Comparative Analysis of Ranking differentials between FDOSM and TOPSIS

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ABSTRACT:

Multi-criteria decision-making (MCDM) approaches are an excellent tool for prioritizing and ranking options with competing criteria when dealing with complicated issues in expert systems. Banks comprise financial market entities that contribute to the entire economic financing system. Therefore, it is essential to evaluate banks' functions. As the best bank selection problem comprises various criteria and alternatives, in this work, we employ one of the most recent MCDM approaches, the fuzzy decision by opinion score method (FDOSM), to the decision matrix to efficiently rank and assess amongst the main banks in kingdom of Saudi Arabia. Their goal is to rank each variation from best to worst. We also examined the different rank results obtained from FDOSM and TOPSIS. Following comparing the obtained rankings. The result stated that Bank Al Rajhi is the best bank, indicating that FDOSM is more logical and closer to decision-makers opinions. The work concluded with a report on the results.

Keywords:(Multi-criteria Decision Making, MCDM, Fuzzy Set, FDOSM, TOPSIS).

1. INTRODUCTION

Decision making is an important aspect of our life. Every single day, we take decisions of all types, from the simplest decisions which do not need deep knowledge or seriously thinking, to complex decisions at which mistakes may result in consequences, and choosing the right choice demand a lot of understanding and work with various levels of priority [1], and it is nearly challenging for humans to figure out the right decision Making. The most challenging aspect of the decision-making process is the variety of criteria set for assessing the alternatives, they usually conflict with one another, therefore there may be no way to meet all criteria at the same time [2]. To deal with these kinds of problems, decision-makers employ multicriteria decision making (MCDM), which refers to the process of making decisions in the context of several, generally in conflict criteria. (MCDM) is beneficial in determining the best solution for a certain decision issue by ranking/prioritizing a set of alternatives based on various evaluation criteria [3, 4]. However, a focus should be taken for selecting the correct method for the specific decision issue so that the findings become trustworthy [5, 6]. However, uncertainty and ambiguity, consistency difficulties, unnatural comparisons, normalisation, and distance measuring are examples of MCDM challenges and issues. Furthermore, making decisions requires seeking the advice of professionals and specialists [7]. An MCDM problem is often defined by a m×n decision matrix, with each member aij representing the performance of the ith alternative against the jth criteria [8, 9].

Because many real-life systems consist of incomplete and inaccurate information, as they employ linguistic terms. Furthermore, it is hard for decision makers to provide a specific ranking to an alternative based on the criteria. As a result, decision-makers (experts) are unable to determine weights in real numbers, complicating the resolution associated with these difficulties. Therefore, one of the benefits of MCDM methods is to be built on a fuzzy environment by assigning relative significance to criteria using fuzzy numbers rather than crisp numbers to handle the ambiguity [10, 11]. Zadeh [12] developed the fuzzy set notion as a modeling tool for complicated systems, assigning grades from [0, 1] to various alternatives. Since Zadeh's approach to fuzzy collection, fuzzy logic has been utilized to describe imprecision, ambiguity, and obscureness in a number of domains. So, fuzzy set theory has proved beneficial for MCDM approaches as a tool for tackling uncertainty and ambiguity that is exist in many decision-making processes [13, 14]. There are several approaches to solving MCDM challenges. Whether it is associated with mathematical techniques such as (Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)[15] and VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR)[16]) used for extract weight for assessment criteria by turning decision-makers' preferences into numerical values [17], or human approaches employed for ranking alternatives according to many of evaluation criteria [11], like (analytic hierarchy process (AHP)[18] and best-worst method (BWM)[19]). However, in some situations, these two techniques face a variety of concerns and challenges. For example, mathematical techniques suffer from (normalization and distance measurement), whereas in human approaches, the main issue is the inconsistency ratio caused by pair comparisons [20]. Furthermore, this challenge is uncommon and difficult to accomplish when comparing multiple uncorrelated criteria. As a result, reference comparisons and pairwise of various criteria consumed an extensive amount of time. Another significant problem for researchers using MCDM methods (i.e., human and mathematical approaches) is ambiguity, uncertainty, and vagueness of information [21, 22]. Therefore, one of the latest MCDM methods created to solve MCDM issues is the fuzzy decision by opinion score method (FDOSM), which is employed to rank alternatives in a fuzzy environment [23]. FDOSM, a powerful and effective approach, was published in 2020 [24]. The primary idea behind FDOSM is to tackle those identified difficulties by utilizing the best solution and an opinion matrix [25]. The FDOSM makes logical decisions according to experts' opinions [26]. Minimized the amount of comparisons, offered fair and implicitly clear comparisons, avoided inconsistency, decreased ambiguity, and provide the fewest mathematical operations. Since its launch, FDOSM has been used in various research to address a broad range of MCDM challenges; as a consequence, this approach saves data while still achieving a responsible conclusion [20]. However, despite the effectiveness it has in tackling a wide range of challenges, FDOSM continues to struggle with the uncertainty issue, which is an open challenge produced by the opinions of specialists [27]. Because the FDSOM approach suffers from these drawbacks, several academics are attempting to provide different ideas by recommending the use of a fuzzy environment. They have recently begun extending FDSOM to different fuzzy environments with the goal for enhancement outcomes. In [20] the authors enlarged the FDOSM into the 2-tuple-FDOSM and compared the results to TOPSIS to overcome the problem of information loss during the transformation of a decision matrix into an opinion decision matrix. This study [28] introduces a Fermatean by fuzzy decision opinion score method (F-FDOSM) framework for assessing Timing side-channel attack countermeasure methods (TSCA-CTs) in the scenario of Multiprocessor System-On-Chips (MPSoCs)-based IoT. Furthermore, the criteria's significance is weighted using the inter-criteria correlation (CRITIC) approach. The researchers in [29] develop both the FWZIC and FDOSM methods by including Fermatean probabilistic hesitant-fuzzy sets (called FPH-FWZIC and FPH-FDOSM) to assess agriculture-food 4.0 supply chain techniques. This work [30] expands FDOSM and fuzzy-weighted zero-inconsistency (FWZIC) to a neutrosophic fuzzy environment (NS-FWZIC and NS-FDOSM) to benchmarking smart e-tourism apps. In [24], the author developed FDOSM to a fuzzy type-2 environment that uses interval type-2 trapezoidal (IT2T) membership to benchmark active queue management (AQM) approaches of network congestion control. The research [7] presents a novel homogeneous Pythagorean fuzzy environment for calculating COVID-19 vaccination doses by merging a new formulation of the PFWZIC and PFDOSM approaches. In [31] developed the FWZIC and FDOSM approaches for the Q-rung orthopair fuzzy rough sets (q-ROFRS) environment (named q-ROFRS-FWZIC and q-ROFRS FDOSM) for assessing the performance of sustainable transportation in the shipping sector. Although the FDOSM and TOPSIS methods are having the same objectives, the rankings produced by these methods are often different since the TOPSIS concept is to choose the alternative that is closest to the positive ideal solution and most distant from the negative ideal solution [32]. In general, Hwang and Yoon (1981) created and developed the TOPSIS approach [33], which then was further developed and enhanced by Chen (2000). The positive ideal solution (PIS) is a hypothetical alternative that increases the benefit criterion (BC) while reducing the cost criterion (CC), whereas the negative ideal solution (NIS) actually a reverse version of the positive ideal solution (PIS), which means that it raise the cost criterion (CC) and decreases the benefit criterion [34]. TOPSIS has the following advantages: (a) simple, logically understood concept, (b) high processing efficiency, and (c) the ability to quantify the relative performance of each alternative in an easy mathematical way [35, 36]. According to this approach, the ideal or best solution is the one that is nearest to the PIS but also farthest from the NIS [37]. When employing the TOPSIS approach, the computations occur in six main steps (Asr et al., 2015)[31, 38]:

Step 1. Constructing Decision Matrix (X)

Step 2. Identify Weight Values

Step 3. Identifies the negative and positive ideal solutions.

Step 4. Calculate separation measurements using Euclidean distance.

Step 5. Calculate the relative nearness to the optimal answer.

Step 6. Rank alternatives based on their nearness to the ideal solution.

This study is focused on choosing the best suitable bank for businessmen and all other individuals dealing with banks using fuzzy decision by opinion score method (FDOSM), and intend to compare the results of both methods in order to calculate and rank the banks data according to predetermined criteria that include (Growth Rat, Number of Branches, Numbers of ATM, Net Income (M), Lending (M)). As a result, employing FDOSM methods has been considered suitable for ranking those alternatives for identifying which banks are best depending on certain criteria.

The following paper is organized as follows. Section 2 presents the methodology of the study, which is provided by presenting the case study of this research and introduces the basic FDOSM method. Section 3 presents the results and gives a Discussion of individual decision-making. Lastly, this paper's conclusion and future work are made in section 4.

2. Methodology

2.1 Case Study

The banking sector is one of the world's safest and most efficient sectors; it has grown over years into a financially robust system designed to serve the economy effectively. The system is built on a broad foundation, consisting of a group of institutions that provide an extensive range of financial services to customers and investors. It represents a system that is very efficient and employs advanced technology, has been subject to rigid control, and operates on a strong foundation.

2.1.1 Selected Banks as alternatives

This study will focus on rating the most well-known banks, including:

1. National commercial bank NCB
2. Bank Al-bilad
3. Riyad Bank
4. Arab National Bank ANB
5. Bank Al-Jazira
6. The Saudi Investment Bank
7. Al Rajhi Bank
8. Al-Inmaa Bank
9. Saudi French Bank
10. Saudi British Bank SABB
11. Saudi Holland Bank
12. Saudi American Bank SAMBA.

The challenge of identifying one of the most suitable banks may be handled by assessing the different banks based on certain important criteria; the criteria were chosen to represent particular needs of decision making, both economic/social and technological in form. After analyzing several criteria, select the most important criteria that it can create a difference between alternatives.

2.1.2 Identify the Main Criteria:

C1: Growth Rate

C2: Number of Branches

C3: Numbers of ATM

C4: Net Income (M)

C5: Lending (M)

2.1.3 Identify the decision matrix

The decision matrix of determining the most ideal Bank case study procedure consists of an intersection of the identified 12 alternatives and their performance 5 assessment criteria in terms of selecting the ideal Bank for businessmen and all individuals who interact with banks. The decision matrix data represent the values for evaluating each bank based on the main evaluation and sub-criteria construction. (Table 1) displays the main decision matrix, alternatives, and corresponding criteria. The decision matrix was obtained using sources from the literature [36].

Table1. Decision Matrix

Ci /Bi	**C1**	**C2**	**C3**	**C4(M)**	**C5(M)**
B1	7	312	1,891	6,613	163
B2	72	88	728	941,804	1,078
B3	10	252	2,594	3,466	117,471
B4	10	145	980	2,371	86,329
B5	65	54	350	501	29,897
B6	29	48	380	912	34,051
B7	7	476	3,300	78,470	2,212
B8	70	87	650	733	819,000
B9	4	86	591	3,015	103
B10	12	79	579	3,240	96,098
B11	21	45	261	1,253	453
B12	1	72	530	4,333	0.104800

2.2 FDOSM Method

FDOSM serves as a novel MCDM method that deals with the highlighted issues by utilizing the concept of an ideal solution and an opinion matrix. FDOSM makes logical choices since it relies on the DM's (expert's) opinion. FDOSM may successfully overcome inconsistency, which is a crucial challenge in the human approach, and save time when performing comparisons. FDOSM lowers the amount of mathematical equations. As a consequence, this strategy maintains the data while providing a logical conclusion. Furthermore, the mathematical approach handles issues related to normalisation and weight [23, 39]. The procedure for FDOSM is as follows:

Step 1: Create a decision matrix.

Step 2: Determine the best solution for each of the criteria (min, max, and critical value).
Step 3: Generate an opinion matrix through assessing the ideal solution to alternate values for each criterion based on decision-makers' perspectives.

Step 4: Convert the opinion matrix into triangular fuzzy numbers.

Step 5: Conducting summation with arithmetic means.

Step 6: Choosing to the final decision in which the lowest option is the best.

The FDOSM approach provided a mathematical model for addressing MCDM challenges through an individual decision-making context. In the context of decision making, FDOSM is made up of three block units: data input, data transformation, and data processing [40].

The FDOSM Phase are as follows by specifying each unit, along with the steps and formulas associated with it [32]:

2.2.1 Phase one: Data Input Unit

This method, like most MCDM approaches, handles MCDM issues that include (m) alternatives (A1..., Am) and (n) decision criteria (C1..., Cn). The decision matrix M×N consists of both of these elements (M rows and N columns).

$$D = \begin{matrix} & c1 & c2 \ldots\ldots & cn \\ A_1 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

This block's output is the decision matrix.

2.2.2 Phase two: Data Transformation Unit

Following the building of the decision matrix, which is the result of the first block, FDOSM performs the transformation unit by selecting the most optimal solution from the three parameters (minimum, maximum, and critical values). The cost criteria employ a minimum value; therefore, the best solution can be found by the lowest value, and the opposite is true. The value used in many situations, particularly when the optimal answer is neither minimal nor maximal. such as with blood pressure, this is referred to as crucial value concept. At this stage, the following steps are illustrated and explained:

Step 1: Choose the best possible solution. Thus, the optimum solution is defined as follows:

$$A* = [(maxi\ vij|j \in J), (mini\ vij|j \in J), (Opij \in I.\ J)\ |i=1.2.3\ldots.\ m] \quad (2)$$

The crucial value is $Opij$ when the ideal value lies in between the max as well as min. The max reflects the ideal value having benefit criteria and the min indicates the ideal solution having cost criteria.

Step 2: reference comparison for each criterion between the ideal solution and all other values is concocted. There is an implied approach for weighting the evaluation criteria. Subjective assessments are used to determine the significance of the differences between the ideal solution and its alternatives.

DMs were tasked to figure out if their perspectives have changed significantly as an outcome of the relevant differences. Figure (1) depicts the suggested reference comparisons for use in the implicit weight assignment process. Using Eq. (2.2), the DM selects the optimum solution for vectors V31, V22, V43, and V14. The ideal solution selection process entails comparing the optimum solution to its alternatives.

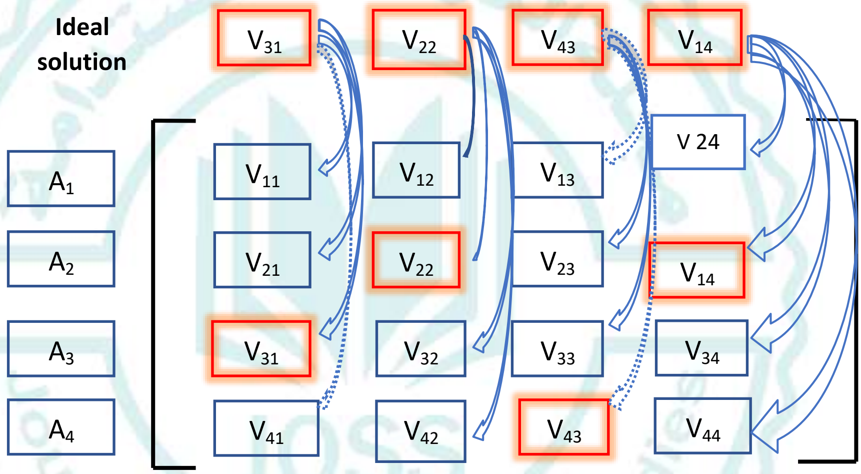

Figure 1:

Steps of the transformation unit

$$Op_{\text{Lang}} = \left\{\left(\left(\tilde{v}_{ij} \otimes v_{ij} \mid j \in J\right) \cdot\mid i = 1.2.3 \ldots\ldots m\right)\right\} \quad (3)$$

where ⊗ means a reference comparison between the optimal solution and the alternatives.

2.2.3 Phase three: Data-Processing Unit

This stage produces the linguistic phrase opinion matrix, which is now ready to be converted into fuzzy numbers using fuzzy membership.

$$Op\_\text{Lang} = \begin{matrix} A_1 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} op_{11} & \cdots & op_{1n} \\ \vdots & \ddots & \vdots \\ op_{m1} & \cdots & op_{mn} \end{bmatrix}$$
(4)

This section will be described in the following steps:

Step 1: To create a fuzzy decision matrix, the opinion phrases in the opinion matrix are replaced with triangular fuzzy numbers (TFNs), as illustrated in (Table 2). The final outcome is a fuzzy opinion decision matrix (FDij).

Table 2. Linguistic variable and triangular fuzzy matrix

Notation	Linguistic variable	triangular fuzzy numbers
N D	No difference	(0.00,0.10,0.30)
S D	Slight difference	(0.10,0.30,0.50)
DI	Difference	(0.30,0.50,0.75)
B D	Big difference	(0.50,0.75,0.90)
H D	Huge difference	(0.75,0.90,1.00)

Step 2: For each alternative, aggregate the findings from the previous step using an aggregation operator (such as arithmetic mean). After finishing the fuzzy decision matrix, the aggregation process is performed to find the ideal solution using one of the following aggregation operators:

$$\text{Arithmetic mean } A_{m(x)} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (5)$$

$$A_{m(x)}= \frac{\sum(a_f+a_m+a_l)(b_f+b_m+b_l)(c_f+c_m+c_l)}{n} \quad (6)$$

Step 3: The centroid procedure has been used to defuzzify the aggregate results, as follows:

$$\frac{(a+b+c)}{3} \quad (7)$$

3. Research Result and Discussion

This section displays and discusses the findings for selecting the most ideal bank using the FDOSM methodology. Section (3.1) presents the opinion matrix result, in which the decision maker determined the ideal solution and made reference comparisons across the optimal solution and other values of alternatives using the same criteria, resulting in a matrix of the decision maker's opinion in linguistic terms. The next part (3.2) discusses the fuzzy opinion decision matrix, displaying its results using the Opinion Matrix and the triangular Fuzzy Opinion Matrix. In section (3.3), we discussed the differences in the final rankings obtained using the FDOSM and the TOPSIS for the exactly the same case study.

3.1 The Result of Opinion Matrix

This section of the work will provide an overview of the opinion matrix. The following process is performed by converting the original decision matrix shown in (Table 1) to the opinion matrix displayed in (Table 3) based on the decision maker's own opinions expressed using the five Likert scales. According to the principle of FDOSM. The decision maker determines the optimal solution, which is stated in Equation (2). To create the decision-maker's opinion matrix, reference comparisons are made between the most ideal solution and other values of alternatives based on the same criteria, as illustrated in Equation (3).

Table 3. the opinion matrix

Ci /Bi	**C1**	**C2**	**C3**	**C4(M)**	**C5(M)**
B1	H.D	S.D	S.D	B.D	H.D
B2	N.D	B.D	DI	N.D	H,D
B3	H.D	DI	N.D	H.D	S.D
B4	H.D	DI	DI	H.D	DI

B5	S.D	H.D	H.D	H.D	DI
B6	B.D	H.D	H.D	H.D	S.D
B7	H.D	N.D	N.D	S.D	H.D
B8	N.D	H.D	B.D	H.D	N.D
B9	H.D	B.D	B.D	H.D	H.D
B10	H.D	H.D	B.D	H.D	DI
B11	H.D	H.D	H.D	H.D	H.D
B12	H.D	H.D	B.D	H.D	H.D

*NO. D = No difference, S.D = Slight Difference, DI = Difference, B.D = Big Difference, H.D = Huge Difference

3.2. Fuzzy Opinion Decision Matrix Result

In the following phase, we present the fuzzy opinion decision matrix. The process involves converting an opinion matrix into a fuzzy opinion decision matrix by replacing linguistic phrases and triangular fuzzy numbers based on compensation (Table 2). This results in a fuzzy opinion decision matrix, as shown in (Table 4).

Table 4. Fuzzy Opinion Decision Matrix

Ci /Bi	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**	**B10**	**B11**	**B12**
C1	0.75	0	0.75	0.75	0.1	0.5	0.75	0	0.75	0.75	0.75	0.75
	0.9	0.1	0.9	0.9	0.3	0.75	0.9	0.1	0.9	0.9	0.9	0.9
	1	0.3	1	1	0.5	0.9	1	0.3	1	1	1	1
C2	0.1	0.5	0.3	0.3	0.75	0.75	0	0.75	0.5	0.75	0.75	0.75
	0.3	0.75	0.5	0.5	0.9	0.9	0.1	0.9	0.75	0.9	0.9	0.9
	0.5	0.9	0.75	0.75	1	1	0.3	1	0.9	1	1	1
C3	0.1	0.3	0	0.3	0.75	0.75	0	0.5	0.5	0.5	0.75	0.5
	0.3	0.5	0.1	0.5	0.9	0.9	0.1	0.75	0.75	0.75	0.9	0.75
	0.5	0.75	0.3	0.75	1	1	0.3	0.9	0.9	0.9	1	0.9
C4	0.5	0	0.75	0.75	0.75	0.75	0.1	0.75	0.75	0.75	0.75	0.75
	0.75	0.1	0.9	0.9	0.9	0.9	0.3	0.9	0.9	0.9	0.9	0.9
	0.9	0.3	1	1	1	1	0.5	1	1	1	1	1
C5	0.75	0.75	0.1	0.3	0.3	0.1	0.75	0	0.75	0.3	0.75	0.75
	0.9	0.9	0.3	0.5	0.5	0.3	0.9	0.1	0.9	0.5	0.9	0.9
	1	1	0.5	0.75	0.75	0.5	1	0.3	1	0.75	1	1

In the table above, we provide fuzzy opinion matrix, which are formed by converting each decision-maker's opinion matrix to a fuzzy opinion matrix. afterwards the displaying of the fuzzy opinion matrices, an aggregation equation (5) will be used via (Table 4). (Table 5) shows the findings, which were obtained by aggregating each alternative.

Table 5. Aggregation Step for Three Experts

Ci /Bi	score		
B1	2.2	3.15	3.9
B2	1.55	2.35	3.25
B3	1.9	2.7	3.55
B4	2.4	3.3	4.25
B5	2.65	3.5	4.25
B6	2.85	3.75	4.4
B7	1.6	2.3	3.1
B8	2	2.75	3.5
B9	3.25	4.2	4.8
B10	3.05	3.95	4.65
B11	3.75	4.5	5
B12	3.5	4.35	4.9

The defuzzification equation (7) was then applied to the preceding matrix, yielding a final outcome for the decision maker, as given in (Table 6). The following sections explain the outcomes of each process.

The Decision Maker's final result is displayed in the table below, depending on the Opinion Matrix and the triangular Fuzzy Opinion Matrix (see Table 6).

Table 6. The Final Result of Individual Decision Making

Ci /Bi	**score**	**Rank**
B1	3.083333	5

B2	2.383333	2
B3	2.716667	3
B4	3.316667	6
B5	3.466667	7
B6	3.666667	8
B7	2.333333	1
B8	2.75	4
B9	4.083333	10
B10	3.883333	9
B11	4.416667	12
B12	4.25	11

According to FDOSM philosophy, the best an appropriate alternative is the one closest to the no difference linguistic term (the optimal solution) with the lowest value, and vice versa.

According to (Table 6), the best bank is (**B7**) "Al Rajhi Bank", which achieved the best possible score of "2.333333". On the other hand, the alternative (**B11**) "Saudi Holland Bank" had the worst score, "4.416667". The decision maker's perspective influences the variations in ranking scores.

As shown in (Table 3), it was found that the best alternative using FDOSM gave outcomes that were quite similar to the expert's perspective. Additionally, as shown in (Table 3) that illustrates there is an alignment of the worst-alternatives between the expert opinion and the previous table.

3.3 Comparative Analysis with TOPSIS method

In the following section, we offer a comparative analysis between the final rankings derived from the FDOSM method with the TOPSIS method in the exact same case study. When comparing FDOSM method with TOPSIS method, the researchers found variation in the outcomes. (Table 7) shows the variations more clearly.

Table 7: Comparison between FDOSM and TOPSIS method.

Ci /Bi				
	FDOSM		TOPSIS	
	Score	Rank	Score	Rank
B1	3.083333	5	0.147308	6
B2	2.383333	2	0.552957	1
B3	2.716667	3	0.179162	4
B4	3.316667	6	0.089673	7
B5	3.466667	7	0.152155	5
B6	3.666667	8	0.075476	9
B7	2.333333	1	0.24269	3
B8	2.75	4	0.433595	2
B9	4.083333	10	0.029489	11
B10	3.883333	9	0.075887	8
B11	4.416667	12	0.051549	10
B12	4.25	11	0.021518	12

The table above, presents the best and worst alternatives to the FDOSM method and TOPSIS method. for the best alternatives, there has been an alteration in the result between the alternative (**B2**) and (**B7**), where each alternative takes the best rank.in contrast, the alternatives (**B11**) and (**B12**) are chosen as the worst one. Figure (2) shows the differences in final rank produced by the FDOSM and TOPSIS methods. The differences have been presented comprehensively in (Tables 7), and will be explained below in detail.

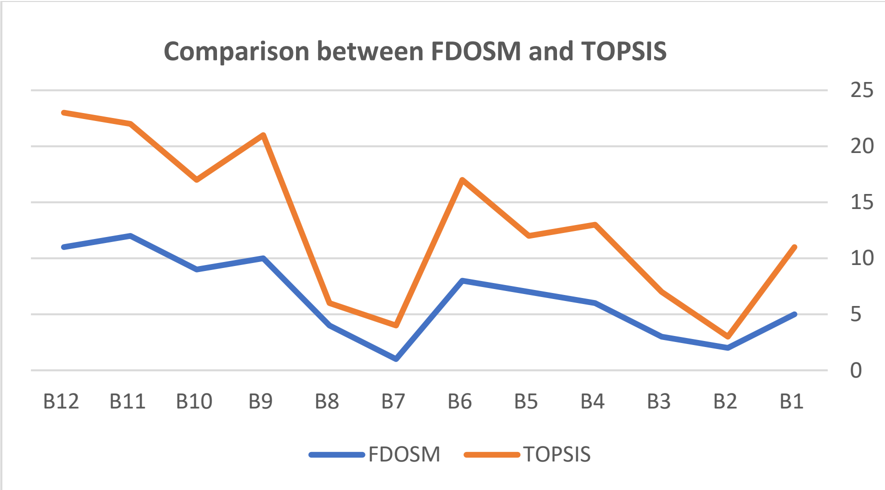

Figure 2. compare the result of ranking between FDOSM and TOPSIS method

It can be discover some variations in final ranking between the basic FDOSM and TOPSIS method (see fig. 2) among all alternatives, where the rank of the alternative (B1) in the TOPSIS method was "6 " and became in the FDOSM "5", the alternative (B2) was "1 " and has become"2", as well the alternative (B3) was "4 " and turned "3". The alternative (B4) changed from "7" to "6". While the alternative (B5) was "5", it was transformed into "7". The alternative (B6) changed from "9" to "8".

The rank of the alternative (B7) was "3" in the TOPSIS method, but it became "1" in FDOSM. Additionally, the rank of alternative (B8) transformed from "2" to "4", while the rank of alternative (B9) changed from "11" to "10". The alternative (B10) was initially assigned a value of "8" but later changed to "9". While the alternative (B11) began with a value of "10" and later converted to "12". The alternative (B12) has been modified from "12" to "11".

As a result, the final ranking associated with FDOSM is more rational and in line with expert opinions than the TOPSIS method, since the opinions of the DMs (experts) are implicitly included in the opinion decision matrix. As thus, the FDOSM method, which employs a 5-point Likert scale, outperforms other MCDM methods in terms of handling ambiguity.

4. Conclusions

Multi-criteria decision making (MCDM) has become widely used in our daily lives in a variety of ways, with several success stories in many fields to assist decisionmakers in analyzing complicated problems and providing an accurate decision process. Because of the presence of multiple criteria, their importance, as well trade-offs or conflicts between them, Therefore, the MCDM solution is required to address these complicated issues. Where several approaches have been employed for choosing the most desirable alternatives according to these criteria. In this study, one of the most current MCDM methods, the fuzzy decision by opinion score method (FDOSM), has been utilized to identify the best suited bank for businessmen and all individuals working with banks in kingdom of Saudi Arabia based on individual decision-making preferences. This research established comprehensive assessment guidelines by using the (FDOSM) approach to improve the integrity of decision-making. FDOSM is an appropriate decision-making tool for a variety of reasons, including its ease of calculation and understanding, ability to detect issues, justify the criteria employed, selection of alternatives, implementation of the decision, and evaluation of the result. The variations between the results produced from the FDOSM and the TOPSIS method have been analyzed and compared using the same case study (banking sector) with 12 alternative and 5 criteria, as indicated in (Table 7), and then discussed the results. The results showed that Al Rajhi Bank was the best bank based on the five criteria used in the evaluation, indicating that FDOSM is more rational and closer to decision makers' perspectives. Because of the interesting results, future study should focus on integrating FDOSM with other methods as well as using another fuzzy set, such as spherical hesitant fuzzy, to provide better solutions and tackle different issues such as uncertainty, ambiguity, and consistency issues currently present in several domains.

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