Performance evaluation of Iran's state banks based on FinTech innovation indexes

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ABSTRACT

The present research aims to evaluate the performance of Iran's state banks based on FinTech innovation indexes. For realization of the research objectives, the opinions of 13 Central Bank experts and university professors were used until the theoretical saturation. Data analysis was done in three phases: identifying the factors affecting the evaluation of the performance and status of the banks based on the technology-enabled innovation in financial services (FinTech) through interviews and using thematic analysis method, determining the degree of importance of the components through the questionnaire and Shannon's entropy method, and ranking the country's state banks through the questionnaire and MABAC method. The research findings indicated that 19 components identified in the qualitative phase obtained the highest degree of importance among the factors affecting the performance evaluation and status of banks based on the FinTech indexes. These components include as follows: employees' training and learning, reforming the organizational structure, developing big data analysis, actively identifying customer needs, sharing financial data, developing smart investment management, alliance with financial peers, multi-faceted business strategies, application of blockchain technology, customer orientation, delivery of customized services, development of financial affairs, credit risk management, improving service efficiency, organizational innovation culture, enhancing digital marketing, increasing customer communication channels, new payment methods, and cooperation with traditional banks, respectively. Furthermore, National Bank of Iran (Bank Melli), Bank of Agriculture, Sepah Bank, Maskan Bank, Post Bank of Iran, Export Development Bank of Iran, Bank of Industry and Mine, and Cooperative Development Bank, respectively, gained the highest priority among the state banks according to the 19 identified factors.

Keywords: FinTech, bank, electronic banking, performance evaluation.

1. Introduction

With the rapid development of technologies such as big data, cloud computing, blockchain, and artificial intelligence, financial technology (FinTech) is currently expanding worldwide. "Fintech" can be broadly defined as financial innovations with technology that can lead to new business models, applications, processes, and products with associated material effects on financial markets, financial institutions, and the provision of financial services (International Organization of Securities Commission (IOSCO), 2017).

Financial technology innovations, which are emerging in many aspects of finance, such as retail finance, wholesale payments, investment management, insurance, credit provision and equity capital raising, are not only competing with traditional financial services, but also promoting their innovation and transformation (An & Rau, 2021; Gai et al., 2018). However, despite the emergence of financial innovations in the financial industry, the effects of Fintech on the financial system are less well known (Phan et al., 2020). Fintech has recently begun to expand beyond online business (such as mobile payments) and from traditional banking services to innovative financial services (Ryu, 2018). The increase in FinTech companies' investments in financial service innovation has led to significant changes in the business environment and intense competition among banks (Ghose et al., 2016). In this regard, various advantages and opportunities of using financial technology in the banking industry can be listed as follows:

- More access to capital: Peer-to-peer (P2P) platforms and Equity Crowd Funding (ECF) appear in providing credit to borrowers, especially small and medium-sized companies that do not have access to bank loans, and provide new opportunities to access net assets (Al-Ajlouni et al.);
- Relatively low risk of financial services/products (e.g., default risk, maturity risk) (Alt & Puschmann, 2012);
- The utilization of the banks from the competitive advantage of FinTechs (such as high standard and low-cost financial services, internet-based services and less geographic concentration, changing consumer behavior

and less regulations regarding financial services) (Romānova & Kudinska, 2016);
- Access to extensive data: the bank's cooperation with big data startups allows the bank to find extensive information about customers and leads to the bank having the power of deterrence and defense (Aliyev & Gasimov, 2018);
- Providing exclusive and distinctive services to customers: the bank's cooperation with Internet of Things Fintechs makes the bank become a part of users' daily lives. Such cooperation makes the bank provide exclusive and distinctive services to its customers and increase its innovation capacity (Coetzee, 2018);
- Increasing public trust, virtual security, expanding the scale of activity, and finally, access to various options of financial services, improving the user experience, and increasing the understanding of the financial system related to the new requirements of financial developments among users are among the benefits of this cooperation for banks (Zalan & Toufaily, 2017).

In addition to the above benefits, Fintech offers new approaches in relation to productivity, customer experiences and decentralization of services, which lead to innovation and transformation in the financial services industry (Wang et al., 2021). Previous studies have shown that financial service innovation plays an important role in the highly competitive banking industry (e.g., YuSheng & Ibrahim, 2019; Lusch & Nambisan, 2015). In this regard, Lusch and Nambisan (2015) stated that the banking industry can achieve higher profits through innovation, and the performance of banks investing in innovation is significantly better than the performance of those that do not. It can be said that the main factor for the success of using financial technology in the banking industry is to protect the innovative features of Fintech to push this cooperation towards new ideas and to use banking capacities, such as knowledge, formal processes, and assets. From this point of view, Fintech is not a source of disruption or a competitor of the banking system, but is seen as an opportunity to strengthen cooperation and innovation in the relationship between banks and Fintech (Al-Ajlouni et al., 2018). Therefore, the current research specifically focuses on innovative

banking services in response to the impact created by the use of Fintech.

Many banks are looking for ways to help the future development of the banking industry with the help of Fintechs, but Fintech research and studies are lagging behind the current developments in this field since banking and academic researchers believe that Fintech players are not able to completely reform the banking system (Wang et al., 2021). On the other hand, banks and credit financial institutions are one of the most important economic sectors. This group of organizations, by directing and organizing receipts and payments, facilitates trade and commercial exchanges and helps expansion of markets and economic growth and prosperity. Today, in the age of information, organizations need to measure all financial and non-financial aspects of their organization (Kazemizadeh et al., 2016). Although the previous studies are not much comprehensive, they have addressed various research questions concerning bank and Fintech cooperation. However, previous studies have rarely used the combination of qualitative methods and multi-criteria decision making (MCDM) to evaluate innovative strategies affecting the performance and position of banks during the financial technology revolution (Fintech). In addition, other methods such as structural equation modeling (SEM) in previous studies do not consider a decision-making model to measure the performance and position of banks, which can make the evaluation process deficient. Also, in the research conducted in the country, the identification and evaluation of factors affecting the performance and position of banks based on the Fintech indexes have been completely neglected. In fact, since Fintech is a new phenomenon in Iran and the world, the innovative strategies of banks' services to respond to the impact created by the use of Fintech have not been investigated comprehensively in the country. Therefore, the present study addresses the technology-enabled *innovation* in financial *services* in order to develop a model for evaluating the performance and position of the country's banks to increase the competitive advantages of the Iranian banking industry during the financial technology revolution. The current research answers this main question: How is the model for evaluating the performance and position of banks based on the technology-enabled *innovation* in financial *services* (Fintech)? And what are its components?

This article is organized as follows. First, the theoretical and empirical background are examined and the literature related to financial technology, banking industry, and the relationship between financial technology and banking industry based on previous studies are presented. Then, the methodology used in this research is briefly described. The findings are then presented, and finally, the results and practical implications of this research are discussed.

Theoretical foundations and research background

Experts have introduced the serious emergence of Fintech since 2008, this term has been used in some cases before that. The lexical origin of Fintech can be traced back to the early 1990s, referring to the "Financial Services Technology Consortium" and initiated by Citigroup to facilitate technological collaboration efforts in the financial sector (Arner et al., 2015).

Based on the analysis of Fintech companies' services, these services can be divided into two groups:

- Fintech companies providing services complementary to bank services (e.g., providing technologies for banks to use to provide financial services)
- Fintech companies providing services that were covered by banks in the past (e.g., payments)

This classification creates a basis for further analysis of the bank's potential action and reaction regarding Fintech development, which can be considered both as a competitor and as a partner (Alt & Puschmann, 2012). The development of Fintech has an increasing impact on the banking business as well as many information-based banking products. Therefore, it can be purchased from many different financial service providers. In addition, modern data analysis methods and information technology allow the personalization of many digital financial services to make these services customer-oriented (Romānova & Kudinska, 2016). Financial experts believe that traditional financial services companies (including banks, insurance companies, and asset management companies) face a real risk of bankruptcy. Therefore, it is increasingly crucial for banks to staying updated through working with FinTech and forming partnerships or other solutions (Alt & Puschmann,

2012). Therefore, based on the previous literature, it can be stated that FinTech provides new approaches related to productivity, customer experiences and decentralization of services, which leads to innovation and transformation in the financial services industry (Wang et al., 2021). Previous studies have shown that financial service innovation plays an important role in the highly competitive banking industry (e.g., YuSheng & Ibrahim, 2019; Lusch & Nambisan, 2015). To this end, Lusch and Nambisan (2015) stated that the banking industry can achieve higher profits through innovation, and the banks that invest in innovation significantly outperform compared to those that do not. Therefore, it can be stated that the main success factor of using financial technology in the banking industry is to protect the innovative features of FinTech, to push this cooperation towards new ideas, and to use banking capacities, such as knowledge, official processes, and assets. From this point of view, FinTech is not a source of disruption or a competitor of the banking system, but is seen as an opportunity to strengthen cooperation and innovation in the relationship between banks and FinTech (Al-Ajlouni et al., 2018).

On the other hand, every organization needs an evaluation system in order to know the level of desirability and quality of its activities, especially in dynamic complex environments. Moreover, the absence of evaluation and control in a system is considered to mean the lack of communication with the internal and external environment of the organization, which results in the eventual death of the organization (Farhadi Cheshme Morvari & Jalili Ghasem Agha, 2020). The two main concepts hidden in the performance evaluation structure are: 1) effectiveness, 2) efficiency; Effectiveness means achieving the expected results and advancing strategies, and efficiency means the existence of a logical relationship between the resources used and the results obtained (Seyed Nurani & Ebadi, 2019). In this regard and considering that in recent years and with the growth of the FinTech phenomenon, "bank and FinTech cooperation" has become an important subject in the financial ecosystem, the cooperation and application of financial technology in the electronic banking industry needs more scientific investigation and scrutiny. By examining the theoretical literature and the existing background, the theoretical gaps in this field were revealed. It was found that, while the

speed of producing scientific resources in this field has been good in recent years, there is still little literature about the aspects and dimensions of evaluating the performance and position of banks based on the technology-enabled *innovation* in financial *services* (Fintech) in Iran. However, previous researches have helped expand knowledge in this field, some of these studies are summarized below:

Syahwildan and Damayanti (2022) determined the effect of mobile phone banking, internet banking, and SMS banking on the financial performance of Islamic banking. The obtained results showed that mobile banking, internet banking and SMS banking have a significant effect on the financial performance of Islamic banking in Indonesia. Therefore, it can be concluded that the higher the level of importance and significance of the relationship between mobile banking, internet banking, and SMS banking with financial performance, the greater the financial performance of Islamic banking in Indonesia. Legowo et al. (2021), in a descriptive-analytical research and using qualitative method investigated the relationship between FinTech and bank. This descriptive analysis was conducted with a critical review of various scientific journals related to the phenomenon of FinTech and documents of banking institutions. The results of this analysis show what has happened to FinTech and banks in the past, present, and future. Soltani and Tahmasbi Aghbolaghi (2020) conducted a research entitled "explaining the role of the strategic partnership of Tejarat Bank with FinTechs in efficiency through the mediation of technological developments and digital banking". Based on the findings of this research, the role of Tejarat Bank's strategic partnership with FinTechs, digital technological developments, digital banking, the role of digital technological developments and digital banking on efficiency was confirmed. On the other hand, the indirect role of mediating variables of digital technological developments and digital banking between Tejarat Bank's strategic partnership with FinTechs and efficiency was confirmed. Moghani et al. (2018) conducted a research entitled "Designing and explaining the quality model of modern banking services based on FinTech (digital banking)". According to the results of the evaluations in this research, the index of information and service personalization, stability of services, security and authentication, ease of access to services, and

innovation in services are prominent indexes in the quality of digital banking. As it is evident in the results of the thesis, business changes due to changes in technology, especially information and communication technology, are not a continuous improvement, but in some cases, the paradigms governing businesses, especially banking, change, which causes changes in some scientific concepts about traditional businesses. Lien et al. (2020) used multivariate regression to estimate the research model. Research results show that FinTech services are very important for Vietnam's banking sector. In addition, this paper achieved great success by identifying the factors that influence customers' intention to use FinTech services. Accordingly, willingness to use FinTech services is positively affected by perceived usefulness, social impact, customer trust, and perceived ease of use. Based on the results of this study, bank managers will have a basis for improving the quality of FinTech services. Moreover, the results of this study are valuable for policy makers and researchers.

By examining the theoretical literature and the existing background, the theoretical gaps in this field were revealed. It was found that, the speed of producing scientific resources in this field has been good while in recent years, there is still little literature about the aspects and dimensions of evaluating the performance and position of banks based on the technology-enabled *innovation* in financial *services* (Fintech) in Iran. Another research gap is that most of the previous studies have investigated the willingness of individuals and companies to use new FinTech-based systems, such as mobile payments (Hwang et al., 2021), crowdfunding (Baber, 2020), and online loans (Agarwal & Zhang, 2020), and no measure has been taken to provide a comprehensive view of evaluating the position of banks based on the technology-enabled *innovation* in financial *services* (Fintech) with the aim of improving the situation of banks to maintain a competitive advantage. Besides, these studies have used only qualitative or quantitative methods. Additionally, to date, the focus on FinTech has largely been from a Western perspective. Due to cultural and legal differences, the findings of studies on Western countries may not be generalizable to Iran. Thus, the present research analyzes opinions and views with the aim of evaluating the performance of Iran's state banks based on the FinTech indexes. To this end,

the following goals are defined for the use of financial technology in the electronic banking industry:

- Identifying and evaluating the performance of Iran's state banks based on FinTech innovation;
- Determining the degree of importance of evaluating the performance of Iran's state banks based on FinTech innovation;
- Evaluation of the performance of Iran's state banks based on FinTech innovation.

Methodology

The current research is an applied research in terms of purpose, it is descriptive in terms of the inference method, and in terms of the nature of the data, it is exploratory mixed. The research population in the present study include university professors, managers and experts of Central Bank of Islamic Republic of Iran. These people were experts in the field related to the research topic. The judgmental sampling method (review by the members of the research team) was used to select the participants in the current research. According to the nature of the sampling method, the sample size was determined as 13 based on the experts accessible and their tendency for cooperation. Considering that in the exploratory mixed research method, qualitative research methods are firstly used, and then quantitative research methods are employed, the research was conducted according to the following steps:

Qualitative part: In this part, in order to collect data and information for the qualitative analysis, the thematic (content) analysis was used. Necessary measures were taken for a qualitative interview with a group of 13 bank specialists and experts who had sufficient knowledge of the subject. In the qualitative phase of the research, data collection continued until the theoretical saturation of the categories, and more clearly, until it was no longer possible to obtain new data. After transcribing the interviews, primary and secondary coding was done. In order to confirm the validity of the analysis of the interviews, the open methods of the stability index test were used based on different perspectives, especially the perspective (Khastar, 2009). To calculate the reliability of the above tests, three interviews were selected as samples from among the conducted interviews and each of them was recoded in a short time interval (one week). Then, the specified codes were compared in two time

intervals for each of the interviews. In each of the interviews, codes that were similar in two time intervals were identified as "agreement" and non-similar codes as "disagreement". The re-test reliability of the interviews conducted in this research using the determined formula is equal to 80%, which is more than the acceptable value of 60%.

Quantitative part: According to the purpose and nature of the research subject, the most appropriate method in the quantitative phase for the present research was the descriptive-survey research method. Thus, this method was used to obtain the views of the experts on the performance evaluation of Iran's state banks based on FinTech innovation. In this part of the research, a researcher-made questionnaire was used to collect quantitative data. The questionnaire was designed based on the components extracted from the thematic analysis process. The importance of each component was determined by the Shannon's entropy method, and finally, Iran's state banks were ranked using the MABAC method, which was first presented by Pamucar and Cirovic (2015).

Findings

Identifying the components of evaluating the performance and position of banks based on the FinTech indexes

As mentioned in the research method section, in the present research, interviews were used in order to collect data in the qualitative part, and thematic (content) analysis method was used for analysis. To this end and with the aim of collecting qualitative data, after reviewing the literature related to the research topic, a framework was developed for the questions of the interviews with experts. Then, 13 university professors, managers and experts of Central Bank of Islamic Republic of Iran were selected through judgmental sampling method. In the second phase, the interviews were coded using Braun and Clarke's (2006) six-step inductive *thematic* analysis method. Consequently, during the data familiarization stage, the verbal evidences (43 cases) identified from the text of the interviews were labeled in the form of 40 primary codes. Then, the primary codes were categorized into 19 sub-themes and then a major theme. The summary of the final results of the current research (thematic analysis) is presented in Table 1.

Table 1- Summary of the results of the current research in the thematic analysis section

Major theme	Minor theme	Abbreviation	Primary code	Verbal evidence (the number in parentheses indicates the code of the interviewee)
Evaluation of the performance and position of banks based on the FinTech indexes	Customer Orientation	C1	Focus on customer needs	Focusing on customer needs to provide personalized and customized services (1)
			Customer orientation	The financial services industry in Fintech has changed from a product-oriented approach to a customer-oriented approach. (2)
			Responding to customer needs	Responding to customer needs that are always changing rapidly (4)
	Improving service efficiency	C2	Acceleration of transaction speed	Mobilizing new technologies to accelerate transaction speed and improve service efficiency
			Improving the financial transaction structure	Financial technology has transformed the structure of financial transactions and it is increasingly spreading due to the favorable efficiency (7).
			Increasing efficiency	The increase in the efficiency of FinTech companies is mainly due to the personalization of loans and the mediation of processes by removing intermediaries (11).
	Credit risk management	C3	Reducing credit risk	Mobilizing new financial technologies to collect consumer behavior data to reduce credit risk
			Optimal management of liquidity	The establishment of individual credit FinTech can lead to optimally directing financial resources to the micro sectors and the withdrawal of liquidity from speculative and financing activities (3).
	Financial development	C4	Development of new financial	The combination of financial services with new business scenarios for the development of new

Major theme	Minor theme	Abbreviation	Primary code	Verbal evidence (the number in parentheses indicates the code of the interviewee)
			services	services has been realized in fintech (12).
			Financial progress	Every innovation, even a small one, is important in the progress of financial affairs (13).
	Increasing customer communication channels	C5	Setting up more service channels	Fintech has mobilized new innovations to launch more service channels such as mobile banking, internet banking, etc. (9).
			Multiple communication channels	Multiple communication channels are essential as a foundation for a better customer experience (10).
	Active identification of customer needs	C6	Active analysis of potential needs of target customers	Mobilizing new technologies to actively analyze the potential needs of target customers (5)
			Examining customer needs	Analyzing plans according to customer needs and providing detailed financial services (5)
	Providing customized services	C7	Providing personal services	Providing personal services for different customer needs (12)
			Customization	Customization is the most important feature of FinTech platforms (7).
	Financial data sharing	C8	Sharing data with financial technology companies	Sharing data with financial technology and e-commerce companies to investigate the financial needs of potential customers for increasing customer satisfaction (2)
			High flexibility in data sharing	FinTech companies have high flexibility in using financial data of other companies (12).
	Cooperation with traditional banks	C9	Partnering with offline businesses	Partnering with offline businesses to install bank ATMs in commercial complexes (6)
			Providing services to traditional banks	Providing easy and free access for credit card holders and providing other appropriate services to traditional banks (4)
	Alliance with financial peers	C10	Forming alliances with domestic and foreign financial peers	Forming an alliance with domestic and foreign financial peers to develop content and service areas (9)
			Cooperation of FinTech companies	FinTech companies have the ability to cooperate in different projects (11).
	Multifaceted business strategies	C11	Development of diverse products or markets	Working in international banking businesses to develop diverse products or markets such as domestic e-commerce platforms (4)
			Multifaceted business data mobilization	Mobilizing business data from e-commerce transactions to provide multifaceted financial services (8)
			Creating value by providing more diverse products and services	The ability to create strategic value by using financial technology and focus on specific groups to provide more diverse products and services (11)
	Modifying the organizational structure	C12	Process improvement to accelerate financial innovation	Setting up online financial centers and process improvement departments to accelerate financial innovation (10)
			Quick modification and adaptation to external changes	Correcting and quickly adapting to external changes and improving the efficiency of decision-making (3)
	Employees' training and learning	C13	Fintech service staff training	Training of FinTech service employees to increase their professional knowledge and skills for ensuring the uniformity of new service implementation (13)
			Training of current employees	The use of new financial technology requires the training of current employees to use these

Major theme	Minor theme	Abbreviation	Primary code	Verbal evidence (the number in parentheses indicates the code of the interviewee)
				technologies (1).
	Organizational innovation culture	C14	Motivating employees to participate in innovation	Determining incentive mechanisms to motivate employees for participating in innovation and developing an innovative organizational culture (4)
			Creating a different organizational culture	The use of FinTech requires the creation of a different organizational culture and a suitable environment for sharing knowledge and managing ideas in the organization (7).
			Encouraging employees to share ideas	Changing the culture and finding ways to encourage employees for sharing their views and ideas (2)
	Development of big data analysis	C15	Big data analysis	Using big data analysis to create customer behavior patterns to check new customer demands (6) Employees and lower ranks should be encouraged to use big data so that they have sufficient knowledge and understanding of big data analysis. (10)
	Development of intelligent investment management	C16	Smart investment portfolio recommendations to clients	Using new financial technologies to provide smart investment portfolio recommendations to bank customers (8)
			Intelligence in investment	Intelligent investment or investment intelligence is one of the needs and necessities of successful FinTech development (1).
	Using blockchain technology	C17	Instant settlement of transactions with blockchain technology	Applying the innovation provided by blockchain technology in domestic FinTechs has the potential to lead to almost instant settlement of transactions (11).
			Improving transaction security with blockchain technology	Using blockchain technology to improve FinTech financial transaction security (4)
	New payment methods	C18	Adoption of Internet of Things and biometric identification technology	Adopting the Internet of Things and biometric identification technology to provide innovative payment methods using face recognition and voice control (13)
	Increasing digital marketing	C19	Use of digital media in marketing	Using digital media, content marketing, and database marketing to increase advertising of new services and accelerate customer understanding of these services (2)
			Using virtual space in marketing	Banks and financial and credit institutions that use virtual space well can have satisfied and interactive customers (1).

Determining the importance (weight) of each component with Shannon's entropy method

In this research, in order to determine the degree of importance (weight) of each of the performance evaluation components of banks based on the FinTech indexes, Shannon's entropy questionnaire and method were used. Accordingly, after obtaining the opinion of the participants (n=13) using the questionnaire and summarizing the opinions, the following steps were taken for data analysis:

The first step is to form the decision matrix: In this research, a five-point Likert scale (very low, low, medium, high, very high) was used for evaluation. According to the average opinion of experts, the decision matrix was formed (Table 3). To form this matrix, if the criteria are qualitative, it is enough to obtain the evaluation of each option using the verbal expressions for each criterion, and if the criteria are quantitative, the actual number of that evaluation is

used. In the decision matrix of the current research, the criteria are the components of evaluating the performance and position of banks based on the FinTech indexes (Table 1) and the options include eight state banks of the country (Table 2).

The second step, normalizing the decision matrix: In this step, the decision matrix is normalized and each normalized row is called p_{ij}. Normalization is done by dividing the amount of each column by the sum of the columns. The results of the calculations of the first and second steps are shown in Table 4:

Table 2- The state banks of the country

	State bank name	Abbreviation
۱	National Bank of Iran	A1
۲	Sepah Bank	A2
۳	Bank of Industry and Mine	A3
۴	Bank of Agriculture	A4
۵	Maskan Bank	A5
۶	Export Development Bank of Iran	A6
۷	Cooperative Development Bank	A7
۸	Post Bank of Iran	A8

Table 3-Decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
A1	2/76	3/35	3/06	1/82	2/53	1/12	2/18	0/59	3/47	3/82	3/47	2/35	3/35	1/94	3/53	1/65	2/35	2/65	2/18
A2	3/35	1/82	2/65	1/88	3/53	1/24	1/71	1/59	2/82	2/24	2/76	3/12	2/12	3/35	1/59	2/88	1/06	2/94	1/18
A3	0/88	2/18	1/76	1/76	3/59	3/59	1/59	1/18	1/47	1/29	1/06	0/94	0/71	0/82	0/35	1/24	0/65	1/59	0/88
A4	3/41	1/71	1/06	2/41	3/59	1/18	2/59	3/59	3/29	1/94	2/88	3/47	2/24	2/41	2/29	1/41	2/76	3/59	2/53
A5	1/76	3/06	1/24	1/24	1/71	1/18	1/47	3/24	2/88	2/53	1/12	2/59	1/24	3/29	0/94	0/65	0/88	2/82	2/47
A6	0/94	2/71	2/35	3/65	3/71	1/59	0/76	1/41	1/82	0/65	0/76	0/65	0/65	1/47	1/65	2/53	1/24	1/29	1/24
A7	0/82	0/65	0/88	3/88	2/59	0/65	0/53	0/65	1/71	0/71	0/94	0/47	0/35	2/35	0/65	0/41	0/53	2/59	1/35
A8	2/47	3/18	1/29	0/53	1/41	0/41	3/53	3/29	2/94	0/94	1/24	0/71	0/65	2/29	0/71	0/76	1/24	2/12	2/35

Table 4-Normalized decision matrix (unscaled)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
A1	0/17	0/18	0/21	0/11	0/11	0/10	0/15	0/04	0/17	0/27	0/24	0/16	0/30	0/11	0/30	0/14	0/22	0/14	0/15
A2	0/20	0/10	0/19	0/11	0/16	0/11	0/12	0/10	0/14	0/16	0/19	0/22	0/19	0/19	0/14	0/25	0/10	0/15	0/08
A3	0/05	0/12	0/12	0/10	0/16	0/33	0/11	0/08	0/07	0/09	0/07	0/07	0/06	0/05	0/03	0/11	0/06	0/08	0/06
A4	0/21	0/09	0/07	0/14	0/16	0/11	0/18	0/23	0/16	0/14	0/20	0/24	0/20	0/13	0/20	0/12	0/26	0/18	0/18
A5	0/11	0/16	0/09	0/07	0/08	0/11	0/10	0/21	0/14	0/18	0/08	0/18	0/11	0/18	0/08	0/06	0/08	0/14	0/17
A6	0/06	0/15	0/16	0/21	0/16	0/15	0/05	0/09	0/09	0/05	0/05	0/05	0/06	0/08	0/14	0/22	0/12	0/07	0/09
A7	0/05	0/03	0/06	0/23	0/11	0/06	0/04	0/04	0/08	0/05	0/07	0/03	0/03	0/13	0/06	0/04	0/05	0/13	0/10
A8	0/15	0/17	0/09	0/03	0/06	0/04	0/25	0/21	0/14	0/07	0/09	0/05	0/06	0/13	0/06	0/07	0/12	0/11	0/17

The third step is to calculate the entropy of each component: the entropy Ej is calculated as follows and k keeps the value of E_j between 0 and 1 as a constant value.

$$E_j = -k \sum_{i=1}^{m} P_{ij} \times Ln\, P_{ij} \quad , k = \frac{1}{\ln m} \quad , \quad i = 1.2. \dots. m$$

The fourth step is to calculate the distance of each component from its entropy (determining the degree of deviation): Next, the value of dj (degree of deviation) is calculated ($d_j = 1 - E_j$), which indicates the amount of the useful information are provided by the corresponding component (dj) to the decision maker for making decision. The closer the measured values of an index are to each other, it indicates that the

competing options do not differ much in terms of that index. Therefore, the role of that index in decision-making should be reduced to the same extent.

The fifth step is to determine the weight of each index: then, the weight value of Wj is calculated. In fact, the criterion weight is equal to each dj divided by the sum of djs ($w_j = d_j / \sum d_j$). The results of the calculations of the fourth and fifth steps are shown in Table 6:

According to the results of this section (Table 6), employees' training and learning, reforming the organizational structure, developing big data analysis, actively identifying customer needs, sharing financial data, developing smart investment management, alliance with financial peers, multifaceted business strategies, application of blockchain technology,

customer orientation, providing customized services, financial affairs development, credit risk management, service efficiency improvement, culture of organizational innovation, improving digital marketing, increasing customer communication

channels, new payment methods, and cooperation with banks traditional, respectively, obtained the highest degree of importance among the factors affecting the performance evaluation of banks based on the Fintech indexes.

Table 5 – calculation of $(-kP_{ij} \times Ln\ P_{ij})$

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
A1	0/14	0/15	0/16	0/11	0/12	0/11	0/14	0/06	0/14	0/17	0/17	0/14	0/17	0/12	0/17	0/13	0/16	0/13	0/14
A2	0/16	0/11	0/15	0/12	0/14	0/12	0/12	0/11	0/13	0/14	0/15	0/16	0/15	0/15	0/13	0/17	0/11	0/14	0/10
A3	0/08	0/12	0/12	0/11	0/14	0/18	0/12	0/09	0/09	0/11	0/09	0/09	0/08	0/07	0/05	0/12	0/08	0/10	0/08
A4	0/16	0/11	0/09	0/13	0/14	0/12	0/15	0/16	0/14	0/13	0/16	0/17	0/15	0/13	0/15	0/12	0/17	0/15	0/15
A5	0/12	0/14	0/10	0/09	0/09	0/12	0/11	0/16	0/13	0/15	0/10	0/15	0/12	0/15	0/10	0/08	0/10	0/13	0/15
A6	0/08	0/13	0/14	0/16	0/14	0/13	0/08	0/10	0/10	0/07	0/08	0/07	0/08	0/10	0/13	0/16	0/12	0/09	0/10
A7	0/07	0/06	0/08	0/16	0/12	0/08	0/06	0/06	0/10	0/07	0/09	0/05	0/05	0/13	0/08	0/06	0/07	0/13	0/11
A8	0/14	0/14	0/10	0/05	0/08	0/06	0/17	0/16	0/13	0/09	0/10	0/07	0/08	0/13	0/08	0/09	0/12	0/12	0/14

Table 6- Calculation of entropy of each index, degree of deviation, weight, and rank of each component

Components		Entropy of index (Ej)	Degree of deviation of index (Dj)	Weight of index (Wj)	Rank of index
Employees' training and learning	C13	0/888	0/112	0/094	1
Modifying the organizational structure	C12	0/896	0/104	0/087	2
Development of big data analysis	C15	0/897	0/103	0/086	3
Active identification of customer needs	C6	0/911	0/089	0/074	4
Financial data sharing	C8	0/912	0/088	0/073	5
Development of intelligent investment management	C16	0/921	0/079	0/066	6
Alliance with financial peers	C10	0/922	0/078	0/065	7
Multifaceted business strategies	C11	0/927	0/073	0/061	8
Using blockchain technology	C17	0/930	0/070	0/059	9
Customer Orientation	C1	0/936	0/064	0/053	10
Providing customized services	C7	0/937	0/063	0/053	11
Financial development	C4	0/938	0/062	0/052	12
Credit risk management	C3	0/958	0/042	0/036	13
Improving service efficiency	C2	0/962	0/038	0/032	14
Organizational innovation culture	C14	0/967	0/033	0/028	15
Increasing digital marketing	C19	0/969	0/031	0/026	16
Increasing customer communication channels	C5	0/976	0/024	0/020	17
New payment methods	C18	0/979	0/021	0/017	18
Cooperation with traditional banks	C9	0/980	0/020	0/017	19

Ranking of Iran's state banks based on performance evaluation and their position based on the Fintech using MABAC method

In this research, in order to rank Iran's state banks according to the degree of importance of evaluating their performance and position based on the Fintech indexes, the MABAC questionnaire and method were used. Accordingly, after obtaining the opinions of the participants (n = 13) through a questionnaire and

summarizing the opinions, the following steps were taken to analyze the data:

The first step, forming the initial decision matrix (X): In this step, it is assumed that there are m options and n criteria. Each of the options is displayed as a vector and as Aij=(xi1,xi2,...,xin) where xij specifies the status of the ith option in the jth criterion. Accordingly, the initial decision matrix is the same as the matrix of the previous step (Shannon's entropy). Also, xij are the terms of the initial decision matrix (X) and -xi and +xi are defined as follows:

$:x_i^+ = \max(x_1. x_2. \dots x_m)$ represents the highest value observed among the options in a given criterion.

$x_i^- = \min(x_1. x_2. \dots x_m)$: represents the lowest value observed among the options in a given criterion. The results of the calculations of the first step are shown in Table 7:

The second step is to normalize the components of the initial decision matrix (N): because the type of each of the criteria may be different, in the second step, the decision matrix is normalized to neutralize the effect of the different scale of the criteria. To this end, according to the nature of each criterion, the relationship $n_{ij} = \frac{x_{ij} - x_i^-}{x_i^+ - x_i^-}$ is used to normalize the positive criteria and the relationship $n_{ij} = x_{ij} - x_i^+ xi - xi +$ is used to normalize the negative criteria. It should be noted that in this research, all indicators were considered as positive criteria. The results of this step are shown in Table 8:

The third step is to form the weighted decision matrix (V): since the criteria have different weights in the evaluation process, in this step, the components of the weighted matrix should be calculated based on the relationship $(v_{ij} = w_i(n_{ij} + 1))$. In this relation, nij represents the normal matrix components (N) and wi represents the weight of the ith criterion. Also, vij forms the components of the weighted matrix V. This matrix is defined as follows:

The fourth step is to specify the border approximate area matrix (G): the border approximate area for each measure is calculated using the following relation: $g_i = \left(\prod_{j=1}^{m} v_{ij}\right)^{1/m}$. After calculating gi for each criterion, the border approximate area matrix, denoted by G, is formed, which is shown in Table 10:

The fifth step is to calculate the distance of the options from the border approximate area border approximate area (Q): the distance of the options from the border approximate area is determined according

to the relation $Q = V - G$, equal to the difference between the components of the weighted matrix (V) and the value of the border approximate area (G). After determining the value of the Q matrix, the status of each option can be determined by defining the border approximate area vector (G), the upper limit of the area (+G) and the lower limit of the area (-G). To this end, the option Ai belongs to the community of the mentioned set. In this definition, the upper limit of the approximate area (+G) is the area where the ideal option (+A) is present, and the lower limit of the approximate area (-G) is the area where the anti-ideal option (-A) is present. The degree of affiliation of the Ai option to the community is obtained based on the following relation.

$$A_i \in \begin{cases} G^+ q_{ij} > 0 \\ G q_{ij} = 0 \\ G^- q_{ij} < 0 \end{cases}$$

Based on the logic of MABAC method, so that the Ai option is the best option in the set of options, it needs to be closer to the upper limit of the approximate area (+G) than the other options. In other words, if the value is 0 < qij, then the option Ai will be close to or equal to the ideal option. The same problem exists in reverse and for the condition qij > 0, If qij > 0, then the Ai option is close to or equal to the anti-ideal option. The results of this step are shown in Table 11:

The sixth step of ranking the options: In the last step of the MABAC method, the value of the criteria functions is calculated based on the sum of the distances of the options from the the border approximate area (qi) according to the relation $S_i = \sum_{j=1}^{n} q_{ij}$. By calculating the sum of the components of the Q matrix in a row, the final value of the criterion functions is determined for each option and it is the basis of the option ranking.

Table 7- Initial matrix (average opinion of respondents)

DM	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
A1	2/76	3/35	3/06	1/82	2/53	1/12	2/18	0/59	3/47	3/82	3/47	2/35	3/35	1/94	3/53	1/65	2/35	2/65	2/18
A2	3/35	1/82	2/65	1/88	3/53	1/24	1/71	1/59	2/82	2/24	2/76	3/12	2/12	3/35	1/59	2/88	1/06	2/94	1/18
A3	0/88	2/18	1/76	1/76	3/59	3/59	1/59	1/18	1/47	1/29	1/06	0/94	0/71	0/82	0/35	1/24	0/65	1/59	0/88
A4	3/41	1/71	1/06	2/41	3/59	1/18	2/59	3/59	3/29	1/94	2/88	3/47	2/24	2/41	2/29	1/41	2/76	3/59	2/53
A5	1/76	3/06	1/24	1/24	1/71	1/18	1/47	3/24	2/88	2/53	1/12	2/59	1/24	3/29	0/94	0/65	0/88	2/82	2/47
A6	0/94	2/71	2/35	3/65	3/71	1/59	0/76	1/41	1/82	0/65	0/76	0/65	0/65	1/47	1/65	2/53	1/24	1/29	1/24
A7	0/82	0/65	0/88	3/88	2/59	0/65	0/53	0/65	1/71	0/71	0/94	0/47	0/35	2/35	0/65	0/41	0/53	2/59	1/35
A8	2/47	3/18	1/29	0/53	1/41	0/41	3/53	3/29	2/94	0/94	1/24	0/71	0/65	2/29	0/71	0/76	1/24	2/12	2/35

DM	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
X+	3/41	3/35	3/06	3/88	3/71	3/59	3/53	3/59	3/47	3/82	3/47	3/47	3/35	3/35	3/53	2/88	2/76	3/59	2/53
X-	0/82	0/65	0/88	0/53	1/41	0/41	0/53	0/59	1/47	0/65	0/76	0/47	0/35	0/82	0/35	0/41	0/53	1/29	0/88
W	0/05	0/03	0/04	0/05	0/02	0/07	0/05	0/07	0/02	0/07	0/06	0/09	0/09	0/03	0/09	0/07	0/06	0/02	0/03

Table 8-Normalization of the initial matrix (N)

N	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
A1	0/75	1/00	1/00	0/39	0/49	0/22	0/55	0/00	1/00	1/00	1/00	0/63	1/00	0/44	1/00	0/50	0/82	0/59	0/79
A2	0/98	0/43	0/81	0/40	0/92	0/26	0/39	0/33	0/68	0/50	0/74	0/88	0/59	1/00	0/39	1/00	0/24	0/72	0/18
A3	0/02	0/57	0/41	0/37	0/95	1/00	0/35	0/20	0/00	0/20	0/11	0/16	0/12	0/00	0/00	0/33	0/05	0/13	0/00
A4	1/00	0/39	0/08	0/56	0/95	0/24	0/69	1/00	0/91	0/41	0/78	1/00	0/63	0/63	0/61	0/40	1/00	1/00	1/00
A5	0/36	0/89	0/16	0/21	0/13	0/24	0/31	0/88	0/71	0/59	0/13	0/71	0/29	0/98	0/19	0/10	0/16	0/67	0/96
A6	0/05	0/76	0/68	0/93	1/00	0/37	0/08	0/27	0/18	0/00	0/00	0/06	0/10	0/26	0/41	0/86	0/32	0/00	0/21
A7	0/00	0/00	0/00	1/00	0/51	0/07	0/00	0/02	0/12	0/02	0/07	0/00	0/00	0/60	0/09	0/00	0/00	0/56	0/29
A8	0/64	0/93	0/19	0/00	0/00	0/00	1/00	0/90	0/74	0/09	0/17	0/08	0/10	0/58	0/11	0/14	0/32	0/36	0/89

Table 9-Formation of the weighted matrix (V)

V	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
A1	0/09	0/06	0/07	0/07	0/03	0/09	0/08	0/07	0/03	0/13	0/12	0/14	0/19	0/04	0/17	0/10	0/11	0/03	0/05
A2	0/11	0/05	0/06	0/07	0/04	0/09	0/07	0/10	0/03	0/10	0/11	0/16	0/15	0/06	0/12	0/13	0/07	0/03	0/03
A3	0/05	0/05	0/05	0/07	0/04	0/15	0/07	0/09	0/02	0/08	0/07	0/10	0/10	0/03	0/09	0/09	0/06	0/02	0/03
A4	0/11	0/04	0/04	0/08	0/04	0/09	0/09	0/15	0/03	0/09	0/11	0/17	0/15	0/04	0/14	0/09	0/12	0/03	0/05
A5	0/07	0/06	0/04	0/06	0/02	0/09	0/07	0/14	0/03	0/10	0/07	0/15	0/12	0/05	0/10	0/07	0/07	0/03	0/05
A6	0/06	0/06	0/06	0/10	0/04	0/10	0/06	0/09	0/02	0/07	0/06	0/09	0/10	0/03	0/12	0/12	0/08	0/02	0/03
A7	0/05	0/03	0/04	0/10	0/03	0/08	0/05	0/07	0/02	0/07	0/07	0/09	0/09	0/04	0/09	0/07	0/06	0/03	0/03
A8	0/09	0/06	0/04	0/05	0/02	0/07	0/11	0/14	0/03	0/07	0/07	0/09	0/10	0/04	0/10	0/08	0/08	0/02	0/05

Table 10- The border approximate area matrix (the geometric mean of each column of the weighted matrix)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
gi	0/52	0/29	0/28	0/50	0/15	0/70	0/49	0/80	0/11	0/62	0/57	1/01	1/02	0/23	0/90	0/67	0/53	0/11	0/21

Table 11- Calculation of the distance of the options from the border approximate area (Q)

Q	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
A1	-0/43	-0/23	-0/21	-0/43	-0/12	-0/61	-0/41	-0/73	-0/08	-0/48	-0/45	-0/87	-0/84	-0/19	-0/73	-0/57	-0/43	-0/08	-0/16
A2	-0/42	-0/25	-0/22	-0/43	-0/11	-0/60	-0/42	-0/70	-0/08	-0/52	-0/47	-0/84	-0/87	-0/17	-0/78	-0/54	-0/46	-0/08	-0/18
A3	-0/47	-0/24	-0/23	-0/43	-0/11	-0/55	-0/42	-0/71	-0/09	-0/54	-0/51	-0/91	-0/92	-0/20	-0/82	-0/58	-0/47	-0/09	-0/18
A4	-0/42	-0/25	-0/24	-0/42	-0/11	-0/60	-0/40	-0/65	-0/08	-0/52	-0/47	-0/83	-0/87	-0/18	-0/77	-0/58	-0/42	-0/08	-0/15
A5	-0/45	-0/23	-0/24	-0/44	-0/13	-0/60	-0/42	-0/66	-0/08	-0/51	-0/51	-0/86	-0/90	-0/17	-0/80	-0/60	-0/47	-0/08	-0/16
A6	-0/47	-0/24	-0/22	-0/40	-0/11	-0/59	-0/43	-0/71	-0/09	-0/55	-0/51	-0/92	-0/92	-0/19	-0/78	-0/55	-0/46	-0/09	-0/18
A7	-0/47	-0/26	-0/24	-0/40	-0/12	-0/62	-0/44	-0/72	-0/09	-0/55	-0/51	-0/92	-0/93	-0/18	-0/81	-0/61	-0/48	-0/08	-0/17
A8	-0/44	-0/23	-0/24	-0/45	-0/13	-0/62	-0/39	-0/66	-0/08	-0/54	-0/50	-0/91	-0/92	-0/18	-0/81	-0/60	-0/46	-0/09	-0/16

Table 12-Ranking of Iran's state banks

Rank	Options		si
1	National Bank of Iran	A1	-8/03
2	Bank of Agriculture	A4	-8/04
3	Sepah Bank	A2	-8/14
4	Maskan Bank	A5	-8/31
5	Post Bank of Iran	A8	-8/40
6	Export Development Bank of Iran	A6	-8/41
7	Bank of Industry and Mine	A3	-8/47
8	Cooperative Development Bank	A7	-8/60

According to the results of MABAC method (Table 12), National Bank of Iran, Bank of Agriculture, Sepeh Bank, Maskan Bank, Post Bank of Iran, Export Development Bank of Iran, Bank of Industry and Mine, and Cooperative Development Bank, respectively, have the highest priority among the banks according to the 19 factors affecting the evaluation of the performance of the banks based on the FinTech indexes.

Conclusion and discussion

Creating innovation in banking financial services and encouraging banks to review and improve the current situation are important missions that, if properly implemented, can lead to significant benefits for the banking industry. To help the banking industry in identifying the key components of evaluating financial technology innovation and achieving service innovation after the Fintech revolution, the current research presented a model for assessing the performance and position of banks based on financial technology service innovation (FinTech). The components of this model were identified based on the analysis of the results of the interviews using the thematic analysis method, and then the importance of each component was determined using the Shannon's entropy method, and finally, the state banks of Iran were ranked using the MABAC method. The results of the research showed that the employees' training and learning, reforming the organizational structure, developing big data analysis, actively identifying customer needs, sharing financial data, developing smart investment management, alliance with financial peers, multifaceted business strategies, applying blockchain technology, customer orientation, providing customized services, developing financial affairs, credit risk management, improving service efficiency, organizational innovation culture, improving digital marketing, increasing customer communication channels, new payment methods and cooperation with traditional banks obtained the highest degree of importance among the factors affecting the performance evaluation of banks based on the FinTech indexes. Furthermore, National Bank of Iran, Bank of Agriculture, Sepah Bank, Maskan Bank, Post Bank of Iran, Export Development Bank of Iran, Bank of Industry and Mine, and Cooperative Development Bank, respectively, gained the highest priority among the state banks according to 19 factors.

The review of the domestic and foreign studies indicated that there is no research addressing the development of a model for evaluating the performance and position of banks based on the technology-enabled *innovation* in financial *services* (Fintech). Nevertheless, in order to examine topics such as financial technology, banks, and cooperation between banks and FinTech, studies conducted by Syahwildan and Damayanti (2022), Legowo et al. (1398), Lien et al. (2020), Soltani and Tahmasbi Aghbolaghi (2020), and Moghani et al. (2019) were reviewed in the literature review section, which were consistent. In explaining the results of the present research, it can be said that the banking sector has been relying on technology for providing new services to customers for some time. For example, the introduction of ATMs in the 1960s changed the way customers deal with financial assets in banks (Barberis, 2014). However, the FinTech revolution goes beyond the impact of new technology (e.g., big data, cloud computing) on the financial industry. Fintech involves a lot of innovation for products, processes, services, business models, technology, and delivery systems in the banking system (Hong et al., 2016). Therefore, this study is important to provide a comprehensive view on how to improve the situation of banks to maintain competitive advantage through financial technology services (Fintech) innovation. Moreover, the present research helps expand and promote research related to the relationship between banks and FinTech. Most FinTech-based studies examine the willingness of individuals and companies to use new FinTech-based systems, such as mobile payments (Hwang et al., 2021), crowdfunding (Baber, 2020), and online loans (Agarwal and Zhang, 2020). In addition, most current studies have only used qualitative or quantitative methods. Meanwhile, the current research uses the combination of qualitative methods and multi-criteria decision-making to evaluate innovative strategies affecting the performance and position of banks during the financial technology revolution (Fintech) and its findings can be used as a decision-making reference for evaluating the performance and position of banks based on the technology-enabled *innovation* in financial *services* (Fintech). Up to now, the focus on FinTech has largely been originated from a Western perspective. Few studies have investigated the service innovation in the country's banks. Due to cultural and legal differences,

the findings of studies on Western countries may not be generalizable to Iran. Therefore, this research provided a new perspective on the development of financial technology service innovation strategies in Iran's banking industry during the financial technology revolution. Consequently, according to the research findings, the bank managers are recommended to consider the identified components according to their degree of importance and priority in order to increase the innovation of banking services regarding FinTech. Also, considering the research findings, it was found that currently the employees' training and learning has the highest importance among other evaluation components. Therefore, it is suggested to the banking industry to hold in-service training programs in order to train FinTech service employees for increasing their professional knowledge and skills so that the implementation of FinTech services is guaranteed. These programs can be put on the agenda periodically and by updating the training needs.

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