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FUZZY MATHEMATICAL MODEL FOR DESIGN AND EVALUATION OF THE LOGISTIC ORGANISATIONAL STRUCTURE

***Abstract:** This paper presents a fuzzy mathematical model for the analysis of organizational structure of administrative bodies. The organizational structure of administrative bodies of logistic support of the Petroleum Industry of Serbia has been analyzed in order to analyze the situation and optimize the existing organizational structure. Analysis of the state of organization is aimed at creating a picture of the current mode of organization and, on the basis of that, removing identified deficiencies. This model has been applied for the analysis of process and business functions, and tasks of the administrative bodies of the organizational structure taking into account the fact that administrative bodies should be designed and sized so that they can meet the basic goals and tasks of their existence. Each task set before the administrative bodies should be completed in a quality and reliable way in all environmental conditions. Since most of the data collected during the study of organizational structure are characterized by a high degree of uncertainty, subjectivity and ambiguity, fuzzy logic was used to show the described uncertainties and ambiguities. Fuzzy linguistic descriptors were used to describe the criteria used for assessing the organizational structure. In this way, fuzzy logic has enabled the exploitation of tolerance that exists in imprecision, ambiguity and partial truth of the research results obtained.*

***Keywords:** Organizational structure design, administrative bodies, fuzzy logic*

JEL classification: C61, C67, L1, L16

1. Introduction

The organizational structure of business systems is necessary to be designed and sized to meet the basic corporate goals and objectives. Almost every task set before the system management should be completed in a quality and reliable way in different environmental conditions. To make complex business systems with such dynamic and stochastic controllable and non-controllable variables effective

and able to respond to market challenges, they must constantly adapt its organizational structure.

One of the possible approaches to analyzing the degree of coordination and effectiveness of organizational structure is based on the division of the organization according to business and process functions and on their evaluation. Organizational or business functions relate to a group of different activities that are centered on a single task. This way, organizational and business functions are differentiated by type. Process functions relate to particular phases of activity taking place within each organizational function and within each of the subdivisions of organizational functions, or work areas of organizational functions. The nature and number of business and process functions is not specified or definite. Some analysts, for example, believe that management and leadership does not make a business function, but that these activities belong to the administrative functions in accordance with the criteria that some of the authors of the science of organization mention (Fayol, 1947). Urwick (1964) believes that business and administrative functions at the same level of itemization should be the same or nearly the same importance and complexity. However, business and process functions formally the same rank differ by “difficulty” and complexity. This approach was also used when creating a model for assessing the infrastructure business functions. The paper presents the fuzzy model for the analysis of the organizational structure of administrative structures of business system. In complex organizational systems that operate in a changing environment there are many problems at all levels of management whose solutions are characterized by different types of uncertainty and imprecision. They can be described by the linguistic expressions and modeling uncertain numbers. In the classical approach, modeling uncertainty is based on the application of probability theory, where the uncertainties are modeled by random variables which are differently distributed. Treatment of uncertainty in this way has certain limitations. One of the limitations is that calculating the probability of each random variable requires a large number of data from the records, and the fact that the combination of different uncertainties leads to a complex probability distribution which requires complex mathematical expressions, and increases the complexity and volume of calculations. Development of new fields in mathematics made it possible to describe the uncertainty and imprecision in a more realistic way. In other words, soft computing methods are alternatives to the classical approach of treating uncertainties. One of the methods of soft computing is fuzzy theory.

For evaluation of successful functioning of the existing administrative bodies, as well as for assessing the organization of certain business functions, a mathematical model based on fuzzy logic has been developed. In the next part of this paper, the phases of this model and its application will be presented.

2. A brief review of relevant literature for organizational design

Organizational design is specific to every organization, and therefore a unitary organizational structuring cannot be established. Various approaches to organizational design are possible not only due to the differences between

companies, but also because certain factors affect different companies in different ways.

In recent years, the methodological approaches of computational modeling and simulation are becoming increasingly popular among organizational researchers. Simulation, unlike mathematical modeling, allows researchers to reflect the natural complexity of organization systems as given. Computational modeling facilitates studies of more complex systems than traditional mathematical approaches.

Many authors approached organizational design as an information-process problem (Levitt et al., 1999; Jin and Levitt, 1996; Galbraith, 1977; March and Simon, 1958). This approach relies on the assumption that information transmission methods are relevant to considering and designing organizational models.

Computational and mathematical models of organizational design may be found in the papers by Carley (1995) and Carley and Lin (1995). Kujacic and Bojovic (2003) proposed the model for selecting the organizational structure using the fuzzy multi-criteria analysis. The developed fuzzy multi-criteria methodology takes into consideration the uncertainty and imprecision of the input data. Researchers in the field of computational organization theory use computational analysis methods to study both humans and organizations as computational entities. Human organizations can be viewed as intrinsically computational, as many of their activities involve sharing and transforming information from one form to another and also because organizational activity is often information-driven (Simon, 1976; Carley and Gasser, 1999).

For this reason, many researchers have developed simulation-based analysis tools for organizations during the past two decades primarily based on information processing theory (Cyert and March, 1963, 1992; Simon, 1976; March and Simon 1958). Starting with computational modeling tools such as OrgCon in the late 1980s, VDT in the early 90's and OrgAhead in the mid-90's, researchers and practitioners have begun using computational models of organizations for analyzing the existing organizations and designing better ones. The Virtual Design Team (VDT) is a project organization modeling and simulation tool that integrates organizational and process views of strategic, time-critical projects (Jin and Levitt 1996). The vision behind VDT is to offer a methodology to design an organization the way an engineer designs a bridge.

Khosraviani (2004) developed organizational design optimization using genetic programming. Genetic Programming is used as an evolutionary computational optimization approach, to help project managers find near optimal designs for their project organizations. Organizational Consultant or OrgCon is another example of a computational model that is built based on the viewpoint that an organization is an information processing entity (Butron and Obel 2004). Other examples are OrgAhead (Loue et al., 2003) an organizational learning model designed to test different forms of organizations under a common task representation, or OrgMem (Carley et al., 2000), a multi-agent simulation program that imitates the interpersonal communication, information processing and decision making processes in organizations.

Organization design and choosing the organizational structure for a company is the problem which has been solved by different methods, considering numerous of criteria but still it cannot be defined in the most suitable method of the selection the adequate organizational structure for all companies. Soulsby and Clark (2007) presented the post-socialist organizational research and the post-socialist transformation of the organization theory. Kujacic and Bojovic (2007) presented the process and relevant issues of the postal traffic organization design. Bojovic et al (2010) applied the ANP method for the selection among alternatives of organizational structure.

An interesting approach to computational organizational modeling was used by inter alia, (Hyatt et al. 1997). In this paper, an object-oriented simulation environment using difference equations for organization network modeling was developed. This model also relies in the information-process approach. Joslyn and Rocha (2000) modeled socio-technical organizations by employing the principles of semiotics. The fundamental principles of semiotic agents as decision-making entities embedded in artificial environments and exchanging and interpreting semiotic tokens were introduced. The previous section presents some of the approaches to designing organizational structures through highlighting the main characteristics of each of these models. In the next part of the paper, based on relevant theoretical approaches, a new model for the analysis of organization of the administrative bodies which is based on fuzzy logic is developed. Fuzzy mathematical model is tested on the example of the organizational structure of administrative bodies of logistic support of the Petroleum Industry of Serbia in order to analyze the situation and optimize the existing organizational structure. The above model will be shown in the next section of work.

3. Fuzzy sets

In the process of designing the organizational structure, certain decisions have to be made. Subjective evaluation of certain parameters differs from one decision-maker to another, it is worth pointing out. Quite a convenient approach in quantifying these parameters is fuzzy set theory.

Fuzzy sets theory. Zadeh (1965) defines fuzzy set A as a set of ordered pairs:

$$A = \{x, \mu_A(x) \mid x \in X, 0 \leq \mu_A(x) \leq 1\}, \quad (1)$$

where $\mu_A(x)$ is a membership function which shows to what extent $x \in X$ meets the criteria for membership in a set A . For the membership function $0 \leq \mu_A(x) \leq 1$, for every $x \in A$, i.e. $\mu_A: X \rightarrow [0, 1]$.

According to the fuzzy theory the choice of membership functions that is, the form of the function and confidence intervals width are usually made based on subjective estimates or experience. The most commonly used are trapezoidal and triangular fuzzy numbers. Triangular fuzzy numbers with membership functions (Figure 1) are used in this paper.

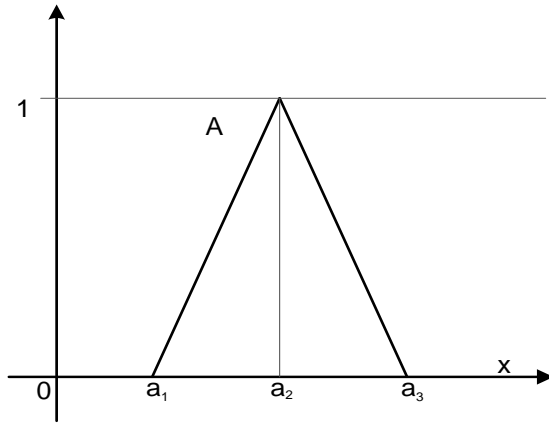


Figure 1. Triangular fuzzy number

Triangular fuzzy numbers are usually given in the form $A = (a_1, a_2, a_3)$, where a_2 is the value where the membership function of the fuzzy number is 1.0, a_1 is the left distribution of the confidence interval and a_3 the right distribution of the confidence interval of the fuzzy number A .

Fuzzy number A membership function is defined as:

$$\mu_A(x) = \begin{cases} 0, & x < a_1 \\ \frac{x - a_1}{a_2 - a_1}, & a_1 \leq x \leq a_2 \\ \frac{a_3 - x}{a_3 - a_2}, & a_2 \leq x \leq a_3 \\ 0, & x > a_3 \end{cases} \quad (2)$$

For defuzzification and mapping of the fuzzy number $A = (a_1, a_2, a_3)$ value into a real numbers, numerous methods are used.

The centre of gravity method has been used in the paper.

$$defuzzy\ A = \left[\frac{a_3 - a_1}{3} + a_2 - a_1 \right] B^{-1} + a_1 \quad (3)$$

4. Basic model - Fuzzy mathematical model for evaluation of infrastructure business functions

In order to successfully describe the fuzzy mathematical model it is necessary to define basic principles of fuzzy arithmetic.

Let X be a finite set $X = \{x_1, x_2, \dots, x_n\}$. Fuzzy set L is defined on a set X and is a set of ordered pairs $\{(x_1, f_L(x_1)), (x_2, f_L(x_2)), \dots, (x_n, f_L(x_n))\}$,

where $f_L : X \rightarrow 0,1$ is a membership function of fuzzy number L , where $f_L x_i$ is the degree of belonging of element x_i to the set L .

Definition 1. Fuzzy set L defined on a set X that represents a finite set of elements $X = x_1, x_2, \dots, x_n$ is defined as:

$$L = \frac{\mu_L x_1}{x_1} + \frac{\mu_L x_2}{x_2} + \dots + \frac{\mu_L x_n}{x_n} = \sum_{i=1}^n \frac{\mu_L x_i}{x_i} \quad (4)$$

where the sign "+" indicates the union of elements.

Definition 2. Fuzzy set L is a convex set if it satisfies the condition

$$\mu_L \lambda l_1 + 1 - \lambda l_2 \geq \mu_L x_1 \wedge \mu_L x_2, \quad \forall l_1, l_2 \in L, \quad \forall \lambda \in 0,1 \quad (5)$$

Definition 3. Fuzzy set L which is defined over a set X is normal if membership function $f_L x_i$ satisfies the condition $\max_x f_L x = 1$.

Definition 4. Alpha cut α -cut of the fuzzy set L_α and strong alpha cut

α -strong cut of the fuzzy set $L_{\alpha+}$ is defined as:

$$L_\alpha = x_i \mid f_L x_i \geq \alpha, x_i \in X, \quad \alpha \in 0,1 \quad (6)$$

$$L_{\alpha+} = x_i \mid f_L x_i > \alpha, x_i \in X, \quad \alpha \in 0,1 \quad (7)$$

Definition 5. Membership function of fuzzy set L is defined as:

$$\mu_L x = \begin{cases} 0, & x < l_1 \\ \frac{x-l_1}{l_2-l_1}, & l_1 \leq x \leq l_2 \\ \frac{l_3-x}{l_3-l_2}, & l_2 \leq x \leq l_3 \\ 0, & x > l_3 \end{cases} \quad (8)$$

where $l_1 \leq l_2 \leq l_3$ and $l_1, l_2, l_3 \in [0,10]$

Let $A = a_1, a_2, a_3$, and $B = b_1, b_2, b_3$, be triangular fuzzy numbers. The basic rules of fuzzy arithmetic can be described as:

$$A + B = a_1, a_2, a_3 + b_1, b_2, b_3 = a_1 + b_1, a_2 + b_2, a_3 + b_3 \quad (9)$$

$$A - B = a_1, a_2, a_3 - b_1, b_2, b_3 = a_1 - b_1, a_2 - b_2, a_3 - b_3 \quad (10)$$

$$A \times B = a_1, a_2, a_3 \times b_1, b_2, b_3 = a_1 \times b_1, a_2 \times b_2, a_3 \times b_3 \quad (11)$$

$$A \div B = a_1, a_2, a_3 \div b_1, b_2, b_3 = a_1 \div b_3, a_2 \div b_2, a_3 \div b_1 \quad (12)$$

$$k \times A = k \times a_1, a_2, a_3 = k \times a_1, k \times a_2, k \times a_3 \quad (13)$$

$$A^{-1} = \left(\frac{1}{a_1}, \frac{1}{a_2}, \frac{1}{a_3} \right) \quad (14)$$

Fuzzy mathematical model for evaluation of infrastructure business functions includes the following steps:

Step 1: Selection and identification of business functions. Define and make the choice of n business functions that are assessed (P_1, P_2, \dots, P_n) . The choice of business functions depend on the purpose and tasks performed by the organizational structures.

Step 2: Selection and identification of k business functions $(P_{p1}, P_{p2}, \dots, P_{pk})$.

Step 3: Define and make the choice of i process functions $(P_{f1}, P_{f2}, \dots, P_{fi})$.

Step 4: Determining the correlation of process functions P_{fi} , $(i = 1, \dots, M)$ and tasks P_{pk} $(k = 1, \dots, K)$ for a selected business function P_n $(n = 1, \dots, N)$.

Correlation is a correlation matrix $A = f_{ik} \text{ }_{M \times K}$, where:

$$f_{ik} = \begin{cases} 1, & \forall P_{fi} \in P_k \\ 0, & \forall P_{fi} \notin P_k \end{cases}, \quad (i = \overline{1M}, k = \overline{1K}) \quad (15)$$

Step 5: Defining a set of linguistic descriptors

$S = l_1, l_2, \dots, l_i$, $i \in H = 0, \dots, T$ where T is a total number of linguistic descriptors. Linguistic variables are represented by triangular fuzzy number which is defined as $L = (l_1, l_2, l_3)$, (Figure 2), where l_2 present the value where the membership function of fuzzy number has a maximum value.

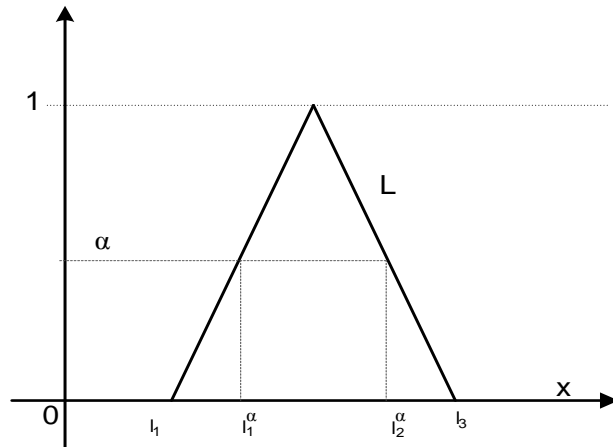


Figure 2. Fuzzy number L with the appropriate confidence interval and degree of conviction

Values l_1 and l_3 represent the left and right distribution of membership function of the value in which the membership function reaches its maximum value.

$$L = l_1, l_2, l_3 = \left\{ \begin{array}{l} l_1 = \min B_{ijk} \\ l_2 = \sqrt[n]{\prod_{k=1}^n B_{ijk}} \\ l_3 = \max B_{ijk} \end{array} \right\} \quad (16)$$

where B_{ijk} is preference k of the expert.

Step 6: Defuzzification of linguistic descriptors is performed using the method developed by Liou and Wang (1992):

$$g_{\alpha, \beta} L = [\beta \square f_{\alpha} l_1 + 1 - \beta \square f_{\alpha} l_3], \quad 0 \leq \beta \leq 1, \quad 0 \leq \alpha \leq 1 \quad (17)$$

where $f_{\alpha} l_3 = l_3 - l_3 - l_2 \square \alpha$ is the left border of the confidence interval of fuzzy number L while $f_{\alpha} l_1 = l_2 - l_1 \square \alpha + l_1$ is the right border of the confidence interval of fuzzy number L .

Step 7: Determination of process weights for each of the studied business functions by forming a matrix $W = \begin{bmatrix} w_{pji} \end{bmatrix}_{l \times l}$.

Step 8: Determination of the task weights for each of the studied business functions by forming a matrix $W = \begin{bmatrix} w_{pi} \end{bmatrix}_{l \times l}$. Elements of the matrix in steps 7 and 8 are linguistic descriptors defined in step 5. Most often it happens that in the situation analysis of organizational structure numerous experts, that is, decision-makers, are included. In this case, valuation of task and process weights by all group members should be obtained first in order to perform necessary synthesis and proceed to step 9. In other cases, proceed to step 10.

Step 9: When in the process of situation analysis of the organizational structure, more experts, that is, decision makers, are involved, valuation by all group members should be obtained first in order to perform necessary synthesis.

In the case of group synthesis with complete information, individual preference ratings at all levels of hierarchy are aggregated by using the expression:

$$w'_i = \left[\prod_{j=1}^n \lambda_j a_{ij} \right]^{1/n} \longrightarrow w_{kij} = \frac{\lambda_j \square w'_{k_j}}{\sum_{j=1}^K \lambda_j \square w'_{k_j}} = \left[\prod_{j=1}^n \lambda_j a_{ij} \right]^{1/n} \square \left\{ \sum_{i=1}^n \left[\prod_{j=1}^n \lambda_j a_{ij} \right]^{1/n} \right\}^{-1} \quad (18)$$

$$\sum_{j=1}^K w_k = 1, w_k \in 0,1, \lambda \in 0,1 \quad (19)$$

where λ_j is the preference of decision maker, i.e. degree of conviction.

In the case of group synthesis with incomplete information, micro aggregation in position i, j in a given matrix is done by geometric averaging of ratings of those group members who have declared on element E_i preference in relation to element E_j . In this case it is necessary that at least one of the decision makers declare on value a_{ij} . By modifying the previous form we get:

$$w^G_i = \left[\prod_{l \in L} \lambda_j \square a_{ij} \ l \right]^{1/M} \longrightarrow w_{kij} = \frac{\lambda_j \square w^G_{k_j}}{\sum_{j=1}^K \lambda_j \square w^G_{k_j}} = \left[\prod_{j=1}^n \lambda_j a_{ij} \right]^{1/n} \square \left\{ \sum_{i=1}^n \left[\prod_{j=1}^n \lambda_j a_{ij} \right]^{1/M} \right\}^{-1} \quad (20)$$

$$\sum_{j=1}^K w_k = 1, w_k \in 0,1, \lambda \in 0,1 \quad (21)$$

where l is a set of group members who evaluated a couple of elements E_i, E_j , and M is number of such members.

Step 10: Defining the matrix of required weights $\begin{bmatrix} W_{pp} \end{bmatrix}_{w_{p_f} \times w_{p_p}}$, where W_{pp} is represented by the following expression:

$$W_{pp} = \begin{cases} W_{pj} \square W_{pp}, & \forall f_{ik} = 1 \\ 0, & \forall f_{ik} = 0 \end{cases}, (i = \overline{1M}, k = \overline{1K}) \quad (22)$$

Step 11: Assessment of implementation of activities of administrative bodies. Using expressions (18) and (19), the matrix of task assessment is defined $[C_{ij}]_{I \times I}$:

$$C_{ij} = \begin{cases} O_{ij}, & \forall f_{ik} = 1 \\ 0, & \forall f_{ik} = 0 \end{cases} \quad (23)$$

Step 12: Defining the matrix of actual weights $[W_{spij}]$ from the expression:

$$W_{spij} = \begin{cases} W_{ppij} \square \frac{C_{ij}}{T}, & \forall f_{ik} = 1 \\ 0, & \forall f_{ik} = 0 \end{cases} \quad (24)$$

Step 13: Calculating the average task assessment O_i :

$$O_i = \frac{\sum_j W_{spij}}{\sum_j W_{ppij}} \square T \quad (25)$$

Step 14: Calculating the average score of logistics functions O_p :

$$O_p = \frac{\sum_i \sum_j W_{spij}}{\sum_i \sum_j W_{ppij}} \square T \quad (26)$$

Average ratings of business functions are obtained based on the average ratings of each business function individually, and their common view is shown in tables, where you can see the sum of the weights required, the sum of actual weights and the average rating for each business function and the overall average rating of functioning organizational structure.

Step 15: Calculating the average rating of process functions and their ranking. Average ratings of process functions are calculated by means of actual and required weights (O_{pf}) using the form:

$$O_{pf} = \frac{W_{spf}}{W_{ppf}} \square T \quad (27)$$

where:

- W_{spf} , actual process weight,

- W_{ppf} , required process weight and

- T , total number of linguistic descriptors.

Based on the results, process and business functions of the organizational structure according to the average ratings obtained are ranked.

On the basis of the proposed algorithm, a program based on the concepts of object-oriented programming in *Visual Basic* programming package has been developed. The program has been created and designed on the basis of the presented fuzzy mathematical model and can be used to analyze the performance of administrative bodies in all business systems.

5. Results and discussion

Application of the described model will be presented through evaluation of organization of the logistics administrative bodies in the Petroleum Industry of Serbia. The logistics administrative bodies are organized on a functional principle and carry out their tasks through the following logistic functions:

-supply (P_1),

-maintenance (P_2),

-transportation (P_3),

-general logistics (P_4) and

-security and safety at work (P_5).

For each of the following logistic functions k tasks have been identified. In the analysis of performance of the logistics administrative bodies in the Petroleum Industry of Serbia, apart from nine characteristic process functions (Table 1), there is also another process function, command and control, which is typical of military organization.

Table 1. Review of Process Functions with abbreviations and meanings

Name of process function	Symbol	Meaning
Recording	Rc	Inclusion of all business activities within organization
Informing	In	Submission of data and information on all positions in the organization
Monitoring	Mn	Comparison of activities performed with pre-set criteria, standards and guidelines
Analyzing	An	Dismantling, comparing and reasoning about the causes of deviations
Decision- making	Dm	Re-intervention on the developments in the

Name of process function	Symbol	Meaning
Planning	Pl	existing processes and designing future processes Provision of necessary elements for the implementation of decisions
Harmonizing	Har	Combining and directing individual efforts into the overall effort
Organizing	Org	Search and design of appropriate organizational procedures and execution of tasks
Performance	Per	The execution of tasks in all positions in the organization
Command and control	Cmc	Assigning tasks to subordinate units and bodies. By issuing orders the plans and decisions are exercised.

Identification of tasks was followed by determining the correlation between process functions and tasks P_{pk} ($k = 1, \dots, K$) for the studied logistic function. The correlation between process functions and tasks of the logistic function is shown by correlation matrix $A = f_{ik}^{M \times K}$.

In order to determine the process and task weights ($W = \begin{bmatrix} w_{pfi} \end{bmatrix}_{l \times l}$) of logistic functions ($W = \begin{bmatrix} w_{pfi} \end{bmatrix}_{l \times l}$) a set of linguistic descriptors is defined $S = l_1, l_2, \dots, l_i, i \in H = 0, \dots, T$, (Figure 2).

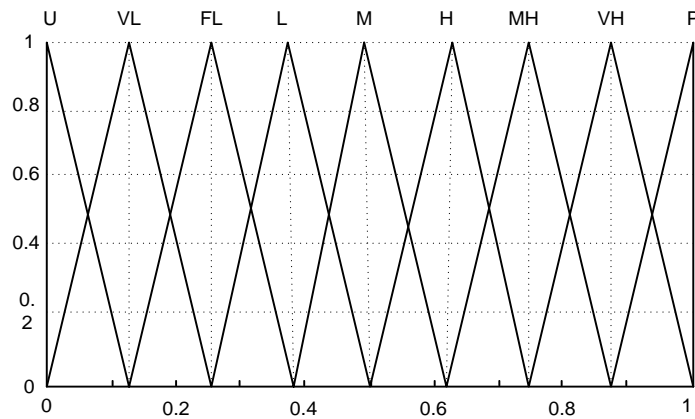


Figure 2. Graphical display of linguistic descriptors

where: U – unessential, VL – very low, FL - fairly low, L - low, M - medium, H - high, MH - medium high, VH - very high and P - perfect.

After decision aggregation the process weights for each of the studied logistic functions were obtained. The process weights are the same for all the studied logistic functions (Table 2).

Table 2. Process Weights of Logistic Function “Maintenance”

		Maintenance (P_1)			
Process Symbol	$\left(\min B_{ijk}, \sqrt[n]{\prod_{k=1}^n B_{ijk}}, \max B_{ijk} \right)$	Process Weights ($W_{P_{foi}}$)			
		$\alpha=0.35$	$\alpha=0.5$	$\alpha=1$	$\sqrt[3]{\prod_{k=1}^3 W_{P_{foi}}}$
P_{fRc}	(0.056, 0.168, 0.333)	0.160	0.181	0.251	0.197
P_{fIn}	(0.168, 0.314, 0.481)	0.296	0.319	0.398	0.338
P_{fMn}	(0.354, 0.516, 0.686)	0.493	0.518	0.601	0.537
P_{fAn}	(0.317, 0.479, 0.649)	0.456	0.481	0.564	0.500
P_{fDm}	(0.630, 0.794, 0.927)	0.764	0.786	0.861	0.804
P_{fPl}	(0.668, 0.832, 0.962)	0.802	0.824	0.897	0.841
P_{fHar}	(0.389, 0.554, 0.704)	0.527	0.551	0.629	0.569
P_{fOrg}	(0.408, 0.572, 0.723)	0.545	0.569	0.648	0.587
P_{fPer}	(0.130, 0.298, 0.461)	0.272	0.297	0.379	0.316
P_{fCmc}	(0.554, 0.723, 0.851)	0.691	0.713	0.787	0.730

The task weights (Table 3) for each of the studies logistic functions are obtained by aggregation of the examinees’ preferences.

Table 3. Task Weights of Logistic Function “Maintenance”

		Maintenance (P_1)			
Task symbol	$\left(\min B_{ijk}, \sqrt[n]{\prod_{k=1}^n B_{ijk}}, \max B_{ijk} \right)$	Task Weights ($W_{P_{foi}}$)			
		$\alpha=0.35$	$\alpha=0.5$	$\alpha=1$	$\sqrt[3]{\prod_{k=1}^3 W_{P_{foi}}}$
P_{po1}	(0.444, 0.611, 0.767)	0.584	0.608	0.689	0.627
P_{po2}	(0.233, 0.401, 0.566)	0.375	0.400	0.483	0.420
P_{po3}	(0.357, 0.521, 0.678)	0.495	0.519	0.599	0.538
P_{po4}	(0.611, 0.778, 0.899)	0.745	0.767	0.839	0.783
P_{po5}	(0.289, 0.456, 0.622)	0.431	0.456	0.539	0.475
P_{po6}	(0.401, 0.566, 0.722)	0.540	0.564	0.644	0.582
P_{po7}	(0.479, 0.645, 0.799)	0.618	0.642	0.722	0.660
P_{po8}	(0.168, 0.321, 0.489)	0.301	0.325	0.405	0.344
P_{po9}	(0.622, 0.789, 0.910)	0.756	0.778	0.850	0.794
P_{po10}	(0.479, 0.643, 0.811)	0.619	0.644	0.727	0.664
P_{po11}	(0.367, 0.533, 0.700)	0.508	0.533	0.616	0.553
P_{po12}	(0.345, 0.511, 0.678)	0.486	0.511	0.594	0.530
P_{po13}	(0.245, 0.399, 0.567)	0.378	0.403	0.483	0.421
P_{po14}	(0.223, 0.389, 0.555)	0.364	0.389	0.472	0.408
P_{po15}	(0.311, 0.478, 0.645)	0.453	0.478	0.561	0.497

After defining the necessary matrix of weights $\left[W_{pp} \right]_{w_{P_f} \times w_{P_p}}$, according to expression (22), the evaluation activities at the workplace according to process functions within each logistic function are defined, defining the matrix of actual weights $\left[W_{sp_{ij}} \right]$ using expression (24), using expression (25) average task assessments of logistic functions were obtained (Table 4).

Table 4. Average Task Assessments within Logistic Functions

Process symbol	Task Assessments				
	Supply (P_1)	Maintenance (P_2)	Transportation (P_3)	General Logistics (P_4)	Security and Safety at Work (P_5)
P_{po1}	0.794	0.788	0.794	0.772	0.495
P_{po2}	0.713	0.696	0.712	0.696	0.605
P_{po3}	0.842	0.744	0.841	0.812	0.757
P_{po4}	0.711	0.644	0.724	0.661	0.608
P_{po5}	0.589	0.638	0.669	0.614	0.566
P_{po6}	0.617	0.620	0.635	0.567	0.564
P_{po7}	0.555	0.577	0.635	0.518	0.536
P_{po8}	0.540	0.541	0.565	0.523	0.517
P_{po9}	0.603	0.555	0.622	0.527	0.523
P_{po10}	0.639	0.643	0.632	0.627	0.639
P_{po11}	0.644	0.646			0.511
P_{po12}	0.496	0.508			0.519
P_{po13}	0.790	0.790			0.662
P_{po14}	0.638				
P_{po15}	0.542				

Average ratings of logistic functions were obtained using the expression (26).

Table 7. Average Ratings of Logistic Functions

Logistic Functions	Average score of logistic function
Supply (P_1)	0.648
Maintenance (P_2)	0.641
Transportation (P_3)	0.669
General Logistics (P_4)	0.625
Security and Safety at Work, (P_5)	0.576

On the basis of expression (27) the ratings of process functions within logistic functions were obtained.

Table 8. Average Ratings of Process Functions within Logistic Functions

Process symbol	Ratings of Logistic Functions					$\sqrt[5]{\prod_{k=1}^5 W_{P_k}}$
	Supply (P_1)	Maintenance (P_2)	Transportation (P_3)	General Logistics (P_4)	Security and Safety at Work (P_5)	
P_{fRe}	0,603	0,678	0,641	0,545	0,483	0.5900
P_{fIn}	0,711	0,729	0,708	0,675	0,653	0.6952
P_{fMn}	0,689	0,381	0,696	0,645	0,528	0.5878
P_{fAn}	0,640	0,407	0,638	0,601	0,623	0.5818
P_{fDm}	0,672	0,649	0,672	0,597	0,612	0.6404
P_{fPl}	0,653	0,660	0,653	0,653	0,653	0.6544
P_{fHar}	0,564	0,373	0,557	0,625	0,547	0.5332
P_{fOrg}	0,599	0,407	0,653	0,699	0,576	0.5868
P_{fPer}	0,601	0,748	0,600	0,604	0,766	0.6638
P_{fCmc}	0,716	0,639	0,730	0,665	0,811	0.7122

Law average ratings point out those tasks that are neglected in the organizational structure. All average ratings with a value below 0.55 indicate the tasks and functions that are critical points in the organization.

Average ratings of business functions indicate the importance that they have in the overall functioning of the organizational structure. If these ratings are very different, it points to the unadjusted leadership and management. In addition, average rating of business functions is the evaluation of the organizational level of

the organizational structure. Average task ratings indicate the importance they have in the overall functioning of administrative bodies. As these ratings are very different ranging from 0.496 to 0.811, this means that the cause was the unadjusted task management.

Strengths and weaknesses of the existing organization and functioning of the organizational structure show the ranking of process functions. The ranking shows what process functions should be given more attention; this applies especially to those process functions that have high weights, and low average ratings. Average ratings of process functions indicate those process functions which have to be significantly changed and improved. This applies particularly to those process functions that are rated below average, and in this case it is process function *harmonizing* with an average rating of 0.5332.

6. Conclusion

Designing leadership and management systems has great impact on the creation, adaptation, survival and quality functioning of the studied business system. There is not an organizational system that can function without its management subsystem, as it issues commands for the desired behavior of the system, while the actual behavior can deviate from that desired.

In addition, to organizations operating in an uncertain environment, there is a degree of uncertainty and ambiguity of the criteria used in the organization design process. Fuzzy mathematical model developed in this paper allows the quantification of the specified criteria and analysis of the degree of organization of the business system. The presented model allows the analysis of organizational structure regardless of the number of business functions. The model predicts the selection of tasks and functions that are problem points.

Since the process of designing organization often involves a number of experts, the model considers the possibility of value synthesis of the optimality criterion in case of group decision-making. Decision-making in the group differs from individual decision-making on the methodological and mathematical level. The model considers the group synthesis with complete information and with incomplete information.

Application of the described model is shown on the example of the analysis of administrative bodies of logistic support in the Petroleum Industry of Serbia. Complex environment of the administrative bodies does not allow organizational improvisations, but requires planned and methodological project of the organization and its continuous modification and adaptation. Choosing the appropriate organizational structure is one of the most important decisions, because if you adopt an organizational structure that does not correspond to the situation in which the organization is, it will slow down the ability of the management system. Analytical procedure obtained by this method provides a quantitative assessment of organizational level and on the fact taking measures for further organizational activity.

Although, shown on the example of the administrative bodies of logistic support of the Petroleum Industry of Serbia, the model has great adaptability and ability to adapt to the particular problem. It can easily be applied to analyze the organizational structure of any business system in the society.

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