A Neutrosophic Model for Blockchain Platform Selection based on SWARA and WSM

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Abstract

The blockchain as a distributed ledger with flourishing blocks are secured and linked with cryptographic hashes. The blockchain is a type of distributed database that is used in many vital business transactions of replication, sharing, tracking, synchronization data among various sites. Recently, the global technological and industrial revolution is accelerating, the bitcoin extends the industrial revolution to become a lot of interest from both the business world and academic circles. This paper aims to take the advantages of blockchain concepts to be applied in Enterprise Banking Systems (EBS). The EBS depend on smart contract and blockchain technologies for trust only the installation of a blockchain platform with a solid design and a proven user base. Unfortunately, only a few blockchain platforms (BP) have achieved stable design and confident implementation. The selection of appropriate BP is leading step for decision makers that pretended to be a real challenge. Therefore, any digital transformation project that makes use of blockchain must contend with the difficulty of selecting a BP that is suited to the requirements of EBS. In this study, a hybrid approach of a neutrosophic theory for uncertainty conditions in a multi-criteria decision-making problem with the use **wise weight assessment ratio** analysis (SWARA) and Weighted Sum Method (WSM) to select the appropriate and efficient BP. A case study is applied on EBS, as an uncertain environment, to show the efficiency for the proposed model in aiding decision makers to achieve to ideal BP according to challenges to achieve sustainability.

Keywords: Blockchain; MCDM; SWARA; WSM; Neutrosophic Sets; Enterprise Banking System.

1. Introduction

As the dawn of the 21st century has seen a rapid technological development in various disciplines e.g., financial, commercial, and industrial sectors. Nowadays the use of technology is an vital discipline for the progress for enterprises. The newly introduced technology will have a significant impact on the operations of the business. Therefore, considering the introduction of a new technology is strongly recommended. Nowadays technology is available almost everywhere, a poll was conducted in forty different nations, and the results showed that 67% of individuals are utilizing the internet[1], [2]. The use of smartphones has also seen an increase in popularity. The manufacturing industry, the service sector, and even leisure activities have all profited from technological advancements. Technology raises people's overall well-being and quality of their lives [3], [4]. Evaluating the prospective value of innovations, as well as their advantages for an organization's competitiveness and profitability, is an important part of the technology selection process. As a consequence of advancements in technology, the use of blockchain technology (BT) in commercial settings is becoming more widespread [5], [6]. BT is a method for the creation of distributed databases that use a decentralized processing system for the transactions. Blocks in Bitcoin have linked each other, and each block may include several transactions. The bitcoin facilitates peer to peer exchange according to decentralized protocols. Before any transaction submitted

Doi: https://doi.org/10.54216/NIF.010204
Received: December 01, 2022 Accepted: March 10, 2023

to the system as a freshly produced block, a recently completed transaction must have its legitimacy checked to ensure it is genuine. A sequence of transactions may be thought of as a blockchain's representation[7]–[9]. The Bitcoin transactions are open to the public. As a result of the growing need from companies and governments to conduct transactions in a more secure manner, BT was developed. The recent anticipation vision's ensures the widespread adoption of BT will have a significant effect on businesses in the foreseeable future[10], [11].

The use of blockchain technology and traditional financial systems resulted in an increase in the power that is exercised among counterparties. There is a possibility of the existence of universal blockchain that can reduce the requirement for intermediaries. To verify financial transactions and the friction that is created in financial networks as a result of the various intermediaries, typically make use of a variety of technological infrastructures[12]–[14]. In principle, such a linked infrastructure has the possibility of providing large efficiency advantages by minimizing the need for duplicate record keeping, doing away with the need for reconciliation, lowering the likelihood of mistake, and allowing for speedier settlements[15]–[17].

In the current environment, the enterprise-bank interactions are undergoing a significant transformation. As seen from the viewpoint of the businesses, the establishment of these ties is done so with the intention of establishing banking assistance for the companies, carrying out individual operations, and constructing financial support for the businesses. Because of this, having productive interactions between a company and a bank is a crucial step towards accomplishing the strategic financial and non-financial goals of an organisation while simultaneously putting their strategic plans into action.

Online finance firms are well aware that finance is not a separate entity, but rather an element that is interwoven inside a variety of different real-life settings[18]. As a result, the most effective strategy for increasing the size of the target market is to develop platforms on mobile terminals and offer applications that are tailored to a variety of use cases to keep the customer's attention. Therefore, this paper aims to select best BP in EPS[19], [20]. This selection problem has a conflicting criterion, so the concept of MCDM is employed in this paper. Hence, achieving to the appropriate BP is a vital aspect according to decision makers (DMs) to choose between competing needs and face a significant degree of ambiguity in their choices.

MCDM addresses the challenges involved with the optimal alternative selection (or ranking). These techniques are used across a broad range of industries. Recent years, the publications in the academic world use various MCDM methodologies in the blockchain space, mostly for the purpose of selection blockchain platform. It is underlined that MCDM approaches have the potential to be used for BP selection, which involves determining the most significant criteria and assigning weight. But the process of selection BP surrounded with an uncertain information. Hence, the neutrosophic sets used to overcome uncertainty conditions[21]–[24]. The MCDM is employed with the neutrosophic set to select the most appropriate BP. The SWARA and WSM methods addressed the way of achieving the ideal solutions BP. The SWARA illustrated to obtain weights of criteria to show the priorities to be clear for DMs. The WSM used to numerically rank the possible alternatives to efficiently aid DM to achieve to sustainable EPS.

The study is structured as follows. Section 2 mentions the related work for blockchain technologies and the motivations of EPS. Section 3 describes the proposed model and focuses on the various research methodologies that were used in this study. In Section 4, a numerical case study to show the importance and the efficiency for the proposed model. Sensitivity analysis presented in section 5. Section 6 presented the comparative study. Finally, section 7 summarizes conclusion and future work.

2. Literature Review

In this section, the previous studies related to blockchain are illustrated to show the need for the use of MCDM neutrosophic theory in uncertainty conditions. In the context of a developing economy, Vafadarnikjoo et al. [25] have a sophisticated understanding of the obstacles that stand in the way of using blockchain technology in the supply chain. In addition, a structure for an action plan that might be used to validate blockchain transactions in an emerging market was developed. This would give useful insights. At the beginning, numerous possible roadblocks to the use of blockchain technology were recognized based on the existing body of research. These roadblocks were then examined by industry professionals with the intention of developing a decision framework. In order to conduct the evaluation and figure out what course of action to take, a panel of six

Doi: https://doi.org/10.54216/NIF.010204
Received: December 01, 2022 Accepted: March 10, 2023

specialists in Iranian manufacturing was consulted. The framework had a total of five obstructions. The study created and utilized a technique known as N-AHP, which was used to assess and prioritize the most pertinent obstacles to blockchain technology based on their importunate in the context of Iran's six different manufacturing sectors. By taking into consideration the suggested action plan framework, administrators and policymakers in the case firms that were researched have the potential to make substantial practical contributions to the production of SCs for the adoption of blockchain technology.

Cali et al. [26]ranked the importance of a variety of energy use cases in which blockchain technology has the potential to be employed to actively produce extra value. In order to assess and rank a collection of current use cases of an energy blockchain system, they introduced a Type-2 Neutrosophic Number (T2NN) based EDAS. The approach is evaluated and validated by comparing it to one other T2NN-based MCDM model as well as an existing technique taken from the research literature.

Aliahmadi and Nozari[27] have made an effort to evaluate security indicators in the AIoT and blockchain-depend smart supply chain using a mixed judgement approach in a fuzzy neutrosophic environment. This attempt was undertaken in response to a question posed by Nozari. To examine the interrelations and order of these obstacles while reflecting the vagueness and impreciseness of human judgment, Promentilla and Kuok[28] developed a unique T-spherical Neutrosophic Fuzzy DEMATEL-ANP. An illustrated case study is offered in order to investigate the obstacles that stand in the way of the widespread use of blockchain technology for trash managing in future smart city projects in Cambodia. The results arising from this problem approach might give policymakers with insights and speed up the deployment of blockchain technology in confluence with the building of smart cities. A multi-criteria assessment approach based on type-2 neutrosophic numbers (T2NNs) was established by Torkayesh et al. [29]in order to uncover reasons leading to the failure in the adoption of IoT and blockchain in smart MWM systems in Istanbul, Turkey. According to the findings of the case study, the primary reasons that contribute to the inability of an organization to successfully embrace smart technologies are a lack of skilled employees, market acceptability, transparency, and training for various stakeholders.

Kim and Shin [30]conducted research on the effect that the BCT application had on the cooperation and performance of the supply chain. The blockchain, a relatively new information technology platform, has been used most often in the markets for digital currencies. It is anticipated that its application to supply chain cooperation will be helpful as a result of the characteristics of BCT, which include greater transparency, information data integrity, and smart contracts. Abid Haleem and colleagues [31]conducted research on Blockchain technology and the substantial advantages it offers in the medical field. In the world of medicine, apps built on blockchain technology have the potential to precisely detect significant and even hazardous errors. Mohd Javaid and colleagues[32] addressed the significant potential of Blockchain in the context of Industry 4.0. For the purpose of gaining insights, a number of different drivers, enablers, and related capabilities of Blockchain technology for Industry 4.0 are examined.

Hutsaliuk et al. [33]established a method to identifying engagement tactics appropriate for this particular sort of stakeholder. Their strategy consisted of the steps outlined: deciding the interaction aims for both businesses and banks; clarifying and making comparisons potential partners; scoring banks to explain the selected partner or partner organisations for interaction; and choosing communication techniques and forming the material of the behaviour patterns that are inherently present in businesses. Abhishek and Stuti [34]gave a summary of Blockchain Technology, including its advantages and a focus on the ways in which the technology may be used in the Indian banking sector.

Doi: https://doi.org/10.54216/NIF.010204
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Guo and Liang [19]came to the conclusion that blockchains might potentially change the underlying technology of the support financially and credit information systems in banks, which would result in an upgrade and transformation of such systems. Garg et al. [35]established criteria to assess the considered business advantages of using blockchain technology in the banking industry. They also looked at the potential business advantages associated with using blockchain technology. Issues about safety, principles, and standards are very necessary for the functioning of a bank.

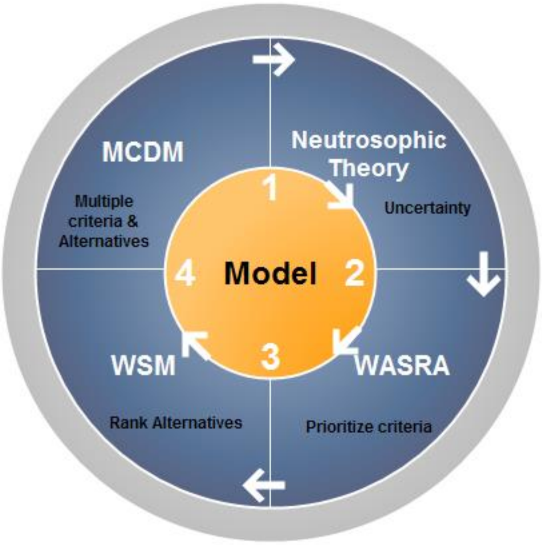

Figure 1: The proposed neutrosophic model of BP selection

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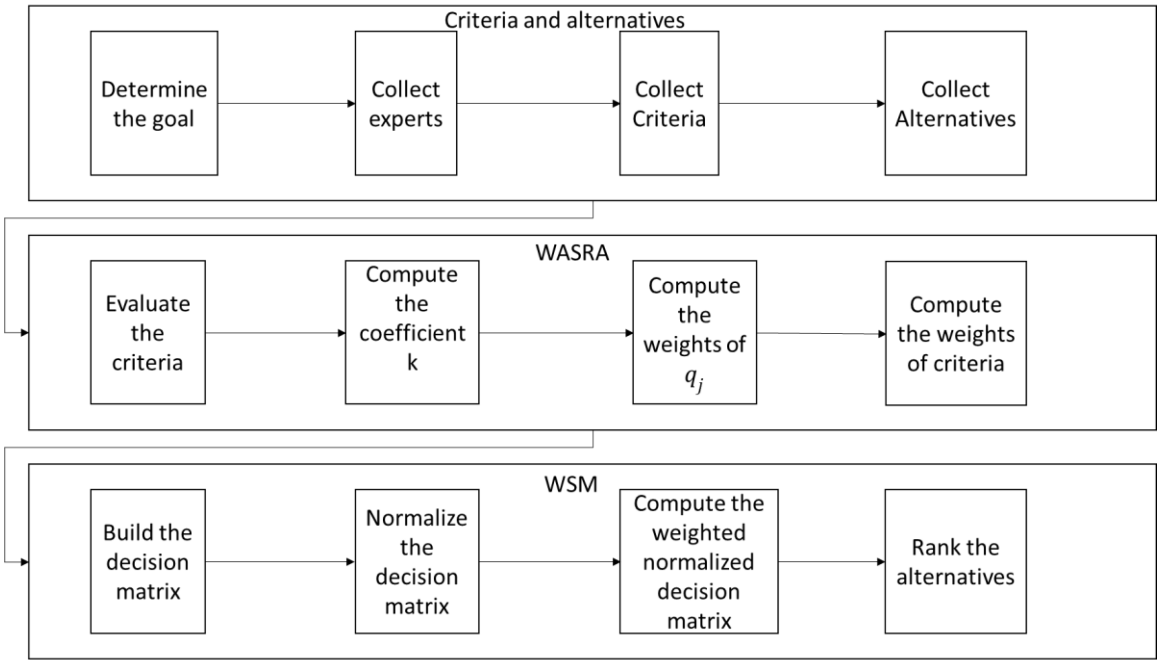

Figure 2: Steps for the proposed model.

3. The Proposed Neutrosophic Model for BP selection

The neutrosophic theory addressed the real environmental circumstances of uncertainty to aid decision makers in various levels to make ideal decisions achieving sustainability of enterprises[36]–[39]. The proposed model handles the selection of appropriate BP in a competitive environment of EPS. Hence, the current challenge of BP selection be faced with various criteria and alternatives. The MCDM is optimized to achieve the most appropriate criteria and alternatives[40], [41].

Vrtagi et al. [42] present an enhanced methodology for SWARA to efficiently investigate criteria for the model. Hence, numerous studies have attempted it in a variety of contexts, including the analysis of a logistics village, the analysis of a healthcare system, the choice of heavy equipment, the effect of vehicles on the security of traffic, the transportation of hazardous goods, the sustainability of the market structure, and the enhancement of production[43]–[45]. Figure 1 shows the proposed methodology. Where the concept of MCDM is used. Then, the neutrosophic theory is used . Then WASRA method is used. Then WSM is used. The enhanced SWARA consists of the following five phases in sequential order: figure 2 shows the proposed model. Figure 2 has a three main steps, first the criteria and alternatives are collected and evaluated by the selected experts. Then the second step, the weights of criteria are computed according to the WASRA. The third step, the rank of alternatives are computed according to the WSM method.

The steps for the proposed illustrated in Fig.2 and mentioned in the following steps

Step 1: Analysis and ranking of criteria based on their relative value, from most important to least important.

Step 2: The achievement of the major significance of the criteria (C_j) in comparison to the one that came before it (C_{j-1}), based on the first obtained categorization and linguistic levels.

Step 3: Compute the coefficient k

$$k_j = \begin{cases} 1 & j = 1 \\ s_j & j > 1 \end{cases} \quad (1)$$

Step 4: Compute the weights of q_j

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$$q_j = \begin{cases} 1 & j = 1 \\ \frac{q_{j-1}}{k_j} & j > 1 \end{cases} \quad (2)$$

Step 5: Compute the weights of criteria by:

$$w_j = \frac{q_j}{\sum_{j=1}^{m} q_j} \quad (3)$$

The WSM also known as the Simple Additive Weight, is the technique that is the least complicated for ranking the many options. It tries to calculate the weighted total of performance evaluations on m different options in terms of n different choice criteria. Only in the case when the data values have the same units can it be applied. As a result, the resulted decision matrix to be normalized. Without the need for complicated reasoning, WSM can find a balance between several criteria and straightforward computations. Therefore, there is a possibility that the produced findings will not yield information that is logically connected[46]–[48].

Finally, WSM is concerned with benefit criteria, which means that cost criteria are recast as benefit criteria. After the transition, the criteria with the lowest cost will become the biggest, and the criterion with the highest cost will become the lowest. After that, a normalized matrix generated by dividing the value of every criterion by the total value of all the criteria. The last step is to multiply the overall score of each option by the weight associated with it. The alternative that received the greatest overall score among all the alternatives was determined to be the best option. Bagoius et al. used the aggregated WSM in conjunction with the weighted product method (WPM)[49], [50].

4. Case Study

The inefficacy of bank credit information systems is primarily attributable to the different indicators: first, the lack of data and the poor data quality that renders it hard to assess the state of personal credit; second, there are problems in inter-institutional data sharing; and third, the ambiguous ownership of user data, which results in challenges in bloodstream due to concerns for security and confidentiality. Blockchain technology has the potential to provide some aid in resolving these concerns, despite the fact that finding answers to these problems would involve the collaboration and participation of a variety of parties.

As blockchain technology is capable of performing data encryption, it may assist us in establishing ownership and maintaining control of our own huge data. This may further assure that the information is authentic and dependable, while also minimizing the expenses incurred by credit agencies throughout the process of data collecting. By using blockchain technology, large amounts of data may be converted into credit resources that have unambiguous personal ownership, and they can even serve as the basis for future credit systems. In this study, we made this experiment in the enrtprise bank in Egypt to select best BP to help decision makers and manger to do their work better. The description of the selected criteria are shown below:

The term "security" refers to whether or whether a certain BP is sufficiently private, verified, and has an appropriate level of integrity assurance. In the first place, it is necessary to specify the degree of privacy, identification, and consistency that is required by the EPS. When this question is answered, it will be feasible to establish whether blockchain platform (or platforms) are capable of satisfying the safety requirements of the bank.

The capacity to access data across a variety of blockchain systems is the definition of interoperability. With this in mind, the efficiency of blockchain technology is in part reliant on the level of interaction and integration that may occur across the various blockchain systems. Hence, choose a BP that has the capacity to enable successful data sharing through boosting interoperability amongst blockchains is essential.

The criteria evaluate the degree to which an alternative to BP provides online assistance in the form of web pages, forums, and other online communities in order to maintain software developers' awareness of product

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upgrades and updates. When evaluating alternatives to BP, reputation might be a key factor. The public image of the firm, the regularity with which updates are released, and the launch date of the most recent version are some of the factors that may be used to assess the reputation of an option. The ability of a given BP to be used in a variety of business settings refers to the term "multi-functionality. Then such a BP would be able to meet numerous criteria of bank or both regular bank operations and financial activities.

The capacity of a business process to deal with an increasing volume of work is what is meant by the term "scalability." It's a measurement of how straightforward it is to add more storage space. To put it another way, as the volume of transactions and users on a blockchain network grows, the network should be able to expand and adapt to accommodate the changing circumstances. The first step is to determine the scalability requirements of EPS. The decision-maker should next assess which BP(s) can serve that demand, if any of them can, depending on the response to the question.

First step compute the weights of six criteria. Let experts to evaluate the criteria. This study used the single valued neutrosophic scale[51]. The experts used the linguistic terms single valued neutrosophic sets. Then replace these terms by the single valued neutrosophic numbers. Then compute the k coefficient by using Eq. (1), then weights of q_j is computed by using Eq. (2), then compute the weights of criteria by using Eq. (3) as shown in figure 3.

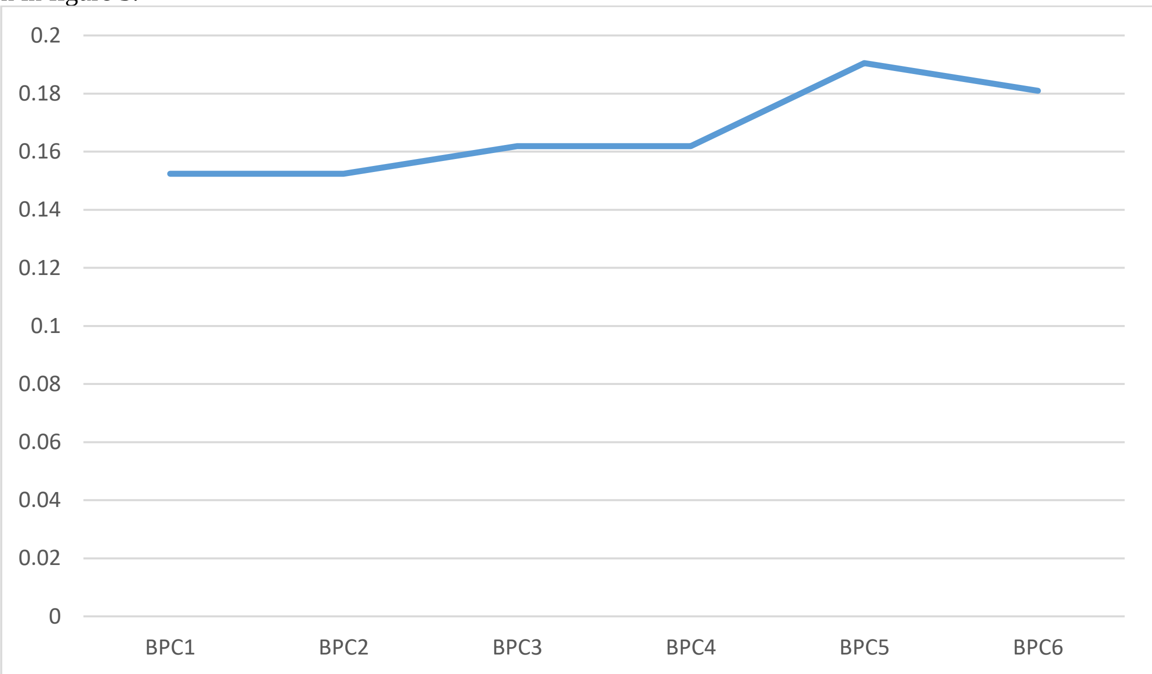

Figure 3: The importance of six criteria.

Then let experts to evaluate the criteria and alternatives to build the decision matrix. Then normalize the decision matrix as shown in table 1. Then multiply the weights of criteria by the normalization matrix as shown in table 2. Then compute the sum of each row. Then rank the alternatives according to the highest value of each row. Table 3 shows the rank of alternatives.

From table 3, the alternative 2 is the best alternative followed by alternative 3 and alternative 5, and the alternative 1 is the worst alternative in ten alternatives.

Table 1: The normalization decision matrix.

	BPC_1	BPC_2	BPC_3	BPC_4	BPC_5	BPC_6
BPA_1	0.058824	0.058537	0.0625	0.116822	0.108597	0.070968
BPA_2	0.132353	0.131707	0.13125	0.084112	0.122172	0.154839

Doi: https://doi.org/10.54216/NIF.010204
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BPA_3	0.132353	0.097561	0.1125	0.116822	0.113122	0.064516
BPA_4	0.088235	0.131707	0.075	0.084112	0.104072	0.116129
BPA_5	0.110294	0.04878	0.1	0.084112	0.122172	0.141935
BPA_6	0.066176	0.131707	0.11875	0.116822	0.058824	0.077419
BPA_7	0.080882	0.039024	0.075	0.084112	0.122172	0.174194
BPA_8	0.066176	0.097561	0.13125	0.116822	0.113122	0.077419
BPA_9	0.176471	0.131707	0.1125	0.070093	0.058824	0.03871
BPA_{10}	0.088235	0.131707	0.08125	0.126168	0.076923	0.083871

Table 2: The weighted normalized decision matrix

	BPC_1	BPC_2	BPC_3	BPC_4	BPC_5	BPC_6
BPA_1	0.008964	0.00892	0.010119	0.018914	0.020685	0.012842
BPA_2	0.020168	0.02007	0.02125	0.013618	0.023271	0.028018
BPA_3	0.020168	0.014866	0.018214	0.018914	0.021547	0.011674
BPA_4	0.013445	0.02007	0.012143	0.013618	0.019823	0.021014
BPA_5	0.016807	0.007433	0.01619	0.013618	0.023271	0.025684
BPA_6	0.010084	0.02007	0.019226	0.018914	0.011204	0.014009
BPA_7	0.012325	0.005947	0.012143	0.013618	0.023271	0.031521
BPA_8	0.010084	0.014866	0.02125	0.018914	0.021547	0.014009
BPA_9	0.026891	0.02007	0.018214	0.011348	0.011204	0.007005
BPA_{10}	0.013445	0.02007	0.013155	0.020427	0.014652	0.015177

Table 3: The rank of alternatives

	Rank
BPA_1	10
BPA_2	1
BPA_3	2
BPA_4	5
BPA_5	3
BPA_6	9
BPA_7	6
BPA_8	4
BPA_9	8
BPA_{10}	7

5. Sensitivity analysis

We made the sensitivity analysis to show the changing in the rank of alternatives when changing the weights of criteria. Firstly there are six cases in changing the weights of criteria. Firs but one criteria with weight 0.5 and other weights have weights equal like in cases 2 the criterion 1 has a weight 0.5 and all other criteria have a 0.1 weight. The changing the weights of criteria are shown in figure 4. After changing the weights of criteria, the rank of alternative are computed.

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Received: December 01, 2022 Accepted: March 10, 2023

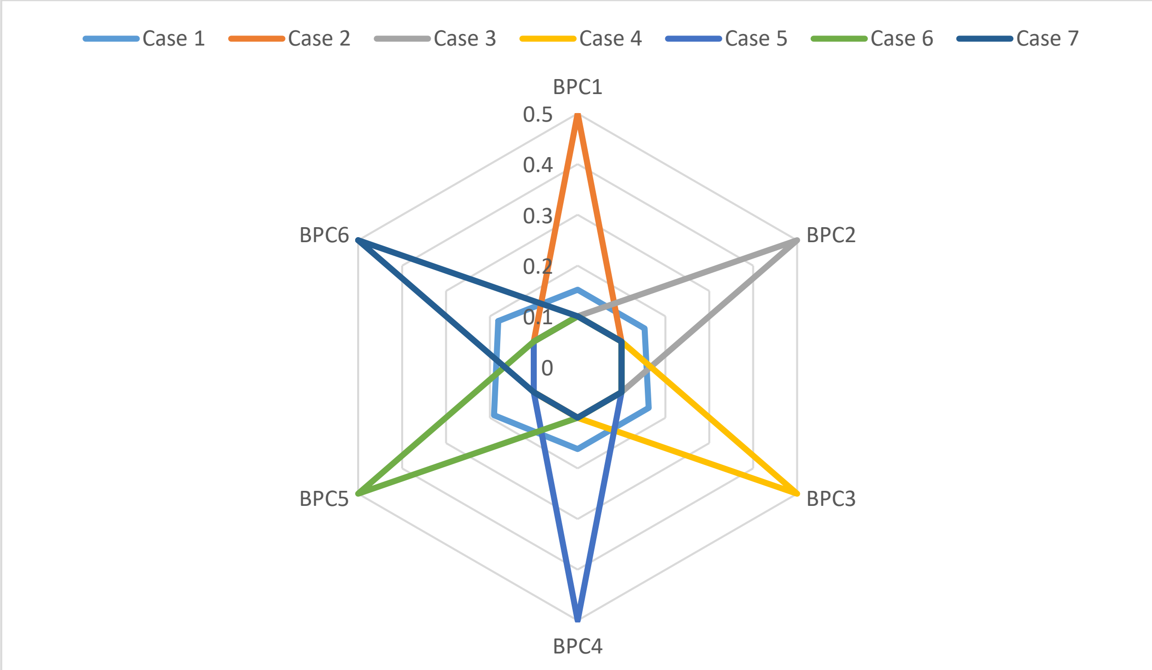

Figure 4:The changing in the weights of criteria.

When changing the weights of criteria, the rank of alternatives will change. Figure 5 shows the rank of alternatives after changing the weights of criteria. In case 1, the alternative 9 is the best alternative and alternative 1 is the worst alternative. In case 2, the alternative 2 is the best alternative and alternative 1 is the worst alternative. In case 3, the alternative 2 is the best alternative and alternative 1 is the worst alternative. In case 4, the alternative 3 is the best alternative and alternative 9 is the worst alternative. In case 5, the alternative 2 is the best alternative and alternative 6 is the worst alternative. In case 6, the alternative 2 is the best alternative and alternative 9 is the worst alternative. There are four cases are similar to the original rank of alternatives and there are two cases are different to the original rank of alternatives.

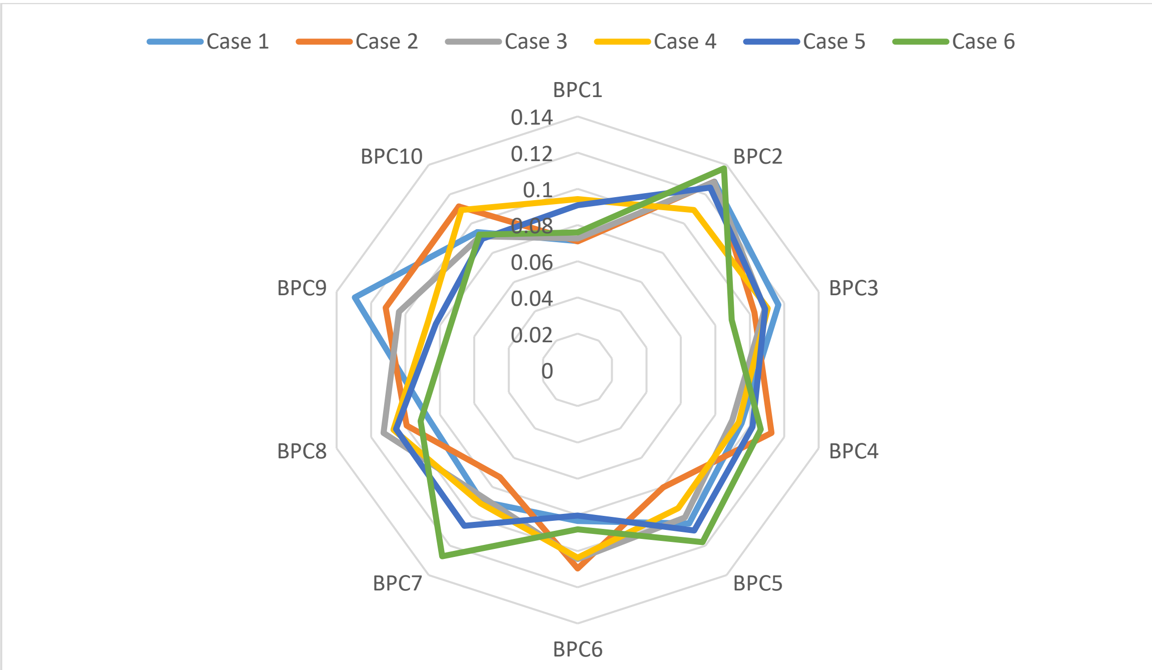

Figure 5: The rank of alternatives after changing the weights of criteria.

Doi: https://doi.org/10.54216/NIF.010204
Received: December 01, 2022 Accepted: March 10, 2023

6. Comparative analysis

In this section, we compared proposed methodology with the previous studies to show the robust of this model. The proposed methodology is compared with the single valued neutrosophic sets TOPSIS and VIKOR method. Figure 6 shows the comparative study. All three methods similar in ranking of best alternative.

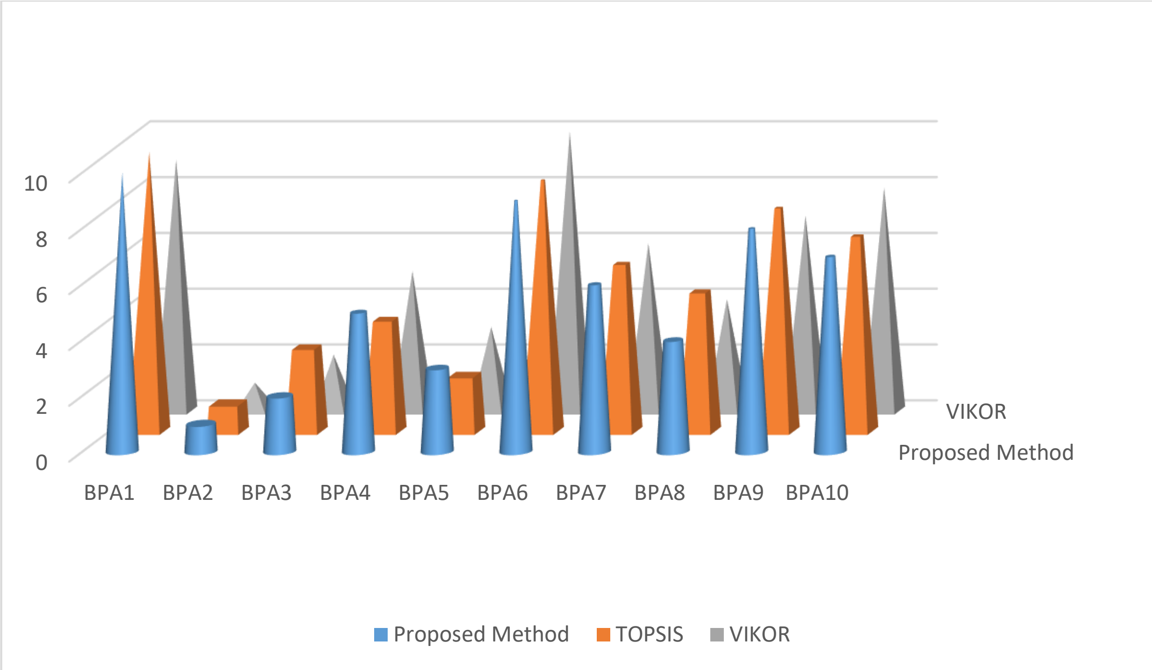

Figure 6: The rank of alternatives under comparative study.

7. Conclusions

Blockchains have the potential to change the technology that is used as the foundation for support financially and credit reporting systems in banks, which would result in an upgrade and transformation of these systems. Applications of blockchain technology also encourage the establishment of "multi-center, weakly intermediated" situations, which will result in an increase in the banking industry's overall effectiveness. It is important to note that the issues of regulation, effectiveness, and safety have always aroused substantial discussion throughout the process of developing new financial innovations. This is something that should not be overlooked. The technological, legislative, and other issues that now plague blockchain technology will, however, inevitably be overcome at some point in the future. This will not prevent history from occurring. As a result, the possibility of using blockchain technology inside the financial sector will most likely become a reality. So, this paper introduced neutrosophic model to select best BP in bank system. The MCDM is employed with the neutrosophic sets to handle uncertainty conditions. SWARA method used to compute the weights of criteria. The neutrosophic WSM used to rank the alternatives. The results of the proposed methodology shown the alternative 2 is the best alternative and alternative 1 is the worst alternative in all ten alternatives. The proposed model is the best tool for the decision makers to help them in the selection best platform in any enterprise.

The number of criteria would be expand in the future study. Also, there many types of neutrosophic sets can be applied in this kind of problem like interval valued neutrosophic sets, type-2 neutrosophic sets and other. There are many MCDM methods like TOPSIS, VIKOR and AHP can be applied in this problem. The proposed methodology can be applied in many different problem in decision making.

Doi: https://doi.org/10.54216/NIF.010204
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