E-ISNN: 2676-7007

Contents lists available at FOMJ

Fuzzy Optimization and Modelling

Journal homepage: http://fomj.qaemiau.ac.ir/

Paper Type: Research Paper

Score-Distribution-Based Voting System with Feasibility of Plurality-Voted Choice

Homayun Motameni, Seyed Mohammad Mohammadi*

Department of Political Science, Ayatollah Amoli Branch, Islamic Azad University, Amol, Iran

ARTICLE INFO

Article history:
Received 13 December 2021
Revised 24 January 2022
Accepted 28 January 2022
Available online 28 January 2022

Keywords:
Group Decision Making
Voting System
Democracy
Electoral Regulation

ABSTRACT

Voting system as one of the bases of electoral regulations, due to its direct impact on voters' involvement, plays a drastic role in attracting citizens' participation in administration of electoral processes. The Islamic Republic of Iran as a religion-republic-based regime has continually administrated elections in different levels of country management after the Islamic revolution. One of the challenges that serially arises in handling varieties of elections in different periods is the problem of invalid or void ballots which causes decrement of valid ballots' final count, and consequently, degrades the desirability of elections' statistical outcomes. This paper proposes a score-distribution-based voting system with feasibility of assigning score to "plurality-voted" choice. By allowing arbitrary score distribution among candidates, the proposed voting system provides conditions of fair voting for voters to select according to their favorites, preferences, and priorities. Also, the research results indicates that the feasibility of assigning score to "plurality-voted" option potentially reduces the count of invalid and specially, void ballots, and increases the count of final correct votes.

1. Introduction

Political regulations and regimes due to some common factors such as culture, civilization, historical background, religious traits, and level of development have observed variety of evolutions and revolutions all around the world. Although the role of local and global wars is undeniable in birth and death of different regimes; the most influencing factors in this ambit can be traced in beliefs, ideologies, submissiveness, and social selection of a nation. In recent decades, election studies, besides investigation around election regulations and voting systems, have attracted a great attention in social and political research communities, specially, for regimes with "*democratic*" nature. In other words, election has been accepted as the heart of democratic processes in the world which facilitates public and/or political parties' participation by employing voting system [4]. When the people of a society with distinctive favorites and different preferences should choose one or more

* Correspondig author
E-mail address: s.m.mohammadi@iauamol.ac.ir (Seyed Mohammad Mohammadi)

DOI: 10.30495/Fomj.2022.1949802.1056

among many candidates, phenomenon of election occurs. The algorithm which calculates the "*best*" choice according to voters' preferences under the election process is generally called "*voting*". In most common condition, one candidate wins the election as outcome of such system [20]. However in some cases, more than one candidate may be introduced as winner depending on the goal of election. Election's outcome by the majority of people in a society can affect different aspects of life of all the citizens. Therefor it is reasonable to employ a voting system which is capable to apply voters' most overall preferences [5].

Islamic Republic of Iran (IRI) after revolution of February 11th, 1979 (Bahman 22th, 1357) has continually emphasized on public participation in different areas of regime structure construction under the term of "*republic*". Numerous principals of constitution of IRI clearly indicate that most of the political positions, e.g. presidency, membership of council of experts, and membership of parliament, are determined by periodical public elections [7]. By considering the importance of public elections in IRI, enhancement of public participation and reducing related challenges are among crucial topics in this ambit. One of the ever-seen challenges in all durations of elections in IRI is the phenomenon of "*void*" or generally "*invalid*" ballots. According to constitution of IRI, ballots with some contents are considered as invalid, such as: ballots containing the name of unapproved candidates; void ballots; and scrabbled (unreadable) ballots. Invalid ballots are taken into account in total number of ballots, while they are not considered as valid ballots of any of candidates [7], hence, these types of ballots potentially reduce the final number of votes belonging to winner(s). Therefore, it is obvious that invalid ballots are basically undesirable in election's statistical reports. As mentioned before, invalid ballots are ever-seen in all durations of elections in IRI. Although, the exact reason which leads to this challenge is unknown, there exist some impressions about this argue, which are listed as follows:

- The favorite candidate of the voter has not been approved by related administrator organization;
- Voter is hesitant to select a candidate (for single winner elections) and tries to choose two or more candidates according to his/her own preferences;
- Voter has no choice in approved list, but wants to use his/her choice-right by participating in election with a void ballot, and consequently accepts the plurality-voted choice.

Investigation in literature addresses valuable researches based on mathematical models employed to constitute voting systems with the goal of handling voting challenge based on voters' favorites, preferences and priorities: Alcantud et al. [1], Azadfallah [2], Azadfallah [3], Cheng and Deek [6], Dery et al. [8], Dery et al. [9], Diss and Tsvelikhovskiy [10], Dudycz et al. [11], Eggers [12], Hajimirsadeghi and Lucas [13], Kim and Ahn [14], Liamazares and Pena [15], Mirzaei [16], Montes et al. [17], Nalic et al. [18], Obata and Ishii [19], Soltanifar et al. [21], Stanovov et al. [22], Stein et al. [23], Tajvidi Asr et al. [24], Wang et al. [25], and Yang et al. [26].

The main research gap in the literature can be presented as a question: How a voter can choose the plurality-voted choice as his/her vote while filling the ballot? In the other words, how a voter can fill the ballot with the option of plurality-voted choice, instead leaving the void ballot in the process of voting? On the other hand, in multi-winner elections one may consider the plurality-voted choice as an addition option besides normal list of candidates. However, by taking every kind of approaches into account, the probability of invalid ballots occurrence would not be thoroughly tackled, current study proposes a voting system based on score distribution with feasibility of plurality-voted choice, which intends to satisfy denoted research gap. Therefor the contributions of current paper are presented as follows:

- A voting system based on score distribution with feasibility of plurality-voted choice is designed.
- The ballot structure is proposed.
- Protocols of voting, vote counting, winner(s) determining, and corresponding algorithms and formulas are proposed.

The rest of the paper is organized as follows. Section 2 gives an overview on related studies; Section 3 is dedicated to propose voting system and its fundamentals. Discussion and a brief illustrative example are represented in Section 4; and Section 5 follows the conclusion and future directions.

2. Related Works

Electoral regulation and voting system have a great importance in the current policies of nations, specially, in construction of regimes with democratic and republic foundations where attentions are focused on priorities, favourites, and preferences of majority (or plurality) of citizens. Due to the mentioned importance, many studies are performed on proposing voting approaches which are suitable for taking priorities and preferences of voters into account. Current section has an overview on related studies.

Alcantud et al. [1] proposed a computational and formal analysis of the measurement of consensus in a society. The study proposed a unifying model which makes a consistent decision in terms of the individual preferences. Then the model measures the consensus that arises from it. Finally, a computational analysis of Borda and the Copeland rules under a Kemeny-type measure are used to compare their respective performances. Azadfallah [2] proposed a Multiple Attribute Group Decision Making (MAGDM) model based on the improved Analytic Hierarchy Process (AHP) which resulted in more assuredness by applying a systematic model. The proposed model showed a desirable effectiveness and feasibility in comparison against TOPSIS and Borda's function approaches. Azadfallah [3] proposes three approaches: election result prediction by pre-election preference information using Markov chain model; Improved Borda's function method using the weights of voters; And TOPSIS-based approach applying ordinal set of preferences for ranking candidates in voting systems. Finally, three numerical examples in social choice context are given to show the feasibility of the proposed methods. Cheng and Deek [6] firstly represent a theoretical framework for studying and using voting in Group decision support systems (GDSS). In next step, the factors related to voting are examined. This step is followed by proposing and discussing classifications of voting methods. The paper also investigates issues for implementing advanced voting tools in GDSS and suggests specific methods of augmenting voting functionalities in existing GDSS. Dery et al. [9] implemented the secure system that was proposed in Dery et al. [8] and described the system's components – election administrators, voters and talliers – and its operation. The implementation was in Python open source environment. The research presented a demo as an essential step towards convincing decision makers in communities that practice score-based elections to adopt it as an election platform. Diss and Tsvelikhovskiy [10] studied about coalitional manipulability within the class of scoring voting rules. An approach to characterize all the outcomes which are manipulable by a coalition of voters was introduced. The paper opened the possibility of determining the probability of manipulable outcomes for scoring voting rules in the case of small number of alternatives and large electorates. Dudycz et al. [11] proposed an approximability of Thiele rules, which are known to be NP-hard to solve exactly. Authors provided a tight polynomial time approximation algorithm for a natural class of geometrically dominant weights that includes such voting rules as Proportional Approval Voting or p-Geometric. The research proved that better approximation ratio cannot be obtained even in time f(k)*pow(n,o(k)).

Eggers [12] proposed a diagram for describing and analysing single-winner elections in which voters rank the candidates, Condorcet methods, and instant-runoff voting. The proposed diagram shows how the outcome of an election depends on each candidate's share of top rankings as a function of the voting system and the pattern of lower rankings. Research shows how the diagram can concisely present preferences and results under different voting systems, identify Condorcet cycles, highlight system properties such as join-inconsistency and the no-show paradox, and illuminate strategic voting incentives. Hajimirsadeghi and Lucas [13] have focused on proposing a fuzzy extension of TOPSIS with a quantifier guided distance metric and majority opinion aggregator for multi-criteria decision making in a group decision environment. The distance metric was defined

based on OWA aggregators which use linguistic quantifiers to have linguistic definitions for proximity. On the other hand, the majority opinion aggregator is used to make a consensual judgment for synthesizing the individual opinions. A human resource selection problem was considered as the case study. Simulation results showed that proposed algorithm was effective in reflecting opinions of the majority of decision makers and provided more confidence for their decisions. Kim and Ahn [14] presented a new ranking method for a ranked voting system that explicitly considered the unknown discriminating factors as they were. Authors solved a dual of a dominance problem for a pair of candidates to manage the unknown discriminating factors. Then they computed the volume of a set of the discriminating factors in favor of a candidate over another. A decision rule indicated that a candidate in a pair of candidates is preferred to another if the pair of candidates results in a larger volume than the reversed pair of candidates in that more discriminating factors necessarily yield a larger volume and thus more evidence in favor of a candidate over another exists. Results showed that the volume-based ranking method can be used to obtain the rank order of candidates in situations where any prior information on the discriminating factors is unavailable.

Liamazares and Pena [15] proposed a model that allows each candidate to be evaluated with the most favourable weighting vector for him/her and avoids the previous drawback. Moreover, in some cases, a closed expression for the score assigned with model to each candidate was given. Mirzaei [16] has proposed a model based on fuzzy logic to solve the weaknesses of the previous models. The proposed model was based on the solving of multi-objective programming models with the help of fuzzy logic, in this way it provided a vector of common weights, and finally, the alternatives can be ranked. Montes et al. [17] introduced a probabilistic framework that makes possible to explore a correspondence between some usual voting procedures based on either preference orderings or individual evaluations and some classical stochastic orderings. The paper also considered a multivariate stochastic ordering, called probabilistic preference, and showed its connection with the plurality and veto procedures. Nalic et al. [18] proposed a hybrid data mining model based on combination of various feature selection and ensemble learning classification algorithms, in order to support decision making process. The research also proposed a voting method that performed an acceptable functionality. The experimental results showed that hybrid model that was based on features selected by the proposed voting method and ensemble model performed the highest performance. Obata and Ishii [19] proposed a method that does not use information about inefficient candidates to discriminate efficient candidates. The proposed method has solved a weak point that the order of efficient candidates may be changed by existence of an inefficient candidate. Soltanifar et al. [21] represented a methodology to rank the ranking models for the performance indices of only Data Envelopment Analysis (DEA) efficient candidates based on a voting model. Also, an approach for combining the results obtained from the ranking models was presented.

Stanovov et al. [22] studied on confidence-based voting of neural net classifier and fuzzy logic based classifiers. For the cases when the fuzzy system was confident enough in its decision, fuzzy system makes the decision, otherwise, the neural net was applied. The experimental results showed that proposed setup allowed improving the classification quality, meanwhile, allowed to explain the classification process the explanation of the classifier functioning. Stein et al. [23] proposed a stochastic dominance which was used to define a partial ordering of candidates. The effect of choosing different point values and, in particular, determined all possible orderings of the candidates was studied. Finally, some examples from sports competitions was used as illustration samples. Tajvidi Asr et al. [24] proposed multi attribute decision making (MADM) methods including simple additive weighting (SAW), technique for order preference by similarity to ideal solution (TOPSIS), and linear assignment (LA) were used for selection of a proper support system for Beheshtabad water transporting tunnel from among the six proposed support systems by considering the attributes of cost, safety factor, applicability, installation time, displacement and capable of mechanization. Aggregation of the results of ranking by the ranks mean, borda and copland techniques were led to the suggestion of a support

system of injectional rock-bolt 3 m in length with 1.5×1.5 m distance together with shotcrete by 10 cm in thickness. Wang et al. [25] proposed three new models to assess the weights associated with different ranking places. Two of them were linear programming (LP) models which determine a common set of weights for all the candidates considered and the other was a nonlinear programming (NLP) model that determined the most favourable weights for each candidate. The proposed models were examined with two numerical examples and it was shown that the proposed models not only choose a winner, but also give a full ranking of all the candidates.

Yang et al. [26] proposed a ranked choice online voting system, which eliminated hardwired restrictions on the possible assignments of points to different candidates according to the voters' personal preferences. In order to protect the confidentiality of the votes, each cast ballot was encrypted using the exponential ElGamal cryptosystem before submission. In addition, during voting the system ensured that proofs were generated and stored for each element in the cast ballot. These proofs could then be used to verify the correctness and the eligibility of each ballot before counting without decrypting and accessing the content of the ballot. The security and performance analyses demonstrated that proposed method has achieved improvements in comparison with the previous systems, and it was shown that proposed protocols were feasible for practical implementations.

3. The Proposed Voting System Model

Voting process as an important portion of electoral system and regulation is one of the bases of nation participation in regime's construction in democratic and republic societies. People's votes influence a regime's policies directly or indirectly through election process. Obviously, security, calculation precision, and flexibility of voting system has an inevitable impact on public trust and citizens' participation in election event.

In this section, four necessary properties of proposed score-distribution-based voting system with feasibility of plurality-voted choice, are represented in details, include: ballot designing, and required steps for voting by voters, counting algorithms, and determining the winner(s). The proposed system can cover technical capabilities of many classes of electoral systems, such as: proportional, ranking based, and score systems. Also, by considering the protocols which are used for vote counting and winner(s) introducing, the proposed voting system would be customized to be employed for single/multi winner elections based on majority/plurality choice. Meanwhile, the proposed system would be implemented in both manual and electronic versions.

Score distribution in proposed system is defined as assigning arbitrary portions of one vote (belonging to one voter) to his/her favourite candidate(s). Also, voter can arbitrary assign a portion of the vote to an extra option: plurality-voted choice. The independent variable "*Score*" carries the assigned portion of vote to each item (include candidates and plurality-voted choice) which can be a value in [0, 1] interval. The numerical index i is used for traverse on list of items which is defined on $\mathbb{N}$. So, if there exist n items in the candidates list, then we have: $i = 1,2,3,...,n$. In a similar manner, numerical index j is used for traverse on participants or voters. Therefore, if there are m individuals in voters' population, then we have $j = 1,2,3,...,m$.

The ballot in proposed system includes the list of approved candidates from administrator organization with an additional option: plurality-voted choice. Each of items in ballot can receive a score defined in [0, 1] interval, so that, the summation of scores in each ballot does not exeed 1.00. Accordingly, the summation of assigned scores in each ballot would be calculated as eq. (1):

$$Total_{Score} = \left[\sum_{i=1}^{n} Score(i) \right] + Score\left(pluralityVote \right) \le 1 \tag{1}$$

where $0 \le Score_i \le 1$, as mentioned earlier. Figure 1 illustrates the structure of the ballot.

The total number of votes of each candidate is calculated by summation of his/her scores from all of the ballots, according to eq. (2):

$$Total_{Score(i)} = \sum_{j=1}^{m} Score(i, j), \quad \forall i, (1 \le i \le n) \tag{2}$$

After counting the number of votes belonging to each candidate, results should be sorted in descending manner. Then the winners are respectively introduced from top of the ordered list for multi-winner elections.

For single-winner elections, if the total score achieved by a candidate is more than half of voters, then the candidate is winner, according to eq. (3):

$$Total_{Score(i)} \ge \frac{m}{2} \tag{3}$$

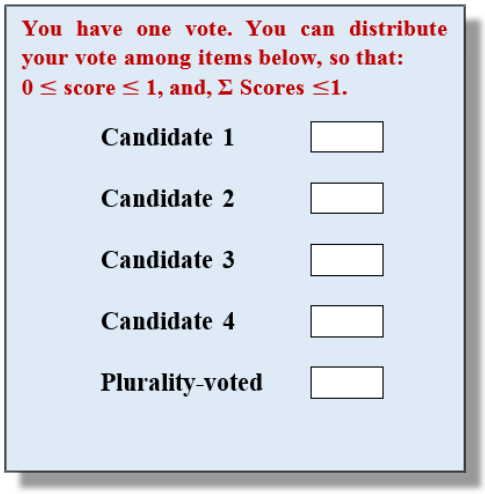


Figure 1. Structure of ballot for proposed voting system

Also, if the average of score belonging to a candidate from all of the ballots is greater than 0.5, then the candidate is winner, according to eq. (3) defined above: *if* $\overline{Score_i} > 0.5$ *then* $\overline{Score_i} \times m \ge m/2$

If the winner is not exactly determined in one round, the second round election will introduce the final result in a similar way with traditional two-round election system.

The proposed score-distribution-based voting system represents the advantage of consistency with well-known voting systems such as: plurality/majority, proportional, ranking, scoring, and single/multi winner systems. Hence, by considering the integration of voting system and simplicity of calculations, the proposed system can be employed in administration of electoral events. Specially, the proposed system is compatible with fair social selections based on preferences and priorities of participants. In addition, when a voter is not able to make an exact decision, the novelty of proposed voting system (feasibility of assigning score to plurality-voted choice), can help him/her to respect to the nation-voted candidate(s) instead of leaving a void or invalid ballot.

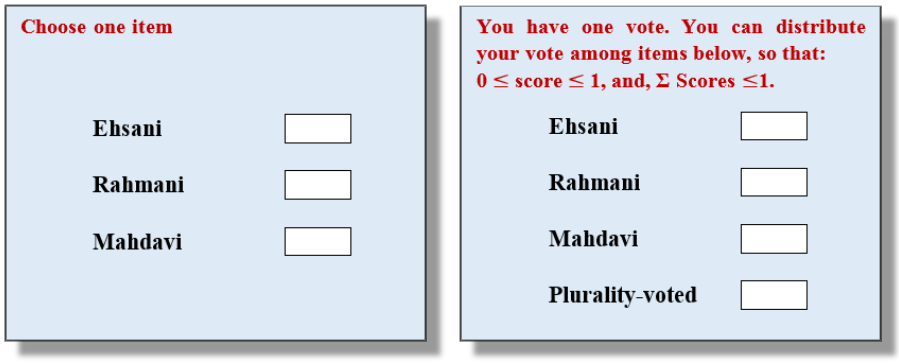
In the next section, the feasibility and applicability of the proposed voting system is examined using an illustrative example of group decision making case.

4. Discussion and illustrative example

For representing an intuitive application of proposed voting system, we employed proposed system versus the traditional approval voting system in an example of group decision making: selecting the head of department.

Two types of ballots corresponding to approval voting system and proposed voting system, shown in Figure 2(a) and 2(b) respectively, were distributed among twenty persons of faculty members of a department, as voters. The voters were asked to fill the ballots respecting to their own favourites, preferences and priorities. Outcome of the examination is summarized in Table 1.

As Table 1 shows, the possibility of score distribution among candidates, along with existence of plurality-voted choice option in ballot of Figure 2(b) not only has reduced the number of invalid/void ballots, but also has increased the number of votes of winner voted by majority of voters. By considering the plurality-voted score, the winner has achieved more than half of votes and gained the majority-voted label, while the winner of ballot of Figure 2(a) has gained the plurality-voted label. So, the role of plurality-voted choice in reducing the number of invalid/void ballots is significant.



(a): Approval voting system ballot (b): Proposed voting system ballot

Figure 2. Two types of ballots used in voting example

Table 1. Results of voting example

	# of voters	winner	# of invalid ballots	plurality-voted score	Final result
Ballot Fig. 2(a)	20	Rahmani (8 votes)	3	-	Rahmani (8 votes)
Ballot Fig. 2(b)	20	Ehsani (8.5 score)	1	4.8	Ehsani (13.3 score)

A brief comparison between outcomes of two types of ballots can clearly show that the winner of Figure 2(a) ballot has gained the plurality vote (the most votes, but less than 50 percent of voters). While the winner of Figure 2(b) ballot won the majority vote (the most votes, and more than 50 percent of voters), due to gaining the score of plurality-voted option. This advantage is desired in elections with the requirement of having a majority-voted winner. In such elections, if the winner gains the plurality vote, generally the second round is needed to determine the winner of majority. Obviously, administration of an additional round of elections increases related expenditures in different aspects. The other noticeable outcome is that when the approval system switches to proposed system, the winner is changed. This event can prove this fact that when the voting system is flexible, the actual preferences of all voters can be applied in their choices. This condition results in more precise voting process which is called "fair" and even can change the chance of victory.

As discussed in Section 3, due to integrity of proposed voting system and ease of calculations, the proposed system is flexible enough to be used in a variety of electoral administrations. Table 2 summarises a comparative representation of some existing voting systems' properties against the characteristics of proposed score-distribution-based voting system.

Table 2. Comparison among properties of some existing voting systems vs. proposed system

Ref #	approval	proportional	ranking	scoring	Plurality-voted choice
[9]	✓		✓	✓	
[10]			✓	✓	
[11]	✓	✓			
[14]			✓		
[18]	✓			✓	
Proposed	✓	✓	✓	✓	✓

5. Conclusion

Electoral systems and voting processes are accepted as an inevitable portion of electoral regulations in regimes with democratic or republic foundation. Voting systems in interaction with citizens reflect the nation participation in construction of a regime. After revolution of 1979, IRI has continually administrated elections in different levels of country management. One of the ever-seen challenges that has arisen in different elections of IRI is the problem of invalid or void ballots which causes decrement of valid ballots' final count, and consequently, degrades the desirability of elections' statistical outcomes. This paper proposed a score-distribution-based voting system with feasibility of assigning score to "plurality-voted" with the goal of reducing aforementioned challenge by allowing voters to arbitrarily distribute their vote score among candidates besides plurality-voted choice, based on their own priorities, preferences, and favourites. Our intuitive results denote the feasibility of distributing vote's score among candidates besides assigning score to "plurality-voted" option. The proposed system reduces the count of invalid and, specially, void ballots, meanwhile, increases the count of final correct votes. As future direction, fuzzy and probabilistic voting approaches can be used to enhance election process precision. Also, data mining and knowledge engineering techniques can be employed to discover patterns of ruling in different political parties which aim to design voting decision making systems.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Alcantud, J. C. R., de Andrés Calle, R., & Cascón, J. M. (2013). A unifying model to measure consensus solutions in a society. *Mathematical and Computer Modelling*, 57(7-8), 1876-1883.
2. Azadfallah, M. (2016). A new aggregation rule for ranking suppliers in group decision making under multiple criteria. *Journal of Supply Chain Management Systems*, 5(4), 38–48.
3. Azadfallah, M. (2021). Three new models for ranking of candidates in the preferential voting systems. *International Journal of Management Research and Social Science*, 8(2), 60-75.
4. Bogdanor, V., & Butler, D. (Eds.). (1983). *Democracy and elections: Electoral systems and their political consequences*. CUP Archive.
5. Bouyssou, D., Marchant, T. and Perny, P. (2009) 'Social choice theory and multi criteria decision aiding', in Bouyssou, D., Dubois, D., Pirlot, M. and Prade, H. (Eds.): Decision-making Process: Concepts and Methods, ISTE, London, UK.
6. Cheng, K. E., & Deek, F. P. (2012). Voting tools in group decision support systems: theory and implementation. *International Journal of Management and Decision Making*, *12*(1), 1-20.
7. Constitution of Islamic Republic of Iran. (1980) (1358).
8. Dery, L., Tassa, T., & Yanai, A. (2021). Fear not, vote truthfully: Secure Multiparty Computation of score based rules. *Expert Systems with Applications*, 168, 114434.
9. Dery, L., Tassa, T., Yanai, A., & Zamarin, A. (2021). A secure voting system for score based elections. In Proceedings of the 2021 ACM SIGSAC Conference on Computer and Communications Security. 2399-2401.
10. Diss, M., & Tsvelikhovskiy, B. (2021). Manipulable outcomes within the class of scoring voting rules. M*athematical Social Sciences*, 111, 11-18.
11. Dudycz, S., Manurangsi, P., Marcinkowski, J., & Sornat, K. (2021). Tight approximation for proportional approval voting. In Proceedings of the Twenty-Ninth International Conference on International Joint Conferences on Artificial Intelligence. 276-282.
12. Eggers, A. C. (2021). A diagram for analyzing ordinal voting systems. *Social Choice and Welfare*, 56(1), 143-171.
13. Hajimirsadeghi, H. and Lucas, C. (2009) Extended TOPSIS for group decision making with linguistic quantifier and concept of majority opinion, 1–7 [online] https://www.semanticscholar.org (accessed 20 July 2017).
14. Kim, J. H., & Ahn, B. S. (2021). Volume-based ranking method for a ranked voting system. *International Transactions in Operational Research*, 0(2021), 1-20.
15. Liamazares, B., & Pena, T. (2013). Aggregating preferences rankings with variable weights. *European Journal of Operational Research*, 230(2), 348-355.
16. Mirzaei, S. H. (2019). Ranking voting systems with using fuzzy logic. *Journal of Decisions and Operations Research*, 3(4), 317-324.
17. Montes, I., Rademaker, M., Pérez-Fernández, R., & De Baets, B. (2020). A correspondence between voting procedures and stochastic orderings. *European Journal of Operational Research*, 285(3), 977-987.
18. Nalic, J., Martinovic, G., & Žagar, D. (2020). New hybrid data mining model for credit scoring based on feature selection algorithm and ensemble classifiers. *Advanced Engineering Informatics*, 45, 101130.
19. Obata, T., & Ishii, H. (2003). A method for discriminating efficient candidates with ranked voting data. *European Journal of Operational Research*, 151(1), 233-237.
20. Polykovskiy, S., Berghammer, R. and Neumann, F. (2016). Solving hard control problems in voting system via integer programming. *European Journal of Operational Research*, 250(1), 204–213.
21. Soltanifar, M., Ebrahimnejad, A., & Farrokhi, M. M. (2010). Ranking of different ranking models using a voting model and its application in determining efficient candidates. *International Journal of Society Systems Science*, 2(4), 375-389.
22. Stanovov, V., Akhmedova, S., & Kamiya, Y. (2020). Confidence-based voting procedure for combining fuzzy systems and neural networks. *In IOP Conference Series: Materials Science and Engineering*, 734(1), 012087. IOP Publishing.
23. Stein, W. E., Mizzi, P. J., & Pfaffenberger, R. C. (1994). A stochastic dominance analysis of ranked voting systems with scoring. *European Journal of Operational Research*, 74(1), 78-85.
24. Tajvidi Asr, E., Hayaty, M., Rafiee, R., Ataie, M., & Jalali, S. E. (2015). Selection of Optimum Tunnel Support System Using Aggregated Ranking of SAW, TOPSIS and LA Methods. *International Journal of Applied Operational Research*, *5*(4), 49-63.
25. Wang, Y. M., Chin, K. S., & Yang, J. B. (2007). Three new models for preference voting and aggregation. *Journal of the Operational Research Society*, 58(10), 1389-1393.
26. Yang, X., Yi, X., Nepal, S., Kelarev, A., & Han, F. (2018). A secure verifiable ranked choice online voting system based on homomorphic encryption. *IEEE Access*, 6, 20506-20519.

Motameni, H., & Mohammadi, S. M. (2022). Score-Distribution-Based Voting System with Feasibility of Plurality-Voted Choice. *Fuzzy Optimization and Modelling Journal*, 3 (1), 1-10.

https://doi.org/10.30495/fomj.2022.1949802.1056

Received: 13 December 2021 Revised: 24 January 2020 Accepted: 28 January 2022