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MCDM approach for weighted ranking of candidates in e-voting

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Abstract. The aim of the study is the application of multi-criteria evaluation methods for ranking of candidates in e-voting. Due to the potential to enhance the electoral efficiency in e-voting multiple criteria, such as personality traits, activity and reputation in social media, opinion followers on election area and so on for the selection of qualified personnel can be considered. In this case, the number of criteria excesses in the decision-making stage directed us to the use of a multi-criteria decision making model (MCDM). This paper proposes MCDM for weighted ranking of candidates in e-voting. Criteria for the candidates' ranking and selection are determined and each voter uses the linguistic scales for the ranking of each candidate. Candidates' ranking is evaluated according to all criteria. In a numerical study, it is provided the candidates' evaluation on the base of selected criteria and ranked according to the importance of criteria. To assess the importance of the criteria and to evaluate the suitability of the candidates for each of the criteria, the voters use linguistic variables. In practice, the proposed model can use different evaluation scales for the selection of candidates in e-voting. The proposed model allows selecting a candidate with the competencies based on the criteria set out in the e-voting process and making more effective decisions.
Keywords: E-democracy, E-voting, Multi-criteria decision making model, MCDM, Candidate selection, Weighted rank, Triangular fuzzy numbers (TFNs).

Introduction

E-democracy is regarded as the involvement of citizens and government agencies in political relations and processes. This stage is characterized by improving the citizens' participation in socio-political processes (Zheng, 2017; Yusifov, 2018). The efficiency in the governance concept can be achieved with improving citizens' participation, as well as civil societies in the process of politico-administrative decision-making.

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The development of democratic institutions, the use of information-communication technologies (ICT) and information infrastructure for the expansion of citizen participation in the public and political processes represents the essence of e-democracy (Carrizales, 2008; Alguliyev & Yusifov, 2016; Strielkowski et al., 2017; Zheng, 2017). E-participation, as one of the important components of e-democracy, constitutes the participation of citizens in political decision-making processes concerning public issues by ICT tools.

E-democracy is thought as a contemporary model for direct participation by means of ICT tools, and it has some solutions for the problems of the traditional participation process. E-voting is one of the main components of e-democracy. Currently, the study of the role of e-voting in the countries, which has adopted the formation of e-democracy as a priority, is deemed as an integral part of explorations in the field of e-democracy (Musial-Karg, 2014; Gibson et al., 2016). The dynamic development of ICT and the enhancement of social media tools have resulted in significant changes in the functioning of modern countries and societies. ICT has started to play a practically important role in all fields of human life, including the political processes. As one of the important tools of e-democracy, e-voting includes interesting research topics, such as participation mechanisms in elections, the provision of legitimacy, technological solutions and their efficient application in e-voting process. In this regard, e-voting can be considered as one of the forms of e-democracy (Musial-Karg, 2014; Shahandashti, 2016; Wang et al., 2017; Yusifov, 2018). In this study, the approaches regarding the development of new e-voting mechanisms are analyzed.

Currently, human resources are considered as the main strategic resource of the government. The selection of qualified personnel at the government level and their appointment to the responsible positions are important issues in the economic and political processes and globalization in the world. Candidate selection is understood as a process in which a particular position is occupied by the best candidates for the vacancy. Different methods and technologies that help the decision makers to predict how successful a candidate will be in the future workplace he/she applied for in the recruitment and selection process (Kabak et al., 2012; Tuan, 2017, 2018; Afshari et al., 2017). In literature, multi-criteria decision making (MCDM) is widely used in various fields, such as the selection of appropriate personnel in the recruitment process, choice of equipment in production, selection of projects, manager selection etc. (Kabak et al., 2012; Kazana et al., 2015; Tuan, 2017, 2018; Huang, 2017). Some research studies focus on the comparison and review of MCDM (Stanujkic et al., 2013; Zavadskas et al., 2014; Mardani et al., 2015, Khorami & Ehsani, 2015; Tuan, 2017; Huang, 2017) are reviewed.

A few research studies on the application of MCDM for the candidates' selection in the election process. Royes & Bastos (2001) are dedicated to the use of fuzzy multi-criteria decision-making in the election prediction. As the practical result of the research, a computational system for election forecasting is proposed. According to the decision maker (system user), the proposed flexible system allows selecting the fuzzy weights and fuzzy evaluation functions of the criteria. Kazana (2015) shows in his research that totally 15 criteria are taken into account when selecting deputy candidates for political parties. The weight of the criteria is evaluated with the party representatives by the method of the ana-

lytical hierarchy process (AHP), using the FARE (Factor Relationship) method. MCDM techniques are applied in these basic criteria. Ten sample deputy candidates are ranked according to PROMETHEE method by the criteria weights obtained with AHP method (Kazana, 2015). Azadfallah (2019) proposes a new MCDM approach for the ranking of candidates in voting systems. The proposed method is based on the improved analytic hierarchy process (AHP) model and assumed that the voters are not equally important. For assigning different importance weights to voters, the voters are classified in the categories with different importance levels. The proposed method is estimated to be more satisfactory than the conventional model for solving voting systems problems (Azadfallah, 2019).

Note that the effective government functioning is directly dependent on human resources, and the participation of qualified personnel with competencies in governance is of national importance. From this point of view, the candidates' selection with the appropriate competencies for administrative positions as a result of e-voting, the criteria and factors of which should be considered in the selection process, are referred to as topical issues. The paper considers the application of MCDM for the candidates' selection in e-voting. The aim of the study is the application of MCDM methods for candidate selection in e-voting.

MCDM approach FOR candidates' ranking

Voting is a fundamental tool for decision-making in any consensus-based society, and democracy hinges upon the accurate governance of nationwide elections. At present, numerous voting systems are adopted all over the world, each of which possesses specific advantages and problems. Some countries abandoned e-voting due to its risky feature. Other countries do not accept the advantages of e-voting in comparison with traditional voting. With the rapid development of the Internet starting from the 1990s, more politicians, researchers and journalists have started to reflect upon whether e-voting proposes better solutions for elections or referendums. The governments of European counties, numerous scientific incentives of non-government organizations at the global scale endeavor the use of the voting methods and solutions based on ICT the application of which constitutes the basis for the democratic processes (Zetter, 2008; Voting system; Trechsel et al., 2016; Meserve et al., 2017). Nowadays, most countries support e-voting, and more countries reckon e-voting systems to be useful and practically applicable in the election processes. Moreover, note that most efforts are still at the stage of testing and conceptual analysis. The benchmark practice regarding the application of e-voting system at a global scale can be characterized by US practice (Zetter, 2008; Voting system; Trechsel et al., 2016;).

At present, new voting technologies are being implemented in different countries (Voting system; Trechsel et al., 2016). Surely, the efforts to implement an e-voting system mentioned above result in various outcomes in different countries. For instance, the analysis of e-voting results from elections to the European parliament, country parliament elections (2011), municipal elections (2013) show that the interest for the implementation of a new system has been systematically growing, and therefore, it is concluded that the citizens consider this voting method to be more comfortable and effective (Zetter, 2008; Voting system; Trechsel et al., 2016; Meserve et al., 2017). Note that the ratio of the

Internet voters has grown from 1% in 2005 to 11,4% in 2014 (Mona et al., 2013; Musia-Karg, 2014; Trechsel et al., 2016; McCormack, 2016)

The participation of citizens in political processes and the facilitation of voting during the adoption of important decisions, as well as the provision of their direct participation is considered to be the basis for democracy. Despite the wide implementation of ICT in business, various fields of activity, education, public administration and government entities, the use of ICT in the process of voting is treated with cautiousness in many countries. In addition, one of the main causes of postponed implementation of advanced voting technologies is the presence of inconsistencies in the opinions and skeptical thinking regarding Internet voting in societies (Mona et al., 2013; Musial-Karg, 2014; McCormack, 2016).

Despite the progress achieved towards the better development of e-voting systems, there is no classification for understanding the general characteristics, aims and limitations of these approaches. Hence, the absence of comparative research or inaccurate determination of directions for selecting appropriate methods for specific requirements may be the main drawbacks. In this regard, the development of effective e-voting methods and mechanisms by taking into consideration the democratic processes is a topical issue.

The ability of e-democracy to overcome the barriers causing the deterrence or limitation of the participation of citizens in direct decision-making is considered as the main advantages of the development of effective e-voting mechanisms. From this point of view, e-voting attracts the government entities, political parties and politicians and is deemed as a powerful tool for sustaining democratic principles. The conducted research shows that e-voting has become one of the main tools of e-democracy by attaining more importance (Musial-Karg, 2014; Yusifov, 2018). In this regard, the development of e-voting technologies and the study of implementation opportunities of new technologies are considered as important research topics.

Nowadays, countries are ruled with different regime and government forms. A qualified personnel factor is needed for operating the different regimes and governments. From this point of view, if we compare traditional voting and e-voting, selection of qualified personnel at the government level and their appointment to the responsible positions needs the candidates' evaluation and selection upon multiple criteria, which is very important for both forms. Due to the potential of enhancing the electoral efficiency in e-voting, the multiple criteria, such as personality traits, education level, activity and reputation in social media, number of followers, recognition in the election area and so on for the selection of qualified personnel can be considered. In this case, the number of criteria excesses in the decision-making stage enable us to use MCDM. The review of the literature shows that, since the different regimes, government forms, political views have no standardized system for appointment of the candidate to the responsible positions, the qualifications, which the government or political parties prefer, are taken into consideration.

Generally, it is supposed that depending on the government forms, political views of the parties, mainly following criteria, are taken into account in candidate selection and are shown in Table 1.

Table 1. ***Basic criteria for candidates' evaluation***

Personality traits	Social relations
Education	Adoption of national culture and values
Family status	Familiarity with global culture
Adoption of democratic values and fundamental principles	Recognition of the election area
Government experience	Recognition in the election area
Professional competence	Representation skills
Experience in international projects	Evaluation of political leaders
Effective communication skills	Activity in social media (followers)

The approach proposed in this research is based on the multi-criteria evaluation of candidates, taking into account the relation of each candidate to another candidate. Assume that, as a result of e-voting, the candidates are elected to be appointed to the relevant position. Personality traits, age, education, work experience, professional competencies, health, recognition of election region, social reputation, social media followers, adoption of democratic principles and etc. can be attributed to the criteria for the selection of the competence of candidates. Linguistic scales are used for the ranking of each candidate in the study. The problem statement is as follows.

MCDM approach for candidate selection. Let $A_i = (A_1, A_2, ..., A_n)$, $i = 1,2,...,n$ be a set of n candidates (decision alternatives) which are to be evaluated by a group of K voters V_k, $k = 1,2,...,K$ with respect to a set of m evaluation criteria $C_j = (C_1, C_2, ..., C_m)$, $j = 1,2,...,m$. The evaluation criteria are measurable quantitatively or assessable qualitatively, and are independent of one another. Assessments are to be made by each voter V_k to determine the weight vector $W^k = (w_1^k, w_2^k, ..., w_m^k)$ and decision matrix $X^k = \left\| x_j^k \right\|$, $i = 1,2,...,n$, $j = 1,2,...,m$, $k = 1,2,...,K$. The decision matrix X^k represents the performance ratings assigned to the candidate A_i with respect to the criteria C_j, which are either objectively measured (for quantitative criteria) or subjectively (for qualitative criteria) assessed by the voter V_k using the cardinal values. The weight vector W^k represents the weights of the criteria C_j which are given by the voters V_k using a linguistic scale.

To assess the importance of the criteria and to evaluate the suitability of the candidates according each of the criteria, the voters use the linguistic variables shown in Tables 2–3.

Table 2. ***Linguistic scales for the ranking of each candidate (alternative)***

Definition	Ranking scale
Very good	5
Good	4
Fair	3
Poor	2
Very poor	1

Table 3. ***Scale of the relative importance of criteria***

Intensity of importance	Definition	Membership function
1	Good (G)	(5,6,7)
2	Fair (F)	(3,4,5)
3	Poor (P)	(1,2,3)

Candidate selection using MCDM model consists of the following steps:

Step 1. Each voter V_k constructs a matrix for the evaluation of candidate according to each criteria C_j:

$$X^k = \left[x_j{}^k\right] = \begin{Vmatrix} x_{11}{}^k & x_{12}{}^k & \dots x_{1m}{}^k \\ \dots & \dots & \dots \dots \\ x_{n1}{}^k & x_{n2}{}^k & \dots x_{m}{}^k \end{Vmatrix} \tag{1}$$

Step 2. Thereafter, Q_{ij} – decision matrix denotes the final opinion of the voter V_k regarding the candidate A_i according to each criterion C_k and is calculated as follows:

$$Q_{ij} = \sum_{k=1}^{K} x_j^k, \ \ i = 1,2,...,n; \ j = 1,2,...,m; \ \ k = 1,2,...,K \tag{2}$$

Step 3. The overall opinion of the voter V_k regarding the candidate A_i according to all criteria is calculated as follows:

$$O_i = \sum_{j=1}^{m} Q_j, \ \ i = 1,2,...,n; \ j = 1,2,...,m \tag{3}$$

The last relationship expresses the final opinion of all voters regarding the candidate A_i according to the criterion C_k.

Step 4. According to all criteria, the ranking of the candidate A_i can be calculated as follows:

$$R_i = \sum_{j=1}^{m} Q_j, \ \ i = 1,2,...,n; \ j = 1,2,...,m; \tag{4}$$

Assume that, w^k expresses the weights of criteria. In this case, the weighted ranking of the candidate A_i can be calculated with the following formula:

$$R_i^w = \sum_{j=1}^{m} w_j R_i = \sum_{j=1}^{m} w_j \left(\sum_{j=1}^{m} Q_j\right), \text{ where, } w^k \in [0,1], \ \sum_{j=1}^{m} w_j = 1,$$

$$i = 1,2,...,n, \ \ j = 1,2,...,m \tag{5}$$

Step 5. For the calculation of the weights of criteria, the arithmetic mean operator is used (Saaty, 2008; Rotshtein, 2009; Zadeh, 2016; Alguliyev et al., 2016 and others).

Numerical experiment

Assume that 10 candidates are presented based on 5 criteria (for example, personality traits (C1), age (C2), education (C3), work experience (C4), and professional competencies (C5)). To evaluate the correspondence of the candidates for each of the criteria, 10 voters use the linguistic variables reported in Table 2. Ten voters construct the matrixes for the evaluation of the candidate according to each criterion as shown in Tables 4-8.

Table 4. ***Individual decision matrix of voters*** V_1 ***and*** V_2

	C1	C2	C3	C4	C5		C1	C2	C3	C4	C5
A1	1	5	2	1	2	A1	2	1	5	1	2
A2	2	3	1	5	1	A2	2	2	1	1	1
A3	2	1	5	2	1	A3	2	1	1	1	1
A4	1	1	1	1	1	A4	4	1	4	2	1
A5	2	2	1	4	2	A5	2	2	3	1	2
A6	4	5	1	1	2	A6	1	2	1	3	2
A7	2	2	2	4	1	A7	2	1	2	5	5
A8	2	1	2	1	1	A8	2	5	2	1	5
A9	1	2	1	2	2	A9	2	2	1	2	2
A10	2	3	1	1	5	A10	2	2	2	1	0

Table 5. ***Individual decision matrix of voters*** V_3 ***and*** V_4

	C1	C2	C3	C4	C5		C1	C2	C3	C4	C5
A1	2	1	1	1	1	A1	1	2	2	1	2
A2	2	1	5	1	2	A2	2	4	4	4	1
A3	2	1	4	1	2	A3	2	1	1	2	1
A4	2	2	2	4	1	A4	1	2	2	2	1
A5	1	4	1	5	2	A5	4	2	1	1	1
A6	1	1	1	5	1	A6	1	5	1	5	2
A7	4	1	1	4	1	A7	4	2	2	1	1
A8	4	1	2	1	1	A8	1	5	5	5	1
A9	1	2	1	2	2	A9	1	2	1	2	2
A10	1	5	1	4	5	A10	1	1	1	1	1

Table 6. ***Individual decision matrix of voters*** V_5 ***and*** V_6

	C1	C2	C3	C4	C5
A1	1	1	1	1	2
A2	2	2	2	2	2
A3	2	1	5	5	4
A4	2	1	1	2	2
A5	2	2	1	1	1
A6	1	3	1	4	4
A7	3	2	2	1	1
A8	3	1	2	1	1
A9	1	2	1	2	1
A10	1	2	2	1	1

	C1	C2	C3	C4	C5
A1	2	2	2	2	2
A2	2	1	1	5	1
A3	1	1	1	1	1
A4	1	1	4	5	1
A5	2	2	1	1	2
A6	3	3	1	2	2
A7	2	1	2	2	2
A8	1	1	2	1	1
A9	1	2	1	5	2
A10	2	1	2	1	4

Table 7. ***Individual decision matrix of voters*** V_7 ***and*** V_8

	C1	C2	C3	C4	C5
A1	5	4	1	1	2
A2	2	2	1	2	2
A3	2	1	5	5	1
A4	1	2	2	2	2
A5	2	2	1	1	2
A6	1	2	1	1	2
A7	2	2	2	1	1
A8	2	1	2	1	1
A9	1	2	1	2	2
A10	5	5	1	1	5

	C1	C2	C3	C4	C5
A1	1	2	1	4	2
A2	1	2	1	4	3
A3	2	1	1	4	1
A4	1	1	2	3	1
A5	4	4	1	5	2
A6	2	1	1	1	2
A7	4	3	2	1	1
A8	1	1	2	1	3
A9	1	5	1	2	2
A10	2	3	3	2	2

Table 8. ***Individual decision matrix*** *of voters* V_9 ***and*** V_0

	C1	C2	C3	C4	C5
A1	1	1	1	1	2
A2	3	2	2	1	1
A3	2	1	1	1	1
A4	3	1	5	5	3
A5	2	2	3	1	2
A6	1	5	1	5	2
A7	2	2	1	1	1
A8	5	5	2	1	1
A9	1	2	1	2	2
A10	1	2	2	2	2

	C1	C2	C3	C4	C5
A1	2	2	2	1	2
A2	2	1	1	4	1
A3	1	1	4	1	1
A4	1	1	4	1	1
A5	2	5	1	2	2
A6	1	2	1	2	2
A7	1	2	2	2	2
A8	1	1	2	2	1
A9	1	2	2	2	2
A10	1	2	1	1	2

The final opinion of the voters and the ranking of the candidate A_i are calculated based on formulas (2-4), respectively based on the criterion C_k, and given in Table 9-10.

Table 9. ***Final opinion of voters based on 5 criteria***

	C1	C2	C3	C4	C5
A1	18	21	18	14	19
A2	20	20	19	29	15
A3	18	10	28	23	14
A4	17	13	27	27	14
A5	23	27	14	22	18
A6	16	29	10	29	21
A7	26	18	18	22	16
A8	22	22	23	15	16
A9	11	23	11	23	19
A10	18	26	16	15	27

Table 10. ***Ranking of candidates based on all criteria***

Candidate	Sum(opinion)	Rank
A1	90	9
A2	103	3
A3	93	8
A4	98	6
A5	104	2
A6	105	1
A7	100	5
A8	98	6
A9	87	10
A10	102	4

For the calculation of the criteria weights, linguistic variables were used as shown in Table 2, and the voters independently assessed the criterion accordingly for the importance of the criteria. Importance degree of criteria based on the evaluation of voters is shown in the sample in Table 11.

Table 11. ***Importance degree of criteria based on the evaluation of voters***

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
C1	F	G	F	F	G	G	F	P	F	G
C2	G	F	F	P	F	F	G	G	G	P
C3	P	G	F	G	P	P	F	P	G	F
C4	F	P	P	G	G	P	P	F	P	F
C5	P	P	P	G	G	F	P	F	F	F

Due to the uncertainty, voters prefer to give their opinions in linguistic variables to assess the criteria. A linguistic variable is a variable the values of which are the linguistic terms. Each linguistic value can be represented by a fuzzy number, which can be assigned to a membership function as shown in Table 3. Among the various shapes of a fuzzy number, the triangular fuzzy number (TFN) is the most popular one (Chang et al., 2013). In this article, to calculate the weights of the criteria, we use the arithmetic mean operator as shown in formula 6 (Chang et al., 2013; Alguliyev et al., 2016). Defuzzification is the process of converting a fuzzy number into a crisp (non-fuzzy) value. The center-of-area (COA) method is the most popular and commonly used method to defuzzify TFNs. Using this method, the defuzzification value is obtained and is shown in Table 12.

Table 12. ***The defuzzification of voters' decision matrix***

C1	C2	C3	C4	C5
4,00	6,00	2,00	4,00	2,00
6,00	4,00	6,00	2,00	2,00
4,00	4,00	4,00	2,00	2,00
4,00	2,00	6,00	6,00	6,00
6,00	4,00	2,00	6,00	6,00
6,00	4,00	2,00	2,00	4,00
4,00	6,00	4,00	2,00	2,00
2,00	6,00	2,00	4,00	4,00
4,00	6,00	6,00	2,00	4,00
6,00	2,00	4,00	4,00	4,00

From the formula (6), using the arithmetic mean operator, we obtain the following aggregated weights of criteria, respectively (Saaty, 2008; Rotshtein, 2009; Zadeh, 2016; Alguliyev et al., 2016 and others), as shown in Table 13.

$$W^k = \frac{1}{K}\sum_{k=1}^{K} w_j^k \tag{6}$$

The weighted ranking of the candidate can be calculated according to the formula (5) as shown in Table 14.

Table 13. The weights of criteria obtained by the arithmetic mean operator

	W^k
C1	4,60
C2	4,40
C3	3,80
C4	3,40
C5	3,60

Table 14. ***Ranking of candidates according to importance of criteria***

Candidate	Sum(opinion)	Rank	Weighted Sum(opinion)	Weighted Rank
A1	90	9	325,60	5
A2	103	3	313,00	7
A3	93	8	290,40	9
A4	98	6	308,80	8
A5	104	2	363,00	2
A6	105	1	321,60	6
A7	100	5	331,60	4
A8	98	6	356,60	3
A9	87	10	268,80	10
A10	102	4	368,80	1

If we compare these rankings described in Table 14, the weighted rank of the candidates are A_0 , A_5, A_8, A_7, A_1, A_6, A_2, A_4, A_3 and A_9. As the result shows, in this case, according to multi-criteria evaluation of the candidates, the candidate A_0 is more appropriate for the competencies to related position.

If we compare these rankings and calculate the Pearson's correlation coefficient (Pearson Correlation), $r = 0.633$, and Kendall's rank correlation coefficient (Kendall & Gibbons, 1990) $\tau = 0.42$, obviously, these ranks are poorly correlated and do not provide the same results. If we compare these rankings, the weighted ranking seems to be more appropriate for the candidate selection, because it has the capability to assess the importance of the criteria and to evaluate the suitability of the candidates for related positions. Several methods can be used for the calculation of the weights of criteria. To calculate the weights of criteria, the arithmetic mean operator is used. Note that the alternatives and criteria can be evaluated using various approaches, and that it will be illustrated in the ranking of alternatives. The results can be improved by employing a fuzzy hybrid approach for the ranking of alternatives.

The personnel selection and evaluation problem is a MCDM problem that depends on several criteria. The model proposed in the paper is based on each voter using the linguistic values for the evaluating of each candidate. The candidates' rank is calculated based on MCDM and candidates are selected based on the importance of criteria. The proposed approach enables selecting a candidate with more relevant competencies within the framework of selected criteria.

In general, the effectiveness of e-democracy mechanisms directly depends on human resources, and the participation of qualified personnel with competencies in governance is an important issue for the government. From this point of view, the proposed approach allows selecting a candidate with competencies based on the criteria set out in the e-voting process and making more effective decisions. In practice, the proposed model can use different evaluation scales for the multi-criteria selection of candidates in the e-voting process. With the implementation of the proposed model, we can create tools for the election of a candidate with more relevant competencies for certain criteria among the rest of the candidates.

Conclusion

E-voting is one of the main tools of e-democracy. The results of the research showed that there was a growing interest towards the implementation of new forms of citizens' participation in e-voting on a global scale and in European countries. This was substantiated by the pilot projects proposed by numerous countries supporting the idea of e-voting in parliaments in the world practice. The results of the research showed that e-voting gradually gained more importance and became one of the main tools of e-democracy.

The selection of qualified personnel at the governments level and their appointment to the responsible positions are important issues in economic and political processes and globalization in the world. Candidate selection is understood as a process in which a particular position is occupied by the best candidates for the vacancy. Note that the effective government functioning directly depends on human resources, and the participation of competent and qualified personnel in governance is an issue of national importance. From this point of view, the election of the candidates with the appropriate competencies to administrative positions, as a result of e-voting, and the selection of criteria and factors, should be considered. This paper considered the application of MCDM for the candidates' ranking and selection in e-voting. If we compare traditional voting with e-voting, we can conclude that the selection of qualified personnel at the government level and their appointment to the responsible positions need the candidates' evaluation and selection upon multiple criteria which is very important for both forms. Due to the potential of enhancing the electoral efficiency in e-voting, multiple criteria, such as personality traits, education level, activity and reputation in social media, number of followers, recognition in the election area and so on, can be considered for the selection of qualified personnel. In this case, the number of criteria excesses in the decision-making stage enables us to use the multi-criteria decision making model.

The approach proposed in this paper was based on the use of linguistic scales of each voter for the ranking of each candidate. The weighted rank of the candidates was calculated based on MCDM, and the candidates were selected based on the importance of criteria. The proposed approach enabled the selecting of a candidate with more relevant competencies within the framework of the selected criteria. In the numerical experiment, ten candidates were selected on five criteria (personality traits (C_1), age (C_2), education (C_3), work experience (C_4), and professional competencies (C_5)), evaluated and ranked according to the importance of the criteria. The proposed model allowed the selection of the candidate with the competencies based on the criteria set out in the e-voting process, making more effective decisions. Future studies will examine the application of a fuzzy MCDM for the candidates' selection in the election process.

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