Journal of Money and Economy
Vol. 21, No. 2, Spring 2026
pp. 245-278

Original Research Article

Analysis of the Critical Success Factors for Blockchain Technology in the Banking Industry Using the Bayesian Best-Worst Method

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Received: 25 May 2026 Approved: 26 Aug 2026

Blockchain technology, due to its outstanding features such as transparency, high security, data immutability, and the ability to eliminate intermediaries, has the potential to transform the banking industry. This technology, by utilizing a distributed ledger, enables secure, fast transactions without the need for central authorities, which can reduce operational costs and improve the efficiency of banking systems. This study was conducted to identify and determine the importance of the critical success factors of blockchain technology in the banking industry to help banks effectively leverage this new technology. First, the critical success factors were identified through a comprehensive literature review, and then they were screened using the fuzzy Delphi technique. Next, the importance of each factor was calculated using the Bayesian best-worst group multi-criteria decision-making method. The findings revealed that high scalability and rapid transaction processing capability, the security and standardization of blockchain technology, and interoperability with existing systems were identified as the most critical success factors. Finally, based on the results and in order to improve the efficiency and security of banking systems, practical and research recommendations were proposed.

Keywords: Blockchain, Banking Industry, Critical Success Factors, Scalability, Security and Standardization, Bayesian Best-Worst Method.
JEL Classification*:* G2

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1 Introduction

In recent years, the banking industry has faced increasing security challenges, including hacking, cyberattacks, fraud, theft, and other vulnerabilities that pose significant threats to the stability of financial systems (Porfírio et al., 2024). As economies transition from traditional linear models to a modern digital economy, many countries are taking significant steps to modernize their financial systems (Petare et al., 2024). To address these challenges and gain a competitive edge, the banking sector must adopt innovative technologies. One such transformative technology is blockchain, which has the potential to play a crucial role in optimizing the performance of financial systems by streamlining operational processes (Mbaidin et al., 2023). Possessing unique capabilities, blockchain contributes to higher resource productivity and more efficient utilization. According to the *Harvard Business Review*, approximately 60% of financial institutions are planning to use blockchain for international cross-border transfers, 23% view it as a tool for settlement and clearing security, and 20% deploy it for Know Your Customer (KYC) and Anti-Money Laundering (AML) processes (Ito et al., 2017). Furthermore, the World Economic Forum predicts that by 2027, blockchain technology with broad participation from the financial sector could drive a 10% increase in global Gross Domestic Product (GDP) (World Economic Forum, 2024).

The concept of blockchain emerged from the development of the Bitcoin protocol and network and was first introduced and described by Satoshi Nakamoto in 2008 (Lai & Chuen, 2018). Blockchain is a distributed ledger that is collectively maintained and enables the decentralized exchange of verified data through consensus mechanisms and advanced cryptographic techniques without the need for a central authority. This technology has the potential to eliminate intermediaries and costly reconciliation processes. Moreover, the guaranteed traceability and immutability of digital transactions recorded on blockchain networks contribute to resource efficiency (Garg et al., 2025).

According to Van Engelenburg et al. (2018), the primary objective of blockchain technology is to provide participants with transparency and comprehensive visibility of information while eliminating the need for intermediaries to establish trust in environments where sufficient transparency is often lacking. Furthermore, blockchain can improve productivity and enhance the efficiency of financial systems by optimizing energy consumption and strengthening global financial infrastructures (Cocco et al., 2017). In addition, through enhanced information transparency, improved security, cost reduction, and time efficiency, blockchain transforms traditional paradigms and creates significant opportunities for improving operational efficiency in the banking industry (Pandey et al., 2024).

Given the growing opportunities offered by blockchain technology, identifying the Critical Success Factors (CSFs) for its implementation in the banking industry has become increasingly essential. A review of the literature indicates that only a limited number of studies have investigated and analyzed blockchain-related CSFs in the banking sector. In this regard, Mbaidin et al. (2024) employed Structural Equation Modeling (SEM) to examine the relationships among CSFs affecting blockchain adoption in Islamic banks. Similarly, Mishra et al. (2025) applied the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method to refine these factors and investigate their causal relationships and relative influence. Despite considerable advances in exploring blockchain applications across various industries, no comprehensive study has yet identified and prioritized the relative importance of blockchain CSFs within Iran's banking system. This gap represents a significant limitation in the existing literature, particularly in the Iranian context, where the banking sector faces unique challenges, including international sanctions, a semi-governmental banking structure, and infrastructure limitations.

To maximize the benefits of blockchain adoption in the banking sector, accurately determining the relative importance of these factors is essential, as banks operate under resource constraints, and a dispersed allocation of resources across multiple factors may reduce implementation effectiveness. Therefore, a systematic and targeted focus on the most influential factors is required to enhance the effectiveness of blockchain implementation. Previous studies, including Mbaidin et al. (2024) and Mishra et al. (2025), have mainly focused on modeling relationships and causal interactions among factors using approaches such as SEM and DEMATEL. Although these methods are effective in analyzing structural relationships and factor interdependencies, they provide limited insight into the relative priority and weight of factors, thereby restricting their practical applicability in complex environments such as Iran's banking system.

In response to these limitations, this study presents a novel approach by applying the Bayesian Best-Worst Method (BBWM), introduced by Mohammadi and Rezaei (2020). Traditional group decision-making approaches often rely on simple averaging procedures for aggregating expert preferences, which may not adequately capture uncertainty and differences among decision-makers. In contrast, BBWM determines optimal aggregated weights by incorporating decision-makers' preferences within a probabilistic framework. The key advantages of BBWM include probabilistic modeling of inputs using multinomial distributions and outputs using Dirichlet distributions to handle uncertainty, the introduction of confidence-based credal rankings for criteria prioritization, and the visualization of relationships among criteria through weighted directed graphs.

Within the context of Iran's banking system, which faces challenges such as sanctions and infrastructure constraints, BBWM provides a more accurate assessment of the relative importance of blockchain CSFs. The main contribution of this study lies in integrating the BBWM approach with the specific contextual conditions of Iran's banking sector. Unlike previous studies conducted primarily in different economic environments (such as Singapore, the UAE, and Egypt), which have not considered Iran-specific challenges, including sanctions, infrastructure limitations, and the demand for real-time banking services, this study identifies, localizes, and prioritizes blockchain CSFs by considering the unique characteristics of the Iranian banking environment.

This research aims to support Iranian banks in enhancing their resilience against internal and external threats by reducing reliance on intermediaries and improving transaction speed and operational efficiency. Consequently, such improvements can contribute to strengthening the security and sustainability of the national banking system. Without effective adoption of such technologies, Iranian banks may continue to face significant vulnerabilities arising from existing threats, potentially resulting in more severe financial and economic challenges and further decline in public confidence in the banking system.

Accordingly, this study seeks to answer the following two fundamental research questions:

1) What are the Critical Success Factors (CSFs) for blockchain technology in the banking industry?
2) What is the relative importance of these Critical Success Factors?

The remainder of this paper is organized as follows: Section 2 presents the theoretical background and reviews previous studies related to blockchain adoption in banking and its Critical Success Factors. Section 3 describes the research methodology adopted in this study. Section 4 presents the data analysis procedures and research findings. Section 5 focuses on the validation of the obtained results. Section 6 discusses the findings and their implications. Finally, Section 7 provides the conclusions, practical and research implications, and future recommendations based on the findings and limitations of the study.

2 Literature Review

2.1 Theoretical Foundations

2.1.1 Blockchain

The concept of a distributed ledger was first introduced in the field of cryptography in 1976 through a paper titled "New Directions in Cryptography". In 1997, Adam Back proposed the Hashcash mechanism, which provided the foundation for developing peer-to-peer (P2P)-based digital currency concepts (Sarmah, 2018). Blockchain technology itself was introduced in 2008 through Satoshi Nakamoto's proposal of the Bitcoin protocol and network in the white paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System" (Lai & Chuen, 2018). Over time, this technology evolved into a more comprehensive framework that encompasses different types of Distributed Ledger Technologies (DLTs).

Blockchain employs cryptographic techniques such as hashing and asymmetric encryption to ensure the security and integrity of transactions (Chen et al., 2021). Its cryptographic mechanism is based on a pair of keys, including a public key used for data encryption and a private key used for participant authentication (Rezaei et al., 2024a). Furthermore, consensus mechanisms facilitate secure ledger updates by ensuring that records are modified only when the majority of network nodes reach agreement on the validity of the data (Halilbegovic et al., 2019).

2.1.2 Evolution of Blockchain

The evolution of blockchain technology has so far gone through five fundamental stages. The first stage began with Blockchain 1.0, when Bitcoin was introduced as the first cryptocurrency and digital financial transactions became possible (Sun et al., 2022). Then Blockchain 2.0 emerged, which, by introducing the concept of smart contracts, allowed individuals to independently execute programs. These contracts were executed without the need for intermediaries and based on predefined logic (Leng et al., 2020). After that, Blockchain 3.0 appeared on a broader scale, with the goal of programmable social governance (or digital society) and the capability of simultaneity and ease in data traceability; this issue can lead to a reduction in regulatory costs in society and the transformation of human societies through the creation of better collaboration and governance (Su et al., 2023). In this regard, Blockchain 4.0 entered the scene as a usable platform for businesses, with the capability of integration with other technologies such as artificial intelligence. This generation of blockchain, with the potential to integrate various platforms, brings greater coherence and coordination to meet commercial and industrial needs (Mukherjee & Pradhan, 2021). Finally, Blockchain 5.0, which is known as smart blockchain, has the capability of integration with other technologies such as machine learning, artificial intelligence, the Internet of Things, and data analytics, which leads to intelligent and automated operations. This generation of blockchain is capable of dynamically identifying and solving problems, optimizing processes, and facilitating data-driven decision-making for businesses (Choi & Siqin, 2022).

2.1.3 Blockchain Applications in Banking

Due to its significant advancements in data storage and information transfer capabilities, blockchain technology has gained considerable attention in the field of financial technology (FinTech) (Guo & Liang, 2016). This technology provides various functionalities and applications for banking systems, including the following key areas:

- **Fraud Prevention:** Peer-to-peer (P2P) networks and blockchain's tamper-resistant characteristics, combined with rapid information exchange and verifiable transactions, can contribute to reducing fraudulent activities (Nurmukhametov et al., 2018).
- **Privacy and Confidentiality Protection:** Private and hybrid blockchain networks, while supporting large-scale transaction processing, enhance transparency, trust, and efficiency while preserving users' privacy and confidentiality (Wenhua et al., 2023).
- **Identity Management:** By creating secure and tamper-proof digital identities, blockchain enables users to access financial services in a more reliable and trustworthy manner (Kabir & Islam, 2021).
- **Transaction Data Traceability:** Through distributed ledger technology, blockchain provides accurate and efficient tracking of transaction records (Ortiz-Lizcano et al., 2023).
- **Smart Contracts:** Blockchain enables the development of smart contracts that automatically define and execute the terms and conditions of financial agreements, including loan contracts (Yuyan & Lan, 2020).
- **Monetary Transactions:** By storing transaction details in each block and using cryptographic hashes that reference previous blocks, blockchain enables peer-to-peer transfer and receipt of funds without the need for intermediaries (Wenhua et al., 2023).

– **Accelerated Transaction Processing:** Blockchain-based payment systems enable transactions to be completed within seconds or minutes, providing businesses with faster and more reliable financial transfers (Luo & Tang, 2022).
– **Auditing Facilitation:** The immutable records maintained on blockchain networks assist auditors in accurately verifying transaction compliance and financial records (Thommandru & Chakka, 2023).

2.2 Empirical Background

To conduct a systematic review of the literature, a comprehensive search was carried out across Scopus, Web of Science, and the domestic database SID using keywords such as Critical Success Factors, Blockchain, and Banking.

For international literature, the following Boolean query was applied:

(Blockchain OR "Distributed Ledger" OR "Smart Contract") AND ("Critical Success Factors" OR CSF) AND (Bank* OR Financ*)

Due to the limited number of studies specifically addressing blockchain critical success factors in the banking industry, the scope of the review was expanded to include studies investigating blockchain CSFs in the broader service sector to obtain a more comprehensive perspective. At this stage, 36 initial articles were identified, and after removing irrelevant studies, 16 articles were selected for further analysis.

Previous studies analyzing blockchain CSFs across various sectors have utilized diverse methodological approaches:

In recent years, numerous studies have investigated the critical success factors of blockchain technology across various industries. These studies have employed diverse methodological approaches to identify and analyze such factors.

Some studies have relied exclusively on systematic literature reviews to identify blockchain-related CSFs (Sun et al., 2023; Grida et al., 2022; Nasrollahpour et al., 2024), mainly focusing on extracting and synthesizing key concepts from previous studies.

Another group of researchers has employed advanced statistical methods, particularly Structural Equation Modeling (SEM), to examine the relationships among CSFs and empirically test the proposed relationships between factors (Mohammadi, 2024; David et al., 2025; Mbaidin et al., 2024).

Furthermore, several studies have utilized Multi-Criteria Decision-Making (MCDM) approaches. Most of these studies have applied methods such as DEMATEL, ISM, and TISM to identify causal relationships and hierarchical structures among CSFs (Asgharpour et al., 2024; Mutahhar et al., 2025;

Vishnu et al., 2025; Bali et al., 2023; Mishra et al., 2025; Grida et al., 2022; Erol et al., 2021; Prasad et al., 2018).

Finally, some studies have employed AHP and Fuzzy AHP (FAHP) approaches to determine the relative importance and prioritize blockchain CSFs (Li et al., 2024; Zhou et al., 2020).

Table 1 summarizes the reviewed studies in this research area.

Table 1
Summary of Literature Review on Blockchain CSFs

Authors (Year)	**Objective**	**Key Findings**	**Methodology**	**Study Context / Sector**
Mutahhar et al. (2025)	Analyze the CSFs of blockchain-based Intelligent Transportation Systems (ITS)	Legal issues have the strongest influence on system integrity and reliability	DEMATEL	Intelligent Transportation Systems
David et al. (2025)	Evaluate blockchain applications and identify CSFs contributing to successful renewable energy projects	Blockchain technology positively moderates the relationship between CSFs and project success metrics.	PLS-SEM	Renewable Energy
Mishra et al. (2025)	Identify and analyze CSFs driving blockchain adoption	Simplified domestic/international regulations, user data privacy, and data security/integrity are the most critical factors.	FDM / DEMATEL	Banking
Vishnu et al. (2025)	Assess the feasibility of blockchain integration into public distribution systems	Absence of appropriate government regulations and lack of policy support represent the primary barriers.	ISM / MICMAC	Public Distribution Systems
Li et al. (2024)	Investigate CSFs for blockchain implementation in the maritime industry	The top five CSFs are relative advantage, internal leadership, HR capability, scalability, and ease of use.	FAHP	Maritime Industry
Mbaidin et al. (2024)	Examine blockchain components in finance, focusing on Islamic bank adoption in the UAE	Effective blockchain adoption relies on organizational readiness, regulatory compliance, technical expertise, and financial resources.	PLS-SEM	Islamic Banking
Bali et al. (2023)	Analyze blockchain CSFs within the healthcare sector	Data transparency emerged as the most influential factor, while implementation cost was the least influential.	DEMATEL	Healthcare
Sun et al. (2023)	Analyze publication trends and present a framework for blockchain implementation	Decentralized protocols, lifecycle data transparency, immutability, enhanced security, and supply traceability were most cited.	SLR	Construction

Grida et al. (2022)	Evaluate and prioritize CSFs influencing blockchain adoption	Regulations, supportive policies, and competitive pressure represent the most critical driving factors.	DEMATEL	-
Erol et al. (2021)	Analyze CSFs to improve blockchain-based SPVEE performance	Effective government incentive programs and clear regulatory updates are vital for blockchain SPVEE success in Turkey.	IF-DELPHI / IF-DEMATEL	Renewable Energy
Zhou et al. (2020)	Explore challenges and CSFs for maritime blockchain implementation	High implementation cost was identified as the most important factor, while scalability restrictions were least important.	AHP	Maritime Industry
Çaldağ & Gökalp (2020)	Review CSFs in blockchain-based Intelligent Transportation Systems	CSFs span four dimensions: Technical (performance, security), Managerial (feasibility), Governance (transparency), and Quality of Life.	SLR	Smart Transportation
Prasad et al. (2018)	Identify and analyze structural interactions among CSFs	Regulatory transparency, industry collaboration, ecosystem building, standard development, and leadership education are critical.	TISM	Blockchain Cloud Services
Asgharpour et al. (2024)	Design an interpretive structural framework for SME supply chain blockchain adoption	Top-management support and effective execution are primary drivers; government support and financial management form secondary levels.	ISM	Small & Medium Enterprises (SMEs)
Nasrollahpour et al. (2024)	Map the impact of blockchain technological functions on the Iranian banking system	Smart contracts and decentralized databases lower transaction costs and processing time; immutability and auditability improve risk management.	SLR / FDM	Banking
Mohammadi (2024)	Evaluate blockchain properties on financial innovation in banking	Dynamism, identity preservation, information security, reduced costs, time efficiency, and decentralization drive financial innovation.	SEM	Banking

Note. The table was compiled by the authors based on the studies listed in the references.

Despite significant advancements in exploring the Critical Success Factors of blockchain technology, previous studies still exhibit several limitations that this study seeks to address:

Failure to Determine the Relative Importance of Factors: Most existing studies have focused on modeling relationships among factors using methods such as Structural Equation Modeling (SEM), DEMATEL, and Interpretive Structural Modeling (ISM), while paying limited attention to assessing the relative importance and priority of these factors. This issue represents a significant research gap, particularly in the Iranian banking system, where effective allocation of limited resources requires accurate prioritization of CSFs.

Limited Contextual Focus on Iran: Most existing studies (e.g., Zhou et al., 2020; Grida et al., 2022) have been conducted in different economic and institutional contexts and have not sufficiently considered the specific structural, regulatory, and technological challenges of Iran’s banking sector.

Limitations of Traditional Decision-Making Methods: Traditional MCDM approaches, such as Analytic Hierarchy Process (AHP) and DEMATEL, which have been widely applied in previous studies, particularly in non-banking contexts, may face limitations related to a high number of pairwise comparisons and potential cognitive biases (such as anchoring bias and equal-weight bias), which can affect the reliability of decision-making outcomes.

Although previous studies have made valuable contributions by applying approaches such as AHP, DEMATEL, and SEM, they have mainly focused on identifying structural relationships among factors and have rarely addressed probabilistic group prioritization approaches that account for uncertainty and cognitive biases in expert judgments. To address this gap, this study employs the Bayesian Best-Worst Method. The key advantages of BBWM compared with traditional approaches include a substantial reduction in the number of pairwise comparisons, incorporation of probabilistic confidence levels in criterion ranking, and improved management of uncertainty in expert evaluations.

According to Boynton and Zmud (1984), Critical Success Factors refer to a limited number of key areas in which satisfactory results are essential for achieving successful competitive performance within an organization. These factors require continuous managerial attention and prioritization to achieve optimal performance. Accordingly, the CSFs identified through the systematic review of the literature on blockchain adoption in banking are presented in Table 2.

Table 2

Critical Success Factors (CSFs) of Blockchain in Banking

NO	Critical Success Factor	Symbol	Definition	References
1	High Scalability and Fast Transaction Processing Speed	C1	The ability to process high transaction volumes quickly, accelerate verification times, and minimize latency to facilitate widespread industry adoption.	Erol et al. (2021); Grida et al. (2022); Mishra et al. (2025); Li et al. (2024)
2	Security and Standardization of Blockchain Technology	C2	Cryptographic mechanisms, security protocols, and standardized frameworks used to protect data, prevent cyberattacks, and ensure interoperability across systems.	Prasad et al. (2018); Çaldağ & Gökalp (2020); Mishra et al. (2025); Sun et al. (2023); Bali et al. (2023)
3	Interoperability with existing systems	C3	High interoperability enabling institutions to integrate blockchain advantages seamlessly without requiring fundamental overhauls of existing core IT infrastructure.	Prasad et al. (2018); Çaldağ & Gökalp (2020); Mishra et al. (2025); Sun et al. (2023)
4	Smart Contract Execution and Process Automation	C4	Autonomous execution of agreements and financial transactions without intermediaries, reducing operational costs, processing delays, and human error.	Prasad et al. (2018); Mishra et al. (2025); Sun et al. (2023)
5	Top Management Support and Organizational Commitment	C5	Active backing and commitment from executive leadership and key decision-makers, which is critical for securing resources and overcoming adoption hurdles.	Zhou et al. (2020); Grida et al. (2022); Bali et al. (2023); Mishra et al. (2025); Mbaidin et al. (2024)
6	Effective Change Management and Organizational Acceptance	C6	Structured change management strategies to mitigate employee resistance, supplemented by targeted training programs to communicate blockchain benefits.	Çaldağ & Gökalp (2020); Grida et al. (2022); Li et al. (2024)
7	Operational Cost Reduction and Productivity Enhancement	C7	Eliminating financial intermediaries and legacy manual processes to reduce administrative overhead, optimize business flows, and boost institutional efficiency.	Prasad et al. (2018); Mishra et al. (2025)
8	Establishment of Transparent Legal and Regulatory Frameworks	C8	Formulating clear legal regulations to mitigate legal ambiguities and compliance risks, creating a predictable development path for enterprise blockchain adoption.	Prasad et al. (2018); Çaldağ & Gökalp (2020); Zhou et al. (2020); Grida et al. (2022); Mbaidin et al. (2024)
9	Market Competition and Industry Adoption Pressure	C9	Competitive dynamics pushing financial institutions toward innovation, where higher market pressure drives faster and more successful blockchain adoption.	Grida et al. (2022); Mbaidin et al. (2024); Li et al. (2024)

Source: Research findings

3 Research Methodology

This study aims to identify, evaluate, and prioritize the Critical Success Factors of blockchain implementation in the banking sector using the Bayesian Best-Worst Method. First, relevant CSFs were identified through a comprehensive literature review. Next, the Fuzzy Delphi Method was employed to screen and validate these factors based on expert consensus. Finally, the relative weights and importance of the validated factors were calculated using BBWM. Operational and research recommendations were then formulated based on the empirical results and study limitations. The overall conceptual framework of the research methodology is presented in Figure 1.

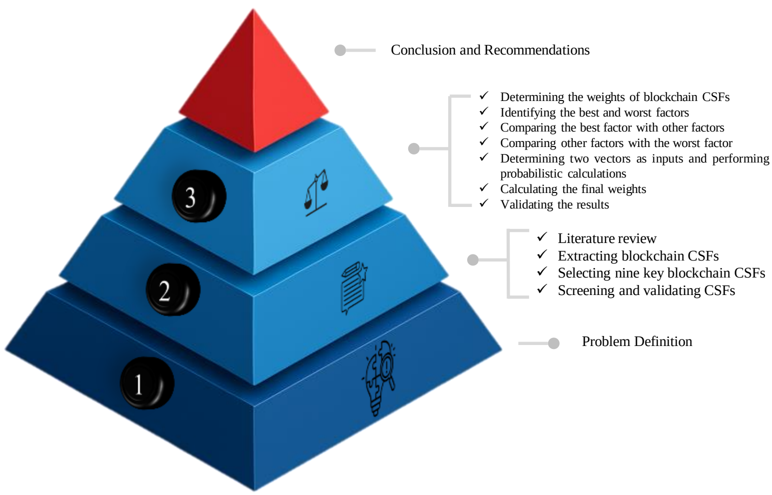

Figure 1. Research Methodology Framework
Source: Research findings

The expert panel for this study comprises six domain experts selected based on specific criteria: extensive banking industry experience, functional knowledge of blockchain technology and its applications in banking, and willingness to participate in the study. Table 3 presents the demographic profile and professional background of the panel members. In multi-criteria decision-making literature, panels of this size are well-established and widely accepted for expert judgment aggregation (Saner et al., 2022; Yalcin Kavus et al., 2023). Thus, selecting six qualified experts aligns with standard methodological practices in the field and ensures rigorous scientific validity.

Table 3
Profile of Expert Panel Members

NO	Professional Position / Title	Educational Degree	Relevant Work Experience
1	Chief Information Officer (CIO) / IT Director	Master's	6 Years
2	Deputy Director of Research & Development	Bachelor's	4 Years
3	Head of Digital Banking Department	Master's	5 Years
4	Manager of Innovation & E-Services Development	Ph.D.	6 Years
5	Manager of IT Policy & Strategic Planning	Bachelor's	3 Years
6	Head of Information Security Department	Ph.D.	4 Years

Source: Research findings

3.1 Fuzzy Delphi Method

The Delphi method, developed by the RAND Corporation in 1948, is an expert-based decision-making technique that relies on the knowledge, experience, and judgment of specialists. By systematically collecting and organizing expert opinions, the method facilitates consensus on complex issues while ensuring that all participants have an equal opportunity to express their views. The Fuzzy Delphi Method is an extension of the traditional Delphi method that integrates fuzzy set theory to better address the uncertainty and ambiguity inherent in human judgments. Instead of relying on precise values, FDM employs triangular fuzzy numbers to represent experts' opinions. This approach overcomes several limitations of the conventional Delphi method by reducing uncertainty, accelerating the data collection process, and improving the accuracy of consensus measurement among experts. The main advantages of FDM include requiring fewer rounds of consultation, reducing time and effort, providing a more accurate representation of linguistic judgments, simplifying the analysis of multi-attribute decision-making problems, and improving the reliability and validity of the results compared with the traditional Delphi method (Tsai et al.,2020).

The steps of the Fuzzy Delphi Method are described as follows:

1) **Identification of CSFs:** Extract critical success factors from a systematic review of the theoretical and empirical literature.

2) **Collection of Expert Opinions:** Form an expert decision-making panel to evaluate the relevance of each factor. Questionnaires featuring linguistic variables (Table 4) are distributed to screen and validate the factors.
3) **Factor Validation and Screening:** Evaluate the aggregated defuzzified score of each factor against an established threshold value (typically set at $\tau = 0.70$).

Table 4
Linguistic Variables and Triangular Fuzzy Numbers

Linguistic Variables	Triangular Fuzzy Numbers (l,m,u)
Absolutely Poor / Extremely Low	(0.00,0.00,0.10)
Very Poor / Very Low	(0.00,0.10,0.30)
Poor / Low	(0.10,0.30,0.50)
Medium / Moderate	(0.30,0.50,0.75)
Strong / High	(0.50,0.75,0.90)
Very Strong / Very High	(0.75,0.90,1.00)
Absolutely Strong / Extremely High	(0.90,1.00,1.00)

Source: Habibi & Afaridi, (2022)

First, individual expert ratings are represented as Triangular Fuzzy Numbers (TFNs). To aggregate the opinions of n experts for factor j, the fuzzy average is calculated using Equation (1):

$$\tilde{a}_j = \left(l_j, m_j, u_j\right) = \left(\frac{1}{n}\sum_{i=1}^{n} l_{ij}\,, \frac{1}{n}\sum_{i=1}^{n} m_{ij}\,, \frac{1}{n}\sum_{i=1}^{n} u_{ij}\right)$$

where index i denotes the expert ($i = 1,2, \dots, n$) and index j denotes the evaluation factor.

The aggregated fuzzy number $\tilde{a}_j$ is then defuzzified into a crisp value S_j using the center of gravity method via Equation (2):

$$S_j = \frac{l_j + m_j + u_j}{3}$$

Factors obtaining a defuzzified value $S_j \geq 0.70$ are retained, while those falling below the threshold are screened out.

3.2 Bayesian Best-Worst Method (BBWM)

Rezaei (2015) introduced the Best-Worst Method (BWM) as a structured MCDM technique to determine criterion weights. Compared to traditional pairwise comparison methods such as the Analytic Hierarchy Process, BWM requires significantly fewer pairwise comparisons, saves time, reduces cognitive load, and mitigates cognitive biases such as equalizing bias (Rezaei et al., 2022) and anchoring bias (Rezaei et al., 2024b). For more information on the benefits of this method, see Wu et al. (2024).

However, classical BWM is primarily designed for individual decision-makers and faces constraints when aggregating multi-expert preferences. To address group decision-making dynamics, Mohammadi and Rezaei (2020) proposed the Bayesian Best-Worst Method. The operational procedure for BBWM consists of the following steps:

1) **Establish Criterion Set:** Define the set of evaluation criteria/factors $\{c_1, c_2, \dots, c_n\}$ derived from literature synthesis and FDM screening.
2) **Execute Best/Worst Selection and Pairwise Comparisons:** Each expert k selects the most important (Best) criterion c_B and the least important (Worst) criterion c_W from the set. Pairwise evaluations are conducted:
   - **Best-to-Others Vector (A_B):** Comparing c_B to all other criteria.
   - **Others-to-Worst Vector (A_W):** Comparing all other criteria to c_W.

   Comparisons use a 1 to 9 scale (1 = equal importance, 9 = extreme importance).
3) **Probabilistic Weight Estimation:** Aggregate individual evaluations into an optimal group weight vector w^* via probabilistic modeling. For each expert k, the vector inputs A_B^k and A_W^k follow a multinomial distribution:

$\sum_j w_j = 1$ and $w_j \geq 0, \forall j$.

The overarching group weight distribution w^* and expert-specific weight distributions w^k are estimated via Dirichlet priors within a Bayesian probabilistic framework:

$$\left(A_B^k \middle| w^k\right) \sim multinomial\left(\frac{1}{W^k}\right);\ \left(A_W^k \middle| w^k\right) \sim multinomial\left(w^k\right), \forall_k = 1,2,\dots,K$$
$$w^k | w^* \sim Dir(\gamma \times w^*),\ \forall_k = 1,2,\dots,K$$
$$\gamma \sim gamma(0.1, 0.1)$$
$$w^* \sim Dir(1)$$

4) **Calculating the credal ranking:** By solving the Bayesian model using Markov Chain Monte Carlo sampling, the posterior probability distributions for the criterion weights w^*, confidence levels, and directional credal rankings are computed to establish a complete prioritization of the critical success factors.

4 Research Findings

In this section, the Fuzzy Delphi Method (FDM) was first utilized to screen and validate the Critical Success Factors identified from the literature. Expert opinions were collected and analyzed using fuzzy logic, as summarized in Table 5. The final decision framework (value tree) representing the conceptual model of the study is illustrated in Figure 2.

Table 5
Fuzzy Delphi Method (FDM) Screening Results

Critical Success Factors (CSFs)	**Fuzzy Mean L**	**Fuzzy Mean M**	**Fuzzy Mean U**	**Defuzzified Score (Sj)**	**Status**
High Scalability and Fast Transaction Processing Speed	0.66	0.83	0.94	0.81	Accepted
Security and Standardization of Blockchain Technology	0.56	0.74	0.90	0.73	Accepted
interoperability with existing systems	0.55	0.76	0.91	0.74	Accepted
Smart Contract Execution and Process Automation	0.65	0.80	0.92	0.79	Accepted
Top Management Support and Organizational Commitment	0.62	0.80	0.93	0.78	Accepted
Effective Change Management and Organizational Acceptance	0.60	0.75	0.88	0.74	Accepted
Operational Cost Reduction and Productivity Enhancement	0.68	0.86	0.95	0.83	Accepted
Establishment of Transparent Legal and Regulatory Frameworks	0.63	0.79	0.90	0.78	Accepted
Market Competition and Industry Adoption Pressure	0.64	0.82	0.93	0.79	Accepted

Source: Research findings

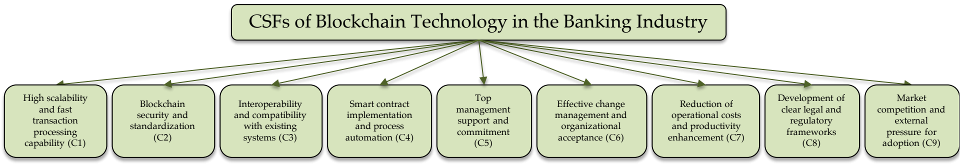

Figure 2. Conceptual Decision Model (Value Tree)
Source: Research findings

Next, the Bayesian Best-Worst Method was applied to determine the importance of the critical success factors of blockchain in banking. Initially, experts were asked to form pairwise comparison vectors between the Best (most important) critical success factor and other factors, as well as between other factors and the Worst (least important) factor, based on Table 2. Table 6 examines the pairwise comparisons between the best factor and other factors. For example, according to the viewpoint of Expert No. 1, "High scalability and fast transaction processing speed (C1)" was selected as the most important factor, and this individual evaluated C1 in relation to other factors as follows: four times more important than C2, three times more important than C3, five times more than C4, two times more than C5, four times more than C6, six times more than C7, eight times more than C8, and nine times more than C9. Similarly, other experts also performed similar comparisons for the various factors. In Table 7, the pairwise comparison vector between other factors and the least important factor is examined. For instance, from the perspective of Expert 1, "Market Competition and Industry Adoption Pressure (C9)" was recognized as the least important factor, and the comparisons were made based on this.

Table 6

Best-to-Others Pairwise Comparison Vectors (A_B)

CSF / Expert	C1	C2	C3	C4	C5	C6	C7	C8	C9
1	1	4	3	5	2	4	6	8	9
2	2	3	4	1	6	3	8	9	5
3	1	3	3	4	2	4	5	7	9
4	5	1	9	2	4	3	4	3	7
5	5	4	9	6	1	2	4	3	4
6	2	3	5	1	5	4	4	5	9

Source: Research findings

Table 7

Others-to-Worst Pairwise Comparison Vectors (A_W)

CSF / Expert	C1	C2	C3	C4	C5	C6	C7	C8	C9
1	9	7	4	8	3	4	2	5	1
2	7	7	8	9	3	2	5	1	6
3	9	6	5	7	4	3	6	5	1
4	4	9	1	3	7	5	6	8	7
5	7	2	1	3	9	4	2	6	8
6	7	4	6	9	5	5	4	3	1

Source: Research findings

Following the computation steps via MATLAB R2020a using the BBWM computational package, the final aggregated weights were calculated. As shown in Table 8, factors C1, C4, and C2, representing "High scalability and fast transaction processing speed", "Smart Contract Execution and Process Automation", and "Security and standardization of blockchain technology", were identified as the top three critical success factors. Conversely, factors C9, C3, and C7, representing "Market Competition and Industry Adoption Pressure," "interoperability with existing systems", and "Operational Cost Reduction and Productivity Enhancement", were ranked as the least influential factors.

Table 8
Final Weights and Prioritization of CSFs via BBWM

Critical Success Factors (CSFs)	**Symbol**	**Relative Weight**
High Scalability and Fast Transaction Processing Speed	C1	0.1611
Smart Contract Execution and Process Automation	C4	0.1464
Security and Standardization of Blockchain Technology	C2	0.1322
Top Management Support and Organizational Commitment	C5	0.1247
Effective Change Management and Organizational Acceptance	C6	0.1046
Establishment of Transparent Legal and Regulatory Frameworks	C8	0.0901
Operational Cost Reduction and Productivity Enhancement	C7	0.0885
Interoperability with existing systems	C3	0.0847
Market Competition and Industry Adoption Pressure	C9	0.0677

Source: Research findings

5 Model Validation

To validate the reliability and robustness of the CSF weights generated by BBWM, two validation procedures were executed.

5.1 Credal Ranking and Confidence Level Analysis

In this section, in order to validate the importance weights of the critical success factors obtained from the Bayesian Best-Worst Method, two procedures were utilized. Initially, the confidence level and the graph related to the calculated weights were determined by solving the model proposed by Mohammadi and Rezaei (2020). Figure 3 represents the confidence level of the ranking of the research factors. These levels indicate to what extent the results obtained from the weighting model are consistent with the experts' views regarding the importance of the factors and have been satisfactory for them.

For example, as also mentioned in Table 8, factors C1, C4, and C2 have been recognized as the most important key success factors in this research. In the aforementioned figure, these factors are also placed from top to bottom, respectively; in such a way that the lower the position of a factor, it indicates its relatively lower importance.

In addition, on the directed lines between the factors, numbers are inscribed that indicate the degree of confidence in the preference of the origin factor over the destination factor, from the experts' perspective. For example, factor C1, from the experts' perspective, has a preference over factors C9 and C7 with a confidence degree of 1 (equivalent to 100%), which indicates complete consensus among the experts' opinions in this regard. The lowest degree of confidence in preference is related to the superiority of factor C8 over C9, whose value has been reported as 0.52%. Similarly, other degrees of confidence in preference among the various factors can also be observed in Figure 3.

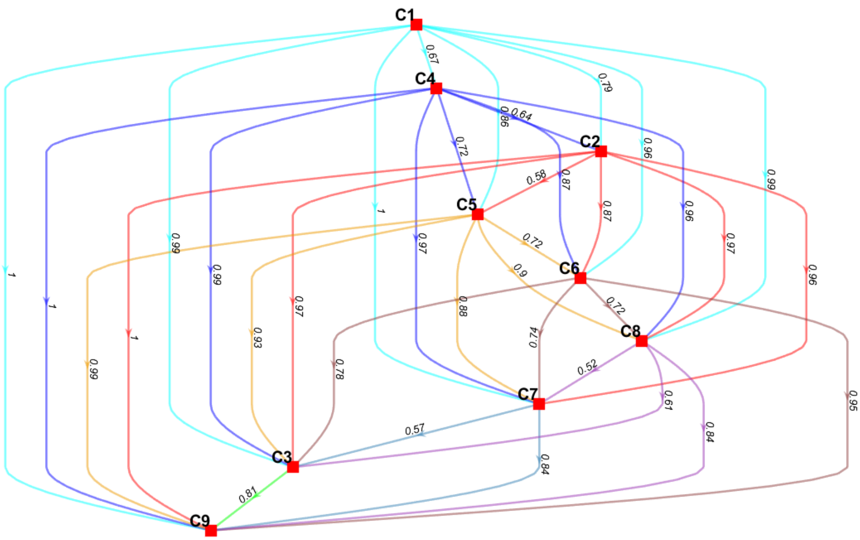

Figure 3. Credal Ranking and Preference Confidence Directed Graph
Source: Research findings

5.2 Comparative Methodological Validation

The performance of BBWM was statistically benchmarked against the non-linear Best-Worst Method (Rezaei, 2015) and linear Best-Worst Method (Rezaei, 2016). Table 9 and Figure 4 present the comparative weights and rankings across these three methods.

To evaluate statistical consistency across methods, Pearson correlation analysis was conducted on criterion weights, while Spearman rank correlation analysis was applied to factor rankings. The Pearson correlation analysis revealed strong consistency between BBWM weights and those of linear BWM ($r = 0.965$) and non-linear BWM ($r = 0.974$). Similarly, the Spearman rank correlation demonstrated high rank consistency between

BBWM and linear BWM ($r = 0.971$), as well as non-linear BWM (r = 0.946). These strong statistical relationships confirm the robust empirical validity of the BBWM results.

Table 9

Comparative Validation Results Across BWM Variants

CSF	BBWM Weight	Linear BWM Weight	Non-Linear BWM Weight	BBWM Rank	Linear BWM Rank	Non-Linear BWM Rank
C1	0.1611	0.1769	0.1687	1	1	1
C2	0.1322	0.1440	0.1441	3	3	3
C3	0.0885	0.0676	0.0801	7	8	6
C4	0.1464	0.1490	0.1589	2	2	2
C5	0.1247	0.1363	0.1358	4	4	4
C6	0.1046	0.1269	0.1223	5	5	5
C7	0.0885	0.0833	0.0795	7	6	7
C8	0.0901	0.0704	0.0744	6	7	8
C9	0.0667	0.0455	0.0362	9	9	9

Source: Research findings

Figure 4. Comparative Weight Trend Across BWM Variants

Source: Research findings

6 Discussion

Due to features such as transparency, high security, elimination of intermediaries, and traceability, blockchain technology has quickly found a special position in various industries, especially the banking industry. Banks and financial institutions, with the aim of improving efficiency, reducing costs, facilitating international transactions, developing digital services, and increasing customer trust, are moving towards broader utilization of this technology. Despite the high potential of blockchain, success in its implementation in the banking system requires identifying and strengthening critical success factors. Factors that can play an effective role in the success of the implementation of this technology.

Based on the findings of the present research, the most important factors are respectively factors C1, C4, and C2, which include "High scalability and fast transaction processing speed", "Smart contract execution and process automation", and "Security and standardization of blockchain technology".

One of the most important and fundamental critical success factors of blockchain technology in the banking industry is having high scalability and the ability to process transactions quickly. This feature is considered the basis for a fundamental transformation in the way banking services are provided and makes it possible to execute a large volume of transactions in a very short period of time and with high stability. In the banking system, which deals with millions of transactions daily, processing speed has a determining role in customer satisfaction, operational efficiency, and maintaining a competitive advantage. Advanced blockchains, by utilizing modern architectures, are able to perform services such as instant fund transfers, interbank settlements, salary and bonus payments, international transactions, and micro-payment services with high speed and accuracy. This level of processing capability allows banks to provide their financial services to customers in a real-time manner and respond to the complex and changing needs of emerging financial markets. In addition, high scalability gives banks the ability to expand the scope of their services without worrying about system slowdown or the need to redesign the infrastructure, attract more users, and respond to increased demand in special circumstances. This feature also provides the necessary infrastructure for the implementation of new technologies such as open banking, decentralized finance (DeFi) applications, smart contracts, and digital wallets. From this perspective, the high processing capability and scalability of blockchain are considered not only a technical capability but also a strategic advantage that can significantly improve the competitive position of banks in the future of the digital economy.

In the Iranian banking system, the high volume of daily transactions such as micro-payments, fund transfers, and interbank settlements, along with infrastructure limitations caused by international sanctions, have created serious challenges for traditional systems. Sanctions have prevented banks from accessing modern global technologies and have caused slowdowns, frequent outages, and inefficiency in transaction processing. In such circumstances, the scalability of blockchain technology with the ability to process a large number of transactions quickly and stably can be a direct response to these problems. This feature is considered a strategic requirement for Iranian banks, which are under increasing pressure to provide real-time services to customers. For example, in large banks that process millions of micro-transactions daily, the use of blockchain can reduce transaction processing time from a few seconds or minutes to a fraction of a second. However, neglecting scalability has significant consequences, including frequent delays in transactions, customer dissatisfaction, and a decrease in public trust in the banking network. A clear example is the frequent outages of online payment gateways during peak transaction times, which occur due to the weakness of traditional systems in managing high volumes. The continuation of this situation, in addition to reducing the operational efficiency of banks, can weaken their competitive position against fintech companies.

Another critical success factor of blockchain that plays a very effective role in the digital transformation of banks is the possibility of executing smart contracts and automating banking processes. Smart contracts, as decentralized and self-executing programs on the blockchain platform, make it possible for financial and administrative agreements to be executed automatically, accurately, and transparently, without the need for human intervention. In the banking industry, this technology can perform a wide range of processes, including loan payments, installment repayments, interbank settlements, management of letters of credit, asset transfers, insurance policies, and even regulatory compliance control, in an intelligent manner and without manual intervention. Smart contracts, by eliminating intermediaries and reducing the need for frequent manual reviews, save time and costs, increase response speed, and reduce execution errors. On the other hand, the transparency and immutability of these contracts increase the trust of customers and stakeholders and provide a suitable environment for creating innovative and reliable financial services. Also, automation of processes through smart contracts makes it possible to implement programmable banking; this means that banks can offer fully customized and adaptable services to customers based on specifically defined conditions. Therefore, the use of smart contracts not only significantly increases the operational efficiency of the bank but also places it on the path toward next-generation banking based on advanced technologies.

The Iranian banking system faces a shortage of specialized human resources and high operational costs, a problem that has been exacerbated by the semi-public structure of banks and conditions caused by international sanctions. In such a context, the use of blockchain-based smart contracts can create a fundamental transformation. This technology, by enabling the automation of complex processes such as loan issuance and repayment, interbank settlements, and the implementation of Anti-Money Laundering (AML) and Know-Your-Customer (KYC) requirements, not only reduces costs and human errors but also increases the transparency and efficiency of banking operations. For this reason, in the Iranian banking system, which has a very high need for transparency and processing speed, the utilization of smart contracts has strategic importance. In practice, in the process of granting retail loans, which currently requires manual document verification and multi-step approval, smart contracts can perform all the steps automatically and in a few seconds. Also, in the field of interbank settlements, which sometimes takes several days, this technology can make instant settlement and transparent recording of transactions possible. Failure to pay attention to such a capacity has significant consequences, including high operational costs, human errors, and long delays in processes. Especially in the areas of KYC and AML, reliance on manual methods, in addition to wasting resources, can lead to unintentional violations or regulatory fines. These inefficiencies ultimately weaken the trust of customers and regulatory bodies and reduce the overall efficiency of the banking system.

Also, high security and standardization of this technology at the level of the network, data, and transactions is another success factor of blockchain. Blockchain, by virtue of its decentralized structure, advanced encryption, and immutable recording of data, inherently has a high level of security, which makes it an ideal option for managing sensitive banking and financial information. In modern banking, protecting customer information, preventing fraud, maintaining data confidentiality, and ensuring the accuracy of transactions are of great importance; blockchain can provide all these goals in an integrated and effective manner. Also, by implementing mechanisms such as digital signatures, asymmetric encryption algorithms, verifying the correctness of transactions, and managing access levels, banks can institutionalize security in all layers of their system. On the other hand, standardization of blockchain technology in the form of international frameworks, specific protocols, and harmonized technical requirements will pave the way for broader cooperation between banks, financial institutions, and regulators. This standardization facilitates data exchange, ensures compliance with regulations, and creates reliable infrastructure for cross-border and international services. When security and standardization are simultaneously considered in the design and implementation of banking blockchain systems, public trust in this technology increases, operational risks are minimized, and the path is paved for the development of new financial services and the broader participation of banking industry players. As a result, security and standardization are recognized not only as technical features, but also as strategic and critical factors for the sustainable success of blockchain in the banking system.

Cybersecurity in the Iranian banking system has become critically important due to the increase in cyber attacks and the necessity of protecting sensitive customer data against internal and external threats. Restricted access to advanced security technologies due to sanctions has made Iranian banks vulnerable to cyber risks. In the meantime, blockchain technology with features such as advanced encryption, decentralized data distribution, and transaction transparency can play an important role in enhancing security. In addition, standardization of blockchain infrastructure is necessary to ensure compatibility with existing banking systems and compliance with domestic and international regulatory requirements. Together, these factors make blockchain-based security and standardization one of the strategic priorities in the digital transformation of the Iranian banking system. In practice, the application of blockchain in digital identity management of customers can prevent data leaks and misuse of banking data. Also, in interbank settlements, immutable recording of transactions on the blockchain platform eliminates the possibility of fraud or data manipulation. In contrast, neglect of this area has led to an increase in cyber attacks, including phishing and infiltration into banking systems.

The empirical findings display notable similarities and contextual divergences when benchmarked against existing literature, as summarized in Table 10.

Table 10
Comparative Analysis with Previous Literature

CSFs Ranked in This Study	Convergent Literature (Similarities)	Divergent Literature (Differences)
High Scalability and Fast Transaction Processing Speed	Li et al. (2024), Mishra et al. (2025)	Zhou et al. (2020)
Smart Contract Execution and Process Automation	Mishra et al. (2025)	—
Security and Standardization of Blockchain Technology	Mohammadi (2024), Mbaidin et al. (2024), Grida et al. (2022), Erol et al. (2021), Zhou et al. (2020), Prasad et al. (2018)	—
Market Competition and Industry Adoption Pressure	—	Grida et al. (2022)

Source: Research findings

The findings of this research show that high scalability and fast transaction processing speed (C1) and execution of smart contracts and process automation (C4) are the most important critical success factors of blockchain technology in the Iranian banking system. Although these factors have also been identified as key factors in some previous studies (such as Li et al., 2024; Mishra et al., 2025), their importance in the context of Iran, due to specific local conditions, including the high volume of daily transactions, infrastructure limitations caused by international sanctions, and the need for real-time services, is considered a distinct finding. For example, in the Iranian banking system, which faces challenges such as the slowness of traditional systems and the need for quick responsiveness to customers, scalability is not only a technical advantage but also a strategic requirement for maintaining competitive advantage and gaining customer trust. Also, smart contracts, by enabling the automation of processes such as loan payments, interbank settlements, and regulatory compliance, in a context where human resources are limited and operational costs are high, create significant added value. In the following, the similarities and differences between the results of the present research and the results of the previous literature, and the reasons for them, are discussed in detail.

According to Table 10, the factor of high scalability and fast transaction processing speed has been identified as the most important factor and is consistent with the results of the studies of Li et al. (2024) and Mishra et al. (2025), but in the study of Zhou et al. (2020), it has a lower degree of importance. In the studies of Li et al. (2024) and Mishra et al. (2025) in countries such as Singapore and India, scalability has been introduced as a critical factor because these countries, like Iran, face hardware resource limitations, rapid growth of digital users, and the need to respond to high volumes of transactions. This finding shows that scalability is not only a technical feature, but also a strategic requirement for banking systems that are transitioning to the digital economy. Regarding the study of Zhou et al. (2020), the reason for this difference is that the low-transaction nature of the maritime transport industry compared to the high volume of transactions in the Iranian banking system has made the importance of scalability more prominent in the financial context and has caused it to find a higher position in the present research.

Similarly, execution of smart contracts and process automation is consistent with the results of the study of Mishra et al. (2025). This alignment indicates that this factor, both in the theoretical literature and in practice, has been recognized as a tool for increasing efficiency and reducing operational costs. Also, the factor of security and standardization of blockchain technology is consistent with the results of the studies of Mohammadi (2024), Mbaidin et al. (2024), Grida et al. (2022), Erol et al. (2021), Zhou et al. (2020), and Prasad et al. (2018). The countries examined in these studies, such as the United Arab Emirates and Egypt, are also in the middle stages of blockchain technology adoption. For this reason, the lack of standardization frameworks, security concerns, and legal ambiguity are major obstacles. As a result, security and standardization have been identified as common success factors. This indicates that the theoretical literature and the findings of experts both emphasize the importance of regulatory integration and the establishment of technical standards, because without them, widespread adoption of blockchain at the banking level will be difficult.

Finally, the factor of market competition and adoption pressure is not consistent with the study of Grida et al. (2022) because in this research, it has been recognized as one of the low-importance factors, but in the study of Grida et al. (2022), it has been evaluated as one of the important factors. In the study of Grida et al. (2022), which was conducted in the economic context of Egypt, competition and market pressure have been evaluated as the main drivers for blockchain adoption. This high importance is due to the fact that in the Egyptian economy, companies, in order to survive in the global market and respond to international pressures, especially in supply chains, are forced to adopt innovations such as blockchain. But in the present research, which focuses on the Iranian banking system, due to the limitations of the real competitive environment, sanctions, and the predominantly government-owned and semi-government structure of banks, market pressure has not yet taken shape seriously and competitively on a large scale. Therefore, this factor has found lower importance in the assessment of domestic experts compared to technological and internal-organizational factors. This difference shows that institutional conditions and market structure in different countries can have an impact on the prioritization of critical success factors, and the results of expert studies should always be interpreted in the socio-economic context of the country in question.

The findings of this research, by addressing the gaps in previous studies, provide a new perspective on critical success factors of blockchain in banking. For example, unlike the study of Mbaidin et al. (2024), which used SEM and focused on the relationships between factors, this research, using BBWM, has determined the relative importance of factors and has shown that High Scalability and Fast Transaction Processing Speed, Smart Contract Execution, and Process Automation have a higher priority in the Iranian banking system. Also, while the study of Grida et al. (2022) has considered Market Competition and Industry Adoption Pressure as a key factor in Egypt, this research, considering the non-competitive conditions of Iran, considers technical factors such as scalability and security as more prominent. These differences indicate the importance of localization of analysis in the socio-economic context of Iran.

7 Conclusion and Recommendations

The present research was conducted with the aim of identifying and evaluating the critical success factors of blockchain technology in the banking industry. Initially, through a comprehensive review of theoretical foundations and literature review, the concept of blockchain, its evolution, and its applications in the banking industry were described. This review showed that blockchain, with features such as transparency, security, cost reduction, and elimination of intermediaries, has high potential for transformation in banking systems. Also, the background of related research was analyzed, and critical success factors of blockchain in various industries, especially banking, were identified. In the following, using a group quantitative methodology and utilizing the Bayesian Best-Worst Method, the relative importance of critical success factors of blockchain in the banking industry was determined. The findings of this research indicated the relative importance of each of the critical success factors, which can be used as a guide for banks in the successful implementation of blockchain technology, and the important factors in this research, in order, are High Scalability and Fast Transaction Processing Speed (C1), Smart Contract Execution and Process Automation (C4), Security and Standardization of Blockchain Technology (C2), Top Management Support and Organizational Commitment (C5), Effective Change Management and Organizational Acceptance (C6), Establishment of Transparent Legal and Regulatory Frameworks (C8), operational cost reduction and productivity enhancement (C7), Interoperability with existing systems (C3) Market Competition and Industry Adoption Pressure (C9).

This research, by identifying high scalability and fast transaction processing speed and execution of smart contracts as the most important critical success factors of blockchain in the Iranian banking system, has localized the factors according to the specific conditions of Iran, including international sanctions, the semi-public banking structure, and the need for real-time services, which creates significant added value. Unlike previous studies that were conducted in different economic contexts, this research, by utilizing the novel Bayesian Best-Worst Method and focusing on the local challenges of Iran, has presented distinct findings that can be used as a guide for the successful implementation of blockchain in Iranian banks.

7.1 Managerial and Practical Recommendations

1) Enhancing Scalability and Transaction Throughput:
    1) Select and architect blockchain infrastructures capable of horizontal and vertical scaling.
    2) Adopt lightweight consensus mechanisms (e.g., PoS or BFT) to minimize latency and maximize transaction throughput.
    3) Establish continuous network performance monitoring and dynamic hardware resource optimization during peak transaction cycles.
2) Smart Contract Deployment and Process Automation:
    1) **Digitalize Banking Contracts:** Transition traditional financial agreements (e.g., loan origination, bank guarantees, Letters of Credit) into self-executing smart contracts to minimize manual workflows.
    2) **Automate Payment and Settlement:** Utilize smart contracts for automated installment collections, interbank clearings, and cross-border transfers to improve turnaround times and reduce operational errors.

   3) **Regulatory Technology (RegTech) Integration:** Embed compliance checking protocols directly into smart contract code to enable automated, real-time KYC and AML verification.

3) Security Elevation and Technical Standardization:
   1) Formulate cybersecurity protocols aligned with established international frameworks such as ISO/IEC 27001 and NIST.
   2) Deploy advanced cryptographic algorithms, secure digital signatures, and robust Key Management Systems (KMS).
   3) Establish a dedicated Cyber Security Incident Response Team (CSIRT) specialized in blockchain infrastructure and smart contract auditing.

7.2 Directions for Future Research

1) Conduct focused empirical studies on the top three prioritized factors to refine their technical and operational frameworks.
2) Employ Exploratory Factor Analysis (EFA) to categorize potential sub-factors, followed by Confirmatory Factor Analysis (CFA) for structural validation.
3) Utilize causal modeling methods such as DEMATEL, Analytic Network Process (ANP), or Social Network Analysis (SNA) to evaluate interdependencies among CSFs.
4) Investigate sub-sector-specific blockchain implementation models across specialized banking domains, including retail digital banking, international trade finance, credit scoring, and syndicated lending.
5) Conduct comparative studies to analyze CSF priority variances between public, semi-public, and private commercial banks.
6) Design context-specific adoption frameworks tailored to the economic, institutional, and technological parameters of emerging markets.
7) Integrate fuzzy logic extensions (e.g., Fuzzy BWM or Interval-Valued Fuzzy Sets) to account for epistemic uncertainty and subjectivity in expert judgments.

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