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MCDM for Candidate Selection in E-Voting

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ABSTRACT

E-voting is one of the most important components of e-democracy and forms the basis of a democratic governance system. Voting results always lead to a broad debate in terms of candidate selection and whether the candidate elected to a position is suitable for that position. At present, the selection of qualified personnel and their appointment to responsible positions in public administration is one of the topical issues. In this article is proposed an MCDM for selection of candidates in e-voting. Criteria for the candidates' selection are determined and the relation of each candidate to other candidates is assessed using a binary matrix. Candidate rating is calculated according to all criteria. A numerical experiment is provided for candidate evaluation on the base of the selected criteria and ranked according to the importance of the criteria. The proposed model allows selecting a candidate with competencies based on the criteria set out in the e-voting process and making more effective decisions.

KEYWORDS

E-government, E-democracy, E-voting, MCDM, Candidate Selection, Election, E-Government Maturity Model, Governance

INTRODUCTION

The efficiency in the governance concept can be achieved with the close participation of citizens, as well as civil societies in the process of politico-administrative decision-making. E-government forming a new environment in this regard. According to some researchers, a transition must be made from e-government term to e-democracy (Williams, 2006; Meier, 2012; Taghavifard, Fadaei & Ebrahimi, 2014).

Describe the general perspective of the article. End by specifically stating the objectives of the article. The strengthening and development of democratic institutions, the use of information-communication technologies (ICT) and information infrastructure for the expansion of civil participation of public and political processes reflects the essence of e-democracy (Anttiroiko, 2003; Carrizales, 2008; Strielkowski et al., 2017).

At present, the study of the role of e-voting in the countries which have adopted the formation of e-democracy as a priority is deemed as an integral part of investigations in the field of e-democracy

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(Musial-Karg, 2014). 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 practically an important role in all fields of human life including the political processes. As one of the important components of e-democracy, e-voting encompasses interesting research topics such as participation mechanisms in elections, the provision of legitimacy, technological solutions and the efficient application of those in e-voting process. In this regard, e-voting can be considered as one of the forms of e-democracy (Musial-Karg, 2014). In the study approaches regarding the development of new e-voting mechanisms are analyzed.

At present, 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 economic and political processes and globalization in the world. Candidate selection is understood as a process in which a particular position is selected 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 are applied in the recruitment and selection process. (Dursun & Karsak, 2010; Kabak et al., 2012; Tuan, 2017; Afshari et al., 2017). In literature MCDM is widely used in various fields, such as selection of appropriate personnel in the recruitment process, choice of equipment in production, selection of projects, etc. (Dursun & Karsak, 2010; Kabak et al., 2012; Kazana et al., 2015; Tuan, 2017). There are research studies on the comparison and review of MCDM (Stanujkic et al., 2013; Zavadskas et al., 2014; Mardani et al., 2015, Khorami & Ehsani, 2015).

Literature analysis has few research studies on the application of MCDM for the candidates' selection in the election process. Royes & Bastos (2001) is dedicated to the use of fuzzy multi-criteria decision-making in the election prediction. As the practical result of the research was proposed computational system for election forecasting According to the decision maker (system user) the proposed flexible system allows to select the fuzzy weights and fuzzy evaluation functions of the criteria. Kazana (2015) showed in research totally 15 criteria are taken into account when selecting deputy candidates for political parties. The weight of the criteria is evaluated by the party representatives by the method of the analytical hierarchy process (AHP), using the FARE (Factor Relationship) method. Candidates are assessed based on the criteria selected by applying the MCDM. An empirical assessment is carried out in the research work and the candidates to the deputies are ranked by the MCDM.

Obviously, the effective government functioning is directly depending on human resources, and the participation of qualified, personnel with competencies in governance is an issue of national importance. From this point of view, the candidates' selection with the appropriate competencies in the appointment of the elected candidates to administrative positions as a result of e-voting, which criteria and factors that should be considered in the selection process is referred to topical issues. The article considers the application of MCDM for the candidates' selection in e-voting.

E-DEMOCRACY AS THE LATEST STAGE OF E-GOVERNMENT DEVELOPMENT

The development of ICT has an impact on social, economic and political life. In particular, the development of ICT, e-government building and the formation of e-government mechanisms have substantially changed the public governance and political processes. Nowadays, advanced technologies and the requirements posed to government services are transforming the functions of e-government. The transformation of citizens' rights, their close participation in social processes and decision-making allows to achieve the effectiveness in public administration and democracy.

The concept of e-democracy emerged in 1990's has started to be perceived as an evidence of changes taking place against a backdrop of democratic principles in government. The support of ICT application in political arena has facilitated the emergence of e-democracy which encompasses new methods of governance of democratic government. Political institutions,

parties and politicians utilize ICT in 3 main processes in political arena including the issues of information, communication and voting.

E-government maturity models of is constituted of the sequence from base stage till advanced stage and these stages determine the e-government maturity level. The proposal of methods for determining the level of development of e-government and ranking e-government portals are considered as the main advantage of mature models (Fath-Allah et al., 2014). Moreover, mature models may assist organizations in fostering the efficiency of e-government. Concha et al have proposed to categorize mature models of e-government in 3 groups (Concha, 2012):

1. **Governmental models:** This model is developed by consultants and scientists for the purpose of assisting the organizations and agencies in order to determine and improve the level of e-government maturity;
2. **The holistic approach models:** These models have been developed to be applied in projects of development of public services with the purpose of helping the organizations to determine the successfulness of e-government projects;
3. **The evolutionary e-government maturity models:** These models are based on developing e-government and raising its efficiency by using successive stages. Layne and Lee model or Andersen and Henriksen model can be considered as well-known mature models in scientific literature (Layne & Lee, 2001; Andersen & Henriksen, 2006).

According to conducted studies, the investigation of three categories, that is, e-government maturity models bears a large importance from the point of view of e-democracy development. The analysis of existing mature e-government models in literature shows that, several models exist proposed by Deloitte & Touche (2000), Gartner group (2000), Layne and Lee (2001), Hiller & Belanger (2001), Wescott (2001), World Bank (2003), Accenture (2003), Reddick (2004), Siau & Long (2005), Andersen & Henriksen (2006), Cisco (2007), Shahkooh et al. (2008), Kim & Grant (2010), Chen et al. (2011), United Nations (2012), Alhomod et al. (2012), Lee & Kwak (2012) and other researchers and numerous organizations (Fath-Allah, 2014; Layne & Lee, 2001; Wescott, 2001; Siau & Long, 2005; Andersen & Henriksen, 2006; Shahkooh et al., 2008). Among those models, the formation of e-democracy has been proposed by several authors including Wescott (2001), Siau & Long (2005) and Shahkooh et al., (2008) as the latest stage of e-government development. While exploring above mentioned models, it is evident that, e-voting, public forums, open government, the analysis of public opinion and development of feedback mechanisms are shown as the foundation of e-democracy formation which is deemed as the evolutionary stage of e-government development. In this regard, the development of e-democracy mechanisms and e-voting technologies in order to boost the transparency and efficiency is necessary and constitutes the basis of open government concept.

All world countries make rigorous efforts to implement e-government programs in order to develop the dialogue between governments and citizens. In this regard, the investigation of research directions enables the close participation of citizens in democratic processes and to determine the level of e-government development within the framework of transparency, openness and participation. Based on conducted research, it is to be mentioned that, although the efforts oriented towards the formation of e-democracy are highly appreciated, this process is at the nascent stage for the majority of countries (Pina et al., 2009; Van der Meer et al., 2014). The building of efficient e-democracy mechanisms necessitates the implementation of rigorous measures.

The analysis of literature shows that, researchers highly appreciate the potential of Internet for expanding the relations between the government and citizens (Lee, 2010; Van der Meer et al., 2014). In particular, the use of Web 2.0 technologies and social networks has created a new interface between citizens and government and these facilities are capable to change the traditional features of government radically. However, researchers reckon that, there are some social groups with doubts regarding the socialization of the real potential of e-government in the society and these thoughts

remain at least for now (Pina et al., 2009; Van der Meer et al., 2014). For instance, the experts reckon that, Internet possesses a capacity to magnify the existing impact on political processes only by active users, and the government can use web-technologies to control the accessibility of information and monitor the behavior of citizens (Van der Meer et al., 2014). Hence, the level of development of relations between citizens and the government is considered as one of topical issues allowing for the expansion of e-democracy mechanism as the evolutionary stage of e-government development. In other words, one of the main discussion topics is the support of the current practice of e-government for the dialogue between citizens and government, as well as e-democracy development.

In general, the analysis of the literature on e-government shows that, the stages of e-government development include some notions such as "information", "transaction" and "integration". These stages can also be reviewed as the development of e-services. Alongside, e-democracy and e-participation are mentioned as the evolutionary stage of several development models of e-government (Lee, 2010).

The last phase or evolutionary stage envisions the formation of new requirements and the expansion of the degree of civil participation on processes by altering the relations between government and citizen. The majority of existing development models incorporates the democratic processes such as political participation, e-participation, wiki democracy, interactive democracy and digital democracy (Van der Meer et al., 2014). All of these terms pertain to democratic processes based on the transformation of relations between citizens and government. E-democracy has been included as the latest stage of a development model in these models. Logically, government must complete preceding information, interaction and transaction/integration stages in order to proceed to e-democracy stage.

E-VOTING SYSTEM AS A TOOL OF E-DEMOCRACY

If to consider the world practice, the difference in opinions regarding the use of e-voting systems are still observed. Although some countries consider the implementation of e-voting as more efficient by presenting various arguments, other countries propose the reverse (Musial-Karg, 2014; Mona et al., 2013).

As a new concept, the implementation of e-voting is based on reducing errors during election processes and oriented towards maintaining the integrity of election process in general. In scientific literature, e-voting is considered as the use of computers and devices offered by computers in election process, and this term has been adopted to characterize elections carried out via Internet more precisely (Abu-Shanab, 2010).

E-government – allows to enhance the accessibility of all public services and operations in accordance with the interests of citizens, organizations, employees and other interested parties, to maintain openness for everyone and foster the efficiency by transforming the system of provision of government services regularly (Toe, 2008; Strielkowski et al., 2017). On the other hand, e-democracy is defined as "the use of Internet as a tool for the democratic election of political leaders and government policies" (Abu-Shanab, 2010). E-democracy has 2 main purposes: to provide an access to information and knowledge regarding political processes, provide services and choice options to citizens and facilitate closer participation of citizens in political processes, in other words, to transform users to active participants. The main characteristics of e-democracy are considered as the expansion of political information, e-voting and the participation in e-decision making (Bozinis & Lakovou, 2005). While defining e-democracy in the categories of e-government, it is seen as more appropriate for relations with citizens and government in accordance with G2C model (Kitlan & Joseph, 2008; Abu-Shanab, 2010).

The system of e-voting comprises 3 actors as such: a voter, a registering entity and commissions for the evaluation of votes. A voter has a right to vote, whereas registering entities register the participation of votes in election day. These entities ensure that, only registered voters participate in elections and they can vote only once during election day. The committees for the evaluation of votes carry out the collection of votes and the evaluation of election results (Cetinkaya & Cetinkaya

D., 2007). E-voting system has proposed numerous advantages for election process. For instance, the facilitation of participation of physically disabled persons and no requests for additional employees for the printing of election ballot papers and election process helps to organize elections more cost-effectively and efficiently by reducing costs. In general, the cost-effectiveness, the expansion of participation and broadening of voting options, more rapid, accurate registration and calculation of votes, as well as accessibility and the flexibility against deviations can be considered as main advantages of e-voting (Abu-Shanab, 2010).

Research studies on e-voting has gradually become an important issue. The reason is a growing number of scientific-research works conducted on the facilities of developing new methods of voting process via Internet and mobile services in European countries and world countries in general. As a result, the terms of e-democracy, e-participation and e-voting are frequently encountered in the context of e-democracy. E-democracy and issues related its forms have been investigated by Browning (2005), Grossman (1995), Tsagarousianou (1999, 2000), Hague, Loader (1999), Krimmer (2006, 2008), Trechsel (2007), Mona (2013) and other researchers (Musia-Karg, 2014). Moreover, it is to be noted that, the studies of authors are mainly confined to practical examples on the implementation of ICT in the political environment of US and the analysis of those results do not attain much attention. In European practice, the studies in the field of e-voting are mainly represented by empirical studies conducted by Estonia (Mädise (2006), Drechsler (2006); Vassil et al. (2016)), Switzerland (Braun (2006), Trechsel (2002, 2007), Serdult, Germann (2015) and other authors), Poland (Porêbski (2004, 2012), Marczewska-Rytko (2002, 2010), Musia-Karg (2010, 2011, 2012), Mider (2008), Lakomy (2013), Maj (2009), Kaczmarczyk (2010) and other authors), Norway (Beyer, Knutsen and Rasch (2014)) and other countries (Drechsler & Madise, 2006; Braun & Brändli, 2006; Trechsel, 2007; Musia-Karg, 2014).

Despite the growing number of studies devoted to the study of the impact of new technologies on democracy, there is a need for conducting comprehensive research studies in the field of e-voting. In particular, it is essential to analyze the issues such as the implementation of e-participation solutions in the example of European countries and the factors necessitating the refusal of its implementation due to various drawbacks, application opportunities of e-voting, existing barriers and effectiveness. Hence, the development of mechanisms and specific technological solutions, its effectiveness and the study of undesirable results in comparison with traditional voting are deemed as topical research directions.

At present, e-voting for elections and referendums at local, regional and country level is rapidly developing at global scale as more efficient and feasible alternative to traditional voting and favorably affects the development of democratic government. Alongside, despite the widening international practice regarding the application of e-voting system, several challenges are still being encountered given the national interests related to legal, social problems and its implementation.

Scientific and public discourse in the field of e-voting in last decade is widening. E-voting systems are categorized as location-bounded and remote voting. In first case, the participation of voter in election is required due to its dependence on location. Remote voting has been applied in various countries such as Estonia, France, Netherlands, Switzerland, etc. E-voting has a great potential for expanding the democratic participation of publicity by facilitating the participation of non-represented groups in political life, including youth and physically disabled persons. Moreover, e-voting fosters economic effectiveness and facilitates the effective organization of elections in comparison with traditional voting (Chondros et al., 2014).

Despite the advantages of e-voting implementation, the transition to new technology is accompanied with numerous social, legal and technical problems (Wang et al., 2017). Among those, the equal access to voting points, privacy maintenance, the fight against interventions, the verification of information, examination, alteration and other procedures, universal verification, the right to vote, one voter one vote principle, robustness against errors and etc. can be considered. The necessity of transforming legal obstacles into technical and security solutions can be specifically mentioned

among these (Wang et al., 2017). Nowadays, broad discussions are held from a legal point of view on holding elections and as a result, it is reckoned that the solution of legal issues plays a bridging role between the law and technology.

MCDM FOR CANDIDATE SELECTION IN E-VOTING

The 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 and each of those possesses specific advantages and problems. Some countries abandoned e-voting due to its risky nature. Other countries do not accept the advantages of e-voting in comparison with traditional voting. With the rapid development of Internet starting from 1990's, more politicians, researchers and journalists have started to reflect upon whether e-voting proposes better solutions for elections or referendum. The governments of European counties, numerous scientific incentives of non-government organizations at global scale endeavor the use of the voting methods, the solutions based on ICT application of which constitute the basis of democratic processes (Zetter, 2008; Voting system; Trechsel et al., 2016; Meserve et al., 2017). Nowadays, the majority of countries support e-voting and the growing number of countries reckon e-voting system as useful and practically apply in election processes. Moreover, it is to be mentioned that, the most of efforts are still at the stage of testing and conceptual analysis. The benchmark practice regarding the application of e-voting system at global scale can be characterized by the practice of the USA (Zetter, 2008; Voting system; Trechsel et al., 2016;).

At present, new voting technologies are being implemented not only in USA, but also in several European countries (Voting system; Trechsel et al., 2016). Surely, the efforts to implement e-voting system mentioned above results in various outcomes in different countries. For instance, the analysis of e-voting results from elections to 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 this is the reason to conclude that, citizens consider this voting method as more comfortable and effective (Zetter, 2008; Voting system; Trechsel et al., 2016; Meserve et al., 2017). It is to be noted that, the ratio of 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 as the basis of 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 differences in opinions and skeptical thinking regarding Internet voting in societies (Mona et al., 2013; Musial-Karg, 2014; McCormack, 2016).

Despite the progress achieved towards better development of e-voting systems, there exists 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 can be shown as main drawbacks. In this regard, the development of efficient methods and mechanisms of e-voting 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 participation of citizens in direct decision-making is considered as main advantages of the development of effective e-voting mechanisms. From this point of view, e-voting gains an attention of 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). In this regard, the development

of e-voting technologies and the study of implementation opportunities of new technologies are considered as important research topics.

The proposed approach to the 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, candidates were elected to be appointed to the relevant position. Intelligent quotient (IQ), age, education, work experience, health, the conviction and etc. can be attributed to the criteria for the selection of competence candidates. Binary matrix is used for the evaluation of candidates in the study. The problem statement is as follows:

Let $A = \left(A_1, A_2, ..., A_n\right)$ be candidates and $C = \left(C_1, C_2, ..., C_n\right)$ the criteria set.

Step 1: Each candidate constructs an evaluation matrix for the evaluation of candidate according to each criterion:

$$P_l^k = (p_{ij})_l^k = \begin{Vmatrix} (p_{11})_l^k & (p_{12})_l^k & \dots (p_{in})_l^k \\ \dots & \dots & \dots \dots \\ (p_{n1})_l^k & (p_{n2})_l^k & \dots (p_{nn})_l^k \end{Vmatrix} \quad (1)$$

Here:

$$\left(p_{ij}\right)_l^k = \begin{cases} 1, & \text{if according to the opinion of } \mathrm{A_k} \text{ candidate, } \mathrm{A_i} \text{ is superior to } \mathrm{A_j} \text{ according to } \mathrm{C_l} \text{ criterion} \\ 0, & \text{otherwise} \end{cases}$$

The principal diagonal of P_l^k matrix is constituted of zeros, $\left(p_{ii}\right)_l^k = 0$ and $\left(p_{ij}\right)_l^k = \left(\overline{p}_{ij}\right)_l^k$, if $i \neq j$, $\overline{0} = 1, \overline{1} = 0$.

Step 2: Thereafter, $Q_l = (q_{ik})_l$ outcome matrix is entered and the elements are calculated as below:

$$(q_{ik})_l = \sum_{j=1}^{n} (p_{ij})_l^k,\ i = 1,2,...,n;\ k = 1,2,...,n;\ l = 1,2,...,m \quad (2)$$

$(q_{ik})_l$ - reflects the final opinion of A_k candidate regarding A_j candidate according to C_l (in comparison with all candidates) criterion:

Then:

$$Q_l = \begin{Vmatrix} (q_{11})_l & \dots & (q_{1n})_l \\ \dots & \dots & \dots \\ (q_{n1})_l & \dots & (q_{nn})_l \end{Vmatrix} \quad (3)$$

Step 3: The overall opinion of A_k candidate regarding all candidates is based on C_l criteria is calculated as below:

$$O_l^k = \sum_{i=1}^{n} (q_{ik})_l \,,\; k = 1,2,\ldots,n;\; l = 1,2,\ldots,m \tag{4}$$

Step 4: The rating of A_i candidate according to C_l criterion is determined with the following formula:

$$R_i^l = \sum_{k=1}^{n} (q_{ik})_l \;\; i = 1,2,\ldots,n; \;\; l = 1,2,\ldots,m \tag{5}$$

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

Step 5: According to all criteria, the rating of the candidate A_i can be calculated as below:

$$R_i = \sum_{l=1}^{m} R_i^l = \sum_{l=1}^{m} \sum_{k=1}^{n} (q_{ik})_l \,,\; i = 1,2,\ldots,n; \;\; l = 1,2,\ldots,m \tag{6}$$

Assume that, $w = \left(w_1, w_2, \ldots, w_m\right)$ expresses the weights of criteria. In this case, the weighted rating of the candidate A_i can be calculated with the following formula:

$$R_i^w = \sum_{l=1}^{m} w_l R_i^l = \sum_{l=1}^{m} w_l \left(\sum_{k=1}^{n} \left(q_{ik}\right)_l \right) i = 1,2,\ldots,n; \;\; \text{where, } w_l \in [0,1],\; l = 1,2,\ldots,m, \;\; \sum_{l=1}^{m} w_l = 1 \tag{7}$$

Step 6: Several methods are used for the calculation of weights of criteria in the literature (Saaty, 2008; Rotshtein, 2009; Zadeh, 2016; Alguliyev et al., 2016 and others). For instance, a very simple formula Zadeh L. approach (Zadeh, 2016), Simple Additive Weighting (Rotshtein, 2009; Alguliyev and et al., 2016), Worst-Case Method (Rotshtein, 2009), Shannon Entropy Method (Rotshtein, 2009; Alguliyev et al., 2016), The Analytical Hierarchy Process (Saaty, 2008), etc. can be shown. The alternatives and the ratings of candidates can be evaluated using various approached. This article employs Zadeh L. (Zadeh, 2016) method for calculating the weights of criteria.

NUMERICAL EXPERIMENT

Assume that, 5 candidates are presented based on 3 criteria (for example, education (C_1), work experience (C_2) and professional competencies (C_2)). Based on Formula (1), the evaluation of candidates according to each criterion is given in Table 1-5.

Based on Formulas (2) and (3), the final opinion of candidate A_k regarding candidate A_j is calculated according to the criterion C_l (in comparison with all candidates) and is given in Table 6.

Based on formula (4), the overall opinion of candidate A_k regarding all candidates is calculated based on criterion C_l and is given in Table 7.

The rating of candidate A_i and the rating of candidate A_i is calculated based on formula (5) and formula (6), respectively based on criterion C_l and given in Table 8.

Table 1. Criteria-based evaluation of candidate A_1

	C_1					C_2					C_3				
	A1	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**
A1	0	0	1	0	1	0	1	0	1	0	0	0	0	1	1
A2	0	0	1	0	1	0	0	0	0	1	1	0	0	0	1
A3	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0
A4	1	1	0	0	0	0	1	1	0	0	0	1	1	0	0
A5	0	0	1	1	0	1	0	1	1	0	0	0	1	1	0

Table 2. Criteria-based evaluation of candidate A_2

	C_1					C_2					C_3				
	A1	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**
A1	0	1	0	0	0	0	1	0	1	0	0	1	0	0	1
A2	0	0	1	1	1	0	0	1	0	0	0	0	1	1	1
A3	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0
A4	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0
A5	1	0	0	0	0	1	1	1	1	0	0	0	1	1	0

Table 3. Criteria-based evaluation of candidate A_3

	C_1					C_2					C_3				
	A1	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**
A1	0	0	0	0	1	0	1	1	1	0	0	1	0	1	0
A2	1	0	1	0	1	0	0	0	0	1	0	0	1	0	0
A3	1	0	0	0	1	0	1	0	1	0	1	0	0	0	0
A4	1	1	1	0	0	0	1	0	0	0	0	1	1	0	1
A5	0	0	0	1	0	1	0	0	1	0	0	1	1	0	0

Table 4. Criteria-based evaluation of candidate A_4

	C_1					C_2					C_3				
	A1	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**
A1	0	1	0	1	1	0	1	0	0	0	0	0	0	1	1
A2	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0
A3	1	0	0	1	1	1	0	0	0	1	0	1	0	0	1
A4	0	1	0	0	0	1	0	1	0	1	0	1	1	0	1
A5	0	1	0	1	0	1	1	0	0	0	0	1	0	0	0

Table 5. Criteria-based evaluation of candidate A_5

	C_1					C_2					C_3				
	A1	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**
A1	0	1	0	0	0	0	1	0	0	1	0	0	1	0	1
A2	0	0	0	1	1	0	0	0	0	1	1	0	0	1	1
A3	1	1	0	0	0	0	1	0	0	1	0	1	0	0	0
A4	1	0	0	0	0	1	1	0	0	0	1	1	1	0	1
A5	1	0	1	1	0	0	0	0	1	0	0	0	1	0	0

Table 6. Final opinion of candidates based on 3 criteria

	Q_1					Q_2					Q_3				
A1	2	1	1	3	1	2	2	3	1	2	2	2	2	2	2
A2	2	3	3	1	2	1	1	1	2	1	2	3	1	1	3
A3	1	1	2	3	2	2	2	2	2	2	1	1	1	2	1
A4	2	3	3	1	1	2	1	1	3	2	2	1	3	3	4
A5	2	1	1	2	3	3	4	2	2	1	2	2	2	1	1

Table 7. Criteria-based opinion of each candidate (final opinion)

O_1	9	9	10	10	9
O_2	10	10	9	10	8
O_3	9	9	9	9	11

Table 8. Rating of candidates based on each criterion

R_1	R_2	R_3	R_{sum}	Rating	Rating No.	Candidate
8	10	10	28	3	1	A4
11	6	10	27	4	2	A5
9	10	6	25	5	3	A1
10	9	13	32	1	4	A2
9	12	8	29	2	5	A3

According to Zadeh (2016) approach, if we take the weights of criteria as $w_1 = 0.6$ (high importance (H)), $w_2 = 0.3$ (medium importance (M)) and $w_3 = 0.1$ (low importance (L)) according to their importance, that is, $R_{wSUM} = 0.6(H) \cdot R_1 + 0.3(M) \cdot R_2 + 0.1(L) \cdot R_3$, then, the rating of candidates is given in Table 9 according to Formula (7).

The results can be improved by employing fuzzy hybrid approach for the calculation of the weights of criteria (Lin, 2010; Chang et al., 2013; Sakthivel & Ilangkumaran, 2015).

Table 9. Rating of candidates according to importance of criteria

R_{wSUM}	Rating	Rating No.	Candidate
8,8	5	1	A4
9,4	3	2	A5
9	4	3	A2
10	1	4	A3
9,8	2	5	A1

In general, the effectiveness of e-democracy mechanisms is directly depending on human resources, and the participation of qualified, personnel with competencies in governance is an important issue for 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, in the proposed model can be used different evaluation scale for multi-criteria selection of candidates in e-voting process. With implementing the proposed model can create tools for enables to select a candidate with more relevant competencies within the framework of certain criteria among the candidates.

CONCLUSION

E-voting is one of the main tools of e-democracy. Results of the research have shown that there is a growing interest towards the implementation of new forms of citizen participation such as e-voting on a global scale and European countries. This is substantiated by pilot projects proposed by numerous countries supporting the idea of e-voting in parliaments in the world practice. The paper explores the e-government maturity models and investigates approaches, tools and mechanisms regarding the formation of e-democracy as the latest stage of e-government development. Results of the research show that, e-voting gradually gains more importance and becomes 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 selected by the best candidates for the vacancy. Note that, the effective government functioning is directly depending on human resources, and the participation of qualified, personnel with competencies in governance is an issue of national importance. From this point of view, the candidates' selection with the appropriate competencies in the appointment of the elected candidates to administrative positions as a result of e-voting, which criteria and factors that should be considered in the selection process is referred to topical issues. The paper considers the application of MCDM for the candidates' selection in e-voting.

The approach proposed in the paper is based on candidate evaluation given the relation of each candidate towards another candidate. The rating of candidates is calculated based on MCDM and candidates are selected based on the importance of criteria. The proposed approach enables to select a candidate with more relevant competencies within the framework of selected criteria. In the numerical experiment, five candidates selected on three criteria (education, work experience, and professional competencies) are evaluated and candidates are ranked according to the importance of the criteria. The proposed model allows selection of candidate with competencies based on the criteria set out in the e-voting process and 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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