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Evaluation of banks in terms of customer preferences with fuzzy SWARA and fuzzy MOORA integrated approach

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Abstract

This study examines the factors influencing customer preferences in retail and private banking in Turkey, utilizing the fuzzy SWARA methodology. In response to global challenges and advancements in technology, the banking sector has undergone significant transformations over the past two decades, leveraging technology to enhance services and efficiency. However, customer preferences may vary across countries and cultures, with Turkish banking customers showing a mix of traditional and digital banking preferences. Against the backdrop of a dramatic financial crisis in 2001, trust emerges as a paramount consideration for Turkish banking customers, alongside factors such as mobile services, customer service quality, and pricing compatibility. Through an analysis of nine banks with fuzzy MOORA method, both private and state-owned, this study aims to provide valuable insights into the factors driving customer preferences in the Turkish banking sector. The findings contribute to the existing literature and offer guidance for banks seeking to meet the evolving needs and expectations of their customers in Turkey's dynamic banking environment.

Keywords: fuzzy SWARA, fuzzy MOORA, banking sector, Multi Criteria Decision Making.

1. Introduction

It is crucial for banks to implement good strategies in order to meet their customer needs. Challenging global environment forces banks to develop new marketing strategies and new products (Ta and Har, 2000).

In the past twenty years, the banking sector worldwide has experienced significant changes to keep up with increasing customer expectations. Banking sector has taken advantage of Technology in order to provide a better service to customers (Vivekanandana and Jayasenab, 2012).

Technological innovation has revolutionized banking by speeding up information processing and transmission, facilitating marketing of products, improving customer access, and expanding regional and global connections. This has led to changes in product range, service channels, resulting in significant efficiencies for banks and related services. Banks increasingly rely on IT development, striving to adopt new systems and processes. Technologic advancements have enabled banks to offer more diverse and convenient services without physical branches, utilizing sophisticated ATMs and Internet-based services. The shift to online transactions and real-time processing has reduced manual work, enhancing efficiency (Jayamaha, 2002; Villavarajah, 2008).

There are many studies that examines how retail banking customers worldwide choose their banks, aiming to understand their preferences and expectations more clearly. This studies involves analyzing various studies that investigate the factors influencing customers' decisions when selecting a bank (Vivekanandana and Jayasenab, 2012), Table 1.

Table 1. Ranking customer's preferences on the facilities offered by a bank

Country	Topmost customer's preference on the facilities offered by a bank
Ghana	Proximity/ accessibility
USA	Online banking & bill payment
Malaysia	Secure Feelings, ATM service & financial benefits, service provision proximity & branch location
India	Safety of funds, security & availability of ATM
Bahrain	Reputation, availability of parking space near the bank, friendliness of bank personnel and ATM
Singapore	High interest rate, convenient location & overall service quality

Reference: Adapted from Vivekanandana and Jayasenab (2012).

As we can see in the table above customer preferences related to financial services may differ according to country or culture. In Turkey there are customer segments who stick with traditional banking methods, resisting digitalization or using it only to a limited extent. Conversely, there are those who fully use digitalization and rely on traditional banking services only when necessary (Beybur, 2022).

As an emerging country Turkey has also adjusted banking services and systems to keep pace with global trends and to remain competitive. Factors such as globalization, advancements in technology, deregulation, and heightened competition compelled Turkish banks to develop and implement new strategies aimed at enhancing customer loyalty and satisfaction (Mermod, 2020).

There are 54 banks in Turkey and they have a wide spectrum of customers. For this study we have chosen nine banks consisting of both private and state banks. We have collected data from ten banking customers who have been working with banks for several years.

Objective of this study is to identify the most important factors that the customers take in to account in their bank preferences in the concept of retail banking and private banking in Turkey by using fuzzy SWARA methodology. We think our study will bring new insights to the literature by being the first study done related to Turkish banks using fuzzy SWARA. In addition, in this study, nine banks operating in Turkey were ranked by the fuzzy MOORA Method according to the criteria determined.

First of all, the study includes a literature review with examples of applications that include the subject of the study and studies that apply the methods used in this study. Then the algorithms of fuzzy SWARA and fuzzy MOORA methods applied in this study are explained. In the following stage, there is an application section in which the importance levels of the factors affecting the preferences of customers in the Turkish banking system are determined and the ranking of nine banks operating in Turkey is made. In the last section, conclusions and recommendations are discussed.

2. Literature review

Table 2 gives examples of studies related to the banking sector and studies that have applied fuzzy SWARA and fuzzy MOORA.

Table 2. Literature Review

Authors	Problem	Methods
	Banking Sector	
Quynh (2024)	Performance analysis of banks operating in Vietnam	Fuzzy TOPSIS approach using integral values
Coşkuner and Rençber (2024)	Ranking of participation banks' performance in Turkey	CRITIC and TOPSIS
Roy and Shaw (2023)	Comparison of mobile banking applications	Fuzzy-BWM and Fuzzy-TOPSIS
Karmakar et al. (2023)	Studying the impact of Covid 19 on public sector banks, private sector banks and non-banking financial companies operating in India	Kruskal-Wallis test and Spearman correlations
Demir (2022)	Evaluation of the financial performance of the Turkish deposit banking sector during the Covid-19 period	LMAW and DNMA
Ecer and Pamucar (2022)	Ranking the performance of banks operating in Turkey	LOPCOW, DOBI, Entropy and MEREC
Rao et al. (2021)	Performance analysis of private sector banks operating in India	CRITIC, ARAS and MOORA
Demir (2021a)	Evaluation of the financial performance of privately owned commercial banks operating in the Turkish banking sector in the 2014-2019 period	SWARA and RAFSI
Eshlaghy et al. (2011)	Identification and weighting of important criteria affecting customer satisfaction in Iranian banking system	Delphi method, Kano model and Fuzzy DEMATEL
	Fuzzy SWARA Method	
Sarğın et al. (2024)	Assessment of soil quality around Van Lake agricultural areas	Pythagorean Fuzzy SWARA and Artificial Neural Network (ANN)
Puška et al. (2023)	Assessment of potential distribution center locations in the Brčko District of Bosnia and Herzegovina	IMF SWARA and fuzzy CRADIS
Demir (2021b)	Comparison of the financial performance of Turkish cement firms	Fuzzy SWARA, COPRAS and MAUT
Vrtagić et al. (2021)	Analysis of safety degrees of observed road sections for traffic management	IMF SWARA, fuzzy MARCOS, DEA
Sahebi et al. (2020)	Detection of deficiencies in administrative organization at Mehrabad airport and prioritization of these deficiencies	Fuzzy SWARA
Zulfiquar et al. (2020)	identify and rank solutions to mitigate sustainable remanufacturing supply chain risks	Fuzzy SWARA and Fuzzy COPRAS
Mishra et al. (2020)	Evaluation of bioenergy production process in terms of sustainability	IF Fuzzy SWARA and COPRAS
Ulutaş et al. (2020)	Evaluation of logistics location alternatives for Sivas province in Turkey	Fuzzy SWARA and CoCoSo

Fuzzy MOORA Method		
Polat and Yaşlı (2024)	Assessing risks for a new business project producing energy storage systems to order	Fuzzy SWARA and Fuzzy MOORA
Kundakcı (2023)	Choosing the best maintenance strategy for a manufacturing company	Fuzzy PIPRECIA and Fuzzy MOORA
Khorshidi et al. (2022)	Evaluation of alternatives for the establish of solar power plants in Turkey	Fuzzy DEMATEL and Fuzzy MOORA
Emovon et al. (2021)	selection of materials for the production of an affordable automatic hammering machine	Fuzzy MOORA, Fuzzy VIKOR and Fuzzy GRA
Khan et al. (2020)	Obtaining the best parametric setting when turning pure titanium under specified cutting conditions	Fuzzy MOORA
Ersöz et al. (2018)	Determining which courses should be given in the industrial engineering department in Turkey	Fuzzy MOORA
Altunöz (2017)	Evaluating the financial performance of 12 banks traded on Borsa Istanbul between the periods of 2007-2016	Fuzzy AHP and Fuzzy MOORA
Mavi et al. (2017)	Choosing the most suitable sustainable third-party reverse logistics provider in the plastics industry	Fuzzy SWARA and Fuzzy MOORA

3. Methodology: Fuzzy SWARA

One of the methods used in the study is fuzzy SWARA (fuzzy Stepwise Weight Assessment Ratio). Fuzzy SWARA is a new method for assessing the weights of the criteria in the problem. The fuzzy SWARA calculation process are in Table 3 (Percin, 2019).

Table 3. Fuzzy SWARA steps

Step	Equation	Equation
Ranking the criteria	$\begin{cases} j = 1 \Longrightarrow \textit{the most important criterion} \\ j = n \Longrightarrow \textit{the least important criterion} \end{cases}$	(1)
Calculation of coefficient value (lower limit)	$\begin{cases} j = 1 \Longrightarrow k_{jdl} = 1 \\ j > 1 \Longrightarrow k_{jdl} = 1 + s_{jdl} \end{cases}$	(2)
Calculation of coefficient value (the most promising value)	$\begin{cases} j = 1 \Longrightarrow k_{jdm} = 1 \\ j > 1 \Longrightarrow k_{jdm} = 1 + s_{jdm} \end{cases}$	(3)
Calculation of coefficient value (upper limit)	$\begin{cases} j = 1 \Longrightarrow k_{jdu} = 1 \\ j > 1 \Longrightarrow k_{jdu} = 1 + s_{jdu} \end{cases}$	(4)
Finding the fuzzy recalculated weights (lower limit)	$\begin{cases} j = 1 \Longrightarrow q_{jdl} = 1 \\ j > 1 \Longrightarrow q_{jdl} = \dfrac{q_{\{j-1\}dl}}{k_{jdu}} \end{cases}$	(5)
Finding the fuzzy recalculated weights (the most promising value)	$\begin{cases} j = 1 \Longrightarrow q_{jdm} = 1 \\ j > 1 \Longrightarrow q_{jdm} = \dfrac{q_{\{j-1\}dm}}{k_{jdm}} \end{cases}$	(6)
Finding the fuzzy recalculated weights (upper limit)	$\begin{cases} j = 1 \Longrightarrow q_{jdu} = 1 \\ j > 1 \Longrightarrow q_{jdu} = \dfrac{q_{\{j-1\}du}}{k_{jdl}} \end{cases}$	(7)

Calculation of fuzzy relative weights (lower limit)	$w_{jdl} = \frac{q_{jdl}}{\sum_{j=1}^{n} q_{jdu}}$	(8)
Calculation of fuzzy relative weights (the most promising value)	$w_{jdm} = \frac{q_{jdm}}{\sum_{j=1}^{n} q_{jdm}}$	(9)
Calculation of fuzzy relative weights (upper limit)	$w_{jdu} = \frac{q_{jdu}}{\sum_{j=1}^{n} q_{jdl}}$	(10)
Integration of the decision-makers` opinions (lower limit)	$w_{jl} = \frac{\sum_{d=1}^{D} w_{jdl}}{D}$	(11)
Integration of the decision-makers` opinions (the most promising value)	$w_{jm} = \frac{\sum_{d=1}^{D} w_{jdm}}{D}$	(12)
Integration of the decision-makers` opinions (upper limit)	$w_{ju} = \frac{\sum_{d=1}^{D} w_{jdu}}{D}$	(13)
Defuzzification of the weights	$w_j = \frac{w_{jl} + w_{jm} + w_{ju}}{\sum_{j=1}^{n}[w_{jl} + w_{jm} + w_{ju}]}$	(14)

Where

j: $criterion; j = 1,2,3, \dots n$

d: $decision\ maker; d = 1,2,3, \dots, D$

l: $TFN\ lower\ limit\ value$

m: $TFN\ the\ most\ promising\ value$

u: $TFN\ upper\ limit\ value$

$\tilde{s}_{jd}$: $fuzzy\ evaluation\ value\ for\ criterion\ j\ according\ to\ decision\ maker\ d$

s_{jdl}: $fuzzy\ evaluation\ lower\ limit$

s_{jdm}: $fuzzy\ evaluation\ the\ most\ promising\ value$

s_{jdu}: $fuzzy\ evaluation\ upper\ limit$

$\tilde{k}_{jd}$: $coefficient\ value\ for\ decison\ maker\ d.$

k_{jdl}: $coefficient\ lower\ limit.$

k_{jdm}: $coefficient\ the\ most\ promising\ value.$

k_{jdu}: $coefficient\ upper\ limit.$

$\tilde{q}_{jd}$: $fuzzy\ recalculated\ weight\ for\ decision\ maker\ d$

q_{jdl}: $recalculated\ weight\ lower\ limit$

q_{jdm}: $recalculated\ weight\ the\ most\ promising\ value$

q_{jdu}: $recalculated\ weight\ upper\ limit$

$\widetilde{w}_{jd}$: $fuzzy\ relative\ weight\ for\ decision\ maker\ d$

w_{jdl}: $relative\ weight\ lower\ limit$

w_{jdm}: $relative\ weight\ the\ most\ promising\ value$

w_{jdu}: $relative\ weight\ upper\ limit$

$\widetilde{w}_{j}$: $aggregated\ fuzzy\ relative\ weight$

w_{jl}: $aggregated\ relative\ weight\ lower\ limit$

w_{jm}: $aggregated\ relative\ weight\ the\ most\ promising\ value$

w_{ju}: $aggregated\ relative\ weight\ upper\ limit$
w_j: $aggregated\ defuzzified\ weight$

The evaluation scale for fuzzy SWARA is given in table 4.

Table 4. Evaluation Scale for fuzzy SWARA

Linguistic Term	s_{jdl}	s_{jdm}	s_{jdu}
Very low	0.00	0.00	0.30
Low	0.00	0.25	0.50
Medium	0.30	0.50	0.70
High	0.50	0.75	1.00
Very high	0.70	1.00	1.00

4. Methodology: Fuzzy MOORA

Another method used in the study is fuzzy MOORA (fuzzy Multi-Objective Optimization by Ratio Analysis). Fuzzy MOORA process is in Table 5 (Ghoushchi et al., 2019).

Table 5. Fuzzy MOORA Steps

Step	Equation	Equation
Initial fuzzy decision matrix for decision maker	$\begin{bmatrix} \tilde{x}_{11d} & \tilde{x}_{12d} & \cdots & \tilde{x}_{1nd} \\ \tilde{x}_{21d} & \tilde{x}_{22d} & \cdots & \tilde{x}_{2nd} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1d} & \tilde{x}_{m2d} & \cdots & \tilde{x}_{mnd} \end{bmatrix}$	(15)
Integration of the decisions (lower limit)	$\tilde{x}_{ijl} = \frac{\sum_{d=1}^{D} \tilde{x}_{ijdl}}{D}$	(16)
Integration of the decisions (the most promising value)	$\tilde{x}_{ijm} = \frac{\sum_{d=1}^{D} \tilde{x}_{ijdm}}{D}$	(17)
Integration of the decisions (upper limit)	$\tilde{x}_{iju} = \frac{\sum_{d=1}^{D} \tilde{x}_{ijdu}}{D}$	(18)
Integrated Initial fuzzy decision matrix	$\begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}$	(19)
Fuzzy normalized performance value (lower limit)	$\tilde{x}^*_{ijl} = \frac{\tilde{x}_{ijl}}{\sqrt{\sum_{i=1}^{m} \left[\tilde{x}^2_{ijl} + \tilde{x}^2_{ijm} + \tilde{x}^2_{iju}\right]}}$	(20)
Fuzzy normalized performance value (the most promising value)	$\tilde{x}^*_{ijm} = \frac{\tilde{x}_{ijm}}{\sqrt{\sum_{i=1}^{m} \left[\tilde{x}^2_{ijl} + \tilde{x}^2_{ijm} + \tilde{x}^2_{iju}\right]}}$	(21)
Fuzzy normalized performance value (upper limit)	$\tilde{x}^*_{iju} = \frac{\tilde{x}_{iju}}{\sqrt{\sum_{i=1}^{m} \left[\tilde{x}^2_{ijl} + \tilde{x}^2_{ijm} + \tilde{x}^2_{iju}\right]}}$	(22)

Weighted Fuzzy normalized performance value (lower limit)	$\tilde{p}_{ijl} = w_{jl}\tilde{x}^*_{ijl}$	(23)
Weighted Fuzzy normalized performance value (the most promising value)	$\tilde{p}_{ijm} = w_{jm}\tilde{x}^*_{ijm}$	(24)
Weighted Fuzzy normalized performance value (upper limit)	$\tilde{p}_{iju} = w_{ju}\tilde{x}^*_{iju}$	(25)
Total Weighted Fuzzy normalized performance value (lower limit)	$\tilde{y}_{il} = \sum_{j=1}^{k} \tilde{p}_{ijl} - \sum_{j=k+1}^{n} \tilde{p}_{ijl}$	(26)
Total Weighted Fuzzy normalized performance value (the most promising value)	$\tilde{y}_{im} = \sum_{j=1}^{k} \tilde{p}_{ijm} - \sum_{j=k+1}^{n} \tilde{p}_{ijm}$	(27)
Total Weighted Fuzzy normalized performance value (upper limit)	$\tilde{y}_{iu} = \sum_{j=1}^{k} \tilde{p}_{iju} - \sum_{j=k+1}^{n} \tilde{p}_{iju}$	(28)
Defuzzified Total Weighted Fuzzy normalized performance value	$y_i = \frac{(\tilde{y}_{iu} - \tilde{y}_{il}) + (\tilde{y}_{im} - \tilde{y}_{il})}{3} + \tilde{y}_{il}$	(29)

Where

$i: alternative; i = 1,2,3, \dots, m$

$d: decision\ maker; d = 1,2,3, \dots, D$

$\tilde{x}_{ijd}: fuzzy\ performance\ value\ \ (decision\ maker\ d)$

$\tilde{x}_{ijld}: fuzzy\ performance\ lower\ limit\ value\ (decision\ maker\ d)$

$\tilde{x}_{ijmd}: fuzzy\ performance\ the\ most\ promising\ value\ (decision\ maker\ d)$

$\tilde{x}_{ijud}: fuzzy\ performance\ upper\ limit\ value\ (decision\ maker\ d)$

$\tilde{x}_{ij}: integrated\ fuzzy\ performance\ value$

$\tilde{x}_{ijl}: integrated\ fuzzy\ performance\ lower\ limit\ value$

$\tilde{x}_{ijm}: integrated\ fuzzy\ performance\ the\ most\ promising\ value$

$\tilde{x}_{iju}: integrated\ fuzzy\ performance\ upper\ limit\ value$

$\tilde{x}^*_{ij}: integrated\ weighted\ fuzzy\ performance\ value$

$\tilde{x}^*_{ijl}: integrated\ normalized\ fuzzy\ performance\ lower\ limit\ value$

$\tilde{x}^*_{ijm}: integrated\ normalized\ fuzzy\ performance\ the\ most\ promising\ value$

$\tilde{x}^*_{iju}: integrated\ normalized\ fuzzy\ performance\ upper\ limit\ value$

$\tilde{p}_{ij}: integrated\ normalized\ weighted\ fuzzy\ performance\ value$

$\tilde{p}_{ijl}: integrated\ normalized\ weighted\ fuzzy\ performance\ lower\ limit\ value$

$\tilde{p}_{ijm}: integrated\ normalized\ weighted\ fuzzy\ performance\ the\ most\ promising\ value$

$\tilde{p}_{iju}: integrated\ normalized\ weighted\ fuzzy\ performance\ upper\ limit\ value$

$\tilde{y}_i: total\ integrated\ normalized\ weighted\ fuzzy\ performance\ value$

$\tilde{y}_{il}: total\ integrated\ normalized\ weighted\ fuzzy\ performance\ lower\ limit\ value$

$\tilde{y}_{im}: total\ integrated\ normalized\ weighted\ fuzzy\ performance\ the\ most\ promising\ value$

$\tilde{y}_{iu}: total\ integrated\ normalized\ weighted\ fuzzy\ performance\ upper\ limit\ value$

$j: benefit\ criterion; j = 1,2,3, \dots, k$

$j: cost\ criterion; j = k+1, k+2, k+3, \dots, n$

$y_i: defuzzified\ total\ performance\ value$

5. Application

In the application part, first of all, the most important factors that customers consider in their bank preferences in retail banking and private banking concepts in Turkey are determined.

For this purpose, interviews were conducted with decision makers. The identified criteria are shown in Table 6.

Table 6. Criteria

Criterion code	Criterion name
c1	Trust
c2	Compatible pricing
c3	Data security and privacy
c4	Customer service quality
c5	Manageable fees
c6	Online and mobile banking
c7	Product variability
c8	Investment advisory service quality
c9	Branch and ATM network
c10	Environmental responsibility

The criteria used in the study mean the following:

- c1 - Trust: Refers to the trust that banks provide to their customers.
- c2 - Compatible pricing: Optimal prices for banking products and services.
- c3 - Data security and privacy: Protecting customer data from unauthorized access, alteration, or destruction.
- c4 - Customer service quality: Level of satisfaction and support provided to customers throughout their interactions with a bank.
- c5 - Manageable fees: Charges or costs associated with banking products and services that customers find reasonable and affordable.
- c6 - Online and mobile banking: Digital banking services that allow customers to access and manage their bank accounts through internet-enabled devices such as computers, smartphones, and tablets.
- c7 - Product variability: Diversity of financial products and services offered by a bank to meet the needs and preferences of its customers (Deposit, loan, investment products, insurance products, payment and wealth management services).
- c8 - Investment advisory service quality: An advisory process, aiming to assist clients in making good investment choices aligned with their financial goals, risk tolerance, and preferences.
- c9 - Branch and ATM network: Physical locations of bank branches and automated machines maintained by a bank to provide services to its customers.
- c10 - Environmental responsibility: Integrating environmental considerations into all aspects of their operations and decision-making processes, with the goal of promoting sustainability.

The bank alternatives to be ranked according to the criteria determined in the study are shown in Table 7.

Table 7. Bank alternatives

Alternative code	Alternative name
1	Yapı Kredi
2	Şekerbank
3	Garanti Bankası
4	Ziraat Bankası
5	İş Bankası
6	Qnb Finansbank
7	TEB
8	Vakıfbank
9	Odeabank

In the study, the weights of the criteria were found with the fuzzy SWARA method.

In the first stage of the fuzzy SWARA method, decision makers evaluate the criteria. As an example, the evaluations of decision maker 1 for the criteria are shown in Table 8.

Table 8. Evaluations of decision maker 1

	s_{j1l}	s_{j1m}	s_{j1u}
1			
2	0.5000	0.7500	1.0000
3	0.0000	0.0000	0.3000
4	0.3000	0.5000	0.7000
5	0.0000	0.0000	0.3000
6	0.0000	0.2500	0.5000
7	0.0000	0.0000	0.3000
8	0.0000	0.0000	0.3000
9	0.0000	0.2500	0.5000
10	0.3000	0.5000	0.7000

Calculations of the coefficient values according to the answers of decision maker 1 for criteria are shown in Table 9.

Table 9. Coefficients (decision maker 1)

	k_{j1l}	k_{j1m}	k_{j1u}
1	1.0000	1.0000	1.0000
2	1.5000	1.7500	2.0000
3	1.0000	1.0000	1.3000
4	1.3000	1.5000	1.7000
5	1.0000	1.0000	1.3000
6	1.0000	1.2500	1.5000
7	1.0000	1.0000	1.3000
8	1.0000	1.0000	1.3000
9	1.0000	1.2500	1.5000
10	1.3000	1.5000	1.7000

Fuzzy recalculated weights according to the answers of decision maker 1 for criteria can be seen in Table 10.

Table 10. Fuzzy Recalculated Weights (decision maker 1)

	q_{j1l}	q_{j1m}	q_{j1u}
1	1.0000	1.0000	1.0000
2	0.5000	0.5714	0.6667
3	0.3846	0.5714	0.6667
4	0.2262	0.3810	0.5128
5	0.1740	0.3810	0.5128
6	0.1160	0.3048	0.5128
7	0.0892	0.3048	0.5128
8	0.0687	0.3048	0.5128
9	0.0458	0.2438	0.5128
10	0.0269	0.1625	0.3945

Fuzzy relative weights according to the answers of decision maker 1 for criteria can be seen in Table 11.

Table 11: Fuzzy Relative Weights (decision maker 1)

	w_{j1l}	w_{j1m}	w_{j1u}
1	0.1723	0.2367	0.3800
2	0.0861	0.1352	0.2533
3	0.0663	0.1352	0.2533
4	0.0390	0.0902	0.1949
5	0.0300	0.0902	0.1949
6	0.0200	0.0721	0.1949
7	0.0154	0.0721	0.1949
8	0.0118	0.0721	0.1949
9	0.0079	0.0577	0.1949
10	0.0046	0.0385	0.1499

The procedure repeats for all decision makers. As a holistic approach, all results derived from the answers of decision maker 1-3 can be seen in Table 12, of decision maker 4-6 can be seen in Table 13, of Decision maker 7-9 can be seen in Table 14.

Table 12. Results (decision maker 1-3)

	w_{j1l}	w_{j1m}	w_{j1u}	w_{j2l}	w_{j2m}	w_{j2u}	w_{j3l}	w_{j3m}	w_{j3u}
1	0.1723	0.2367	0.3800	0.0954	0.1763	0.3428	0.0074	0.0298	0.0859
2	0.0861	0.1352	0.2533	0.1430	0.2204	0.3428	0.2102	0.2639	0.3682
3	0.0663	0.1352	0.2533	0.0221	0.0940	0.2637	0.0097	0.0298	0.0859
4	0.0390	0.0902	0.1949	0.0561	0.1175	0.2637	0.1617	0.2639	0.3682
5	0.0300	0.0902	0.1949	0.0100	0.0627	0.2028	0.0280	0.0670	0.1452
6	0.0200	0.0721	0.1949	0.0374	0.0940	0.2637	0.0808	0.1508	0.2454
7	0.0154	0.0721	0.1949	0.0170	0.0940	0.2637	0.0165	0.0447	0.1117
8	0.0118	0.0721	0.1949	0.0288	0.0940	0.2637	0.0476	0.1005	0.1888
9	0.0079	0.0577	0.1949	0.0050	0.0313	0.1193	0.0057	0.0298	0.0859
10	0.0046	0.0385	0.1499	0.0025	0.0157	0.0702	0.0034	0.0199	0.0661

Table 13. Results (Decision maker 4-6)

	w_{j4l}	w_{j4m}	w_{j4u}	w_{j5l}	w_{j5m}	w_{j5u}	w_{j6l}	w_{j6m}	w_{j6u}
1	0.1754	0.2458	0.3625	0.0052	0.0140	0.0551	0.2391	0.3693	0.4521
2	0.1032	0.1639	0.2789	0.0156	0.0350	0.0936	0.0598	0.1055	0.1773
3	0.0068	0.0342	0.1239	0.2064	0.2628	0.3516	0.0156	0.0450	0.1364
4	0.0529	0.1311	0.2789	0.0934	0.1752	0.2705	0.1195	0.1846	0.2659
5	0.0794	0.1639	0.2789	0.0104	0.0280	0.0936	0.0092	0.0450	0.1364
6	0.0102	0.0428	0.1239	0.1587	0.2628	0.3516	0.0398	0.0844	0.1773
7	0.0265	0.0749	0.1859	0.0026	0.0080	0.0367	0.0120	0.0450	0.1364
8	0.0204	0.0749	0.1859	0.0311	0.0701	0.1591	0.0062	0.0360	0.1364
9	0.0052	0.0342	0.1239	0.0623	0.1401	0.2705	0.0234	0.0563	0.1364
10	0.0040	0.0342	0.1239	0.0013	0.0040	0.0216	0.0041	0.0288	0.1364

Table 14. Results (decision maker 7-9)

	w_{j7l}	w_{j7m}	w_{j7u}	w_{j8l}	w_{j8m}	w_{j8u}	w_{j9l}	w_{j9m}	w_{j9u}
1	0.1725	0.2513	0.3320	0.3171	0.4204	0.4630	0.1303	0.1938	0.2923
2	0.0507	0.0838	0.1502	0.1586	0.2102	0.2723	0.2215	0.2908	0.3800
3	0.1015	0.1675	0.2554	0.0081	0.0178	0.0486	0.0058	0.0197	0.0678
4	0.0088	0.0186	0.0523	0.0933	0.1401	0.2095	0.1002	0.1938	0.2923
5	0.0149	0.0279	0.0680	0.0054	0.0142	0.0486	0.0196	0.0517	0.1323
6	0.2932	0.3769	0.4316	0.0137	0.0267	0.0632	0.0295	0.0646	0.1323
7	0.0022	0.0053	0.0205	0.0549	0.0934	0.1611	0.0034	0.0131	0.0522
8	0.0298	0.0558	0.1156	0.0274	0.0534	0.1074	0.0589	0.1292	0.2249
9	0.0044	0.0093	0.0308	0.0024	0.0095	0.0374	0.0020	0.0088	0.0401
10	0.0013	0.0035	0.0158	0.0041	0.0142	0.0486	0.0116	0.0345	0.1018

The results of decision maker 10 and average values are in Table 15.

Table 15. Decision maker 10 and average values

	w_{j10l}	w_{j10m}	w_{j10u}	w_{jl}	w_{jm}	w_{ju}
1	0.2617	0.3551	0.4471	0.1576	0.2292	0.3213
2	0.1309	0.1776	0.2630	0.1180	0.1686	0.2580
3	0.0099	0.0464	0.1169	0.0452	0.0852	0.1704
4	0.0252	0.0580	0.1169	0.0750	0.1373	0.2313
5	0.0194	0.0580	0.1169	0.0226	0.0609	0.1417
6	0.0654	0.1015	0.1753	0.0749	0.1277	0.2159
7	0.0058	0.0309	0.0899	0.0156	0.0482	0.1253
8	0.0503	0.1015	0.1753	0.0312	0.0788	0.1752
9	0.0129	0.0464	0.1169	0.0131	0.0423	0.1156
10	0.0039	0.0247	0.0899	0.0041	0.0218	0.0824

As can be seen in Table 15 as a result of the analysis made with fuzzy SWARA, the three most important criteria that customers consider while choosing banks are “Trust”, “Compatible pricing” and “Customer service quality”.

After the criterion weights are found, the application of the fuzzy MOORA Method starts at this stage. Nine bank alternatives will be evaluated according to the fuzzy MOORA Method Initial fuzzy decision matrix for decision maker 1 are in table 16.

Table 16. Initial fuzzy decision matrix for decision maker 1

		A1	A2	A3	A4	A5	A6	A7	A8	A9
l	k1	7	1	7	5	9	5	5	5	3
m	k1	9	3	9	7	10	7	7	7	5
u	k1	10	5	10	9	10	9	9	9	7
l	k2	3	1	3	1	3	3	3	5	3
m	k2	5	3	5	3	5	5	5	7	5
u	k2	7	5	7	5	7	7	7	9	7
l	k3	7	3	7	7	9	7	7	7	5
m	k3	9	5	9	9	10	9	9	9	7
u	k3	10	7	10	10	10	10	10	10	9
l	k4	5	3	3	3	3	3	3	5	5
m	k4	7	5	5	5	5	5	5	7	7
u	k4	9	7	7	7	7	7	7	9	9
l	k5	1	5	1	3	1	3	1	3	3
m	k5	3	7	3	5	3	5	3	5	5
u	k5	5	9	5	7	5	7	5	7	7
l	k6	7	1	9	7	7	5	5	5	5
m	k6	9	3	10	9	9	7	7	7	7
u	k6	10	5	10	10	10	9	9	9	9
l	k7	7	1	7	3	5	3	3	5	5
m	k7	9	3	9	5	7	5	5	7	7
u	k7	10	5	10	7	9	7	7	9	9
l	k8	7	1	5	3	3	3	3	5	7
m	k8	9	3	7	5	5	5	5	7	9
u	k8	10	5	9	7	7	7	7	9	10
l	k9	7	7	7	9	9	3	3	5	0
m	k9	9	9	9	10	10	5	5	7	1
u	k9	10	10	10	10	10	7	7	9	3
l	k10	9	1	7	5	9	5	5	5	3
m	k10	10	3	9	7	10	7	7	7	5
u	k10	10	5	10	9	10	9	9	9	7

Integration of the decisions are in table 17.

Table 17. Integration of decisions

		A1	A2	A3	A4	A5	A6	A7	A8	A9
l	k1	7.5000	1.2857	8.1111	6.3750	8.6000	6.2500	5.8571	5.7143	3.1250
m	k1	9.0000	3.0000	9.5556	7.8750	9.7000	8.1250	7.7143	7.4286	5.0000
u	k1	9.7500	5.0000	10.000	8.8750	9.9000	9.5000	9.1429	8.7143	6.8750
l	k2	3.7778	3.3333	2.6000	3.3750	3.2000	4.3750	5.0000	5.2857	4.4444
m	k2	5.6667	5.3333	4.4000	5.1250	5.2000	6.1250	6.8571	7.1429	6.2222
u	k2	7.4444	7.1667	6.3000	6.7500	7.1000	7.7500	8.2857	8.5714	7.7778

l	k3	6.6667	3.6667	7.6667	5.5000	7.4000	6.5000	6.7143	5.8571	4.3333
m	k3	8.1111	5.6667	9.2222	7.3750	8.9000	8.3750	8.4286	7.7143	6.3333
u	k3	8.8889	7.6667	9.8889	8.8750	9.7000	9.6250	9.5714	9.1429	8.2222
l	k4	5.8889	2.3333	5.6000	2.7500	4.4000	5.7500	5.2857	5.0000	5.4444
m	k4	7.7778	4.3333	7.4000	4.7500	6.3000	7.3750	7.0000	7.0000	7.3333
u	k4	9.2222	6.3333	8.8000	6.6250	8.0000	8.5000	8.2857	8.5714	8.8889
l	k5	3.8750	5.6667	2.3000	5.5000	3.7000	4.7500	5.0000	6.1429	6.1111
m	k5	5.7500	7.5000	3.9000	7.3750	5.6000	6.6250	7.0000	7.8571	7.7778
u	k5	7.5000	9.0000	5.7000	8.8750	7.5000	8.1250	8.5714	9.0000	8.8889
l	k6	6.3333	3.3333	8.2000	4.7500	6.5556	7.5000	5.8571	4.8571	4.5556
m	k6	8.1111	5.3333	9.5000	6.7500	8.3333	9.0000	7.7143	6.5714	6.5556
u	k6	9.2222	7.3333	9.9000	8.5000	9.4444	9.7500	9.1429	8.1429	8.3333
l	k7	6.2222	3.0000	6.3000	3.7500	5.7000	5.7500	5.2857	4.2857	4.5556
m	k7	7.7778	5.0000	7.9000	5.6250	7.3000	7.3750	7.0000	6.0000	6.5556
u	k7	8.7778	7.0000	9.0000	7.3750	8.6000	8.5000	8.2857	7.5714	8.3333
l	k8	5.4444	2.5000	5.0000	2.6250	4.8750	5.0000	5.0000	4.0000	5.0000
m	k8	7.4444	4.3333	6.8889	4.5000	6.3750	6.7500	6.7143	5.8571	7.0000
u	k8	9.0000	6.1667	8.4444	6.3750	7.7500	8.1250	8.0000	7.5714	8.7500
l	k9	7.8889	2.5714	8.4000	6.2500	6.6000	4.5000	3.0000	6.1429	1.5556
m	k9	9.2222	4.0000	9.7000	7.8750	8.2000	6.5000	4.7143	7.8571	2.8889
u	k9	9.6667	5.5714	10.000	9.0000	9.3000	8.1250	6.5714	9.0000	4.7778
l	k10	5.5000	3.0000	5.0000	3.2500	4.7500	4.7500	4.7143	3.5714	3.0000
m	k10	7.3750	5.0000	6.8889	5.2500	6.6250	6.7500	6.7143	5.5714	5.0000
u	k10	8.7500	7.0000	8.4444	7.2500	8.0000	8.3750	8.2857	7.5714	6.8750

Fuzzy normalized performance values are in table 18.

Table 18. Fuzzy normalized performance values

		A1	A2	A3	A4	A5	A6	A7	A8	A9
l	k1	0.1880	0.0322	0.2033	0.1598	0.2156	0.1567	0.1468	0.1433	0.0783
m	k1	0.2256	0.0752	0.2396	0.1974	0.2432	0.2037	0.1934	0.1862	0.1253
u	k1	0.2444	0.1253	0.2507	0.2225	0.2482	0.2382	0.2292	0.2185	0.1724
l	k2	0.1220	0.1077	0.0840	0.1090	0.1034	0.1413	0.1615	0.1708	0.1436
m	k2	0.1831	0.1723	0.1421	0.1656	0.1680	0.1979	0.2215	0.2307	0.2010
u	k2	0.2405	0.2315	0.2035	0.2181	0.2294	0.2504	0.2677	0.2769	0.2513
l	k3	0.1645	0.0905	0.1891	0.1357	0.1825	0.1603	0.1656	0.1445	0.1069
m	k3	0.2001	0.1398	0.2275	0.1819	0.2195	0.2066	0.2079	0.1903	0.1562
u	k3	0.2193	0.1891	0.2439	0.2189	0.2393	0.2374	0.2361	0.2255	0.2028
l	k4	0.1686	0.0668	0.1603	0.0787	0.1260	0.1646	0.1513	0.1431	0.1558
m	k4	0.2226	0.1240	0.2118	0.1360	0.1803	0.2111	0.2004	0.2004	0.2099
u	k4	0.2640	0.1813	0.2519	0.1896	0.2290	0.2433	0.2372	0.2454	0.2544
l	k5	0.1105	0.1617	0.0656	0.1569	0.1056	0.1355	0.1426	0.1752	0.1743
m	k5	0.1640	0.2140	0.1113	0.2104	0.1598	0.1890	0.1997	0.2242	0.2219
u	k5	0.2140	0.2568	0.1626	0.2532	0.2140	0.2318	0.2445	0.2568	0.2536

l	k6	0.1605	0.0845	0.2078	0.1203	0.1661	0.1900	0.1484	0.1231	0.1154
m	k6	0.2055	0.1351	0.2407	0.1710	0.2111	0.2280	0.1955	0.1665	0.1661
u	k6	0.2337	0.1858	0.2508	0.2154	0.2393	0.2470	0.2317	0.2063	0.2111
l	k7	0.1758	0.0848	0.1780	0.1060	0.1611	0.1625	0.1494	0.1211	0.1287
m	k7	0.2198	0.1413	0.2232	0.1589	0.2063	0.2084	0.1978	0.1695	0.1852
u	k7	0.2480	0.1978	0.2543	0.2084	0.2430	0.2402	0.2341	0.2140	0.2355
l	k8	0.1646	0.0756	0.1512	0.0794	0.1474	0.1512	0.1512	0.1209	0.1512
m	k8	0.2251	0.1310	0.2083	0.1361	0.1927	0.2041	0.2030	0.1771	0.2116
u	k8	0.2721	0.1864	0.2553	0.1927	0.2343	0.2457	0.2419	0.2289	0.2645
l	k9	0.2143	0.0698	0.2282	0.1698	0.1793	0.1222	0.0815	0.1669	0.0423
m	k9	0.2505	0.1086	0.2635	0.2139	0.2227	0.1766	0.1281	0.2134	0.0785
u	k9	0.2626	0.1513	0.2716	0.2445	0.2526	0.2207	0.1785	0.2445	0.1298
l	k10	0.1685	0.0919	0.1532	0.0996	0.1455	0.1455	0.1444	0.1094	0.0919
m	k10	0.2259	0.1532	0.2110	0.1608	0.2029	0.2068	0.2057	0.1707	0.1532
u	k10	0.2680	0.2144	0.2587	0.2221	0.2451	0.2565	0.2538	0.2319	0.2106

Weighted Fuzzy normalized performance values are in table 19.

Table 19. Weighted Fuzzy normalized performance values

		A1	A2	A3	A4	A5	A6	A7	A8	A9
l	k1	0.0296	0.0051	0.0321	0.0252	0.0340	0.0247	0.0231	0.0226	0.0124
m	k1	0.0517	0.0172	0.0549	0.0453	0.0557	0.0467	0.0443	0.0427	0.0287
u	k1	0.0785	0.0403	0.0805	0.0715	0.0797	0.0765	0.0736	0.0702	0.0554
l	k2	0.0144	0.0127	0.0099	0.0129	0.0122	0.0167	0.0191	0.0201	0.0169
m	k2	0.0309	0.0291	0.0240	0.0279	0.0283	0.0334	0.0374	0.0389	0.0339
u	k2	0.0620	0.0597	0.0525	0.0562	0.0592	0.0646	0.0690	0.0714	0.0648
l	k3	0.0074	0.0041	0.0085	0.0061	0.0083	0.0072	0.0075	0.0065	0.0048
m	k3	0.0171	0.0119	0.0194	0.0155	0.0187	0.0176	0.0177	0.0162	0.0133
u	k3	0.0374	0.0322	0.0416	0.0373	0.0408	0.0404	0.0402	0.0384	0.0346
l	k4	0.0126	0.0050	0.0120	0.0059	0.0094	0.0123	0.0113	0.0107	0.0117
m	k4	0.0306	0.0170	0.0291	0.0187	0.0248	0.0290	0.0275	0.0275	0.0288
u	k4	0.0611	0.0419	0.0583	0.0439	0.0530	0.0563	0.0549	0.0568	0.0589
l	k5	0.0025	0.0037	0.0015	0.0036	0.0024	0.0031	0.0032	0.0040	0.0039
m	k5	0.0100	0.0130	0.0068	0.0128	0.0097	0.0115	0.0122	0.0136	0.0135
u	k5	0.0303	0.0364	0.0231	0.0359	0.0303	0.0329	0.0347	0.0364	0.0359
l	k6	0.0120	0.0063	0.0156	0.0090	0.0124	0.0142	0.0111	0.0092	0.0086
m	k6	0.0262	0.0173	0.0307	0.0218	0.0270	0.0291	0.0250	0.0213	0.0212
u	k6	0.0505	0.0401	0.0542	0.0465	0.0517	0.0533	0.0500	0.0445	0.0456
l	k7	0.0027	0.0013	0.0028	0.0017	0.0025	0.0025	0.0023	0.0019	0.0020
m	k7	0.0106	0.0068	0.0108	0.0077	0.0099	0.0100	0.0095	0.0082	0.0089
u	k7	0.0311	0.0248	0.0319	0.0261	0.0304	0.0301	0.0293	0.0268	0.0295
l	k8	0.0051	0.0024	0.0047	0.0025	0.0046	0.0047	0.0047	0.0038	0.0047
m	k8	0.0177	0.0103	0.0164	0.0107	0.0152	0.0161	0.0160	0.0139	0.0167
u	k8	0.0477	0.0327	0.0447	0.0338	0.0410	0.0430	0.0424	0.0401	0.0463

l	k9	0.0028	0.0009	0.0030	0.0022	0.0024	0.0016	0.0011	0.0022	0.0006
m	k9	0.0106	0.0046	0.0112	0.0091	0.0094	0.0075	0.0054	0.0090	0.0033
u	k9	0.0304	0.0175	0.0314	0.0283	0.0292	0.0255	0.0206	0.0283	0.0150
l	k10	0.0007	0.0004	0.0006	0.0004	0.0006	0.0006	0.0006	0.0004	0.0004
m	k10	0.0049	0.0033	0.0046	0.0035	0.0044	0.0045	0.0045	0.0037	0.0033
u	k10	0.0221	0.0177	0.0213	0.0183	0.0202	0.0211	0.0209	0.0191	0.0174

Total Weighted Fuzzy normalized performance values, defuzzified values and ranks are in table 20.

Table 20. Total Weighted Fuzzy normalized performance values, defuzzified values and ranks

	$\tilde{y}_{il}$	$\tilde{y}_{im}$	$\tilde{y}_{iu}$	y_i	rank
A1	0.0900	0.2103	0.4510	0.2504	1
A2	0.0418	0.1306	0.3433	0.1719	9
A3	0.0907	0.2078	0.4394	0.2460	2
A4	0.0694	0.1729	0.3977	0.2134	8
A5	0.0888	0.2032	0.4355	0.2425	4
A6	0.0877	0.2054	0.4438	0.2456	3
A7	0.0841	0.1995	0.4357	0.2398	5
A8	0.0815	0.1951	0.4320	0.2362	6
A9	0.0661	0.1717	0.4033	0.2137	7

Rank 1 represents the best bank from the point of view of the customers when all of the criteria are considered. Yapı Kredi Bank seems to be the best bank according to customers and Şekerbank is the least preferred bank. As we have mentioned before customer preferences shows a wide spectrum but there are some crucial things for banking customers in Turkey. One of the most important factors is trust. Also, it is a known fact that Turkey has an important ratio of young generation who prefer to use digital or internet banking instead of using traditional services such as visiting a bank branch. We think that these two factors played an important role in ranking the banks.

6. Conclusions

In this study, fuzzy SWARA and fuzzy MOORA methods are applied in an integrated manner to weight the factors that customers attach importance to in banking services and to rank nine banks operating in the Turkish banking sector according to these criteria.

Since there is intense competition in the banking sector as in every sector, it is thought that the results of the study will shed light and be useful for the banking sector managers.

The model formed by the combined application of fuzzy SWARA and fuzzy MOORA methods presented in this study can be used to determine the importance of customer preferences in different sectors and to rank alternative businesses in the relevant sector.

The results of this study provide valuable insights into the types of banking services that customers perceive to be most relevant to their needs and preferences. Trust and favorable pricing appear to be the most important factors in customers' preferences. Other important factors are customer service quality and mobile services.

In 2001 Turkey has experienced a very dramatic financial crisis. Most of the banks have gone bankruptcy or taken over by Turkey Saving Deposit and Insurance Fund. A lot of banking regulations have been implemented after that crisis. These regulations made Turkish banks to become resilient against financial crises. During these crises Turkish banking customers experienced very unpleasant thing as well. Some of them lost all of their money. For that reason, trust is always top criteria for Turkish banking customers.

In conclusion, this study sheds light on the evolving landscape of retail and private banking in Turkey and identifies key factors influencing customer preferences. The banking sector has responded to global challenges and technological advancements by embracing digitalization and enhancing service offerings. However, customer preferences remain diverse, with trust emerging as a critical consideration, particularly in the aftermath of past financial crises. Factors such as mobile services, customer service quality, and pricing compatibility also play significant roles in shaping customer preferences. By understanding these factors, banks can better tailor their strategies to meet the needs and expectations of Turkish banking customers. Moving forward, continued research and adaptation to changing market dynamics will be essential for banks to maintain competitiveness and foster customer loyalty in Turkey's dynamic banking environment.

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