Designing cybersecurity management bodies in strategic planning: application of hybrid analysis

Dragan Bojanić
Strategic research institute
University of defence in Belgrade
Belgrade, Serbia
dragan.bojanic@mod.gov.rs

Ivan Vulić
University of defence in Belgrade
Belgrade, Serbia
ivan.vulic@mod.gov.rs

Vladimir Ristić
Military academy
University of defence in Belgrade
Belgrade, Serbia
vladimir.ristic@mod.gov.rs

Jan Marček
Faculty for Business Studies and Law
University UNION - Nikola Tesla
Belgrade, Serbia
marcek.jan958@gmail.com

Abstract **— It is necessary for the design of the organisational structure of cybersecurity systems or information security systems to meet the basic goals of the organization. Thus, although cybersecurity is only an element of information security, it is its most important part. For that reason, it is essential for the organisational structure to be constantly perfected. The analysis of strengths, weaknesses, opportunities, and threats (SWOT) is one of the methods which can use to create the strategy for securing cyberspace. The basic idea of SWOT analysis is to enable the development behavior of the organization by finding key factors of the problem. The use of multiple criteria decision making (MCDM) in the second decade of the 21st century, some of the lacks has eliminated. The complexity of such decisions indicates that the use of crisp data is not suitable. This paper presents one way of a modification of the Saaty-s scale. To determine the criteria weights and alternative values, fuzzy numbers are used. The confidence interval of a fuzzy number is different from one comparison to another in pairs performed by decision-makers/experts. After the application of the AHP method in this way, the values of the functions criteria for each considered alternative are obtained. The Hybrid method which includes SWOT analysis and the Fuzzy Analytic Hierarchy Process FA'WOT, it was used to create the development strategy for cybersecurity management bodies. This paper is a part of the research project „Hybrid Warfare-experience and perspectives“ run by the Strategic Research Institute, University of Defence in Belgrade.**

Keywords — Cybersecurity, organisational structure, phasification, group decision making, management bodies

I. INTRODUCTION

Cyberspace is a characteristic of modern life and the most important area of the world economy. Cybersecurity is a major concern of every organisations today. Hybrid form and asymmetrical nature of endangerment of Cyberspace which is crucial for cybersecurity of organisations raised an analytical approach to security and organisational forms. Today's organisations depends on cybersecurity to facilitate essential business operations. Cybersecurity covers the steps an organisation must take to protect information that can be accessed via vulnerabilities in its networks and systems. Much of the cybercrime we face is primarily financially directed. To solve these difficulties of cybersecurity, organisations must take not only information data and technology but also managerial and operational aspects into consideration. Every task set for the management must be performed properly and reliably in all environmental conditions. Cybersecurity Management Systems (CSMS) are becoming more and more popular for organisations that want to improve their cybersecurity levels. The effectiveness of the whole CSMS is directly decided by the effectiveness of the implemented cybersecurity in departments [1].

Different departments in an organisation have different security responsibilities and thus adopt different controls in CSMS. With different responsibilities in cybersecurity management, different departments are concerned with different aspects of cybersecurity. The departments with relation to security are the Management Board, HR Department, Security Department, Information Protection Department, and Information System Management Department.

Organisational design is specific to every organisation, and therefore a unique organisational structuring cannot be created. The difference between companies allows The difference between companies allows different approaches to organizational design, as well as different factors, affect companies differently.

Computational modelling and simulation are becoming increasingly popular, an interesting approach to computational organisational modelling was used by, inter alia, [12]. In this paper, an object-oriented simulation environment using difference equations for organisation network modelling was developed. Simulation, unlike mathematical modelling, allows researchers to reflect the natural complexity of organisation systems as given.

Computational modelling facilitates studies of more complex systems than traditional mathematical approaches. Computational and mathematical models of organisational design may be found in the papers by Carley [2]. Kujacic and Bojovic proposed the model and methodology for selecting organisational structure using fuzzy multi-criteria where takes into consideration the uncertainty and imprecision of the input data [3].

It is important for every organization to implement a structure that will allow its employees to fulfill certain tasks, under certain conditions and at a specific time, which is why managers constantly have to review and adjust the organization's structure to the circumstances. In the theory of computational organization, researchers use computational analysis methods to study both employees and organizations as computational entities [2]. Fuzzy management knowledge can be use to create some models, that almost like humans, may analyze the quality information in the smart method. Organizations with its employees can be viewed as basic computational, as many of their activities involve transforming information from one form to another and also because the organizational activity is often information-driven [4].

In the first part of the paper have been presented some design approaches to organisational structure with emphasis on the basic characteristics of each of these models. Further, in the paper is shown, a model based on fuzzy logic for the selection of optimal variants of organisation. To optimise the existing organisational structure of cybersecurity management bodies, FA'WOT model is applied. Using FA'WOT and standard techniques of multi-criteria decision making, the selection of the organizational model was made [5]. In the following section of the paper, the model mentioned above is presented.

II. FUZZY MATEMATICAL MODEL

When we talk about designing the organizational structure, decision support system like fuzzy logic is an interactive system that helps decision-makers to make certain decisions. It must be emphasized that subjective evaluation of certain parameters differs from one to another, and quantifying these parameters with fuzzy set theory, was introduced by Lotfi Zadeh[6].

A large number can be found in the literature the phasification of the Saaty scale, in which they use fuzzy instead of standard values numbers. Roughly speaking, there are two approaches in the phasification of the Saaty scale.

The most common phasing is related to the implementation of fuzzy numbers with predefined numbers confidence interval. Another type of phasification approach is to define the scale applying the variable confidence interval of the fuzzy number. For example, in [10], the confidence interval depends on the degree of DO's confidence in its claims, where the degree of certainty (b) is defined at the whole scale level, Table 1.

The simplest way to fuzzification of the Saaty scale is to use fuzzy numbers with a predetermined confidence interval, that is, with a predetermined left and right fuzzy number distribution. In other words, the confidence intervals of the fuzzy numbers are first established and then the pairwise comparison is made. „Since fuzzification of the AHP method is primarily based on fuzzification of the grading scale, the following part of this paper will present approach to optimisation of the dynamic grading scale“ [9].

„The degree of uncertainty is represented by the length of the fuzzy number base, the greater uncertainty in the assessment of the linguistic expression the bigger the length of the base (certainty interval) of the fuzzy number“ [10].

The model, presented in this paper takes into account the degree of uncertainty indicated by the parameter β, where the value of describe $\beta = 0$ describes the greatest possible uncertainty, while the value of $\beta = 1$ corresponds the situation in which we are sure that the linguistic expression corresponds the given comparison of the optimality criteria. The parameter β takes values from the interval [0,1]. An overview of the phased Saaty scale is given in the Table 1. Upper and lower limits of the β defined by the expression (1) [9]:

$$T = (t_1, t_2, t_3) = \left\{ \begin{array}{lll} t_1 = \beta t_2, & t_1 \le t_2, & t_1, t_2 \in [1/9, 9] \\ t_2 = t_2, & & t_2 \in [1/9, 9] \\ t_3 = (2-\beta) t_2, & t_3 \le t_2, & t_2, t_3 \in [1/9, 9] \end{array} \right\} \quad (1)$$

TABLE I. FUZZIFIED SAATY'S SCALE

Importance intensity	Definition	Fuzzified values	
		Fuzzy number	*Inversive fuzzy number*
1	Same importance	(1, 1, 1) compared with oneself, $(\beta, 1, 2-\beta)$ in other cases	$(1/\beta, 1, 1/(2-\beta))$ in other cases
3	Weak dominance	$(3\beta, 3, (2-\beta)3)$	$(1\,(2-\beta)3, 1/x, 1\,3\beta)$
5	Strong dominance	$(5\beta, 5, (2-\beta)5)$	$(1\,(2-\beta)5, 1/5, 1\,5\beta)$
7	Very strong dominance	$(7\beta, 7, (2-\beta)7)$	$(1\,(2-\beta)7, 1/7, 1\,7\beta)$
9	Absolute dominance	$(9\beta, 9, (2-\beta)9)$	$(1\,(2-\beta)9, 1/9, 1\,9\beta)$
$x = 2, 4, 6,$	Inter-values	$(x\beta, x, (2-\beta)x)$	$(1\,(2-\beta)x, 1/x, 1\,\beta x)$

Fuzzification of Saaty's scale shown in (Table 1). The fuzzy number:

$T = (t_1, t_2, t_3) = (x\beta, x, (2-\beta)x)$, $x \in [1, 9]$ is defined as:

$$t_1 = x\beta = \begin{cases} x\beta, & \forall\ 1 \le x\beta \le x \\ 1, & \forall\ x\beta < 1 \end{cases} \quad (2)$$

$$t_2 = x,\ \forall\ x \in [1, 9] \quad (3)$$

$$t_3 = (2-\beta)x = \begin{cases} (2-\beta)x, & \forall\ x \le (2-\beta)x \le 9 \\ 9, & \forall\ (2-\beta)x > 9 \end{cases} \quad (4)$$

Defining an inverse fuzzy number $T^{-1} = (1/t_1, 1/t_2, 1/t_3) = (1/(2-\beta)x, 1/x, 1/\beta x)$, $x \in [1/9, 1]$ is done with the expressions::

$$1/t_1 = 1/(2-\beta)x = \begin{cases} 1/(2-\beta)x, & \forall\, x < 1/(2-\beta)x < 1 \\ 1, & \forall\, 1/(2-\beta)x > 1 \end{cases} \quad (5)$$

$$1/t_2 = 1/x, \ \forall\ 1/x \in [1/9, 1] \quad (6)$$

$$1/t_3 = 1/\beta x = \begin{cases} 1/\beta x, & \forall\ 1/9 \le 1/\beta x \le 1/x \\ 1/9, & \forall\ 1/\beta x < 1/9 \end{cases} \quad (7)$$

By application of the AHP method, the values of criteria functions, for every alternative are obtained.

Implementation of FA'WOT model (Fig.1), we describe after determination of the parameters of fuzzy Saaty's scale. [7-10].

The steps of FA'WOT model:

Step 1. Identify SWOT sub-factors and determine the alternative strategies according to the SWOT sub-factors. Determine the importance of degrees of the SWOT factors.

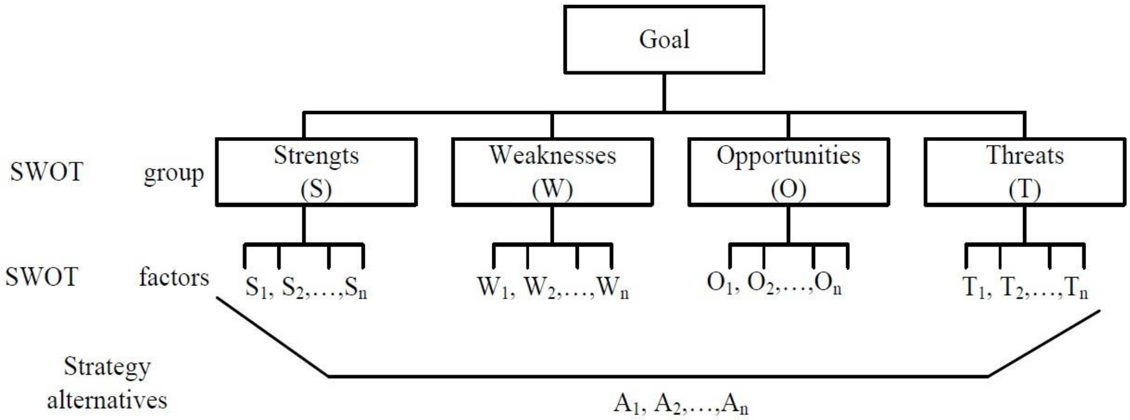

Fig. 1. The hierarchical presentation of FA'WOT analysis

Step 2. The Aggregation principle (Fig. 2). "Looking from the top of the hierarchy, at the level 1 there are the criteria that are compared in pairs, each to each, with respect to the immediate parent element at a higher level (the goal here is at the zero level). The procedure is applied by going down, through the hierarchy until at the last level k there are not performed comparisons" [14].

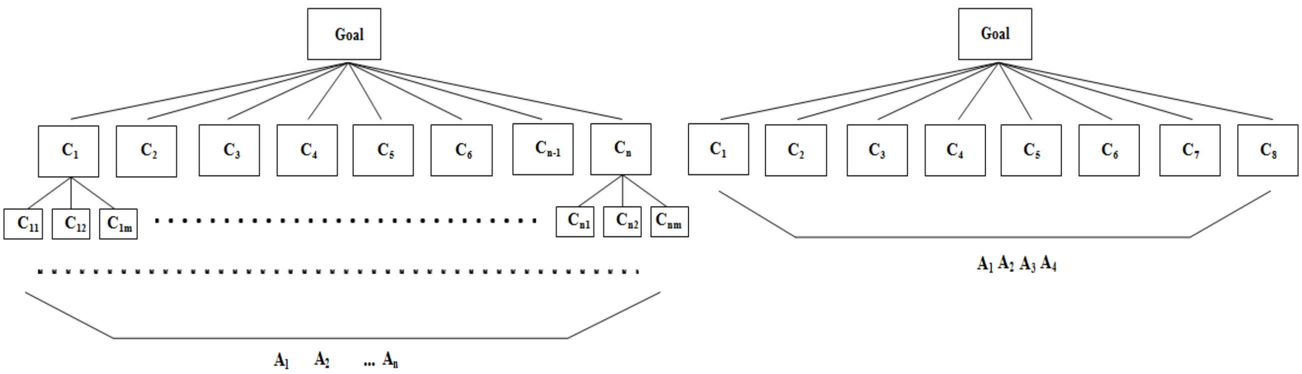

Fig. 2. Aggregation of criteria and sub-criteria levels

Step 3. Estimate of criteria. In order to be ranked, the importance of the goal criteria must first be determined [10]. Judgment matrix for the criteria is obtained using a fuzzified scale, shown in (8):

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n-m} & \cdots & a_{M} \\ \vdots & & & & \vdots \\ a_{k1} & \cdots & a_{kn-M} & \cdots & a_{kM} \\ \vdots & & & & \vdots \\ a_{K1} & \cdots & a_{Kn-M} & \cdots & a_{KM} \end{bmatrix} \quad (8)$$

where $a_{ij}=1$ for all $i=j$ $(i,j=1,2,...,M)$ and $a_{ij}=1/a_{ji}$.

The weights of criteria are determining as shown in (9):

$$w_i = \frac{\sum_{j=1}^{M} a_{ij}}{\sum_{k=1}^{M}\sum_{l=1}^{K} a_{kl}}, \ \sum_{i=1}^{K} w_i = 1, w_i \in [0,1], i = 1,2,...M \quad (9)$$

The fuzzy extent (9) may be obtained by using the extension principle and leads to reduced uncertainty.

Step 4. „Evaluating Sub-criteria. For the given criterion C_j, which splits into k_j sub-criteria, it is necessary to determine the relative importance of the sub-criteria for this criterion. After that the fuzzy judgment matrix can be determined as (10)“ [9]:

$$A_j = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1k_j} \\ a_{21} & a_{22} & \dots & a_{2k_j} \\ \dots & \dots & \dots & \dots \\ a_{k_j1} & a_{k_j2} & \dots & a_{k_jk_j} \end{bmatrix} \quad (10)$$

„Final sub-criteria weights are derived through the aggregation of the weights at two consecutive levels“ [10].

$$w_j^p = \left(\frac{\sum_{l=1}^{k_j} a_{il}}{\sum_{i=1}^{k_j} \sum_{l=1}^{k_j} a_{il}} \right) \cdot w_j, \ j = 1,2,...M; \ p = 1,2,...,k_j \quad (11)$$

Aggregated fuzzy weights of sub-criteria w_j^p (11) are obtained after multiplying criterion weight (9) by sub-criteria weights..

$$W = \left(w_1^1, w_1^2, ..., w_1^{k1}, w_2^1, w_2^2, ..., w_2^{k2}, ..., w_j^1, w_j^2, ..., w_j^{kj}, ..., w_M^1, w_M^2, ..., w_M^{kM} \right) \quad (12)$$

Step 5. „Evaluating alternatives. The provided N alternatives are pairwise compared to each of the K sub-criteria. After obtaining *K* fuzzy judgment matrices of type (12), the fuzzy extent (13) produces the decision matrix (15)“[9].

$$W_k = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1N} \\ a_{21} & a_{22} & \dots & a_{2N} \\ \dots & \dots & \dots & \dots \\ a_{N1} & a_{N2} & \dots & a_{NN} \end{bmatrix}, \quad k = 1,2,...,K \quad (13)$$

$$x_{ij} = \frac{\sum_{k=1}^{K} a_{ik}}{\sum_{l=1}^{N} \sum_{m=1}^{K} a_{lm}}, \quad i = 1,2,...N; \ j = 1,2,...,K \quad (14)$$

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1N} \\ x_{21} & x_{22} & \dots & x_{2N} \\ \dots & \dots & \dots & \dots \\ x_{N1} & x_{N2} & \dots & x_{NN} \end{bmatrix}, \quad k = 1,2,...,K \quad (15)$$

“In the decision matrix *X*, x_{ij} represents the resultant fuzzy performance assessment of the alternative A_i (*i=1,2,..., N*) concerning the *j*th sub-criterion (*j=1,2,...,K*)“ [13] .

Step 6. „Performance matrix. Overall performance of each alternative across all sub-criteria may be represented by the fuzzy performance matrix (16)“ [13].

$$Z = \begin{bmatrix} x_{11}w_1 & x_{12}w_2 & \dots & x_{1N}w_K \\ x_{21}w_1 & x_{22}w_2 & \dots & x_{2N}w_K \\ \dots & \dots & \dots & \dots \\ x_{N1}w_1 & x_{N2}w_2 & \dots & x_{NN}w_K \end{bmatrix} \quad (16)$$

Step 7. Final assessments of alternative performance weights, for the overall goal are calculated by the sum of elements in the rows in matrix (15), after that we obtain relation (17).

$$F_i = \sum_{j=1}^{K} x_{ij} w_j, \quad i = 1,2,...,N \quad (17)$$

To rank the alternatives, it is necessary to apply the method of ranking fuzzy triangular numbers, for the A = (a_1, a_2, a_3), the integral value is as shown in (18) [11]:

$$I_T^\lambda(A) = \left[\lambda a_3 + a_2 + (1-\lambda) a_1 \right] \cdot 2^{-1}, \quad \lambda \in [0,1] \quad (18)$$

λ - ratio of the decision-maker towards risk. „A larger value of λ indicates a higher degree of optimism, values 0, 0.5 and 1 are used respectively to represent the pessimistic, moderate and optimistic views of the decision-maker“ [10].

When we adopt a certain level λ we got the final ranking of alternatives, applying equation (19) on fuzzy numbers equation (17), and regarding to values we were obtained the rank of alternatives for $I_T^\lambda(F)$, *i=1,2,...,N* and the best alternative as [9]:

$$f_{F_i} = \max\left(f_{F_i}\right), \ i = 1,2,...,A \quad (19)$$

III. Application of FA' WOT Model in the Organisational Design of the Cybersecurity Management Bodies

Organizational design has become an important factor in the business success of a modern enterprise. Moreover, organizational design takes the place of a strategically important resource of modern enterprises and is justifiably positioned in front of raw materials, energy, equipment, technology, and people because, by its effect, all these resources are integrated and put into service. realization of the goals of a given company.

In order to support the strategic goals and direct the employees towards their realization, the managers must choose the appropriate design of the organization, the purpose of which is to harmonize the functioning of the whole organization with the purpose of its existence as much as possible, with the strategy is the goal and the design "the means for the realization of the goal".

Different strategies require different organizational ability and designs of the organization of a cybersecurity support management system influences on quality of the system operation. The enterprise should recognize the cybersecurity as their priority i operating, and to protect enterprise critical infrastructure, from network attacks, vulnerable web services, and inadvertent security lapses.

„No organisational system within the cybersecurity support can operate independently of its management subsystem responsible for issuing commands for the desired "behavior" of the system, while the actual behaviour can deviate from the desired" [10]. "SWOT analysis is used to manage the total organisation, the overall pattern of structural components and arrangement" [9]. Through the analysis of the internal and external factors, which affect organisational changes and organisational structuring, four different types of cybersecurity organisations in enterprises were obtained. Applying modified AHP method, evaluation of the suggested types was performed, and the most affordable option of the organisational structure was chosen. The decision hierarchy of FA'WOT model is determined with:

1. Purpose: the best alternative to be identified
2. Criteria: (Level 1), sub-criteria (Level 2):

S. Strengths

S_1: Simple structure
S_2: The minimum number of hierarchical levels
S_3: Functional grouping of working processes
S_4: Quick transfer of information
S_5: Avoidance of resources duplication within functions of the cybersecurity support
S_6: Simple coordination within the cybersecurity support functioning
S_7: Possibility of preferment in a career (career development)
S_8: The ability to track personnel development and motivation
S_9: Low probability of dismissal

W. Weaknesses

W_1: Low specialisation toward work processes
W_2: Need for better coordination between the cybersecurity support functions
W_3: Poor communication between the cybersecurity support functions
W_4: Danger of conflict in defining priorities
W_5: Focusing on section (departmental) problems
W_6: Difficult co-ordination between the cybersecurity support functions when making plans
W_7: Development of managers (executives) specialised in specific areas
W_8: Close monitoring of organisational goals
W_9: The risk of accumulation of decisions at the top of the hierarchy

O. Opportunities

O_1: Effective in a stable environment
O_2: Strong management team
O_3: Training of existing and introduction of new personnel in the administrative structure of the cybersecurity support
O_4: Capability for organisation of management processes cybersecurity bodies
O_5: Introduction of up-to-date informational technology into the process of the cybersecurity support management
O_6: Automated managing of cybersecurity support processes

T. Treats

T_1: Slow adaptation to changes in the environment
T_2: Weak innovative capabilities
T_3: Changing of positions of the expert personnel by the cybersecurity support functions
T_4: Introduction of "outsourcing" technology in some of the functions of cybersecurity support
T_5: Requirements for rapid adaptation and response to social changes

3. Types of the organisational structure of administrative bodies (Level 3):

Alternative 1. Represents an existing organisation of cybersecurity management bodies in an enterprise.

Alternative 2. Represents a modification of the existing organisation of cybersecurity management bodies in an enterprise. Application of the cybersecurity approach and cybersecurity organization upon a functional principle is the basis for the development of II type, based on the inward partition of work, specialization, and separation of organizational parts and bearers of management. Grouping of individual functions, processes and activities was done by the following principles: the executive principle (grouping of individual processes executive personnel into a single function, which creates a functional organisation), the property principle (grouping according to proprietors for whom a job is performed or who perform the functions, processes and activities), the rank principle (grouping according to priority and executive level), according to the phases (grouping according to phases of planning, implementation and control), by purpose principle (grouping according to organising administrative processes feasibility and functions of a particular business in certain organisational units). Functional structure model is based on the functional division of labour. It is oriented towards the labour process and also based on functional groupings of units and the optimisation of employee numbers.

Alternative 3. Represents the organisation of administrative bodies upon cybersecurity processes. The governing process (management) within an organisation consists of five basic sub-processes or phases: planning, organising, leadership, personnel management, and controlling. All stages are interrelated and interdependent and make a continuous process of managing cybersecurity support. These stages or organisational units are attached, connected and interrelated. After the process of planning, the process of organisation continues, associated with the previous one by direct channels and direct feedback. The advantage of such type of organising in support of administrative authority is the fact that specialised personnel is grouped by the same process or governing stage and they are oriented towards the realisation of the process. The disadvantage is reflected in the requirement for better coordination of the entire work, preventing problems in one process causing problems in the whole business.

Alternative 4. Represents the organisation of the administrative organs of cybersecurity by processes and by functions. In this type of the organisational structure, positive sides of functional organisation and organisations designed upon managing processes are taken into consideration.

Using the fuzzified scale in Table 1 [7-10], we made the pairwise compared to a goal to determine the relative importance of the evaluation criteria of SWOT. For the generation of a judgment matrix A, we used linguistically expressions, as shown in (8).

$$A_{SWOT} = \begin{array}{c} \\ S \\ W \\ O \\ T \end{array} \begin{array}{c} \begin{array}{cccc} S & W & O & T \end{array} \\ \begin{bmatrix} \tilde{1} & \tilde{3} & \tilde{3} & \tilde{2} \\ \tilde{3}^{-1} & \tilde{1} & \tilde{2} & \tilde{2} \\ \tilde{3}^{-1} & \tilde{2}^{-1} & \tilde{1} & \tilde{6} \\ \tilde{2}^{-1} & \tilde{2}^{-1} & \tilde{6}^{-1} & \tilde{1} \end{bmatrix} \end{array} \Rightarrow W_{c_2} =$$

$$\begin{bmatrix} W_s \\ W_w \\ W_o \\ W_T \end{bmatrix} = \begin{bmatrix} (0.259, 0.370, 0.481) \\ (0.076, 0.096, 0.125) \\ (0.268, 0.384, 0.499) \\ (0.105, 0.151, 0.196) \end{bmatrix}$$

Using relation (9), the *w* weight vector for the above criterion matrix is determined. When we divide the sum of the elements of a column by the number of elements of that column of the matrix A_{SWOT}, we obtain the *W* weight vector as shown:

$$W_{SWOT} = \begin{bmatrix} W_s \\ W_w \\ W_o \\ W_T \end{bmatrix} = \begin{bmatrix} (0.140, 0.200, 0.259) \\ (0.067, 0.096, 0.125) \\ (0.268, 0.384, 0.499) \\ (0.105, 0.151, 0.196) \end{bmatrix}$$

The Fuzzy decision matrix (10) was obtained using a fuzzy pairwise comparison for the sub-criteria associated with the corresponding criteria. Corresponding weights of criteria were calculated using relation (9):.

$$W_s = \frac{\tilde{1}+\tilde{3}+\tilde{3}+\tilde{2}}{\tilde{1}+\tilde{3}+\tilde{3}+\tilde{2}+\tilde{3}^{-1}+\tilde{1}+\tilde{2}^{-1}+\tilde{2}^{-1}+\tilde{3}^{-1}+\tilde{2}+\tilde{1}+\tilde{6}+\tilde{2}^{-1}+\tilde{2}+\tilde{6}^{-1}+\tilde{1}} = (0.259, 0.370, 0.481)$$

$$W_S = \begin{bmatrix} W_{s_1} \\ W_{s_2} \\ W_{s_3} \\ W_{s_4} \\ W_{s_5} \\ W_{s_6} \\ W_{s_7} \\ W_{s_8} \\ W_{s_9} \end{bmatrix} = \begin{bmatrix} (0.110, 0.157, 0.204) \\ (0.041, 0.059, 0.077) \\ (0.016, 0.023, 0.030) \\ (0.120, 0.171, 0.222) \\ (0.063, 0.090, 0.117) \\ (0.076, 0.108, 0.141) \\ (0.060, 0.085, 0.111) \\ (0.093, 0.133, 0.173) \\ (0.121, 0.173, 0.225) \end{bmatrix}$$

$$W_w = \begin{bmatrix} W_{w_1} \\ W_{w_2} \\ W_{w_3} \\ W_{w_4} \\ W_{w_5} \\ W_{w_6} \\ W_{w_7} \\ W_{w_8} \\ W_{w_9} \end{bmatrix} = \begin{bmatrix} (0.177, 0.252, 0.328) \\ (0.074, 0.106, 0.138) \\ (0.046, 0.065, 0.085) \\ (0.106, 0.151, 0.195) \\ (0.030, 0.043, 0.056) \\ (0.062, 0.088, 0.115) \\ (0.103, 0.147, 0.191) \\ (0.024, 0.034, 0.044) \\ (0.080, 0.144, 0.148) \end{bmatrix}$$

$$W_o = \begin{bmatrix} W_{o_1} \\ W_{o_2} \\ W_{o_3} \\ W_{o_4} \\ W_{o_5} \\ W_{o_6} \end{bmatrix} = \begin{bmatrix} (0.230, 0.328, 0.427) \\ (0.251, 0.359, 0.467) \\ (0.095, 0.135, 0.176) \\ (0.024, 0.034, 0.044) \\ (0.039, 0.055, 0.072) \\ (0.062, 0.088, 0.115) \end{bmatrix}$$

$$W_T = \begin{bmatrix} W_{T_1} \\ W_{T_2} \\ W_{T_3} \\ W_{T_4} \\ W_{T_5} \end{bmatrix} = \begin{bmatrix} (0.140, 0.200, 0.259) \\ (0.071, 0.101, 0.131) \\ (0.357, 0.510, 0.664) \\ (0.026, 0.038, 0.049) \\ (0.106, 0.151, 0.197) \end{bmatrix}$$

Using relation (11), the aggregate weights of the sub-criteria were obtained, related to the goal. The

$$W'_S = W_{s_i} \cdot W_s = \begin{bmatrix} W_s \cdot W_{s_1} \\ W_s \cdot W_{s_2} \\ W_s \cdot W_{s_3} \\ W_s \cdot W_{s_4} \\ W_s \cdot W_{s_5} \\ W_s \cdot W_{s_6} \\ W_s \cdot W_{s_7} \\ W_s \cdot W_{s_8} \\ W_s \cdot W_{s_9} \end{bmatrix} =$$

$$\begin{bmatrix} (0.140, 0.200, 0.259) \cdot (0.110, 0.157, 0.204) \\ (0.140, 0.200, 0.259) \cdot (0.041, 0.059, 0.077) \\ (0.140, 0.200, 0.259) \cdot (0.016, 0.023, 0.030) \\ (0.140, 0.200, 0.259) \cdot (0.120, 0.171, 0.222) \\ (0.140, 0.200, 0.259) \cdot (0.063, 0.090, 0.117) \\ (0.140, 0.200, 0.259) \cdot (0.076, 0.108, 0.141) \\ (0.140, 0.200, 0.259) \cdot (0.060, 0.085, 0.111) \\ (0.140, 0.200, 0.259) \cdot (0.093, 0.133, 0.173) \\ (0.140, 0.200, 0.259) \cdot (0.121, 0.173, 0.225) \end{bmatrix}$$

Subcriteria weights were obtained by fuzzy multiplication of subcriteria with weight vectors and criterion vectors. Example is showen:

TABLE II. RANK OF ALTERNATIVES

	Index of optimism			
Decision alternative	***λ=0.0 (pessimistic)***	***λ=0.5 (moderate)***	***λ=1.0 (optimistic)***	***rank***
A1	0.206	0.214	0.222	4
A2	0.287	0.298	0.309	1
A3	0.214	0.223	0.235	3
A4	0.241	0.250	0.261	2

Based on the relations (13), (14) and (15), an assessment of the alternatives was made. On the basis of equation (17), the weight values of the alternatives, which refer to the overall goal, were calculated and are shown in the following expression.

$$V = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} (0.20, 0.21, 0.23) \\ (0.28, 0.29, 0.32) \\ (0.20, 0.22, 0.24) \\ (0.22, 0.26, 0.27) \end{bmatrix}$$

The ranking of alternatives is obtained by applying equation (18) based on the value of λ (ratio of the decision-maker to risk). Table 2 shows, based on normalized values, that Alternative 2 is the best, followed by A4, A3 and A1, without considering the level of optimism of the decision-maker.

To defuzzify the *V* values we used the centre of gravity method, after normalisation weights of alternatives were: 0.214 (A 1), 0.299 (A2), 0.224 (A3 3) and 0.251 (A4). The final rank is shown in Table 2.

IV. Discussion and conclusion

The organization with its employees is not a sum of mechanical parts, rather a "human being" with a purpose and missionWhen we want to design an organizational structure, it is necessary to define the goals and criteria of the design, as well as to analyze the situation in the organization.

Today's environment is highly dynamic and complex, and with the enterprise's ability to understand the environment in which it operates, determines its competitive advantage. In this sense, organizational design is a tool that managers use to organize a business to cope with the uncertainty of the environment. Therefore, there is also a degree of inaccuracy and uncertainty about the criteria we use in the organization design process. Quantifying of these criteria and selecting the best alternative from the organization's proposed models, enables the fuzzy multi-criteria approach designed and proposed in this paper. With the development and application of mathematical solutions, organizational design has become an important and current issue in the theory and practice of management and organization in the field of cybersecurity. Not considering the number of criteria and sub-criteria, the model we proposed, allows for the evaluation of multiple organizational structure options. The proposed model makes it possible to select the best alternative using the optimal number of K criteria and sub-criteria.

The goal of organizational design, is to enable efficient use of resources, control of activities, coordination and flexibility in a complex environment. Consequently, improvisation of the organizational structure is unacceptable, rather requires a governing bodies have a planed and methodological organizational approach.

The example of such an approach in designing the organizational structure of the management cybersecurity bodes, is shown through the application of our model.

References

[1] L. Hong-li, and Z. Ying-ju, "Measuring Effectiveness of Information Security Management", International Symposium on Computer Network and Multimedia Technology, 2009.

[2] K. M.. Carley, "Computational and mathematical organisation theory: perspective and directions", Computational and mathematical organisation theory, 1(1),1995 pp 39-56

[3] M. Kujacić, and N. Bojović, "Organisational design of post corporation structure using fuzzy multicriteria decision making". Computational and mathematical organisation theory, 9, 2003, p. 5-18.

[4] D. Pamučar, and B. Djorović, "Fuzzy logic applied to organisational design of the administrative management", Metalurgia International, 17 (5), 2012 pp. 87-96.

[5] B. Djorovic, and D. Pamučar, Projektovanje organisaconih struktura: metode i modeli, Medija centar „Odbrana", Beograd 2016., p. 133-219

[6] L. A. Zadeh, , "Fuzzy sets", Inf control 8, 1965 p.338-353.

[7] D. Božanić, S. Karović, and D. Pamučar, "Fazifikacija Saaty-jeve skale primenom trouglastog fuzzy broja sa promenljivim intervalom poverenja", Zbornik radova, SYM-OP-IS, ISBN 978-86-80593-55-5, 2015p. 420-424.

[8] D. Bojanić, M. Kovač, M. Bojanic, and V. Ristic, "Multi-criteria decision-making in a defensive operation of the guided anti-tank missile battery: An example of the hybrid model fuzzy AHP – MABAC". Decision Making: Applications in Management and Engineering, 1(1), Vol. 1, Number 1, 2018, ISSN: 2560-6018 p.51-66.

[9] D. Pamučar., G. Ćirović., and D. Sekulović, "Development of an integrated transport system in distribution centres: a FA'WOT analysis", Tehnički vjesnik, 22(3), p.649-658. doi: https://doi.org/10.17559/TV-20140205170207

[10] D. Pamučar, G. Ćirović, D. Sekulović, and A. Ilić, "A new fuzzy mathematical model for multi-criteria decision making: An application of fuzzy mathematical model in a SWOT analysis" Scientific Research and Essays, 2011, 6(25), 5374-5386.

[11] B. Djorovic., D. Pamucar, and N. Dimitrijević, "Application of fuzzy logic and fuzzy sets for quantification of input and output parameters in DEA analysis", Metalurgia International, 17 (5) 2012 p. 78-86.

[12] A. Hyatt, N. Contractor & P. Jones, (1997). Computational organizational network modeling: Strategies and an example. Computational and mathematical organization theory, 3(4), 285-300.

[13] Shalini Kanuganti, Ruchika Agarwala, Bhupali Dutta, Pooja N. Bhanegaonkar, Ajit Pratap Singh, A.K. Sarkar. "Road safety analysis using multi criteria approach: A case study in India", Transportation Research Procedia, 2017.

[14] Božanić, D., Pamučar, Д., Bojanić, D., Modification of the analytic herarchy processes (AHP) method using fuzzy AHP approach as a support to the decision making process concerning engagement of the group for additional hindering, Serbian Jurnal of Management Volume 10 number (2) 2015 ISSN 1452- 4864 p. 150-173.