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Model for Resource Allocation in the Public Sector Based on Strategic Importance and Quality

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Abstract: Today's competitive environment confronts employees with constant pressure to reduce costs and optimize the use of resources. In this regard, this paper aims to present a model of resource allocation, based on the satisfaction of user requirements from the aspect of priority importance and quality assessment. The methodology includes defining the requirements for specific resources, assessing their availability, ranking using matrices of strategic significance and quality, applying individual and group ranking techniques, and reaching a consensus in the process of making an optimal solution. The writers present the advanced model and its implementation in one military unit, which makes this research specific. The proposed model can facilitate planning, reduce organizational response time, improve performance, increase quality, and reduce costs. The results also indicate the strategic significance of various functions in the field of logistics, when quick planning is necessary. The presented model can be used in sectors that face multiple similar problems in a very vigorous surrounding. It is based on the approach of allocating resources in conditions of insufficient capacity, overcoming the lack of material resources, but also concerning the reduction of strain on human resources, time consumption, and cost reduction.

Keywords: military logistics; public sector; resource allocation; strategic significance; quality

1 INTRODUCTION

Planning resource allocation is a complex and thorough process that provides conditions for the efficient execution of tasks. It is especially important in public sector organizations, such as the military, because decision-makers (experts) face numerous difficulties in managing resources and providing safe and superior services [2]. The proper distribution of a large number of resources in the military sector is a demanding task, considering that the methods and arrangements usually used for such purposes are subject to significant limitations that can lead to far from optimal decisions [5]. The biggest problems of allocation, observed and presented in this work, are reflected in the prediction of consumer demands, extended expert approaches, inconsistency of demands, and negative visibility of logistics resources, where the experts have a great influence by showing subjectivism, working constantly under pressure, and due to being overloaded with work, constantly in the situation bringing reckless decisions [5]. These problems cannot be competently solved without modern technological instruments and software that ensure the process of automation [12]. The aforementioned problems point to the urgency of improving resource allocation planning at the level of the entire logistics system [2]. The method of planning approaches the institutional context of experts and determines the care of the pleasant needs of the users [3]. Experts have a key position in fair allocation because they give priority to specific user requirements [10]. Also, it is important to include the concept of quality as an integral part of cost-reduction planning in later periods of resource exploitation [1]. Based on the above, this article wishes to draw attention to existing areas for improvement in resource allocation simulations, proposing a hybrid model for logistics support planning using modern software solutions based on mathematical modeling and algorithms that follow Industry 4.0, using strategic significance (SS) and quality evaluation (QE) as an essential part of the decision-making technique. Given that the backbone of the model is prioritization based on requests, the abbreviation RPM (Request prioritization model) will be used in the following text. The novelty represents the creation of a completely new model for logistics support planning that would eliminate the mentioned problems and provide perspective to the quality decision-making process, influencing the reduction of costs and system response time, which is of crucial importance in the modern economy and logistics.

In this paper, besides the introduction, there is a second section, which presents the mathematical and theoretical applications relevant to this study. In the third part, the problem description and methodology are presented. In the fourth part, the case study is shown following the discussions and conclusion in the last part.

2 APPLICATION OF MATHEMATICAL MODELS

At this point, the authors presented the mathematical algorithms used in the model. The first algorithm describes the process of resource allocation by unification, where the data are performed through steps. In the following, the process of reaching a consensus among experts is described and the mathematical basis of strategic significance and quality evaluation is presented.

2.1 Resource Allocation

In this paper the authors decided, among many approaches, to resolve the problem of priority allocation in conditions of limited resources. Also, the paper [8] presents a mathematical model for determining the value of individual preferences, where it presents a case based on utility, where he defines the following: Let $X = \{x_1, x_2, \dots, x_n\}$ be various pre-decided alternatives, in which x_i presents the i-th alternative $i = (1, \dots, n)$. So $E = \{e_1, e_2, \dots, e_k\}$ will be a group of experts, who make decisions, where e_k means the k-th expert $k = (1, \dots, m)$. The expert e_k offers his options to alternatives as a range of n application values $U^k = \{u^k(1), \dots, u^k(n)\}$ where $u_j^k \in [0,1]$ presents the application assessment given via the expert e_k to x_i. The bigger value of x_i indicates a better choice degree for the x_i. For obtaining the individual preference vectors [8] suggests the next: Let $R_k = \left\{ r_1^k, r_2^k, \ldots, r_n^k \right\}$, the individual ranking vector where r_i^k stands for the *i*-th rank of requirements $\left(i = 1, \ldots, n \right)$, which expert e_k gives.

Case: The individual ranking vector is calculated as follows:

$$r_i^k = u_i^k \tag{1}$$

Applying a consensus solution according to the following:

Input: The defined palette of criteria $C = \left\{ C_1, C_2, \ldots, C_n \right\}$, the set of alternatives $A = \left\{ A_1, A_2, \ldots, A_N \right\}$, the significance experts' weight vector ξ_{in}^k, the setup consistency threshold *a,* the defined consensus threshold γ, and the installed most quantity of iterations $z_{\max}$, the unique preference information O^k, U^k, P^k, A^k, L^k about criteria and options.

Output: The weight vector of standards $W = \left\{ w_1, w_2, \ldots, w_n \right\}$ with the hooked-up consensus degree γ. The alternatives are presented with $A = \left\{ A_1, A_2, \ldots, A_N \right\}$.

Step 1: Unification process: Using fuzzy preference relations matrix $P^k = \left(p_{ij}^k \right)_{nxn}$ the data are unified.

(i) Consolidation of the experts e_k heterogeneous preference information into the fuzzy relation.

$$p_{ij}^k = \left\{ \begin{array}{l} p_{ij}^k \left(o^k(i), o^k(j) \right) = \dfrac{1}{2} \left(1 + \dfrac{o^k(j) - o^k(1)}{n} \right), \\ \ldots\ldots e^k \in O^k \\ p_{ij}^k \left(u_i^k, u_j^k \right) = \dfrac{\left(u_i^k \right)^z}{\left(u_i^k \right)^z + \left(u_j^k \right)^z}, \ldots e^k \in U^k \\ p_{ij}^k \left(a_{ij}^k \right) = \dfrac{1}{2} \left(1 + \log a_{ij}^k \right), \ldots e^k \in A^k \\ p_{ij}^k \left(l_{ij}^k \right) = \left(\dfrac{1}{2} + \dfrac{\Delta \left(l_{ij}^k \right)}{2\tau} \right), \ldots e^k \in L^k \end{array} \right\} \tag{2}$$

Consistency procedure steps are given as follows:

(i) Consistency index CI_{ij}^k of the expert e_k is calculated:

$$CI^k = 1 - \frac{2}{3n(n-1)(n-2)} \sum_{i,j,l=1, i \neq j \neq 1}^{n} \left| p_{ij} + p_{jl} - p_{il} - 0,5 \right| \tag{3}$$

It stands that $Cl_{ij}^k \in [0,1]$. When $Cl_{ij}^k = 1$, the additive preference relation $P^{(k)}$ is consistent; in the other way, if the $CI_{ij}^k < 1$ then the $P^{(k)}$ is more inconsistent.

(ii) System of controlling consistency: If $CI_{ij}^k \ll \alpha$, then the system is activated. If all experts are compatible, i.e., $CI_{ij}^k \geq \alpha$, then the consensus-reaching process is applied.

(iii) Constructing the consistency matrix $P^k = \left(p_{ij}^k \right)_{nxn}$.

Further steps are given below:

(i) Calculating resemblance degrees between experts e_k and $e_{h(k<h)}$ on the pair of alternatives (x_i, x_j), then constructing its matrix:

$$P^k = MS_{ij}^{(kh)} = (ms_{ij}^{(kh)})_{nxn} \tag{4}$$

The agreement matrix can be built as below: $ms_{ij}^{(kh)} = 1 - \left| p_{ij}^{(k)} - p_{ij}^{(h)} \right|$,

where $k = 1, \ldots m-1$ and $h = k+1, \ldots m$.

The $ms_{ij}^{(kh)} \in [0.1]$ is a resemblance degree among experts e_k and e_h in their preference values $p_{ij}^{(k)}$ and $p_{ij}^{(h)}$. So, $ms_{ij}^{(kh)}$ have the subsequent properties:

1) $ms_{ij}^{(kh)} = ms_{ij}^{(hk)}$;

2) $ms_{ij}^{(kh)} = 1$ in case $p_{ij}^{(k)} = p_{ij}^{(h)}$, i.e., $p_{ij}^{(k)}$ and $p_{ij}^{(h)}$ completely resembles;

3) $ms_{ij}^{(kh)} = 0$ in case $p_{ij}^{(k)}$ and $p_{ij}^{(h)}$ is completely dispersed.

(ii) Calculate the average resemblance degree of settlement for each expert:

1) **Level 1**. The average degree of resemblance between alternatives is calculated as:

$$SPAO_{ij}^{(k)} = \frac{1}{m-1} \sum_{k=1, k \neq h}^{m} MS_{ij}^{(kh)} \tag{5}$$

2) **Level 2**. The average degree of resemblance on alternatives is calculated as:

$$SAO_i^{(k)} = \frac{1}{n-1} \sum_{j=1, j \neq i}^{n} SPAO_{ij}^{(k)} \tag{6}$$

3) **Level 3**. The average degree of resemblance in the preference relation is given as follows:

$$SDPR^{(k)} = \frac{1}{n} \sum_{i=1}^{n} SAO_i^{(k)} \tag{7}$$

(iii) Calculate the Agreement's Relative Degree for e_k:

$$RDA^{(k)} = \frac{SD^{(k)}}{\sum_{k-1}^{k} SD^{(k)}} \tag{8}$$

Let $\xi_{RDA}^{k} = RDA^{(k)}$ be a posterior the weight of the expert e_k, and $\sum_{k=1}^{m} \xi_{RDA}^{k} = 1$.

(iv) Calculate the experts' weight vector.

A weight vector is a linear combination of an earlier weight (ξ_{ID}^{k}) of the e_k and a posterior $(\xi_{RDA}^{k,z})$:

$$\xi_k = \eta \cdot \xi_{ID}^{k} + (1-\eta) \cdot \xi_{RSD}^{k}, \tag{9}$$

where $(k = 1, \ldots, m), \eta \in [0.1]$.

When $\eta = 0$, it means that experts have consistency.

(v) The collective fuzzy preference relationship is shown as:

$$p_{ij}^{(c)} = WA\left(p_{ij}^{(1)}, p_{ij}^{(2)}, \ldots, p_{ij}^{(m)}\right) = \sum_{k=1}^{m} \xi_k p_{ij}^{(k)} \tag{10}$$

where $\xi_k \in [0,1]$ is the weight of the experts $e_k \in D$ and $\sum_{k=1}^{m} \xi_k = 1$.

(vi) Determining the closeness degree at the three different levels:

1) **Level 1.** The closeness degree on pairs of alternatives:

$$PDP_{ij}^{k} = 1 - \left|p_{ij}^{k} - p_{ij}^{c}\right|, \tag{11}$$

2) **Level 2**. The closeness degree of alternatives:

$$PDO_{i}^{k} = \frac{1}{n-1} \sum_{j=1, j \neq i}^{n} PDP_{ij}^{k} \tag{12}$$

3) **Level 3**. Closeness degree on the preference relation:

$$PDPR^{k} = \frac{1}{n} \sum_{i=1,}^{n} PDO_{i}^{k} \tag{13}$$

(vii) Calculate the consensus levels defined at three levels.

1) **Level 1**. The consensus level on options (CSPO) is:

$$CLPO_{ij}^{k} = \varphi \cdot SPAO_{ij}^{k} + (1-\varphi) \cdot PDP_{ij}^{k} \tag{14}$$

2) **Level 2**. The consensus level on the options (CLO) is:

$$CLO_{i}^{k} = \varphi \cdot SAO_{i}^{k} + (1-\varphi) \cdot PDO_{i}^{k} \tag{15}$$

3) **Level 3**. The consensus level on the relation (CLR) is:

$$CLR^{k} = \varphi \cdot SDPR^{k} + (1-\varphi) \cdot PDPR^{k} \tag{16}$$

with $\varphi \in [0,1]$ a framework that manages the weights of resemblance and closeness of criteria. The value for the weighting variable φ is supposed to be 0.5.

(viii) The consensus level managing and controlling.

If the consensus degrees are bigger than a predefined threshold (γ) and lower than 1, then the consensus is reached. Otherwise, the experts are asked to reevaluate their choices. In this article, we assumed that $\gamma = 0.85$.

(ix) Feedback mechanism.

If $CLR^{k} < \gamma$, then the feedback mechanism is activated and the next sequence $(z = z+1)$ begins:

Step 1. The group of experts with consensus levels below the γ is determined:

$$ECL = \left\{k | CLR^{k} < \gamma\right\}, \tag{17}$$

Step 2. For the experts determined in step 1, those alternatives with a consensus level below γ:

$$ECLB = \{(k,i) \mid k \in ECL \wedge CLO_{i}^{k} < \gamma\}, \tag{18}$$

Step 3. In the end, the fuzzy preference values for the experts and alternatives determined in the steps above have to be replaced:

$$FPV = \{(k,i,j) \mid (k,i) \in ECLB \wedge CLPO_{ij}^{k} < \gamma\} \tag{19}$$

The technology of recommendation targets giving adjustment proposals to help reach a consensus degree with feedback mechanism rules is delivered below.

Suppose that the initial preference and the collective preference information p^c on the alternative x_i.

The collective preference vector w_i^c on x_i is:

$$w_i^c = \frac{1}{n}(p_{i1}^c + p_{i2}^c + \ldots + p_{in}^c), \; i = 1, \ldots, n. \tag{20}$$

Normalizing $w^c = (w_1^c, w_2^c, \ldots, w_n^c)^\tau$ submit the systematic collective preference vector $w^{c*} = (w_1^{c*}, w_2^{c*}, \ldots, w_n^{c*})^\tau$, where

$$w_i^{c*} = \frac{w_i^c}{\sum w_i^c} \tag{21}$$

Case: $e_k \in D^U$. The collective preference vector is converted into a utility preference vector and shown as $U^{c,k} = (u_1^{c,k}, u_2^{c,k}, \ldots, u_n^{c,k})^\tau$, where

$$u_i^{c,k} = w_i^{c*} \sum_{i=1}^{n} u_i^k \tag{22}$$

So, $\overline{U^k} = (\overline{u_1^k}, \overline{u_2^k}, \ldots, \overline{u_n^k})^\tau$ will be modified utility preference vector, where

$$\overline{u_i^k} \in \left[\min\left(u_i^k, u_i^{c,k}\right), \max\left(u_i^k, u_i^{c,k}\right)\right] \tag{23}$$

The selection procedure has two different stages [14]:

(i) Stage of accumulation.

$$p_{ij}^{(c)} = WA\left(p_{ij}^{(1)}, p_{ij}^{(2)}, \ldots, p_{ij}^{(m)}\right) = \sum_{k=1}^{m} \xi_k p_{ij}^{(k)} \tag{24}$$

where $\xi_k \in [0,1]$ is the weight of the experts $e_k \in D$ and $\sum_{k=1}^{m} \xi_k = 1$.

(ii) Usage stage.

In this segment, from the collective matrix $p_{ij}^{(c)}$ the very last values of the studied alternatives are gained:

$$v_i = \frac{1}{n(n-1)}\left(\sum_{j=1}^{n} p_{ij} + \frac{n}{2} - 1\right),\ i = 1, \ldots, n. \tag{25}$$

In situations where it is impossible to satisfy all requirements, the Pareto set of viable solutions can be applied. A comprehensive review of the literature in this part of the consensus-reaching process was given by [9].

2.2 Strategic Significance Assessment

In the presented model, the author looked at quality and strategic significance and applied the methods of assessing risk factors and strategic significance that [10] applied in their analysis. Assessment of strategic importance plays a key role in system performance, as stated by [11].

Let A_i (i = 1, …., k) define the requirement, for every criterion k_j (j = 1, …., l), and the intensity of the relationship is defined by s_{ij}. The mean value v_{ij} is:

$$v_{ij} = \frac{\sum s_{ij}}{n} xi \tag{26}$$

where n is the criterion index expressed numerically.

Finally, the significance of strategic score S_{ij} (3S) is obtained:

$$S_{ij} = \sum v_{ij} \tag{27}$$

The aspect ratio coefficient of variation, vc_{ij} is defined as follows:

$$vc_{ij} = \frac{\sigma_{ij}}{v_{ij}} \tag{28}$$

and an increasing value of vc_{ij} indicates a large variability among experts' judgments and, thus, possibly low consensus as stated by [12].

2.3 Quality evaluation

The evaluation of determining the quality of requirements is adapted based on the assessment of the risk of functional failure defined by [10]. The customized assessment defines a quality evaluation matrix QE with five factors that are evaluated, five levels of classification of consequences (CoNFRs) in values as well as the probability of non-fulfillment of requirements (PoNFRs). The mathematical ground is set as follows: Let A_i (i = 1, ..., k) define the requests, for each factor f_j (j = 1, …., 5) which is evaluated in the QE matrix, while the weight values of PoNFRs are defined for each level of CoNFRs consequences in levels from 1 to 5. E_m (m = 1,….,5) represents the experts. The weighting values of requirements wv_i are defined for each requirement:

$$wv_{ij} = \sum_{f=1} E_m \tag{29}$$

QES (Quality evaluation score) is defined for each request individually, according to the following:

$$QES_{ij} = \frac{\sum wv_{ij}}{f} \tag{30}$$

where f = 5. Authors in the paper [13] presented a spectrum of criteria and tools, which helped the author in defining the way to determine the factors in the matrix and determine the weight values.

3 PROBLEM DESCRIPTION

Based on the described problems in the introduction section, the author decided to define the following problem: the focus is on the development of the model for planning logistic support (RPM) using modern software solutions following the tendencies and concept of Industry 4.0. The model is based on combined mathematical methods and algorithms that use qualitative and assessable data gathering based on experiential actions in the process of providing logistics services where the author worked closely with colleagues with the same problems in the military organization [7]. Fig. 1 provides a generic visualization of the entire RPM model.

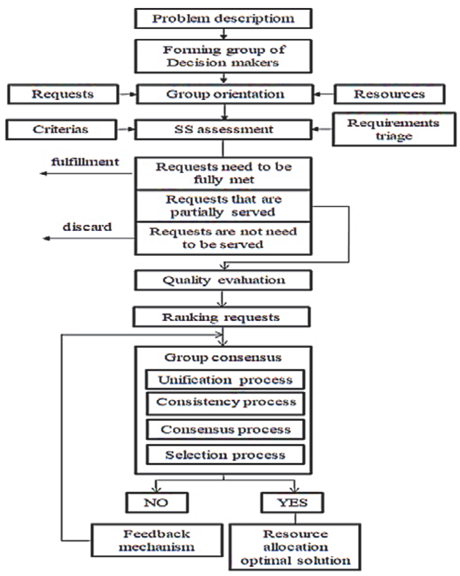

Figure 1 Request prioritization model

The assumption is that five users submit ten requests for one type of resource and that the model evaluates the strategic significance of each request and qualitative assessment, using the QE and SS matrix. After assessing the strategic significance, the experts distinguish the requirements that must be satisfied, the requirements for which there is no urgency to be satisfied and which can be satisfied in the later future, and the requirements that are partially served. The QE assessment covers the requests that are partially served, they are assigned weight values paying attention to the quality of service provision, after which the partially satisfied requests are ranked. At this moment, the model includes the application of an automation process where, with the help of algorithms, to achieve a greater consensus among decision-makers, a re-ranking of requests is carried out partially serving in the case based on the degree of utility. After the individual ranking, RPM consolidates into group rankings using the Kemeny median. Decision makers then establish a consensus solution. RPM itself offers the possibility of making a decision "on a click", after entering the input parameters.

3.1 Use of Strategic Significance Matrix

The matrix of strategic significance is composed of five criteria with accompanying questions presented in Fig. 2. The criteria were examined corresponding to five evaluated levels, with a scale of significance varying from 1 (very low) to 5 (very high) [9].

Criteria	Questions
S1. Task importance	What impact does the task has on the unit's ability to work systematically, individually and/or in cooperation with others?
S2. Cost	What impact does the cost has on the unit's ability to fulfill task, emergency preparedness in critical situations, border control, etc.?
S3. Quality	What influence does the quality has on the unit's ability to have all the equipment on stand by and ready for use in any situation for in a life circle of equipment?
S4. Workload	What impact does the workload has on the units's ability to do the task completely, without mistakes and on time?
S5. Compliance	What impact does the laws and regulations have on the units's ability to do the task regularly and in time without consequences?

Figure 2 Overview of the criteria

The intensity of the relationship (s_{ij}) determines the importance of each requirement, A_i, for each criterion, k_j.

The aspect of the coefficient of variation, vc_{ij}, using Eq. (28), is specifically used to show the degree of flexibility concerning the value v_{ij} calculated from Eq. (26). Emphasizing the factor of variability can contribute to overthrowing the problem of consensus creation that normally shows in similar procedures (Fig. 3).

Unit	Request	S1	S2	S3	S4	S5	SIS: $S_{ij} = \sum v_{ij}$
		Criteria					
U_1	A_1		$v_{ij} = \frac{\Sigma s_{ij}}{n}$				S_1
	A_2						S_2
	A_3		$vc_{ij} = \frac{\sigma_{ij}}{v_{ij}}$				S_3
	.						⋮
	.						
	A_k						S_i

Figure 3 Strategic significance assessment

The defined criteria in the presented model have different weight indices according to the following:
S1 = 1,1, S2 = 1,2, S3 = 1,4, S4 = 1,2, S5 = 1,1.

Also, the RPM defines the thresholds that determine the degree of satisfaction of the user's requirements:

- Requests with no urgency to satisfy: < 30%
- Requests that are partially served: 30%-60%
- Requests that are fully satisfied: > 60%.

3.2 Use of Quality Evaluation Matrix

The QE matrix was constructed based on the relationship between costs, quality, and importance of the task, and it defined five factors [9] which were also benchmarks for decision makers and in SS assessment:

1) importance of the task (dropping within the potential to key necessities are added),
2) cost (the need to obscure work shifts as the cost of the funds needed to fulfill the requirements),
3) quality (originality of parts, reliability of service),
4) human workload (increasing the volume of work for an individual employee in the executive unit) and
5) compliance (impossibility to fulfill the request).

Fig. 4 shows the enhanced QE matrix for assessing the ability to meet user requirements.

QA matrix	Factors						Probability of not fulfilling requests (PoNFRs)				
	Severity rating	Task importance	Cost	Quality	Workload	Complience	1: *Very low* Failure is not expected < 1 %	2: *Low* Never heard of 1 % - 5 %	3: *Moderate* Has occurred 5 % - 25 %	4: *High* Has been experienced several times 25 % - 50 %	5: *Very high* Will certainly occur > 50 %
Consecuences of not fulfilling requests (CoNFRs)	5: Very high → severe	Severe failure in key service deliveries	Resources without which system can function	Non-original parts with less quality favour	Very large increase in workload for the individual employee - it is not possible to introduce compensatory measures	Critical consequences associated with the loss of ability to deliver in accordance with laws and regulations	5	10	15	20	25
	4: High → major	Significantly reduced ability to fulfill service deliveries	Resources with sporadic importance for task fulfillment	Non-original parts with quality favour	Large increase in workload for the individual employee. May reduce somewhat with compensatory measures but not sufficient	Significant consequences associated with the loss of ability to deliver in accordance with laws and regulations	4	8	12	16	20
	3: Moderate → moderate	Reduced ability to fulfill service deliveries	Significant resouces with affordable cost	Non-original parts with best quality favour	Moderate increase in workload - may reduce somewhat with compensatory measures	Moderate consequences associated with the loss of ability to deliver in accordance with regulations	3	6	9	12	15
	2: Low → minor	Minor reduction in the ability to fulfill general services	Important material resouces with high cost	Original parts with less quality favour	Somewhat increased workload, but this can be reduced with compensatory measures	Minor consequences associated with the loss of ability to deliver in accordance with regulations	2	4	6	8	10
	1: Very low → insignificant	Limited and transient quality failure in some services	Critical material resouces with higher cost	Original parts and the best favou	Insignificant increase in workload, no need for compensatory measures either	Insignificant consequences associated with the ability to deliver in accordance with regulations	1	2	3	4	5

Figure 4 Quality evaluation matrix

They are further elaborated according to five levels of classification of consequences (CoNFRs). As the unit consists of an administrative part and different executive units, it is presumed that the criteria will encounter and feature special significance for the groups.

Since the choice makers are towards operational management, they are chosen to do the QE according to the proposed matrix.

Decision makers assessed both the consequences (CoNFRs) and the probability of non-compliance (PoNFRs) following limited circumstances in the system.

4 CASE STUDY

The facts give perception into one military unit. The unit name and resources have been purposely censored to comply with the organization's classified policy, so the unit will be called "$U1$" while the requests will be ranked A_i (i = 1, …., 10). For the monitored planning period, the requests of 5 K_i users (i = 1, ..., 5), who use equal logistics system sources, were analyzed. In the presented model, the resource allocation planning process is carried out through the following steps:

Step 1: Determination of user needs for a certain sort of resource. Following the analysis, user needs are grouped into 10 groups, with the total needed capacity of measurement units.

Step 2: Determining the available resource capacity for the requested sort of resource. For the regarded period, it was decided that the unit for the needed sort of resource has the capacity of the requested units.

Step 3: Finding the deviation of the needed resource capacity according to available. The assumption is that the total required resource capacity is a unit of measure and that there is a lack of resources in the system.

Step 4: Choosing a policy to satisfy user demands is challenging, considering the present shortage of source capacity and the dynamism of user demands in Industry 4.0 [4]. In this model, requirements prioritization using SS and QE assessment was first applied.

Step 4.1. SS assessment using the SS matrix assistance model determines the order of satisfaction of those requirements. Fig. 5 shows the results obtained for A7, A8, and A9 with the corresponding SS categorization for all requirements.

According to the selected criteria, the experts estimated that A8 has the highest 3S, and A10 the lowest, and will not be fulfilled now. Regarding the necessity for the prioritization process, the order of priority can be: 1. A8 (22,28), 2. A7 (21,59), 3. A9 (21,06) (Fig. 5).

Unit	Request	Calculations	Criteria S1	S2	S3	S4	S5	3S	%	Categorisation
U_1	A7	$\check{a}_{ij}$	4.64	3.85	4.76	4.36	3.98	21.59	72.00	Needs to be fully met
		vc_{ij}	0.67	0.81	0.66	0.72	0.78			
	A8	$\check{a}_{ij}$	4.25	4.61	4.92	4.54	3.96	22.28	74.26	Needs to be fully met
		vc_{ij}	0.67	0.81	0.66	0.72	0.78			
	A9	$\check{a}_{ij}$	4.12	4.80	3.94	4.28	3.92	21.06	70.02	Needs to be fully met
		vc_{ij}	0.76	0.65	0.79	0.73	0.80			
	A10	$\check{a}_{ij}$	1.32	1.42	1.85	1.78	1.65	08.02	26.73	Not to be fulfilled now
		vc_{ij}	2.43	2.26	1.73	1.80	1.94			

Figure 5 Requests that need to be fully met

Derived from adjusted RPM with reliance on QE and SS assessment, experts decided to allocate funds to A7, A8, and A9. Calculating vc_{ij} showed variation among experts and their evaluations and perceptions of SS. This probably shows greater consensus in their judgment.

After ranking the requirements that require urgency, the SS assessment further determines the strategic significance score of the requirements based on the defined criteria. Decision makers assign values si to each criterion (S1, S2,..., S5) for each requirement (A1, A2, ..., A6).

Using Eq. (26), the mean values vij are determined for each requirement according to criterion k based on the values assigned by the decision maker. The strategic significance score S_{ij} (3S) is determined by applying Eq. (27), while the aspect of the variation, $vcij$, is stated by Eq. (28) (Fig. 6).

Unit	Request	Calculations	Criteria S1	S2	S3	S4	S5	3S	%
U_1	A1	$\check{v}_{ij}$	3.30	2.40	3.64	4.08	2.20	15.62	52.01
		vc_{ij}	0.95	1.30	0.86	0.77	1.42		
	A2	$\check{v}_{ij}$	3.08	2.40	3.92	4.08	1.76	15.24	50.08
		vc_{ij}	0.99	1.27	0.78	0.75	1.73		
	A3	$\check{v}_{ij}$	2.64	2.88	4.76	3.36	1.98	15.62	52.08
		vc_{ij}	1.18	1.08	0.66	0.93	1.58		
	A4	$\check{v}_{ij}$	2.86	3.36	4.48	3.12	2.20	16.02	53.04
		vc_{ij}	1.12	0.95	0.72	1.03	1.46		
	A5	$\check{v}_{ij}$	2.42	3.60	4.48	3.60	1.98	16.08	53.60
		vc_{ij}	1.33	0.89	0.72	0.89	1.62		
	A6	$\check{v}_{ij}$	1.98	3.12	3.36	3.60	2.42	14.48	48.26
		vc_{ij}	1.46	0.93	0.86	0.80	1.20		

Figure 6 Strategic significance assessment of requests that fulfill partially

Based on the SS assessment, the decision-makers decided that the requirements that are partially satisfied should be met for all users according to the following (Tab. 1):

Table 1 Review of user requirements after triage

	A1	A2	A3	A4	A5	A6	Sum
K1	300	250	0	100	100	100	850
K2	100	200	100	200	150	250	1000
K3	0	150	200	100	150	250	850
K4	150	0	250	300	50	150	900
K5	200	100	150	50	150	100	750
Sum	750	700	700	750	700	750	4350

After the process, there is still a resource shortage, which now amounts to 1250 units.

Step 4.2. QE assessment: Figure 8 shows the results of the QE assessment conducted for six requests that are partially serviced. Using Eq. (29), the decision-makers assigned each request a mean value by factors.

With the sum of the assigned values, the decision makers assigned a QES using Eq. (30) for each request (Fig. 7).

Unit	Request	Factors Task importance	Cost	Quality	Workload	Compliance	QES
U_1	A1	8	10	15	20	25	78
	A2	6	16	12	4	5	43
	A3	10	6	4	12	9	41
	A4	5	10	10	16	8	49
	A5	9	4	2	8	12	35
	A6	15	12	9	5	6	47

Figure 7 Overview of output from quality evaluation

The remaining six requirements (A1, A2, A3, A4, A5, and A6) show moderate values, which require attention. The final total determined the ranking of the defined requirements according to the following: A1, A4, A6, A2, A3, A5.

Step 4.3: Combining individual ranks into a group rank: The appliance of the heuristic algorithm to decide the Kemeny median to determine the final order of the requests according to the level of significance can be seen in [6].

Applying the heuristic algorithm, the group order of the criteria was obtained: PI = (A1, A4, A6, A2, A3, A5). It can be easily determined that for all $k = n - 1, n - 2, ..., 1$ the condition $PI = PII$.

Step 4.4: Calculating the level of consensus: Based on Eq. (2), the combined data are put into the fuzzy preference relation.

Step 4.4.1: Consistency process: According to Eq. (3), the consistency index CI^k for each experte k, is calculated {1,0 0,9975 1,0 0,9593 0,9439}. All matrices are consistent because they are over 0.90.

Step 4.4.2: Consensus-reaching procedure: In this part of the procedure the experts need to address a consensus measure and feedback mechanism.

Computing Consensus Measures: According to Eq. (4), Eq. (5), Eq. (6), and Eq. (7), the resemblance degrees are assessed $SDPR^k$ = {0,8851 0,7987 0,8739 0,8819 0,8049}.

Using Eq. (8), the posterior expert's weight vector is calculated. ξ^k_{RDA} = {0,2084 0,1879 0,2054 0,2072 0,1891}.

According to Eq. (9), the expert weight vector where η = 0.5, is ξ_k = {0,2041 0,1942 0,2025 0,2034 0,1946}.

Applying Eq. (10), with the collective fuzzy preference matrix, Eq. (11), Eq. (12), and Eq. (13), the proximity degree $PDPR^k$ is obtained,

$PDPR^k$ = {0,9291 0,8475 0,9272 0,9326 0,8490}.

Managing the Consensus State: In this article, the consensus entry is γ = 0.85. According to Eq. (14), Eq. (15), and Eq. (16), the consensus level is calculated. The value of the weighting variable ψ is 0.5. The consensus index is then:

CI^k = {0,9072 0,8231 0,9005 0,9074 0,8278}.

If $CI^k < \gamma$, then the feedback mechanism asks for the next loop ($z = z + 1$). Considering that experts e_2 and e_5 do not meet the defined consensus level, the feedback mechanism is activated.

Feedback Mechanism: According to Eq. (17), Eq. (18), and Eq. (19), the given feedback revised rules are used, and experts e_2 and e_5 are advised to change their options applying the next equations.

Using the Eq. (20), the collective preference vector is calculated w^c and based on Eq. (21), w^c is transformed into the standardized collective preference vector w^{c*} :

$w^{c*} = (0{,}3563\ \ 0{,}3121\ \ 0{,}2665\ \ 0{,}2377\ \ 0{,}1984\ \ 0{,}1408)^T$

Since $e_2 \in D^U$, using Eq. (22) converts w^{c*} into the preference information related to e_2. Then is $U^{c,2}$ = (0,9442 0,8831 0,7054 0,6287 0.5236 0,3718)^T

The modified utility function now is $\overline{U^{(2)}}$ = (0,85 0,80 0,60 0,70 0,65 0,50).

Since $e_5 \in D^L$, converts w^{c*} into the preference information, related to e_5, which combined with e_2 gives the consensus index based on Eq. (23) and Eq. (24):

$\overline{CI^k}$ = {0,9074 0,8531 0,9006 0,9074 0,8678}.

Hence, an acceptable consensus has been reached, $\overline{CI^k} > 0.85$, and the progress of reaching a consensus can be seen in Fig. 8.

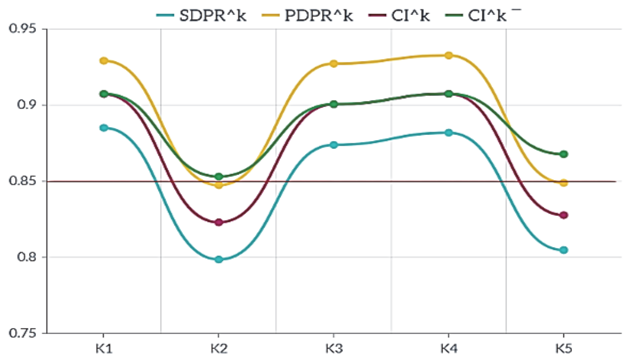

Figure 8 Flow of the process

Step 4.4.3: Process of selection: In this phase, we gain the collective preference vectors by Eq. (25), as v_i = (0,3201 0,2634 0,2365 0,2121 0,1936 0,1793). According to this value, the weights for qualitative criteria are received as $w_j = v_i \cdot 60$.

Step 5: Selection of the resource allocation planning solution: The experts decided on the optimal allocation of limited resources, according to the following:

- Requests that must be fully satisfied: A8, A7, A9.
- Requests that are partially satisfied in order: A1, A4, A6, A2, A3, A5.

5 DISCUSSION

The decision-making model, which combines both aspects of SS and QE, contributes to increasing transparency among experts and avoids wasting time on unnecessary discussions, providing managerial discretion, transparency, and simplification heuristics. Moreover, the incorporation of the developed model enables smooth visualization and systematization of the results, which enables greater knowledge and clarity of current and future conditions in the organization. The given results show a limited picture of the constantly changing reality, where the levels of 3S and QES can vary rapidly, which is largely the case in military organization. Observing the SS assessment, it is concluded that requests A7, A8, and A9 have the highest percentage of 3S and that their satisfaction shows urgency, while on the other hand, request A10 is rejected and its satisfaction is not considered in further process. The work then carried out a qualitative assessment of the other six requests that are partially fulfilled, where the values were assigned to each request concerning the factors, and the order of satisfaction of the requests from the aspect of quality was defined as follows: A1, A4, A6, A2, A3, A5. Given that the model is applied in a specific system, emphasis is placed on the execution of the task and, to that end, the application of the model continues. By combining the ranks and calculating the consensus, it was established that the decision makers e_2 and e_5 are not in consolidation, because the acceptable consensus is $\overline{CI^k}$ > 0.85, and that they need to revise their decisions. After revision, a consensus $\overline{CI^k}$ = {0,9074 0,8531 0,9006 0,9074 0,8678} was established and the selection process of collective preference vectors was carried out, giving the final decision in the order of satisfying the requirements as follows: A8, A7, A9, A1, A4, A6, A2, A3, A5.

During the research, certain theoretical limitations were set. The study is limited to one military unit, preserving the confidentiality required by that organization, and withholding detailed data and information about decision makers and assessments for security reasons. Although this may lead to a misunderstanding of the results, it does not preclude knowing how the proposed RPM is implemented, as well as its strengths and weaknesses. Moreover, the grades are also qualitative, with an emphasis on objectivity in the work, which makes it less susceptible to subjectivism and mistakes.

6 CONCLUSION

Inspired by the practice in the public sector, and especially in the military organization, it was found that there is often a need to make quick and at the same time correct decisions regarding the distribution of limited resources, primarily due to the dynamics of the organization and the sudden situation. The proposed model, RPM, using SS and QE assessment in relation to the existing logistic support planning model, which is realized through a plan based on command-line decision-making without the possibility of applying automation, allows conclusions to be drawn about a less complicated and more objectively oriented, whereby it is taken into consideration of many more organizational elements, such as role and importance of the task, quality, load and cost, shows optimal planning that ensures security of activity monitoring and keeps the system within the voluntary framework of functionality, neutralizing the possibility of a directive decision-making process, transparency, conflict and lack of consensus among experts and improves overall performance and quality of service provision. It is concluded that there is an urgent need for the development of new models and the transition to more innovative automated instruments, which will be included in strategic planning and allocation of resources following modern trends. In addition, the proposed model enriches the existing methods and techniques by using a flexible combination of balanced use of decision group tools under conditions of complexity and uncertainty in the optimization process. The model confirmed that user request prioritization and resource allocation techniques provide the possibility of agile planning and optimal sharing of limited resources in a specific system such as the military. What is novelty that this work brings is the development of a model at the national level, which greatly contributes to the aspect of preserving data security. What sets this model apart and makes it new is the implementation of SS and QE assessment as an integral element in the resource allocation process. Concerning the original SS and QE assessment shown in the paper [10], this paper adapts it to the military system, and looking at the numerical data, it can be concluded that with a larger number of evaluated factors, more precise results and closer values can be obtained, as well as that the subjectivity of the expert then comes into play with a smaller role. It is planned to further expand the possibilities of the proposed RPM for future studies, from the aspect of automation and a wider scope of action, including a larger number of units and the influence of several factors in order to fully automate the adoption of the optimal allocation plan set to respond to each feasible resource selection scenario.

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