



## Ranking of Financial Technology Indicators of Banks based on Fuzzy Approach<sup>1</sup>

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Received: 2024/03/09

Accepted: 2025/02/25

### INTRODUCTION

In the current era, with the expansion of technology use, financial institutions and banks have had no choice but to accept this trend. Furthermore, evaluating the performance of banking institutions has gained significant importance in the country. Identifying and determining the importance (weight) of key factors and indicators that affect performance improvement and efficiency increase in banking institutions are crucial issues. Therefore, in this study, using expert opinions collected via a validated and reliable questionnaire, and statistical information gathered from October to February 2022, the fuzzy analytic hierarchy process (AHP) method was employed. Experts defined banking sector indicators in two groups—software and hardware—and selected nine key indicators in the banking field. The results of ranking financial technologies in the monetary sector show that all consistency ratios are less than 0.1, confirming the reliability and trustworthiness of the measurement tools. Among the obtained weights, the most important software tools are mobile banking (0.256), internet banking (0.205), and digital banking (0.193), while the most important hardware tools are off-site ATMs (0.290) and on-site ATMs (0.271).

1. doi: 10.22051/jfm.2024.43169.2800

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## **MATERIALS AND METHODS**

As the aim of this research is to evaluate expert opinions on the importance and ranking of financial technology indicators in banks, and to translate these opinions into numerical scores for each indicator, the research adopts an exploratory-descriptive approach. This approach aims to identify, describe, and quantitatively rank financial technology indicators in banks, for which prior information was limited. Therefore, the research is descriptive in that it portrays events as they are. The data collection tool is a questionnaire, which was developed and evaluated by banking industry and financial technology experts based on the defined indicators. Furthermore, from the perspective of the implementation process, this research is qualitative; from the perspective of the implementation result, it is applied; from the perspective of the implementation logic, it is inductive; and from the perspective of the time dimension, it is longitudinal.

### **A) POPULATION AND SAMPLE**

"Given the specialized nature of this research, the study population consists of senior bank managers from banks listed on the Tehran Stock Exchange. Participants were selected based on having at least ten years of managerial experience in decision-making and policy-making within the banking industry, or at least fifteen years of experience managing bank branches. Due to the specialized population, the heavy workload of its members, and the limited availability of willing participants, a non-probability sampling method was employed. Thirty-five questionnaires were distributed among professional experts (senior bank managers) who agreed to participate. The insights and perspectives of these experts were crucial for establishing a logical prioritization of criteria. Ultimately, data from 25 completed questionnaires were used, as these experts possessed comprehensive knowledge of the influential indicators. However, the geographic focus on senior staff managers in Tehran represents a limitation of this study.

The second part of the study population comprises all banks listed on the Tehran Stock Exchange since its inception, including those subsequently delisted. When selecting the sample from this population, the following principles were observed: a) the sample was selected in accordance with the research objectives; b) the assumption of fairness was not applied; and c) influential factors were considered when determining the sample size (Khaki, 2022).

### **B) DATA COLLECTION METHOD**

In this study, financial technology variables were categorized thematically into software and hardware. The software group includes indicators such as mobile banking, internet banking, core banking, digital banking, and internet payment gateways. The hardware group encompasses point-of-sale devices, on-site ATMs, off-site ATMs, and cashless ATMs. An initial content analysis, based on expert opinions, identified all relevant components. These components were then classified into indicator-specific sub-components.

Subsequently, to achieve the research objectives and address the research questions, questionnaires utilizing paired comparisons were employed to gather expert opinions. These questionnaires were designed to enable respondents to assess the relative importance of indicators and sub-indicators within each group through pairwise comparisons. For these comparisons, the Thomas-Saaty nine-point scale was used. The identified indicators were then distributed to experts for weighting and ranking. Consequently, these indicators served as the foundation for applying a fuzzy analytic hierarchy process (AHP) to determine their respective weights and rankings.



### C) DETERMINING THE WEIGHT OF THE INDICATORS

Following the identification of key banking industry indicators for bank ranking, a questionnaire was developed to prioritize these factors. Respondents were asked to assign a score between one and nine to each indicator. To enhance scoring accuracy, respondents categorized the indicators into two groups: software systems and hardware systems. They were also asked to assign a score to each of these groups. A sample of managers and senior employees from stock exchange-listed banks, supervised by the Central Bank, were selected to complete the questionnaire. After collecting expert opinions and applying the assigned scores and weights, the final ranking of the indicators was determined based on the obtained scores.

### ANALYSIS OF FINDINGS

In this section of the research, the fuzzy analytic hierarchy process (AHP) was employed, utilizing fuzzification techniques and questionnaire data from specialists and experts, to determine the desired indicators within the two general categories of hardware and software. This process facilitated the ranking, weighting, and importance assessment of these indicators, as well as the analysis of their descriptive statistics. The resulting rankings and weights are presented below.

### PRIORITIZATION OF THE MAIN CATEGORY

Based on Table 1 and expert opinions gathered for Question 1, mobile banking, internet banking, and digital banking are considered the most important software indicators, followed by internet payment gateways. Core banking was ranked lowest.

**Table 1.** Final weight and ranking among the main software indicators

Factors	Mobile banking	Internet banking	Centralized banking	Internet payment gateway	Digital banking
Minimum degree of feasibility	4	3.204	2.565	2.860	3.015
Final weight of indicators	0.256	0.205	0.164	0.183	0.193
Rank	1	2	5	4	3

Source: Research findings

Based on Table 2 and expert opinions gathered for Question 2, off-site ATMs and on-site ATMs are considered more important hardware indicators than point-of-sale terminals and cashless ATMs.

**Table 2.** Final weight and ranking among the main hardware indicators

Factors	Point of sale device	In-branch ATM	Out-of-branch ATM	Non-cash ATM
Minimum degree of feasibility	2.598	2.797	3	1.940
Final weight of the indicator	0.251	0.271	0.290	0.188
Rank	3	2	1	4

Source: Research findings

## CONCLUSION AND SUGGESTIONS

Monetary and financial institutions play a critical role in the economy, and efficient banks are essential for economic development. Enhancing bank efficiency requires identifying and prioritizing software and hardware criteria. This study utilized the fuzzy analytic hierarchy process (AHP) to rank technology indicators in the monetary and financial sectors, focusing on two main categories: software and hardware, encompassing nine key indicators (five software and four hardware). The importance of each criterion for banking development was calculated. The consistency ratios (CRm, CRg) were both below 0.1, confirming the reliability and validity of the measurement tool and the compatibility of utilizing both software and hardware indicators.

The study revealed that among the selected indicators, mobile banking (0.256), internet banking (0.205), and digital banking (0.193) ranked first to third, respectively. Off-site ATMs (0.29) and on-site ATMs (0.271) held the highest ranks in the hardware category. Within the detailed indicators, the transaction amount component of mobile banking (0.349) and the transaction number component of internet banking (0.404) were deemed most important. Among on-site ATM components, the fund transfer transaction component (0.310) ranked first.

Therefore, to further develop monetary institutions (banks), prioritizing the improvement and expansion of software tools like mobile banking, internet banking, and digital banking, as well as hardware tools, particularly off-site and on-site ATMs, is crucial for planners and policymakers in the banking sector. These findings align with the results of previous research by Cultural Research (2015), Bahrami and Zare Elmi (2015), Salimi Bani, Asgari and Khoshmanzarfaraji (2014), Bazaei, Dehghanpour (2012), Bakhtiari and Aghaei (2016), and Tamizi (2017).

Like other studies, this research faced limitations, primarily the unavailability of bank information due to non-disclosure in the banking industry and the high workload of participants, resulting in limited cooperation. Consequently, non-probability sampling was employed.

It is recommended that banks establish working groups to reform and restructure their financial frameworks, creating coherent financial plans. Outsourcing the development of financial services to financial technology companies can further enhance these efforts. Financial technology can assist banks in developing their infrastructure and improving operations. Implementing incentive policies and services to increase bank deposits and attract more customers is also advisable. Finally, further research utilizing other statistical methods in the field of financial service providers is encouraged.

**Keywords:** Fuzzy Analytic Hierarchy. Financial Technology, Bank, Pairwise Comparison Matrix.

**JEL Classification:** G20, C10, M10, O1, O2.

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