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AN APPROACH TO PERSONNEL SELECTION IN THE IT INDUSTRY BASED ON THE EDAS METHOD

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ABSTRACT**: **The evaluation of personnel in the process of recruitment and selection represents a problem that can be solved by applying multiple-criteria decision-making (MCDM) methods. The selection of quality personnel and, above all, the competent and motivated employees who can resist all the business challenges of today, poses a problem which is seriously approached by every organization, because the development of an organization depends on the employees who work there, i.e. on their competencies, motivation and commitment. Therefore, one approach based on the EDAS method is proposed in this manuscript. The SWARA method is utilized in order to determine the weights of the criteria, whereas the newly-proposed EDAS method is used to determine the ranking of the alternatives, i.e. candidates in our case. The usability and effectiveness of the proposed EDAS approach is considered in the conducted empirical application of the proposed model for the selection of IT Business Systems Support (BSS) Experts.

KEYWORDS: EDAS; IT industry; personnel selection; MCDM.

JEL classification: D81, C61, O15, M51.

Introduction

Human Resource Management (HRM) in an organization plays an important role (Martell, Carroll, 1995). HRM as a scientific discipline and a function of practical management is referred to all the activities that have an impact on the increase of the efficiency and effectiveness of work, directing employees towards achieving their organizational goals (Brewster, Mayrhofer, 2015; Huselid *et al*., 1997).

Hirt, Ortlieb (2012) emphasize that HRM in an organization becomes an essential strategic component in achieving competitiveness. In today's global business, an organization's competitive advantage can only be built on a single resource – its employees. Therefore, Sheehan (2005) points out that companies in today's business environment are

increasingly investing their resources in human resources, because they have recognized that investment in people can lead the organization to a competitive advantage.

Employees in an organization, with their talents, skills, knowledge, i.e. competences and motivation, are becoming the key resource that determines the success of an organization nowadays.

Streimikiene, Grundey (2009) highlight the importance and relevance of personnel selection for both, organisation and person searching for a job. They also state that the main task of an organisation is to find an employee that will not only perfectly work but also feel self-satisfaction at work. Therefore, considering the importance of human resources in an organization, it could be said that the process of the recruitment and selection of personnel represents a very important HRM activity. Recruitment is the process of attracting qualified candidates in a number that allows an organization to choose the best in order to fill vacant positions; selection is the process of the final selection of the candidates from the previously created pool of applicants (Cook, 2016; Urošević, Sajfert, 2012; Bogićević Milikić, 2006). Also, during the process of recruitment and selection, various methods and techniques can be used in order to predict the candidates' success in a future workplace. Some of these methods are: intelligence tests, psychometric tests, cognitive tests, personality tests, structured interviews, competence centres (Miller, Gordon, 2014; Kruyen *et al*., 2012; Morgeson *et al*., 2007; Robertson, Smith, 2001; Kline, 1999).

In the real world, often in decision making, the decision maker (DM) is guided by his or her own experience and intuition. Multiple-criteria decision making significantly reduces the possibility of subjectivity and intuition in the decision-making process. The evaluation and selection of personnel in the process of recruitment and selection are a problem that can be solved by applying multiple-criteria decision-making methods.

MCDM represents the process of the selection of one alternative from within a set of available alternatives or, in some cases, the ranking of alternatives based on a predefined set of the criteria that usually have a different significance (Stanujkic *et al*., 2013). Xu and Yang (2001) emphasize the fact that MCDM is decision making in the presence of multiple, often conflicting, alternatives. In general, it is important to distinguish two characteristic types of MCDM problems. The one type is characterized by a finite number of alternative solutions, and the other one by an infinite number of solutions.

Therefore, this manuscript is aimed at applying a new EDAS (Evaluation based on Distance from Average Solution) method to the problem of personnel selection. The SWARA method proposed by Keršulienė *et al*. (2010) is utilized for the purpose of determining the weights and the EDAS method is utilized for the purpose of ranking the alternatives. The remaining part of the manuscript is organized in the following way: the first part presents the Introduction. The second part presents the theoretical background, whereas in the third part, the EDAS method is presented. The fourth part presents the empirical application of the EDAS method to personnel selection. Finally, the fifth part presents the Conclusion.

1. The Theoretical Background

Multiple-Criteria Decision-Making is one of the most important subfields of management science that is often used for solving a range of different managerial problems. MCDM is rapidly evolving, which reflects through the proposed numerous methods, such as: SAW or the WS (Churchman, Ackoff, 1954; Fishburn, 1967), TODIM (Kahneman, Tversky,

1979), AHP (Saaty, 1980), TOPSIS (Hwang, Yoon, 1981), PROMETHEE (Brans, Vincke, 1985), ELECTRE (Roy, 1991), COPRAS (Zavadskas *et al*., 1994), VIKOR (Opricovic, 1998) etc. Because MCDM is faced with demand for modernization, the new generation of MCDM methods that enable us to find more adequate solutions are developed, such as for example: ARAS (Zavadskas, Turskis, 2010), MULTIMOORA (Brauers, Zavadskas, 2010), SWARA (Keršulienė *et al*., 2010), WASPAS (Zavadskas *et al*., 2012), KEMIRA (Krylovas *et al*., 2014), EDAS (Ghorabaee *et al*., 2015) etc. In order to obtain the most adequate results by using a certain method, appropriate extensions are proposed, which include applying fuzzy, intuitionistic fuzzy or grey numbers. A comprehensive overview of these methods, their applications and extensions are given by: Zavadskas and Turskis (2011), Zavadskas *et al*. (2014), Mardani *et al*. (2015), Wang and Wang (2015), Kahraman *et al*. (2015, 2016) and Afful-Dadzie *et al*. (2016).

The problem of personnel selection is very often subject to MCDM methods. Polychroniou and Giannikos (2009) have proposed a fuzzy MCDM methodology for human resources selection in Greek private bank. Kelemenis and Askounis (2010) proposed the personnel selection based on fuzzy TOPSIS incorporating the veto threshold, while Boran *et al*. (2011) used the TOPSIS method extended to the intuitionistic fuzzy environment. In their manuscript, Kabak *et al*. (2012) used the fuzzy hybrid MCDM approach that includes: Fuzzy ANP, Fuzzy TOPSIS and Fuzzy ELECTRE techniques in order to choose the most appropriate personnel. The selection of the right individual among candidates stands for a decision-making problem associated with uncertainties, ambiguities and vagueness, and therefore Baležentis *et al*. (2012) proposed the fuzzy MULTIMOORA method, based on group decision making. Since there may be dependence between criteria, Afshari *et al*. (2013) suggested a new model for personnel selection inclusive of the linguistic extension of the fuzzy measure and the fuzzy integral. Because the selection of academic personnel bears strategic importance and represents the multiple-criteria decision-making process, Rouyendegh and Erkan (2013) applied the fuzzy ELECTRE method. Keršulienė and Turskis (2014) used the fuzzy ARAS and the AHP methods in order to find the most appropriate chief accountant. In the manuscript by Kryvolas *et al*. (2014), the new KEMIRA method is used for the selection of security personnel. Decision makers often use different linguistic terms to evaluate candidates, for which reason Liu *et al*. (2015) used a combination of the VIKOR method and the interval 2-tuple linguistic variables for choosing the best individuals. Sang *et al*. (2015) proposed an analytical solution to fuzzy TOPSIS and applied it to solving the personnel selection problem. Karabasevic *et al*. (2015) used a combination of the SWARA and the MULTIMOORA methods for the selection of candidates in the mining industry, also Karabasevic *et al*. (2016) gave a framework for personnel selection based on the SWARA and the ARAS methods under uncertainties, whereas Ji *et al*. (2016) proposed the application of the projection-based TODIM method under multi-valued neutrosophic environments.

The MCDM method called EDAS (Evaluation based on Distance from Average Solution) is a new decision-making method proposed by Ghorabaee *et al*. (2015) and its applicability is demonstrated by solving multi-criteria inventory classification (MCIC) problems. Ghorabaee *et al*. (2016) developed an extension of the EDAS method in order to enable the solving of decision-making problems in a fuzzy environment and applied it for supplier selection. Stanujkic *et al*. (2017) developed an extension of the EDAS method adapted for the use of grey numbers. Therefore, in this manuscript, the EDAS method will be used for personnel selection in the IT industry.

2. The EDAS Method

As previously mentioned, EDAS is introduced by Ghorabaee *et al*. (2015). Therefore, it can be stated as a newly-proposed method.

The basic ideas of the EDAS method are the use of two distance measures, namely the Positive Distance from Average (PDA) and the Negative Distance from Average (NDA); and that the evaluation of alternatives is done according to the higher values of the PDA and the lower values of the NDA.

The computational procedure of the EDAS method for a decision-making problem with the m criteria and the n alternatives can precisely be presented as follows[1] (Stanujkic *et al*., 2017):

Step 1. Select the available alternatives, the most important criteria that describe the alternatives, and construct the decision-making matrix X, shown as follows:

$$X = [x_{ij}]_{mxn}, \tag{1}$$

where x_{ij} denotes the performance rating of the alternative i on the criterion j, m denotes the number of the alternatives and n denotes the number of the evaluation criteria.

Step 2. Determine the average solution according to all the criteria, as follows:

$$x_j^* = (x_1, x_2, \cdots, x_n), \tag{2}$$

where

$$x_j^* = \frac{\sum_{i=1}^{m} x_{ij}}{m}. \tag{3}$$

Step 3. Calculate the positive distance from the average d_{ij}^+ and the negative distance from the average d_{ij}^-, according to the type of the criteria (a benefit and a cost), as follows:

$$d_{ij}^+ = \begin{cases} \dfrac{\max(0,(x_{ij} - x_j^*))}{x_j^*}; & j \in \Omega_{\max} \\ \dfrac{\max(0,(x_j^* - x_{ij}))}{x_j^*}; & j \in \Omega_{\min} \end{cases}, \tag{4}$$

$$d_{ij}^- = \begin{cases} \dfrac{\max(0,(x_j^* - x_{ij}))}{x_j^*}; & j \in \Omega_{\max} \\ \dfrac{\max(0,(x_{ij} - x_j^*))}{x_j^*}; & j \in \Omega_{\min} \end{cases}, \tag{5}$$

where $\Omega_{\max}$ and $\Omega_{\min}$ denote the set of the benefit criteria and the cost criteria, respectively.

Step 4. Determine the weighted sum of the PDA, i.e. Q_i^+, and the weighted sum of the NDA, i.e. Q_i^-, for all the alternatives, as follows:

$$Q_i^+ = \sum_{j=1}^{n} w_j d_{ij}^+, \tag{6}$$

[1] Some labels used in the original EDAS method have been modified in this approach.

$$Q_i^- = \sum_{j=1}^{n} w_j d_{ij}^- . \quad (7)$$

Step 5. Normalize the values of the weighted sum of the PDA and the weighted sum of the NDA for all the alternatives, shown as follows:

$$S_i^+ = \frac{Q_i^+}{\max\limits_i Q_i^+}, \quad (8)$$

$$S_i^- = 1 - \frac{Q_i^-}{\max\limits_i Q_i^-}, \quad (9)$$

where S_i^+ and S_i^- denote the normalized weighted sum of the PDA and the NDA, respectively.

Step 6. Calculate the appraisal score S_i for all the alternatives, as follows:

$$S_i = \frac{1}{2}(S_i^+ + S_i^-) . \quad (10)$$

Step 7. Rank the alternatives according to the decreasing values of the appraisal score. The alternative with the highest S_i is the best choice among the candidate alternatives.

3. An Empirical Application of the EDAS Method to Personnel Selection

In this section, an empirical application is conducted in order to show the applicability of the proposed approach.

A local IT company is looking for two IT Business System Support Experts. In the vacancy announcement for the position of IT BSS experts, the total of 33 candidates have applied; out of the 33 of such candidates, only six candidates have been selected into the further selection process. In the process of deciding on the candidates, three decision makers participate. In the process of decision making, the decision makers use the SWARA method in order to determine the weight of the criteria and the EDAS method in order to select the alternatives, i.e. in our case – the candidates. On the basis of the vacancy announcement and the job analysis carried out, the IT BSS experts shall have the following responsibilities: the responsibility for the proper functioning of the business systems work, in terms of the availability, accessibility and performance of the data.; conducting an adequate and comprehensive analysis of the business system in the organization, and accordingly he or she is expected to provide appropriate solutions and plans; participating in the development of the recommendations for and the methodology of the BSS and the services; designing, implementing and testing new services and business solutions and maintaining the business systems.

On the basis of the positions and the job requirements, a set of the competencies with respect to which the evaluations of the candidates will be done is created, namely: Interview preparedness, designated as C_1; Education in IT/Technical area – C_2; Relevant work experience – C_3; Special skills and knowledge of Relational Database Management System RDBMS (SQL, Oracle, Java) – C_4; Foreign languages – C_5; Interpersonal skills –C_6 and Communication and presentation skills – C_7.

The application of the proposed approach in terms of personnel selection, i.e. the IT BSS experts, can be accounted for through the following steps:

Step 1. Forming the initial decision-making matrix. The selected criteria, the criteria weights and the optimization directions based on the responses of the three DMs are presented in *Table 1*, *Table 2* and *Table 3*.

Table 1. The initial decision-making decision matrix based on the responses from the first of the three DMs

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Optimization	*max*	*max*	*max*	*max*	*max*	*max*	*max*
w_i	0.31	0.21	0.17	0.13	0.09	0.06	0.03
Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	5	4	3	4	4	5	3
A_2	3	4	5	4	3	3	4
A_3	4	3	2	3	2	3	4
A_4	3	3	3	4	4	3	4
A_5	4	3	3	4	4	4	3
A_6	5	4	4	5	5	5	4
Average	4.00	3.50	3.33	4.00	3.67	3.83	3.67

Source: own calculations.

Table 2. The initial decision-making decision matrix based on the responses from the second of the three DMs

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Optimization	*max*	*max*	*max*	*max*	*max*	*max*	*max*
w_i	0.29	0.22	0.16	0.11	0.09	0.07	0.05
Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	5	5	5	4	5	4	5
A_2	4	5	4	3	4	3	3
A_3	3	3	4	3	3	3	3
A_4	4	3	3	4	3	3	3
A_5	4	4	5	4	4	4	4
A_6	5	4	5	4	4	5	4
Average	4.17	4.00	4.33	3.67	3.83	3.67	3.67

Source: own calculations.

Table 3. The initial decision-making decision matrix based on the responses from the third of the three DMs

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Optimization	*max*	*max*	*max*	*max*	*max*	*max*	*max*
w_i	0.26	0.21	0.18	0.14	0.10	0.08	0.04
Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	5	4	5	4	5	5	4
A_2	4	4	4	3	4	3	3
A_3	3	3	4	4	3	4	4
A_4	3	3	4	4	4	3	3
A_5	4	4	4	4	4	3	3
A_6	5	5	5	4	5	4	4
Average	4.00	3.83	4.33	3.83	4.17	3.67	3.50

Source: own calculations.

Step 2. Calculate the PDA and the NDA. In this step, in order to demonstrate the procedure, only the data from the first DM are shown. The PDA and the NDA obtained by

using Eqs (4) to (5), on the basis of the responses obtained from the first DM, are given in *Table 4* and *Table 5*.

Table 4. The positive distance from the average based on the responses from the first DM

Criteria / Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.25	0.14	0.00	0.00	0.09	0.30	0.00
A_2	0.00	0.14	0.50	0.00	0.00	0.00	0.09
A_3	0.00	0.00	0.00	0.00	0.00	0.00	0.09
A_4	0.00	0.00	0.00	0.00	0.09	0.00	0.09
A_5	0.00	0.00	0.00	0.00	0.09	0.04	0.00
A_6	0.25	0.14	0.20	0.25	0.36	0.30	0.09

Source: own calculations.

Table 5. The negative distance from the average based on the responses from the first DM

Criteria / Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.00	0.00	0.10	0.00	0.00	0.00	0.18
A_2	0.25	0.00	0.00	0.00	0.18	0.22	0.00
A_3	0.00	0.14	0.40	0.25	0.45	0.22	0.00
A_4	0.25	0.14	0.10	0.00	0.00	0.22	0.00
A_5	0.00	0.14	0.10	0.00	0.00	0.00	0.18
A_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: own calculations.

Step 3. Calculate the weighted PDA, NDA and the appraisal score. The weighted sums of the PDA and the NDA for the considered alternatives, obtained on the basis of the data from *Table 4* and *Table 5* by using Eqs (6) and (7) are presented in *Table 6*. The normalized weighted sum of the PDA and the weighted sum of the NDA obtained by using Eqs (8) and (9) are also presented in *Table 6*. Also, the appraisal scores S_i of the considered alternatives obtained by using Eq. (10) as well as the ranking order of the considered alternatives are also given in *Table 6*.

Table 6. The weighted and the normalized weighted sums of the PDA and the NDA based on the responses obtained from the first of the three DMs

Alternatives	Q_i^+	Q_i^-	S_i^+	S_i^-	S_i	*Rank*
A_1	0.13	0.02	0.58	0.88	0.73	2
A_2	0.12	0.11	0.52	0.43	0.47	3
A_3	0.00	0.19	0.01	0.00	0.01	6
A_4	0.01	0.14	0.05	0.27	0.16	5
A_5	0.01	0.05	0.05	0.72	0.38	4
A_6	0.23	0.00	1.00	1.00	1.00	1

Source: own calculations.

The weighted and normalized sums of the PDA and the NDA, as well as the appraisal scores of the considered alternatives and the ranking order of the considered alternatives obtained on the basis of the responses received from the second and the third DMs are shown in *Table 7* and *Table 8*.

Table 7. The weighted and the normalized weighted sums of the PDA and the NDA based on the responses obtained from the second of the three DMs

Alternatives	Q_i^+	Q_i^-	S_i^+	S_i^-	S_i	*Rank*
A_1	0.20	0.00	1.00	1.00	1.00	1
A_2	0.06	0.07	0.30	0.69	0.49	4
A_3	0.00	0.21	0.00	0.00	0.00	6
A_4	0.01	0.16	0.05	0.25	0.15	5
A_5	0.05	0.01	0.25	0.95	0.60	3
A_6	0.13	0.00	0.64	1.00	0.82	2

Source: own calculations.

Table 8. The weighted and the normalized weighted sums of the PDA and the NDA based on the responses obtained from the third of the three DMs

Alternatives	Q_i^+	Q_i^-	S_i^+	S_i^-	S_i	*Rank*
A_1	0.16	0.00	0.82	1.00	0.91	2
A_2	0.01	0.07	0.05	0.56	0.30	4
A_3	0.02	0.15	0.10	0.00	0.05	5
A_4	0.01	0.15	0.03	0.02	0.03	6
A_5	0.02	0.04	0.08	0.75	0.42	3
A_6	0.19	0.00	1.00	1.00	1.00	1

Source: own calculations.

Step 4. Final rankings. Finally, the appraisal scores of the three DMs are presented in *Table 9*.

Table 9. The appraisal scores and the ranking order of the considered alternatives

Alternatives	DM 1		DM 2		DM 3	
	S_i	Rank	S_i	Rank	S_i	Rank
A_1	0.73	**2**	1.00	**1**	0.91	**2**
A_2	0.47	3	0.49	4	0.30	4
A_3	0.01	6	0.00	6	0.05	5
A_4	0.16	5	0.15	5	0.03	6
A_5	0.38	4	0.60	3	0.42	3
A_6	1.00	**1**	0.82	**2**	1.00	**1**

Source: own calculations.

The final ranking order of the considered candidates, based on the dominance theory (Brauers, Zavadskas, 2010), is shown in *Table 10*.

Table 10. The final ranking order of the considered alternatives

Alternatives	Rank
A_1	**2**
A_2	4
A_3	6
A_4	5
A_5	3
A_6	**1**

Source: own calculations.

Table 10 shows us that the candidates designated as A_1 and A_6 are the best in terms of the evaluated criteria.

Conclusions

Human resources in an organization are one of the main strategic resources of the organization, therefore, the process of personnel selection plays an extremely important role in HRM. The selection of, above all, competent and motivated personnel in a competitive business environment is the basis for achieving and maintaining a competitive advantage and for the success of the organization. Therefore, the evaluation and selection of personnel is one of the most important decisions in each single company. In this manuscript, a new approach based on the EDAS method is proposed for the purpose of personnel selection. The SWARA method is utilized in order to determine the weights, whereas in order to rank the alternatives, i.e. the candidates, the EDAS method is applied. Based on the conducted empirical application of the proposed model, it can be seen that the proposed model is effective, adjustable and easy to use in personnel selection. Also, the proposed model can help decision makers to easily choose the best candidates among others. After the application of the proposed model, it can be seen that the candidates designated as A_6 and A_1 are selected as the best in terms of the evaluated criteria. The flexibility of the model also should be pointed out because the proposed model can easily be modified by adding additional criteria/sub-criteria, depending on the objectives we want to achieve. Proposed approach based on EDAS method also has some limitations, applied method is capable of using only crisp numbers.

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PERSONALO ATRANKOS BŪDAS INFORMACINIŲ TECHNOLOGIJŲ PRAMONĖJE REMIANTIS EDAS METODU

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SANTRAUKA

Personalo vertinimas įdarbinimo procese susiduria su sunkumais, kuriuos galima išspręsti taikant MCDM (daugiakriterius diskrečiuosius sprendimų priėmimo) metodus. Kvalifikuotų darbuotojų atranka ir, svarbiausia, kompetentingi ir motyvuoti darbuotojai, galintys pasipriešinti visiems šiandienos verslo iššūkiams, kelia uždavinį, į kurį rimtai žiūri kiekviena organizacija. Jos plėtra priklauso nuo ten dirbančių darbuotojų, t. y. jų kompetencijų, motyvacijos ir pareigos jausmo. Šiame straipsnyje siūlomas EDAS (vertinimo nutolusio nuo įprasto sprendimo) metodika pagrįstas tyrimo būdas. Siekiant nustatyti kriterijų svorį, anksčiau buvo taikomas SWARA (nuoseklaus, laipsniško porinio rodiklių santykinės svarbos lyginimo) metodas. Naujai siūlomas EDAS metodas buvo pasitelktas nustatyti alternatyvų (kandidatų) reitingą. Šio metodo tinkamumą ir efektyvumą patvirtina empirinis siūlomo IT Verslo paramos sistemos (angl. BSS) ekspertų atrankos modelio pritaikymas.

REIKŠMINIAI ŽODŽIAI: EDAS, IT industrija, personalo atranka, MCDM.