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MULTI-CRITERIA DECISION-MAKING APPROACH IN PERSONNEL SELECTION PROBLEM – A CASE STUDY AT THE UNIVERSITY OF PARDUBICE

Abstract. *Nowadays, the personnel selection problem represents one of the crucial issues of any organization dealing with business activities. By employing the right person in the company, it means a lot for that company. Some of the benefits are increased profit, reduced costs, satisfied clients, a better working environment, relationships among people, etc. This article discusses the personnel selection problem at the University of Pardubice. To select the best possible PhD candidate for this educational institution, multi-criteria decision-making methods are being used. The combination of the two methods is used. The first one is the Entropy method, used to obtain the criteria importance, while the second one is the ARAS method, used to obtain the preferences of the PhD candidates. The results obtained by the proposed methodology are schematically presented and clearly discussed.*

Keywords*: Multi-Criteria Decision-Making, Entropy, ARAS, Entropy-ARAS method, Personnel selection.*

JEL Classification: C02, C46, C65

1. Introduction

The field of Human Resources (HR) represents one of the most important parts of any organization. People working at the HR department constantly deal with decision-making problems. Given the fact that their work responsibility is to deal with people, sometimes it is not so easy for them to make various decisions. Among many different kinds of problems dealt with by the HR department of an organization, the evaluation and selection of the most suitable employee have

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always been a challenge. The potential candidates have been evaluated and compared by many methods according to many criteria. Nowadays, thanks to multi-criteria decision-making methods that have arisen in the scientific literature, there are a bunch of them used to solve the personnel selection problem.

Personnel selection is one of the key activities of each company in every type of business. Business leaders pay increasing attention to the issue of employee selection, especially because of changes in the global labor market. First, there is a change due to sociodemographic development. In the last few years, we can follow the trend of an aging population – the proportion of people over 65 years of age has increased compared to the number of people over the age of 18 (OECD, 2019). As a result, people entering the labor market have a bigger supply of job vacancies. Secondly, it is a change in the context of a greater internationalization of enterprises. In the last few years, it has been a common practice for businesses to employ an increasing number of people with different nationalities (Decieux and Mergener, 2019). This trend results in a change of working environment of medium-sized enterprises, which has a direct impact on the employees (existing or new ones) of the enterprise. The change in the company's environment is not only the result of a greater internationalization of the enterprises. The change in the working environment of the enterprise is also affected by the fact that representatives of up to four generations can currently meet in the company (representatives of Baby boomers, Generation X, Generation Y, and representatives of Generation Z), which has never been seen before, at least not to the extent that it has been in the last few years (Gomez et al., 2019).

It is very important in the process of personnel selection, that the company management, first, defines the competences the new employees must meet. Having in mind the well-defined competences during the process of the selection of employees will lead to the selection of such employees who, by their profile, will be compatible with the working culture of the company in relation to existing employees (Lievesen, Sackett and Zhang, 2020). However, current trends in the process of personnel selection consist of more than one or two defined competences. As the number of expected competences grows, so does the risk of not encompassing all wanted competences in the personnel selection process. This process is implemented by people and people have limited cognitive abilities; their decisions are always associated with greater or lesser degree of subjectivity. The importance of the risk is all the greater when the selected competences have different weights – in this case, the subjectivity in the decision-making process of competent persons is essential (Schroder et al., 2021).

The main goal of this article is to demonstrate the process of using the ENTROPY-ARAS approach to the selection of PhD candidates in the environment of the Faculty of Transport Engineering, University of Pardubice. This specific position has been chosen as an example based on its importance in the long-standing trend of decreasing the number of students in doctoral study programs, thereby jeopardizing the process of natural turnover of academic personnel at the

given faculty in the long term. The article is prepared as an interpretative case study in which an approach of entropy method will be used, specifically the Entropy-ARAS Method in the process of employee selection, which has not currently been implemented in the conditions of the process of selection of PhD Candidates within the framework of the scientific and research work.

The content of the article consists of four parts. In the first part, a literary research is carried out in order to define methods used in the process of selecting employees. This chapter also includes the definition of the main competences, which should be respected in the selection of employees based on the current work of the authors. The second part describes the methodology – the approach using entropy method, specifically the description of the ARAS method. The subsequent part of the article consists of demonstrating the ARAS method in a specific case study, namely the selection of PhD Candidates in the environment of the Faculty of Transport Engineering, University of Pardubice. In the last part, the results are discussed, highlighting limitations of this approach in the selection of the employees.

2. Literature review based on the criteria and methods for the personnel selection problem

This section gives an insight into the criteria used by various authors for the personnel evaluation and selection problem. In recent years, there are many studies conducted in scientific sphere regarding the personnel evaluation and selection problem.

Karabašević et al. (2018) proposed an approach to personnel selection in the IT industry using the EDAS method. To solve the Personnel selection problem, they used seven criteria such as: education in IT/technical area, interview preparedness, relevant work experience, special skills and knowledge, foreign languages, interpersonal skills as well as communication and presentation skills. Kilic et al. (2020) used an integrated decision analysis methodology based on IF-DEMATEL and IF-ELECTRE method. The specific criteria that they took into consideration were education, experience, technical skills, personality and personal skills as well as foreign language. Baležentis et al. (2012) carried out the study on the personnel selection based on computing with words and fuzzy MULTIMOORA. The committee of four decision-makers, included in their study, decided to evaluate eight criteria in order to solve the personnel selection problem. Those criteria were creativity/innovation, leadership, strategic planning, communication skills, team management, emotional steadiness, educational background and professional experience. Maghsoodi et al. (2020) suggested an integrated parallel big data decision support tool using the W-CLUS-MCDA method. The decision support tool was applied to a multi-scenario personnel assessment. They took into account the following criteria: education level, education score, knowledge and scholar score, psychological factor scores, general factors location score, suggested salary and flexibility. Yalçın and Yapıcı (2019) conducted the study on the personnel selection problem by applying the Fuzzy-

CODAS Method, which is based on the Fuzzy Envelopes for Hesitant Fuzzy Linguistic Term Sets. In their study, the following eleven criteria were considered by the five decision-makers: level of education, request for learning and development, stress resistance, shift work predisposition, salary expectation, corporate culture adaptation, computer programming skills, communication skills, professional competence, work experience as well as analytical and critical thinking abilities. Afshari et al. (2013) proposed the linguistic extension of fuzzy integral for group personnel selection problem. To select the project manager, they considered four main attributes such as basic requirements (past experience, education, communication skills and computer skills), project management skills (time management, cost management, resource management, quality management), management skills (planning, organizing, controlling), and interpersonal skills (problem solving, decision-making, team development). Boran et al. (2011) solved the personnel selection based on Intuitionistic Fuzzy Sets. They used the following criteria: oral communication skill, past experience, general aptitude, willingness, self-confidence, and first impression. Yeni and Özçelik (2018) proposed IVAIF-CODAS method to a personnel selection problem for an engineering position in a company. The evaluation criteria were defined through communication skills, professional experience, educational background as well as team management. Dursun and Karsak (2010) proposed the fuzzy-MCDM approach for personnel selection. They considered eight criteria such as emotional steadiness, Leadership, self-confidence, oral communication skill, personality, past experience, general aptitude, and comprehension. Heidary et al. (2017) used a hybrid SWARA and ARAS-G methodology for Competency-based IT personnel selection. They utilized the following criteria: subject competency, social competency, method competency, entrepreneurial competency, and personal competency. On the other side, Nabeeh et al. (2019) applied the Hybrid Approach of Neutrosophic with MULTIMOORA in the application of personnel selection. To select the most appropriate candidate, the following criteria were used: creativity and innovation, character, culture, communication skills, team management, commitment, educational background, and professional experience. Mishra et al. (2020) carried out the study about IT personnel selection using the intuitionistic fuzzy information measures and ARAS methodology. They used the following criteria: individual qualifications (expression and communication, emotional balance, quality oriented, internal and external customer oriented, crisis management, basic computer skills, general information about economy and business world) technical specifications (adaptation level to new technology, software and hardware, competence of required software, continuous development and technological relevance, experience) and general features (Microsoft office abilities, foreign language skills, social activities, extra achievements). Hitka et al. (2019) proposed the study regarding the factors that form employee motivation influenced by regional and age-related differences. Recently, Hitka et al. (2021) investigated how the global health pandemic had an impact on the motivation of

employees in small and medium enterprises in the Slovak Republic. Bartáková et al. (2017) analyzed the actual trends in the recruitment process at small and medium enterprises with the use of social network.

Table 1.Review in the criteria and methods used in the Personnel Selection Process

Characteristic	Coding mode	
Kilic et al. [7]	education, experience, technical skills, personality and personal skills, foreign language	IF-DEMATEL and IF-ELECTRE method
Maghsoodi et al. [9]	education level, education score, knowledge and scholar score, psychological factor scores, general factors location score, suggested salary and flexibility	W-CLUS-MCDA method
Mishra et al. [17]	individual qualifications, technical specifications, general features	Intuitionistic fuzzy information measures and ARAS methodology.
Yalçın ans Yapıcı [10]	level of education, request for learning and development, stress resistance, shift work predisposition, salary expectation, corporate culture adaptation, computer programming skills, communication skills, professional competence, work experience, and analytical and critical thinking abilities	Fuzzy-CODAS Method
Nabeeh et al. [16]	Creativity and innovation, character, culture, communication skills, team management, commitment, educational background, professional experience	Hybrid Approach of Neutrosophic with MULTIMOORA
Karabašević et al. [6]	education in IT/technical area, interview preparedness, relevant work experience, special skills and knowledge, foreign languages, interpersonal skills, communication and presentation skills	EDAS method

Yeni and Özçelik [13]	communication skills, professional experience, educational background as well as team management	IVAIF-CODAS method
Heidary et al. [15]	subject competency, social competency, method competency, entrepreneurial competency, and personal competency	Hybrid SWARA and ARAS-G method
Afshari et al. [11]	basic requirements, project management skills, management skills, interpersonal skills	Linguistic extension of fuzzy integral for group personnelselection problem
Baležentis et al. [8]	creativity/innovation, leadership, strategic planning, communication skills, team management, emotional steadiness, educational background and professional experience	Fuzzy MULTIMOORA
Boran et al. [12]	oral communication skill, past experience, general aptitude, willingness, self-confidence, and first impression	Intuitionistic Fuzzy Sets
Dursun and Karsak [14]	as emotional steadiness, Leadership, self-confidence, oral communication skill, personality, past experience, general aptitude, and comprehension.	Fuzzy-MCDM approach

According to an extensive review of the scientific literature in the last decade, it may be concluded that various criteria, as well as methods, have been used by academics in the scientific sphere to solve the personnel selection problem.

3. Methodology

This section describes the two methods that are used to solve the PhD candidate selection problem. The first one is the Entropy method, used to obtain the criteria importance for the PhD candidate selection process. The second one is the ARAS method, a relatively new MCDM method used to obtain the preference of the most suitable PhD candidate.

3.1. Entropy Method

According to Zhang (2015), the Entropy weight method was originally a concept of thermodynamics, which firstly added into the information theory by C.E. Shannon and it is now applied widely in the field of engineering technology, social economy, etc. When it comes to multi-criteria, Ranđelović et al. (2020) emphasized that entropy was mainly used to determine the priority of an

alternative. According to Ranđelović et al. (2020) the method of Entropy is described as follows: let us assume that $c_j = (a_{1j}, a_{2j}, \dots a_{mj})$ denotes a priority vector according to a certain criterion $j, j = 1, \dots, n$. Entropy for this priority vector may be defined by applying the equation 1.

$$H_{Wj} = -H \sum_{i=1}^{m} a_{ij} \ln(a_{ij}), j = 1, \dots n$$

where:

$$H = \frac{1}{\ln(m)} \quad (1)$$

They also emphasized that in information theory, the entropy H_{Wj} could can be defined as a measure of discrete random variable X uncertainty, which could have a value from the finite set $(x_1, x_2, \dots x_n)$ in a way that probability that X is going to be equal to x_j is w_j and can be presented as:

$$P(X = x_j) = w_j \quad (2)$$

3.2. ARAS Method

The Additive Ratio Assessment (ARAS) method is one of the relatively new multi-criteria decision-making methods developed by Zavadskas and Turskis (2010). This method is very efficient and easy to use in situations where multiple criteria are taken into consideration. According to Zavadskas and Turskis (2010), the ARAS method can be described through several steps:

Step 1. Formulate a decision-making matrix (DMM)

A decision-making matrix consists of m feasible alternatives (rows) rated on n sign full criteria (columns).

$$X = \begin{bmatrix} x_{01} & \cdots & x_{0j} & \cdots & x_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix}; \; i = \overline{0, m}, j = \overline{1, n}; \quad (3)$$

where:
m – number of alternatives,
n – number of criteria describing each alternative,
x_{ij} – value representing the performance value of the i–th alternative in terms of the j-th criterion,
x_{0j} – optimal value of j-th criterion.
If the optimal value of j-th criterion is unknown, then:

$x_{0j} = max_i x_{ij}$, if $max_i x_{ij}$ is preferable;

$x_{0j} = min_i x_{ij}^*$, if $min_i x_{ij}^*$ is preferable; (4)

Usually, the performance values x_{ij} and the criteria weights W_j are considered as the entries of a DMM. The system of criteria as well as values and initial weights of criteria is determined by experts. The interested parties can correct the information by considering their goals and opportunities.

Step 2. Normalize the input data

In this step, the initial values of all the criteria are normalized – defining values $\overline{x_{ij}}$ of normalized decision-making matrix $\bar{X}$.

$$\bar{X} = \begin{bmatrix} \bar{x}_{01} & \cdots & \bar{x}_{0j} & \cdots & \bar{x}_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \bar{x}_{i1} & \cdots & \bar{x}_{ij} & \cdots & \bar{x}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \bar{x}_{m1} & \cdots & \bar{x}_{mj} & \cdots & \bar{x}_{mn} \end{bmatrix}; \; i = \overline{0,m}, j = \overline{1,n}; \quad (5)$$

For the criteria with the maximal preferable values, the normalization is done by the following equation:

$$\overline{x_{ij}} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}}; \quad (6)$$

For the criteria with the minimal preferable values, the normalization is done through two-steps, by the following equation:

$$x_{ij} = \frac{1}{x_{ij}^*}; \; \overline{x_{ij}} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}}; \quad (7)$$

Step 3. Define normalized-weighted matrix - $\hat{X}$

It is possible to evaluate the criteria with weights $0 < W_j < 1$. Only well-founded weights should be used because weights are always subjective and influence the solution. The values of weight W_j are usually determined by the expert evaluation method. The sum of weights W_j is limited as follows:

$$\sum_{j=1}^{n} w_j = 1; \quad (8)$$

$$\hat{X} = \begin{bmatrix} \hat{x}_{01} & \cdots & \hat{x}_{0j} & \cdots & \hat{x}_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \hat{x}_{i1} & \cdots & \hat{x}_{ij} & \cdots & \hat{x}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \hat{x}_{m1} & \cdots & \hat{x}_{mj} & \cdots & \hat{x}_{mn} \end{bmatrix}; i = \overline{0,m}, j = \overline{1,n}; \quad (9)$$

Normalized-weighted values of all the criteria are calculated as follows:

$$\hat{x}_{ij} = \bar{x}_{ij} \cdot \mathrm{W_j}; i = \overline{0,m}; \quad (10)$$

Where:

$\mathrm{W_j}$ – is the weight (importance) of the j-th criterion,

$_{ij}$ – is the normalized rating of the j-th criterion.

Step 4. Determine the value of optimality function

$$S_i = \sum_{j=1}^{n} \hat{x}_{ij}; \; i = \overline{0,m}; \quad (11)$$

where:

S_i is the value of optimality function of i-th alternative.

The highest value of S_i is the best one, while the lowest one is the worst. Therefore, the greater the value of the optimality function S_i, the more effective the alternative. The priorities of alternatives can be determined according to the value S_i.

Step 5. Calculate the degree of the alternative utility

To calculate the degree of the alternative utility, it is necessary to compare the variants with the ideally best one S_0. The calculation of the utility degree K_i of an alternative a_i is given in Equation (17):

$$K_i = \frac{S_i}{S_0}; i = \overline{0,m}; \quad (12)$$

Where:

S_i and S_0 – are the optimality criterion values. The calculated values K_i are between 0 and 1.

4. Application of the Entropy-ARAS method to the PhD candidate selection problem – A case study of the University of Pardubice

This section contains an application of the Entropy-ARAS Method to the PhD Candidate selection problem at the University of Pardubice, Faculty of

Transport Engineering. This part of the article is processed as an interpretative case study. Using of interpretative approaches in business and management has increased rapidly over the years. This type of case study is chosen due to its advantages in creating novel insights and its focus on researching social influences in an organizational context. The interpretative case study is concerned with how people create and maintains their social world. The goal of interpretative case studies is to develop an understanding of social life (1995). The University of Pardubice, Faculty of Transport Engineering was established in April 1993. The faculty has become the successor to the tradition of transport faculties in former Czechoslovakia. The faculty provides a comprehensive education in the field of transport and offers modern study and technology facilities for both theoretical and practical education. Students can study bachelor's, master's, and doctoral study programs and branches of study. The total number of PhD students at the Faculty of Transport Engineering is decreasing. Between 2013 and 2019, there was an overall decrease in PhD students by more than 60%. Table 2 represents the number of PhD students for a six-year period.

Table 2. The number of PhD student at Faculty of Transport Engineering (2013-2019)

Year	The number of PhD student	Year-on-year change (%)
2013	134	---
2014	128	-4.47
2015	125	-2.34
2016	90	-28.00
2017	91	+1.11
2018	77	-15.38
2019	69	-10.38
2020	50	-27.53

To eliminate the negative trend in the number of PhD students, it is necessary to define the requirements for the ideal PhD student. Subsequently, these criteria should be evaluated for their importance from the perspective of experts. Then, the evaluation of these criteria should be respected in the Ph.D. student selection process.

In this section, the previously described methodology is applied to the case study of the University of Pardubice. As it may be noticed, the PhD candidate selection problem is the multi criteria decision-making problem. In this case, the authors selected five of possible PhD candidates as the possible alternatives. Regarding the criteria, according to experts' opinions as well as the overview of the literature, the authors selected five of them. Those five criteria should be of crucial importance when evaluating and selecting the PhD candidates. Such criteria are: Flexibility (C1), Foreign language (C2), Computer skills (C3), Number of projects (C4) as well as Communication and presentation skills (C5). The selected criteria are clearly expressed in Table 3.

Table 3. Criteria for PhD candidate selection problem

Criterion	Description of criterion
Flexibility (C1)	This criterion describes the ability of a possible PhD student to accommodate changes and various tasks that are being assigned to him.
Foreign language (C2)	This criterion is expressed by the number of spoken languages of a possible PhD student.
Computer skills (C3)	The ability of a possible PhD student to handle the various computer programs in terms of self-independence.
Number of projects (C4)	This criterion shows the number of projects that a possible PhD student has participated in the previous study degrees.
Communication and presentation skills (C5)	The ability of a possible PhD student to communicate effectively and have the strong presentation skills.

After the description of the criteria for a PhD candidate selection process, the entropy method is employed to find the criteria importance. The following tables show the calculated criteria weights by the Entropy method.

Table 4. Entropy method for obtaining the criteria weights – the initial decision-making matrix

	C1	C2	C3	C4	C5
PhD Candidate 1	4	2	8	2	9
PhD Candidate 2	5	3	10	2	10
PhD Candidate 3	3	1	10	1	9
PhD Candidate 4	4	2	8	2	8
PhD Candidate 5	3	2	8	1	10
Sum	**19**	**10**	**44**	**8**	**46**

The next step in finding the criteria weights in the normalization. The normalized input data are presented in Table 5.

Table 5. Normalization of the initial decision-making matrix

	C1	C2	C3	C4	C5
PhD Candidate 1	0.2105	0.2000	0.1818	0.2500	0.1957
PhD Candidate 2	0.2632	0.3000	0.2273	0.2500	0.2174
PhD Candidate 3	0.1579	0.1000	0.2273	0.1250	0.1957
PhD Candidate 4	0.2105	0.2000	0.1818	0.2500	0.1739
PhD Candidate 5	0.1579	0.2000	0.1818	0.1250	0.2174

The next step in the entropy method is computing the entropy values. It is presented in Table 6.

Table 6. Computing the Entropy value

	C1	C2	C3	C4	C5
PhD Candidate 1	-0.3280	-0.3219	-0.3100	-0.3466	-0.3192
PhD Candidate 2	-0.3513	-0.3612	-0.3367	-0.3466	-0.3318
PhD Candidate 3	-0.2914	-0.2303	-0.3367	-0.2599	-0.3192
PhD Candidate 4	-0.3280	-0.3219	-0.3100	-0.3466	-0.3042
PhD Candidate 5	-0.2914	-0.3219	-0.3100	-0.2599	-0.3318
Sum	-1.5903	-1.5571	-1.6033	-1.5596	-1.6061

In the end, the final weights are presented in Table 7.

Table 7. Obtained criteria weights by the Entropy method

	C1	C2	C3	C4	C5	
Sum	-1.5903	-1.5571	-1.6033	-1.5596	-1.6061	
P2ej	0.9881	0.9675	0.9962	0.9690	0.9979	Sum by rows
dj=1-ej	0.0119	0.0325	0.0038	0.0310	0.0021	0.0813
Weights	0.1465	0.4000	0.0468	0.3811	0.0256	1.0000

After the criteria weights are calculated, the next step is to apply the ARAS method to rank the PhD candidates in order to obtain the most suitable candidate to be enrolled at the Faculty of Transport Engineering at the University of Pardubice. The initial decision-making matrix, normalization of the input data as well as the results of the ENTROPY-ARAS method are shown in the following tables (Table 8 – Table 10).

Table 8. Initial ARAS decision-making matrix

	C1	C2	C3	C4	C5
0 - OPTIMAL VALUE	5	3	10	2	10
PhD Candidate 1	4	2	8	2	9
PhD Candidate 2	5	3	10	2	10
PhD Candidate 3	3	1	10	1	9
PhD Candidate 4	4	2	8	2	8
PhD Candidate 5	3	2	8	1	10
MIN/MAX	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**
Sum	**24**	**13**	**54**	**10**	**56**

Table 9. Normalization of the input data

	C1	C2	C3	C4	C5
0 - OPTIMAL VALUE	0.2083	0.2308	0.1852	0.2000	0.1786
PhD Candidate 1	0.1667	0.1538	0.1481	0.2000	0.1607
PhD Candidate 2	0.2083	0.2308	0.1852	0.2000	0.1786

PhD Candidate 3	0.1250	0.0769	0.1852	0.1000	0.1607
PhD Candidate 4	0.1667	0.1538	0.1481	0.2000	0.1429
PhD Candidate 5	0.1250	0.1538	0.1481	0.1000	0.1786
MIN/MAX	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**
Sum	**0.1465**	**0.4**	**0.0468**	**0.3811**	**0.0256**

Table 10. Weighted D-M matrix as well as obtained preferences (K)

	C1	C2	C3	C4	C5	S	K	RANK
0 - OPTIMAL VALUE	0.0305	0.0923	0.0087	0.0762	0.0046	0.2123		
PhD Candidate 1	0.0244	0.0615	0.0069	0.0762	0.0041	0.1732	**0.8160**	2
PhD Candidate 2	0.0305	0.0923	0.0087	0.0762	0.0046	0.2123	**1.0000**	1
PhD Candidate 3	0.0183	0.0308	0.0087	0.0381	0.0041	0.1000	**0.4709**	3
PhD Candidate 4	0.0244	0.0615	0.0069	0.0762	0.0037	0.1728	**0.8138**	5
PhD Candidate 5	0.0183	0.0615	0.0069	0.0381	0.0046	0.1295	**0.6099**	4
MIN/MAX	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**			**1.0000**

From Table 10 the obtained preferences for the PhD candidate selection process should be noticed. The highest preference is assigned to the PhD candidate 2 (1.000), followed by the PhD candidate 1 (0.8160), PhD candidate 3 (0.4709), PhD candidate 5 (0.6099) and PhD candidate 4 (0.8138). To show better clarity of the obtained preferences, the results are presented in Figure 1.

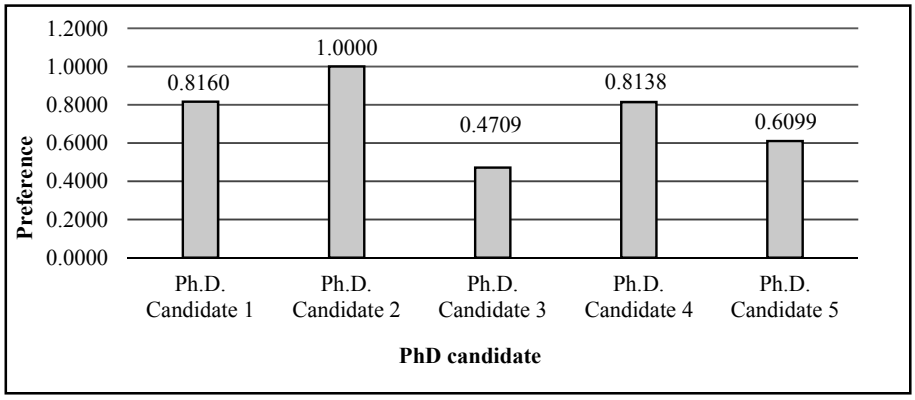

Figure 1. Final rank of the PhD candidates

5. Discussion and conclusion

This article dealt with the PhD candidate selection problem at the Faculty of Transport Engineering at the University of Pardubice. To obtain the best possible PhD candidate at the Transport Faculty, two methods are combined. The first one is the ENTROPY method, which is proved by many scientific articles as an effective one in order to get the criteria importance. The second one is the ARAS method, one of the many multi-criteria decision-making methods used to obtain the preferences of the considered alternatives.

Five PhD candidates were considered in order to find the best one to be enrolled at the Faculty of Transport Engineering at the University of Pardubice. Those five PhD candidates were estimated and the best one was selected according to five criteria such as Flexibility, Foreign language, Computer skills, Number of projects as well as Communication and presentation skills. Regarding the criteria importance, by applying the ENTROPY method, the highest importance was assigned to the foreign language (C2), followed by the number of projects (C4), Flexibility (C1), Computer skills (C3), and Communication and presentation skills (C5) respectively. When it comes to the best PhD candidate, when the ARAS method was applied, the PhD candidate 2 has resulted as the best candidate that the Transport Faculty should consider to enroll. The PhD candidate 2 has the maximum degree of flexibility, knows more foreign languages than the other possible PhD candidates considered in the decision-making process, the highest computer skills level, taken on two projects in the previous study degrees, with the maximal degree of communication and presentation skills.

Limitations of this paper may indicate its possible extension areas. The limitations are: (1) The ENTROPY-ARAS methodology is not applied to a larger sample; However, the methodology has its potential to be applied to a larger sample. (2) The ENTROPY-ARAS methodology is not compared to the other MCDM methods in the PhD candidate selection process; The intention of this study was to show its applicability in the personnel selection process. The proposed ENTROPY-ARAS methodology for the PhD candidate evaluation and selection has a huge potential in the future in the field of human resources. Nevertheless, the methodology is general and can be applied to any other multi-criteria decision-making problem dealing with personnel selection in any other company, except the university.

The Future directions of this paper should be: (i) to apply the methodology to a larger sample; (ii) to compare the methodology to some other multi-criteria decision-making methods; (iii) to extend the proposed methodology in the fuzzy environment, etc.

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