

The Logistics Information System architecture is designed to allow independent work in different locations, while providing the possibility to centrally manage logistics [8]. The functionality of the whole system is geared to meet the functions of planning, organizing and logistical support management, material logistics functions, logistics supply functions, logistics functions in maintenance and repairs, service functions of shipments, contract logistics functions and determining of logistical needs and logistical support to operations [7].

As already mentioned, one of the main tasks of the Engineer Corps is the construction of military bases abroad. The design, construction and cancellation of bases of the Armed Forces of the Czech Republic is a process that cannot do without skilled professionals as well as without software for working with technical data in electronic form, which will enable the creation, storage, transmission, processing and presentation of data [10].

For the Engineer Corps to effectively fulfil their tasks, their operation must be managed not only in terms of operational command, but also in terms of cost and logistics. Engineer measures to ensure movements and protection of forces during military actions are currently one of the priorities of the Engineering Corps of the Armed Forces of the Czech Republic. To be effective and the least financially and materially costly, any foreign operation, must be thoroughly prepared in advance. The construction of bases and logistic support of military operations should be carefully and responsibly planned. Otherwise, the armed forces can suffer from economic losses, or may not fulfil a combat mission at all [13].

This article deals only with ties to engineer materials that will be used for the construction of military bases for the Armed Forces of the Czech Republic in foreign operations. It is necessary to plan not only what material and how much of it will be needed, but also to decide in what way it will be transported to the place of the future base. It is necessary to take into account all of the factors, such as whether the construction of a base is dependent only on its own resources, which have been transported, or whether it uses local resources, as well as many other factors.

A basic activity associated with the construction of temporary military structures (bases) and constructions is their design. The success and effectiveness of this activity depends largely on the quality of the information system, its links with other information systems and the implementation of engineer “know-how”. The design, construction, maintenance and cancellation of a base use the concept of REACH-BACK. When using the concept of REACH-BACK, the troops deployed in a foreign operation do not have to import all the components, which remain in the Czech Republic and perform support tasks for deployed troops. Using this concept, a commander of a deployed troop sends a survey team to site to carry out engineer survey on the site, and from that, they send photographs to the commander and the support team. The support team will evaluate and recommend an appropriate engineering material to the commander and send a request to project the building and to complete data on the building site. Following the decision of the commander, the support team will implement the measures of construction, find additional information, send it all to the support team and return to the unit. The support team prepares the project documentation, construction schedule and instructions for building construction for the commander of the deployed unit. The main advantage is lower consumption of deployed soldiers and especially high financial savings. Modern information technology is a very useful and powerful tool that streamlines tasks during the life of the whole base building. Another advantage of using an information system is high availability and readiness to consult complex technical issues directly with the deployed units. It is linked with another advantage, which is the storage of software in one place [8].

Engineer Corps mainly need the technical data on engineering (construction) material during the construction of military bases. Timely, accurate and updated information can be provided only by a well-designed system, which will contain all technical data about engineering materials. Such a system should be complemented by other methodological guidelines, animations, images, etc. [7].

Specific requirements for material used in the construction depend on numerous factors that affect the base project – for example the climate in the location of the future base, landforms, specific purpose of a base, kind of troops for which the base will be built, the war situation, relations with the local population, co-operation with the armies operating within the operation, logistics options, etc. An important role in the construction process of engineer troops and achieving target operational capabilities will be played particularly by a well-designed information system, software equipment, but also by the professional preparation of the Engineer Corps members.

4. Infrastructure Management of the Armed Forces of the Czech Republic and its Use – Multi-Criteria Decision-Making

When designing a military base, a designer or commander often considers several options from which to choose. The following part of the paper deals with this issue.

In everyday life a professional soldier as well as ordinary people, have to face the situations where it is necessary to make decisions. Often in ordinary life situations each individual decides more or less intuitively. However, there are decisions that have an impact on an individual for the rest of their life. For example, a decision on major financial transactions, evaluation of a project for the construction of a family house, on its performance and many others. In such cases, the approaches to solve the problems are much more rational.

Many decisions that a person has to perform also have a major importance for society. An example might be evaluating development projects of large objects, route selection for the construction of a road infrastructure, etc. In these decisions we cannot solely rely only on intuition. With the development of mathematics and economics during the 18th century, efforts for exact formulation of decision-making tasks began to emerge. In them, it is necessary to respect different and contradictory terms. These circumstances have been pointed out since the early 20th century by Italian economist Vilfredo Pareto. From the mid-20th century, the issue has been greatly studied and a number of methods have been developed for their solution. You can find various scientific studies, dissertations and professional literature on the topic. As an example we can state [3, 4, 9, 11].

This section deals with decision-making tasks, which can be generally described as follows. Consider a set of variations (variants – alternatives – specific decision options that can be implemented) evaluated by different criteria (considerations under which the variants are assessed). The task is to select the most suitable variant of this group from different perspectives. The complexity of the task is that different perspectives may be contradictory and that improving one aspect worsens another aspect. An example of assessed variants may include vehicles with data, such as price, capacity, fuel consumption, manufacturer, etc.

The criteria can be either quantitative or qualitative. The quantitative ones are determined numerically – these are derived by measurement or they are technical parameters (e.g. the number of engine cylinders). On the other hand, the qualitative criteria are given by verbal evaluation. Such data are usually transferred for evaluation to quantitative criteria. It is obvious that the transfer itself may be a very complicated and ambiguous matter.

Quantitative criteria can be maximization and minimization. The evaluation of a variant of a higher number means in maximization criteria a better option than the option ranked with a lower number. The minimization criterion is the opposite: an option scored with a lower number is, according to this criterion, better than an option scored with a higher number.

We will assume that we have a finite set of variants, let us denote it as m variants. That assumption corresponds to real situations because the number of variants is not too large. This does not mean that the selection of variants is a simple process. Each option is evaluated with a finite number of aspects – criteria, denoted as n criteria. A common task is to decide which option is evaluated as the best according to the considered criteria. Another goal may be to sort the options according to the criteria from best to worst. Ideally it would be to find the best option for all criteria, but this situation rarely occurs. Because usually there is no such option, therefore a compromise option is sought after.

$$
\begin{array}{c c}
 & \begin{array}{ccccc} K_1 & K_2 & & & K_n \end{array} \\
\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ \vdots \\ A_m \end{array} &
\begin{bmatrix}
a_{11} & a_{12} & \dots & \dots & a_{1n} \\
a_{21} & a_{22} & \dots & \dots & a_{2n} \\
\vdots & \vdots & & & \vdots \\
\vdots & \vdots & & & \vdots \\
a_{m1} & a_{m2} & \dots & \dots & a_{mn}
\end{bmatrix} \\
 & \begin{array}{ccccc} \mathrm{typ}_1 & \mathrm{typ}_2 & & & \mathrm{typ}_n \end{array}
\end{array}
$$

Formula 1 Multi-criteria matrix

This type of task can be described by criteria matrix (see Formula 1). In that the A_1, A_2, ..., A_m are the investigated variants; K_1, K_2, ..., K_n are the criteria, a_{ij} is the evaluation of the i-th variant by the criteria of K_j, where $i = 1, 2, ..., m$; $j = 1, 2, ..., n$. For each criterion there is its type indicated (maximization, minimization, qualitative).

Before the commencement of the evaluation it is appropriate to transfer all of the criteria into one type – for example to the quantitative maximization criteria. First, the qualitative criteria have to be converted into quantitative criteria. For example, if criterion K_j is minimization, it will be processed in the following way: Let $H_j = \max(a_{ij})$, where $i = 1, 2, \ldots, m$. Values a_{ij}, where $i = 1, 2, \ldots, m$ will be replaced by the values of $H_j - a_{i\,j}$, where $i = 1, 2, \ldots, m$ and it will be marked a_{ij} again, where $i = 1, 2, \ldots, m$. This converts the minimization criterion K_j to the corresponding maximization criterion. In the following, therefore, we assume that all the criteria are maximization.

It is appropriate to define the dominated and non-dominated matrix. A non-dominated variant is such a variant, to which there is no better variant in the sense that it would be possible to improve some of the criteria values, without worsening the values of other criteria. Let's say we have two evaluated variants $A_i = (a_{i1}, a_{i2}, \ldots, a_{im})$, $A_k = (a_{k1}, a_{k2}, \ldots, a_{kn})$, then variant A_i dominates the variant A_k, if $A_i > A_k$ and if there is an integer p that $a_{ip} > a_{kp}$. Variant a_i is called non-dominated if there is no variant which dominates it. If the only non-dominated variant is between the variants, then this variant is the best – the best according to all criteria. This case occurs only in exceptional cases. There are usually more non-dominant variants. Each of them can be understood as a compromise. In multi-criteria decision-making tasks, they often use the term of optimal variant. It is understood as a variant which is recommended to select for implementation. When studying the issue of the optimal solution, the concepts of ideal and basal variant can be found. The ideal variant is an imaginary variant, which has all the best values of the criteria. In contrast, according to all criteria a basal variant has the least favourable values.

Most evaluation methods require determining the importance of criteria. The evaluation of the importance of each criterion is a part of the solution methods. There are many methods to assign importance to each criterion. The procedure can be demonstrated by the following two methods.

The first method is evaluation of criteria by experts. For example, let's suppose that the individual criterion of the problem is expressed by p evaluating experts. Each expert at their discretion sorts individual criteria K_1, K_2, …, K_n. The first place will be given to a criterion that is considered the most important, then the second most important and so on, until the last criterion, which, in expert's opinion, is the least important. The ranking of criteria is converted into points in such a way that the most important (first) criterion is assigned the most points (n), in the other criteria, the number of points is gradually reduced by one, the criterion at the last n-th position is assigned 1 point. This is the basis for the creation of n-tuples of numbers representing the scoring of criteria K_1, K_2, …, K_n by one expert, where the first number of the n-tuple refers to the criterion K_1, the second number to the criterion K_2, etc. The same procedure is repeated for other experts, and thus a total of p n-tuples of numbers is obtained. From each n-tuple of numbers, they take the number on the j-th position and then their sum is calculated. The resulting sum s_j refers to the j-th criterion. The same applies for all other criteria and thus the sums s_j for $j = 1, 2, \ldots, n$ are determined. Importance v_j ($j = 1, 2, \ldots, n$) of each criterion K_j ($j = 1, 2, \ldots, n$) is defined as the quotient of the sum s_j (j = 1, 2, …, n) divided by the number of points assigned by all experts to all the criteria together:

$$v_j = \frac{s_j}{\sum_{j=1}^{n} s_j} \tag{1}$$

The second method is the evaluation of criteria by experts using Fuller's method. This method seeks to eliminate the problem, because to sort a larger number of criteria at once is difficult. Fuller's method achieves a simplification as follows. All pairs of criteria will be mutually compared and at each comparison one point is credited to the more important criteria. The sum of the points assigned to j-th criterion is denoted f_j. Since the number of pairs of criteria is $n(n+1)/2$, j-th criterion is assigned the importance

$$v_j = \frac{f_j}{\frac{1}{2}n(n+1)} \tag{2}$$

The searched optimal variant can be found using the method of weighted sum. This method is based on calculation of linear utility function u. Let us suppose that all the criteria in the criterion matrix are maximization. Designation D_j is the smallest criterion value in the j-th column. Let $D_j = a_{dj}$. Similarly the designation of H_j represents the largest criterion value in the j-th column. Let $H_j = a_{hj}$. The value u_{ij} of the incremental benefit of the i-th variant according to the j-th criterion is calculated by

$$u_{ij} = \frac{a_{ij} - D_j}{H_j - D_j}\,. \tag{3}$$

Function u_{ij} is linear in the variable a_{ij}. You can easily see that $u_{dj} = D_j$, $u_{hj} = H_j$. For i-th variant, A_i is the value of the utility function equal to

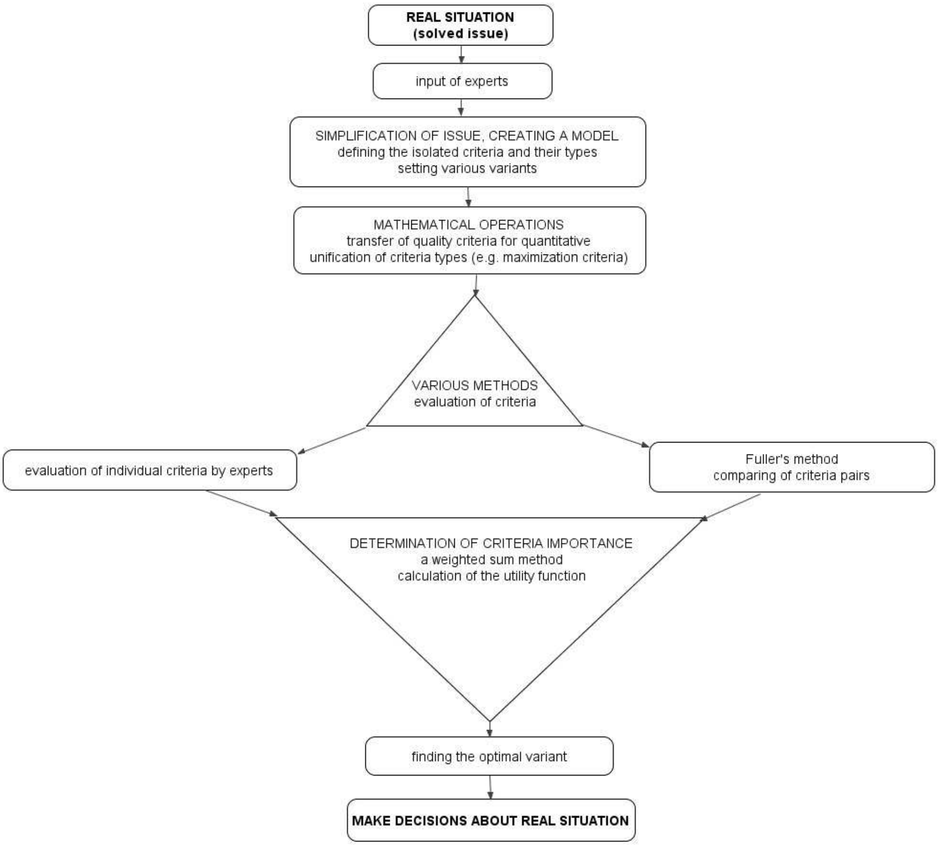
$$u(A_i) = v_1 u_{i1} + v_2 u_{i2} + \ldots + v_n u_{in}\,, \tag{4}$$

where v_i are the weights of individual criteria. Individual variations are ranked in descending order according to the values of the utility function. Individual variants are ranked from the highest according to utility function values. The variant with the highest utility function value is the optimal one.

The main points of the algorithm are shown in schematic figure Formula 2. There are other methods that are neither described in the article, nor mentioned in the scheme mentioned.

Multi-criteria task can be illustrated by the following example which is given by the multi-criteria matrix as shown in Formula 3.

It is a methodical process, so the example is generally selected and from this perspective it is completely irrelevant what specific and individual criteria it may represent. Yet for illustrations for example we can imagine the following meaning behind them: K_1 – the volume of the soil required for the excavations, K_3 – the price of the object, K_4 – the necessary number of staff with specialized training. A better option for all of the minimization criteria is the option with a lower criteria value. Criterion K_2 represents for example the protective coefficient value of structure without modifications; K_5 means the speed of construction. For the maximization criteria a better option is one with a higher criterion value.



Formula 2 Schematic representation of the multi-criteria decision-making

$$
\begin{array}{c}
\\
A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \\ A_6 \\ A_7
\end{array}
\begin{array}{c}
\begin{array}{ccccc} K_1 & K_2 & K_3 & K_4 & K_5 \end{array} \\
\begin{bmatrix}
96 & 205 & 8.5 & 5 & 7 \\
78 & 180 & 10.2 & 2 & 6 \\
98 & 185 & 9.1 & 3 & 9 \\
92 & 198 & 9.3 & 4 & 8 \\
68 & 202 & 7.0 & 7 & 12 \\
72 & 195 & 7.6 & 5 & 10 \\
105 & 214 & 8.1 & 6 & 8
\end{bmatrix}
\end{array}
$$

Formula 3 Entered multi-criteria matrix

Five criteria are in the task. Criteria K_1, K_3 and K_4 are already minimization, criteria K_2, K_5 are maximization and they need to be converted into minimization. Criterion values in the 1st, 3rd and 4th column are transformed using the following equations. The matrix in Formula 3 was transferred to the matrix shown in Formula 4 (see equations (5)), where is criteria matrix only with maximization criteria.

$$\begin{array}{ccc}
\text{first column } (K_1) & \text{third column } (K_3) & \text{forth column } (K_4) \\
105 - 96 = 9 & 10.2 - 8.5 = 1.7 & 7 - 5 = 2 \\
105 - 78 = 27 & 10.2 - 10.2 = 0.0 & 7 - 2 = 5 \\
105 - 98 = 7 & 10.2 - 9.1 = 1.1 & 7 - 3 = 4 \\
105 - 92 = 13 & 10.2 - 9.3 = 0.9 & 7 - 4 = 3 \\
105 - 68 = 37 & 10.2 - 7.0 = 3.2 & 7 - 7 = 0 \\
105 - 72 = 33 & 10.2 - 7.6 = 2.6 & 7 - 5 = 2 \\
105 - 105 = 0 & 10.2 - 8.1 = 2.1 & 7 - 6 = 1
\end{array} \tag{5}$$

$$\begin{array}{ccccc}
K_1 & K_2 & K_3 & K_4 & K_5
\end{array}$$
$$\begin{bmatrix}
9 & 205 & 1.7 & 2 & 7 \\
27 & 180 & 0.0 & 5 & 6 \\
7 & 185 & 1.1 & 4 & 9 \\
13 & 198 & 0.9 & 3 & 8 \\
37 & 202 & 3.2 & 0 & 12 \\
33 & 195 & 2.6 & 2 & 10 \\
0 & 214 & 2.1 & 1 & 8
\end{bmatrix}$$

Formula 4 Criteria matrix (maximization criteria)

The matrix in Formula 4 will be normalized. If we denote its elements $a_{i,j}$, then the standardized matrix U elements (see Formula 5) are determined by the relations

$$u_{ij} = \frac{a_{ij} - D_j}{H_j - D_j}, \tag{6}$$

where $i = 1, 2, \ldots, 7$; $j = 1, 2, \ldots, 5$, while $D_j = \min(a_{ij})$; $H_j = \max(a_{ij})$, (minimum and maximum of each column).

Tab. 1 includes the evaluation of criteria by three independent experts. The rating was performed by each expert in sequence, which was then transferred to a score. The last column of the table indicates the total number of points assigned to each criterion and that in total there were 45 points distributed in the task.

$$\boldsymbol{U} = \begin{bmatrix}
0.24 & 0.74 & 0.05 & 0.4 & 0.17 \\
0.73 & 0.00 & 0.00 & 1.0 & 0.00 \\
0.19 & 0.15 & 0.34 & 0.8 & 0.50 \\
0.35 & 0.53 & 0.28 & 0.6 & 0.33 \\
1.00 & 0.65 & 1.00 & 0.0 & 1.00 \\
0.89 & 0.44 & 0.81 & 0.4 & 0.67 \\
0.00 & 1.00 & 0.66 & 0.2 & 0.33
\end{bmatrix}$$

Formula 5 Standardized criteria matrix

Tab. 1 Evaluation criteria

	Expert 1		Expert 2		Expert 3		TOTAL
	Order	Points	Order	Points	Order	Points	Points
K_1	5	1	4	2	5	1	4
K_2	3	3	5	1	4	2	6
K_3	1	5	1	5	1	5	15
K_4	4	2	2	4	2	4	10
K_5	2	4	3	3	3	3	10
							45

Criteria importance v_j, j = 1, 2, 3, 4, 5 is calculated by dividing the number of points received by criterion K_j divided by the total number of points, in this case 45. The result is the following importance of criteria:

$$\boldsymbol{v} = \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \end{bmatrix} = \begin{bmatrix} 4/45 \\ 6/45 \\ 15/45 \\ 10/45 \\ 10/45 \end{bmatrix} = \begin{bmatrix} 0.089 \\ 0.133 \\ 0.333 \\ 0.222 \\ 0.222 \end{bmatrix} \quad (7)$$

The utility function is calculated for individual variations. Matrix sum shall be performed:

$$\boldsymbol{u}(A) = \boldsymbol{U} \cdot \boldsymbol{v} = \begin{bmatrix} 0.26297 \\ 0.28697 \\ 0.43868 \\ 0.40134 \\ 0.73045 \\ 0.64500 \\ 0.47044 \end{bmatrix} \quad (8)$$

The obtained values of the utility function will be sorted from the largest to the smallest. In this example, the utility function maximum value occurs in the variant of A_5, therefore, this variant will be considered as optimal. Other sequence of the variants is A_6, A_7, A_3, A_4, A_2, A_1.

As mentioned above, to increase their competences Army Engineer Corps could use a software product based on a database that would somehow correspond with the Logistics Information System, and mainly it would streamline some special activities, such as the design of military bases.

The items in infrastructure database used for buildings in foreign operations would be divided into three levels. At the lowest level, there would be structural elements. It is the basic building structure element, further indivisible (e.g. tent, ISO container, protective wall, barbed wire, chipboard, etc.). Medium level (building construction, parts) will consist of a specific set of construction elements. In this case, it is the basic building part of the construction. The highest level (building structure) is the set of elements of middle level. It is a spatially coherent or at least technically separate part of building, which fulfils the defined proposal function. This issue was developed in [6]. From this distribution it is clear that it is carried out directly for the needs of engineers (e.g. for more efficient implementation of bases design). Identification of items in the engineering database will correspond with the Logistics Information System to the maximum extent. Unification of items will allow the use of recorded data for various purposes.

The items will be assigned values of economic-managerial parameters, as well as purely technical ones, and those that will meet the needs of engineers. The resulting features of buildings differ from features of parts they were built of. This circumstance is the reason why it is appropriate to create a new tool. The collected parameters can be divided into several groups – general data, special features, logistics, installation, maintenance, dismantling. Recorded data can have the feature of a verbal description and/or numeric values, as well as it may be images, diagrams, aerial photographs or the references to drawings, documentation, etc. As an example of such data, it is possible to appoint an advanced verbal description, catalogue a number of assets, the number of NATO codification, the purpose of construction, type of troops to which the object is determined, manufacturer, price, rent, ballistic resistance, fire resistance, operating temperature, water resistance, phase of construction, transport specified type, dimensions in transport mode and after composition weight, method of handling, amount of parts, description of the construction process, construction time, machinery and equipment necessary for the construction, the number of workers in the construction, enumeration of specially trained specialists, operational and audit control periods, durability, disassembly time, the machines required for dismantling, removal description and many others.

Individual items in database have different characters. Therefore, it is also possible that with some items it is ridiculous to enter certain values. On the other hand, it would be necessary to add additional monitored parameters to the other items. Here a problem arises for many similar databases. If the item is not to be assigned only descriptive data, but it is supposed to further work with records (e.g. search according to them, count with them, etc.), it is necessary to observe the formal requirements for entry in the database (e.g. a number for a certain amount of valid points must be entered). However, the fact that the fulfilment and maintenance of a thus conceived database would be extremely difficult, time consuming and, most importantly, there could really be a problem to work with such data, goes against it. It is therefore necessary to consider which data on a given item shall be stored in separate database cells, and which can just be stated in a verbal or graphical summary. The parameters for each item of a database should be possible to be completed according to the needs and effectiveness.

If feasible, the database items will be assigned to schematic drawings. These drawings will include a several items of material, while linking from a software point of view will be carried out through an identification number. The schemes will be assigned mainly to the highest level of items in the database – to the building constructions.

How will the design process of a military base work using the new software tool? The designer would use a graphical interface in the design of a base. In its digital proposal they would deploy building structures to a base while addressing other related issues (e.g. communication route etc.). If it was possible (a prerequisite is the existence of the item in the database), then from the schematic drawings database they would drag different parts of the construction by mouse to the created digital drawing of the base design. Only what would not be processed in this way, they would draw directly (and the necessary quantities would also have to be directly additionally computed). The software itself would additionally compute a number of other variables to the proposed blocks of buildings in a base according to the data in the database. For example tables of the material used, its weight, price, supplier, etc. would be automatically created to the given drawing. This procedure would speed up and streamline the implementation of a base design.

Analogous principle would be applied when using a database to select an optimal design by a method of multi-criteria decision-making. Firstly it is necessary to establish criteria for the selection and to determine their importance. It is very complicated, because different criteria and their importance can be determined on the basis of various aspects, i.e. according to the specific conditions of the construction. That is why a specific procedure cannot be laid out, only a general methodology may be designed. The important decision criteria could include for example speed of construction, number of workers required for the construction, machinery that needs to be used, what security issues may arise in the implementation of that particular variant, solving logistical problems, additional costs, environmental protection, fire and ballistic resistance of the resulted construction and much more.

The software would automatically perform the use of the multi-criteria decision-making, so a user would immediately receive the relevant outputs. One of the options of design process performance is there would be several base proposals carried out, for example by several mutually independent groups of specialists. Individual designs would be assessed using multi-criteria decision-making and then an optimal variant would be selected for implementation. Another variant of the method use could be searching for a suitable design of the specific sub-part of a base. For example, one group of specialists would be solving such a partial problem in several ways and would immediately get an answer, as to which solution is the most appropriate one. Such a tool could greatly accelerate the work of designers, because they would have an immediate evaluation of several options. It would not be very complicated to quickly assess a significant amount of variants suggested intuitively or even tentatively. At the same time, lots of details could be easily tuned. But it would just be a tool that will help streamline the decision-making process. It would not be a binding outcome. It is important to state this, because the designer is also responsible for the consideration of the circumstances that are difficult to be quantified. Many things are necessary to be carried out for example on the basis of experience, prediction of the security situation development, international agreements, special circumstances, etc. However, even if the use of the described method had only an indicative nature, it can at least be a significant benefit in some situations, especially when the software automatically performs the evaluation without the need for user intervention.

Everything tends to have its drawbacks, and using the described tool is no exception. The first problem is with the data in the database. The very creation of an extensive database with all the data is a very challenging issue, because to trace all the information collected is not always easy. Another drawback is the maintenance of items in the current state. Again, it is a challenging task. Some data obviously does not have to be constantly changed - such as the weight, volume, etc. Other data may change from time to time, such as price, supplier or control period, which is associated with the regulations in this area. There will also be data that may be required to be updated quite often for full operation, e.g. security situation that can change very quickly and that can have a significant impact on the decisions on the variant of construction. Another difficulty of multi-criteria decision-making is in often highly problematic determination of criteria and their importance. Of course, it does not necessarily have to be a problem. But this idea has already been mentioned in the article.

This proposal for the use of infrastructure management in the design of military bases in foreign operations is to offer some options to the designer. It can be assumed that in some cases it will be very effective to make full use of software tools, including the selection of variants, while in other cases it may be preferable to use a software tool only for selected activities, such as the list of material. Overall, however, a new software tool should streamline the design of military bases, and thereby increase the competence of Engineer Corps Brigade. Another benefit is possible financial savings, which is a positive step, particularly in the current financial and economic crisis, when all cash flows are closely monitored by the military as well as by the general public.

5. Conclusion

The article focused on selected aspects of the infrastructure management of the Armed Forces of the Czech Republic in foreign operations. Quality bases are one of the important factors that contribute to the success of a foreign operation. The life cycle begins with the base preparation and design phase, continuing with construction, operation and it ends by its removal. In all these phases, the key role is played by the Engineer Corps. They use modern technology and software products for their work.

Designing military bases requires the knowledge of the options that are available. It must take into account a number of areas ranging from security, functionality and even the material, logistical, economic and environmental aspects. It applies software based on database tables. When planning a military base, the army Logistics Information System is used, which among other things includes all assets recorded by the Armed Forces of the Czech Republic.

Architecture proposes a software for the needs of engineers in connection with the Defence Research Project, which would be linked to the Logistics Information System, as well as serving for the specific tasks of engineers in designing military bases in foreign operations.

The paper shows another possibility of using the strong potential of the software tool. It shows that using multi-criteria decision-making, it is possible to find the optimal design variant of a military base. All these activities are aimed to streamline operations, increase competencies of the Engineer Corps and to save funds.

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