Futures Study of Smart Contracts in the Banking Industry

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Abstract

Smart contracts are one of the most significant applications of blockchain technology, which have gained considerable importance in the financial industry. These contracts promote transparency and enhance good governance in the banking sector. The present research aims to conduct a Futures Study of smart contracts in the banking industry using a scenario-building approach. This research is applied in nature, and methodologically, it is a mixed-methods study. In this research, fuzzy Delphi, fuzzy WASPAS, and interviews with focus groups were used to analyze the data. In the first step, 37 drivers were identified through a literature review and interviews with blockchain experts. These drivers were then filtered using expert questionnaires and the fuzzy Delphi method. Nine drivers were selected for final prioritization using the fuzzy WASPAS method. The filtered drivers were ranked through prioritization questionnaires and the fuzzy WASPAS method. Based on the scores of the fuzzy WASPAS method and considering three criteria—expertise, importance intensity, and certainty level—the drivers of coordination and integration level of banks in adopting new technologies and contracts, as well as the integration level of information systems in the banking industry, were given the highest priority and were selected for scenario mapping. The research scenarios were developed based on the two prioritized drivers and through interviews with focus groups. These scenarios included: Smart Banking, Integrated Banking, Island Banking, and Traditional Banking. Smart Banking represents the ideal scenario, and practical recommendations were developed based on this scenario.

Keywords: *Futures Study, Driver, Contract, Smart Contracts, Banking Industry*

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1. Introduction

The integration of blockchain technology within the financial sector has introduced transformative opportunities, particularly through the use of smart contracts. Smart contracts, which are self-executing contracts where the terms of the agreement between buyer and seller are directly written into lines of code, offer enhanced efficiency, transparency, and security in financial transactions. Their potential to streamline operations and reduce reliance on intermediaries has attracted considerable attention from various industries, including banking, finance, and construction [1]. However, with these advancements come challenges and complexities that necessitate a deeper understanding of the technology, its applications, and the surrounding legal, security, and operational issues.

Blockchain technology's role in reshaping financial services is widely recognized, as it facilitates decentralized and tamper-proof transaction records. One of the key components of blockchain's success in the financial sector is its application in smart contracts, particularly in improving the reliability of financial systems [2]. As observed by Drummer and Neumann (2020), smart contracts offer distinct advantages in automation and enforcement of contracts, reducing the need for third-party involvement and mitigating the risks of human error and fraud [3]. Furthermore, the adoption of blockchain technology has been identified as a potential catalyst for improved consumer protection in the financial services sector, with a focus on standardized contracts [4].

The rise of decentralized finance (DeFi) is one example of blockchain's impact on traditional financial systems. DeFi platforms leverage smart contracts to offer services such as lending, borrowing, and trading without the need for centralized intermediaries [5]. This decentralized approach has significantly altered the way financial transactions are conducted, with benefits including reduced costs, faster settlement times, and increased accessibility for users around the world [6]. However, as Duran and Griffin (2020) point out, the rapid expansion of fintech, including the use of smart contracts, could potentially trigger new financial crises if not properly managed and regulated [7].

Smart contracts have also been applied in other industries beyond finance. For instance, their use in the construction sector has demonstrated significant benefits, including enhanced efficiency in contract management and reduced disputes due to the clarity and automation provided by blockchain [8]. However, as with any technological innovation, the adoption of smart contracts is accompanied by a number of critical challenges. These include security vulnerabilities, legal ambiguities, and operational barriers that need to be addressed to ensure widespread implementation [9].

Security remains one of the most pressing concerns regarding the use of smart contracts. Numerous studies have identified vulnerabilities in smart contracts that could be exploited by malicious actors. For instance, Lashkari and Musilek (2023) discuss energy-related vulnerabilities in Ethereum smart contracts [10], while Alkhalifah et al. (2021) highlight reentrancy attacks as a common security flaw in Ethereum-based contracts [11]. These vulnerabilities pose significant risks, as they could lead to the loss of funds or the disruption of critical services. Consequently, there has been considerable research into methods for detecting and preventing such vulnerabilities. Techniques such as formal verification, which are used to ensure the correctness and security of smart contracts, have been explored extensively [12, 13].

The legal framework surrounding smart contracts is another important consideration. The question of whether "code is law" has been a topic of debate among legal scholars and technologists alike (Drummer & Neumann, 2020). While smart contracts can autonomously execute agreements based on predefined conditions, there are still uncertainties regarding their enforceability in traditional legal systems. For example, Debono (2019) explores the transformation of public procurement contracts into smart contracts, highlighting the need for legal reforms to accommodate the use of these automated systems [14]. Similarly, Mukhtarova and Lesnova (2019) discuss the implications of smart contracts in international trade, particularly in the realm of intellectual property [15].

In addition to security and legal challenges, there are operational barriers to the adoption of smart contracts. The complexity of implementing and maintaining blockchain-based systems, as well as the need for specialized knowledge and infrastructure, can be significant hurdles for organizations [9]. As noted by Feng (2019), even with advancements in smart contract technology, there are still practical limitations that need to be addressed to ensure the widespread adoption of these systems in various sectors [16]. Moreover, the technical challenges associated with verifying and optimizing smart contracts continue to be areas of active research [17].

Despite these challenges, the potential benefits of smart contracts are undeniable. Their ability to automate complex processes, ensure transparency, and reduce the need for intermediaries has made them a promising solution for various industries. For example, in the energy sector, smart contracts have been used to facilitate decentralized energy trading, enabling more efficient and secure transactions [18]. Similarly, in the healthcare industry, smart contracts have been proposed as a means of enhancing the security and efficiency of data sharing and medical record management [19].

The application of smart contracts in supply chain management is another area where blockchain technology has demonstrated considerable promise. By leveraging the transparency and immutability of blockchain, smart contracts can help ensure the traceability of goods and services throughout the supply chain [20]. This is particularly important in industries where regulatory compliance and product authenticity are critical, such as pharmaceuticals and food production [21]. Moreover, smart contracts can facilitate more efficient and reliable financial transactions within the supply chain, reducing the risk of fraud and improving cash flow management [22].

In addition to their practical applications, smart contracts have also been the subject of extensive research in the field of computer science. Various methods for improving the security and efficiency of smart contracts have been proposed, including the use of machine learning and deep learning techniques to detect vulnerabilities [23]. Furthermore, new tools and frameworks are being developed to simplify the creation and deployment of smart contracts, making them more accessible to non-experts [24]. For example, tools such as FsolidM, which assists in the design of secure Ethereum smart contracts, have been introduced to help developers build more reliable and secure systems [25].

In conclusion, the integration of blockchain technology and smart contracts into the financial sector and beyond offers significant opportunities for innovation and efficiency. However, the challenges associated with security, legal frameworks, and operational implementation must be carefully addressed to ensure the successful adoption of this technology. Ongoing research and development in areas such as vulnerability detection, legal reform, and process optimization will be critical to realizing the full potential of smart contracts in the years to come. As smart contracts continue to evolve, they are likely to play an increasingly important role in shaping the future of industries ranging from finance to construction and beyond. The transformative power of smart contracts lies in their ability to automate and secure transactions in a way that is transparent, efficient, and decentralized, offering a glimpse into the future of how contracts and agreements will be executed across various sectors. The present research aims to conduct a Futures Study of smart contracts in the banking industry using a scenario-building approach.

2. Methodology

The primary objective of the current research is to identify and uncover the drivers and future scenarios of smart contracts in Iran's banking industry. To achieve this, the study employed the fuzzy Delphi method, fuzzy WASPAS, and focus group interviews to rank the drivers and develop scenarios. Both the fuzzy Delphi and fuzzy WASPAS methods are quantitative techniques that rely on judgmental quantitative data for analysis and prioritization. The focus group interviews, on the other hand, are qualitative techniques. The fuzzy Delphi technique was used to filter the drivers, while the fuzzy WASPAS method was employed for evaluating and ranking the drivers. Given the quantitative and qualitative nature of the methods used in the study, the research employs a mixed-methods approach. Furthermore, due to the practical benefits and applications of the research outcomes for the Iranian banking industry, the study has an applied orientation.

For data collection, two instruments were used: interviews and questionnaires. The drivers of the future of smart contracts in the banking industry were obtained through a review of relevant research in the financial industry and smart contracts. Subsequently, two questionnaires were distributed among experts to prioritize the research drivers: a fuzzy screening (expert validation) questionnaire and a WASPAS prioritization questionnaire. The expert validation questionnaires were evaluated using the fuzzy Delphi technique, while the prioritization questionnaires were assessed using the fuzzy WASPAS technique. Since the future drivers of smart contracts in Iran's banking industry were derived from reviewing the literature of reputable international and domestic articles in the fields of blockchain technology and smart contracts, as well as interviews with blockchain technology experts in the banking industry, both the expert validation and prioritization questionnaires had high validity. Additionally, due to the selection of an appropriate sample size (10 individuals) and the filtering of drivers, the prioritization questionnaire demonstrated considerable reliability. The sample size in this study was 10 individuals, which is an appropriate number for judgment-based expert techniques.

The experts in the current study consisted of senior managers, consultants, and experts in the banking industry specializing in smart contracts. All experts held doctoral degrees, and their work experience in the IT departments of banks exceeded 15 years. The sampling method used in the study was judgmental, and the samples were selected based on their expertise in blockchain technology and smart contracts.

The current study was conducted in four stages. In the first step, the drivers of the future of smart contracts in the banking industry were extracted through a literature review and interviews with blockchain technology experts. In the next stage, these drivers were screened using the fuzzy Delphi method and expert validation questionnaires. In the third stage, the most important drivers were identified using the fuzzy WASPAS technique. Finally, in the fourth stage, the future scenarios of smart contracts in Iran's banking industry were developed using focus group interviews.

In the current research, the fuzzy Delphi method was used to filter the drivers of the future of smart contracts. In the fuzzy Delphi technique algorithm for screening, a suitable fuzzy scale must first be developed for the fuzzification of the experts' linguistic expressions. In this regard, common fuzzy scales can be used. In this study, a five-point Likert scale was employed.

The fuzzy WASPAS technique was used to analyze and rank the drivers affecting the future of smart contracts in the banking industry. The evaluation criteria for the research drivers were obtained from the Global Business Network approach, a common and classical method in Futures Study studies. The evaluation criteria for the drivers in this study are: the expertise of the experts regarding each of the research drivers, the intensity of the importance of each driver, and the level of uncertainty associated with each driver. The criteria of expertise and importance intensity are positive and increasing in nature, while the certainty criterion is negative and decreasing. In summary, the higher the level of expert knowledge (regarding each driver) and the intensity of its importance, and the lower its uncertainty, the more suitable the driver is for scenario mapping. The fuzzy WASPAS technique was introduced by Zavadskas in 2015. Like the WASPAS technique, this method combines both the weighted sum model and the weighted product model in a fuzzy environment. This method also requires the weighting of criteria, which must be derived from other methods such as Best-Worst Method (BWM). The steps of the fuzzy WASPAS method are as follows:

1. Normalizing the fuzzy decision matrix: In this step, the fuzzy decision matrix is first obtained. The decision matrix includes an index-option matrix where the indices are in columns and the options are in rows, with the purpose of ranking the research options. This decision matrix is then scored based on common fuzzy scales.
2. Calculating the fuzzy matrix q: The q matrix is derived by multiplying the weights of the criteria by the normalized matrix. This represents the weighted sum model.
3. Calculating the fuzzy matrix p: The p matrix is obtained by raising the values of the normalized fuzzy matrix to the power of the fuzzy weight. This represents the weighted product model.
4. For each option, the values of the q matrix are summed, and the data from the p matrix are multiplied.
5. The resulting numbers are defuzzified.

Calculating the value of each option: The k value for each option is calculated, and the options are ranked accordingly.

3. Findings

The drivers influencing the future of smart contracts in Iran's banking industry were extracted through an analytical review of the literature and interviews with banking experts. A total of 37 drivers were identified, of which 28 were derived from the literature review, and the remaining were obtained from the interviews. These 37 drivers, gathered from the literature review and blockchain technology expert interviews, were filtered using the fuzzy Delphi method. In this phase, 28 drivers were excluded from the analysis, and nine drivers were selected for final ranking. Drivers with a defuzzified value greater than 0.7 were considered for the final ranking using the fuzzy WASPAS method. In the present study, nine drivers had a defuzzified value above 0.7. The value of 0.7 was chosen as the threshold for filtering the drivers. In most studies, the threshold typically ranges between 0.5 and 0.7; in this research, 0.7 was selected as the threshold. Table 1 lists the filtered drivers along with their defuzzified values.

Table 1. Defuzzified values of filtered drivers based on expert opinions

Research Drivers	Lower Bound	Median	Upper Bound	Fuzzy Value
Level of coordination and integration of national banks in adopting new technologies and contracts (SC1)	0.74	0.83	0.95	0.84
Type of interaction between banks and fintechs and financial startups (SC2)	0.70	0.81	0.92	0.81
Regulatory policies in the country (SC3)	0.72	0.84	0.94	0.83
Blockchain and smart contract adoption in other industries, especially energy, supply chain, and real estate (SC4)	0.65	0.80	0.93	0.79
Integration level of information systems in the banking industry (SC5)	0.69	0.78	0.89	0.79
Perceived benefits of blockchain and smart contracts by senior banking industry managers (SC6)	0.60	0.80	0.92	0.77
Hardware and software capabilities of national banks (SC7)	0.68	0.76	0.91	0.78
Development of decentralized banking in the country (SC8)	0.64	0.83	0.87	0.78
Development of IoT infrastructure in the banking sector (SC9)	0.67	0.79	0.88	0.78

Three criteria—expertise,

importance intensity, and certainty—were considered for evaluating the research drivers. First, based on the fuzzy BWM technique, experts compared the most important criterion with others and the remaining criteria with the weakest criterion. The results of these comparisons were then aggregated using geometric means. According to the experts, certainty was identified as the most critical criterion, while expertise was considered the least important. Table 2 presents the fuzzy and definite weights of each evaluation criterion for the drivers affecting the future of smart contracts in the banking industry.

Table 2. Fuzzy and definite weights of driver evaluation criteria

Evaluation Criteria	Fuzzy Weight	Definite Weight
Expertise	(0.24, 0.20, 0.12)	0.19
Importance Intensity	(0.47, 0.36, 0.29)	0.37
Certainty	(0.53, 0.44, 0.35)	0.44

Given the fuzzy and definite weights of the research driver evaluation criteria, the certainty criterion (0.44), importance intensity (0.37), and expertise (0.19) were identified as having the highest significance and weight, respectively.

Next, the filtered drivers were evaluated and ranked using the fuzzy WASPAS method, considering the three criteria: expertise, importance intensity, and certainty. The certainty criterion was negative, while the others were positive and increasing in nature. The experts' opinions on the importance of the research drivers, based on these criteria, were obtained using the fuzzy WASPAS method. Due to the large volume of data, the arithmetic mean method was applied to combine the values in the decision matrix. Following that, the decision matrix values were normalized using a linear normalization method. The normalization process differs for increasing and decreasing criteria. The two criteria of expertise and importance intensity are positive, while the certainty criterion is negative. The normalized matrix values are presented in Table 3.

Table 3. Normalized matrix

Normalized Matrix	Expertise	Importance Intensity	Certainty
SC1	0.848 / 0.932 / 1.000	0.903 / 0.966 / 1.000	0.897 / 0.729 / 0.672
SC2	0.760 / 0.878 / 0.920	0.807 / 0.864 / 0.883	0.803 / 0.672 / 0.655
SC3	0.876 / 0.934 / 0.975	0.783 / 0.910 / 0.960	0.730 / 0.674 / 0.643
SC4	0.675 / 0.720 / 0.760	0.740 / 0.797 / 0.847	0.665 / 0.610 / 0.581
SC5	0.869 / 0.893 / 0.972	0.825 / 0.896 / 0.954	0.878 / 0.816 / 0.722
SC6	0.513 / 0.549 / 0.613	0.574 / 0.631 / 0.698	1.000 / 0.793 / 0.743
SC7	0.530 / 0.580 / 0.626	0.496 / 0.555 / 0.643	0.667 / 0.641 / 0.587
SC8	0.567 / 0.627 / 0.668	0.529 / 0.580 / 0.637	0.628 / 0.593 / 0.564
SC9	0.500 / 0.576 / 0.618	0.560 / 0.629 / 0.663	0.640 / 0.603 / 0.583

By multiplying the weights of the research criteria by the values in the normalized matrix, the weighted normalized matrix was obtained. The weights of the criteria were derived using the fuzzy Best-Worst Method. Table 4 presents the values of the weighted normalized matrix for the future drivers of smart contracts in the banking industry .

Table 4. Weighted normalized matrix

Weighted Normalized Matrix	Expertise	Importance Intensity	Certainty
SC1	0.161 / 0.177 / 0.190	0.334 / 0.357 / 0.370	0.395 / 0.321 / 0.296
SC2	0.144 / 0.167 / 0.175	0.299 / 0.320 / 0.327	0.353 / 0.296 / 0.288
SC3	0.166 / 0.177 / 0.185	0.290 / 0.337 / 0.355	0.321 / 0.297 / 0.283
SC4	0.128 / 0.137 / 0.144	0.274 / 0.295 / 0.313	0.293 / 0.268 / 0.256
SC5	0.165 / 0.170 / 0.185	0.305 / 0.332 / 0.353	0.386 / 0.359 / 0.318
SC6	0.097 / 0.104 / 0.116	0.212 / 0.233 / 0.258	0.440 / 0.349 / 0.327
SC7	0.101 / 0.110 / 0.119	0.184 / 0.205 / 0.238	0.293 / 0.282 / 0.258
SC8	0.108 / 0.119 / 0.127	0.196 / 0.215 / 0.236	0.276 / 0.261 / 0.248
SC9	0.095 / 0.109 / 0.117	0.207 / 0.233 / 0.245	0.282 / 0.265 / 0.257

By summing the values in the weighted normalized matrix for the lower, middle, and upper bounds, the Q values were calculated. The average of the Q values was then determined.

Table 5. Q values

Research Drivers	Q1	Q2	Q3	Average
SC1	0.890	0.855	0.856	0.867
SC2	0.796	0.783	0.790	0.790
SC3	0.777	0.811	0.823	0.804
SC4	0.695	0.700	0.713	0.703
SC5	0.856	0.861	0.856	0.858
SC6	0.749	0.686	0.701	0.712
SC7	0.578	0.597	0.615	0.597
SC8	0.580	0.595	0.611	0.595
SC9	0.584	0.607	0.619	0.603

In the fuzzy WASPAS technique, in addition to the weighted normalized matrix, the powered normalized matrix is also calculated. This matrix is obtained by raising the values of the normalized matrix to the power of the evaluation criteria weights. Table 6 presents the values of the powered normalized matrix.

Table 6. Powered normalized matrix

Powered Normalized Matrix	Expertise	Importance Intensity	Certainty
SC1	0.969	0.987	1.000
SC2	0.949	0.976	0.984
SC3	0.975	0.987	0.995
SC4	0.928	0.939	0.949
SC5	0.974	0.979	0.995
SC6	0.881	0.892	0.911
SC7	0.886	0.902	0.915
SC8	0.898	0.915	0.926

SC9	0.877	0.900	0.913

By multiplying the values of the powered normalized matrix for the lower, middle, and upper bounds, the P values were calculated. The average of the P values was then determined.

Table 7. P values

Research Drivers	P1	P2	P3	Average
SC1	0.889	0.848	0.840	0.859
SC2	0.796	0.776	0.780	0.784
SC3	0.775	0.802	0.807	0.795
SC4	0.694	0.695	0.702	0.697
SC5	0.856	0.859	0.847	0.854
SC6	0.717	0.679	0.699	0.698
SC7	0.572	0.596	0.614	0.594
SC8	0.578	0.594	0.609	0.594
SC9	0.582	0.606	0.619	0.602

Finally, by combining and averaging the Q and P values, the final score for the future drivers of smart contracts was calculated. The higher the driver score, the higher its priority.

Table 8. Final score and ranking of future drivers of smart contracts

Research Drivers	Average Q	Average P	Final Score	Rank
SC1	0.867	0.859	0.863	1
SC2	0.790	0.784	0.787	4
SC3	0.804	0.795	0.799	3
SC4	0.703	0.697	0.700	6
SC5	0.858	0.854	0.856	2
SC6	0.712	0.698	0.705	5
SC7	0.597	0.594	0.595	8
SC8	0.595	0.594	0.594	9
SC9	0.603	0.602	0.602	7

Based on the driver scores presented in Table 8, the most important factors influencing the future of smart contracts in the banking industry include the level of coordination and integration of national banks in adopting new technologies and contracts, the integration level of information systems in the banking industry, regulatory policies in the country, the type of interaction between banks and fintechs and financial startups, and the perceived benefits of blockchain and smart contracts by senior banking industry managers. In the next section, research scenarios will be developed based on the two highest-priority drivers and focus group interviews. However, other drivers will also be used to enrich and develop the scenarios.

The future scenarios of smart contracts in the banking industry were developed based on two key drivers: the level of coordination and integration of national banks in adopting new technologies and contracts, and the level of integration of information systems in the banking industry. These scenarios were also informed by interviews with focus groups. Each driver consisted of two opposing states. The opposing states for the first driver are: high integration of banks in adopting new technologies and contracts versus low integration. The second driver also has two opposing states: high integration of banks' information systems versus low integration.

Experts were asked to share their opinions on each scenario, and the group leader collected their views. From the interaction of these two drivers, four scenarios were developed. The future scenarios of smart contracts in the banking industry are depicted in Figure 1, and each scenario is described below.

A) Smart Banking Scenario: This scenario represents the ideal situation. It arises from the intersection of high integration of banks in adopting new technologies and contracts, and high integration of banks' information systems. In this scenario, national banks collaborate extensively in adopting blockchain technology and smart contracts. Banks also have strong cooperation in research and development projects. This collaboration in adopting smart contracts will lead to widespread expansion of the technology, reducing the risks associated with its adoption.

Moreover, the banks in this scenario benefit from integrated information systems, making the adoption of new technologies simpler and less costly. In this scenario, banks place a high emphasis on harmonizing and aligning new technologies with existing systems.

Banks also embrace open innovation systems and collaborate with fintechs and financial startups on various projects. Due to balanced regulatory policies and extensive investment by banks in fintechs, there is a significant diversity of fintechs in this scenario. The presence of numerous fintechs in this future enables the effective management of various challenges and risks related to the implementation of smart contracts. Strong collaboration between banks and fintechs creates a robust innovation network.

Additionally, in this scenario, blockchain technology has expanded across various industries and services. This development encourages banks to adopt smart contracts. As the technology becomes more prevalent, its benefits become more tangible to bank managers.

B) Island Banking Scenario: In this scenario, banks possess integrated information systems but do not act in a unified manner when it comes to adopting new technologies, including smart contracts. Although banks are open to innovation, their strategies, plans, and favored technologies vary significantly. Due to this independent behavior, the role of RegTechs (regulatory technology) is more prominent in this scenario.

RegTechs are supervisory financial technologies that assess and manage the risks associated with collaborating with fintechs and adopting new technologies. The limited adoption of technologies across the sector leads to greater resistance from managers when considering new technologies. In this scenario, managers are particularly sensitive to the perceived benefits and risks of adopting new technology. The use of RegTechs helps banks identify risks and opportunities for collaboration in advance. As a result, banks tend to form foresight and risk analysis committees. In summary, the lack of widespread adoption and independent behavior among banks and stakeholders makes senior bank managers more conservative in adopting new technologies.

C) Integrated Banking Scenario: In this scenario, banks are highly receptive to adopting new technologies, but a significant challenge exists: their information systems are not integrated. The diversity of technologies, which are often incompatible, leads to high costs in adopting new technologies.

The low level of integration among banks results in numerous issues and challenges post-implementation, and the benefits of smart contracts are not fully realized. To address this, banks must move towards data-driven technologies of Industry 4.0. For example, business intelligence is a suitable technology for data collection and analysis, while the Internet of Things (IoT) can be used to smarten banking processes.

Another issue in this scenario is the slow and cumbersome structure of banks in implementing smart contracts. The presence of multiple, sometimes conflicting, technologies significantly increases the cost of change. Implementing smart contracts in a non-integrated environment with various and diverse standards is nearly impossible. In this future, elements of traditional technology persist. Some actors within banks, due to conservatism, oppose changing certain traditional procedures and technologies.

D) Traditional Banking Scenario: This scenario paints the worst-case outlook for the future of smart contracts. In this future, the innovation systems of banks are closed, and there is minimal collaboration between banks and fintechs. Banks continue to operate using traditional banking methods, and their connections with international organizations, institutions, and banks are severely limited due to financial restrictions.

In this scenario, due to suppressive regulatory policies and the negative outlook of banks towards fintechs, the diversity of fintechs is extremely limited. With minimal competition and banks' disregard for technological changes and customer satisfaction, research and development projects are primarily internal. The regulator in this scenario does not incorporate the opinions and views of various groups, including fintechs, when drafting legislation. Banks either view fintechs as competitors or, due to financial and structural challenges, have little interest in collaborating with them.

Furthermore, in this scenario, the orientations and standards of banks in research, development, and the adoption of new technologies are highly varied and scattered. This fragmentation is not only seen in the financial industry but also in other sectors. The diversity of behaviors and orientations severely hampers the adoption of integrated technologies such as blockchain and smart contracts. In this future, implementing such technologies entails significant costs and risks, leading bank managers to avoid their implementation. Additionally, there is substantial cultural resistance to change in this scenario. Many traditional and status quo-preserving forces would be negatively impacted by new changes.

Traditional processes and methods generate significant benefits and rents for certain stakeholders. Moving towards transparency poses a serious threat to many individuals and groups. In this scenario, governance and corporate governance are weak and ineffective, making the move towards smart contracts, which play a crucial role in financial transparency, unlikely to be prioritized.

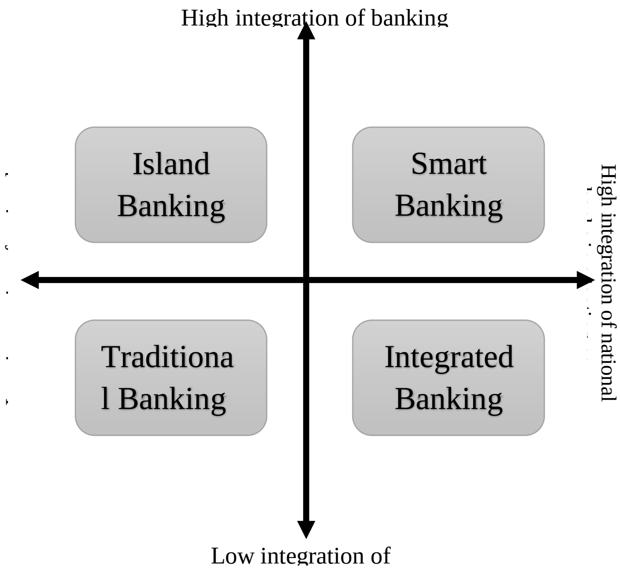

Figure 1. Future scenarios of smart contracts in the banking industry

4. Discussion and Conclusion

The present study sought to develop future scenarios for the implementation of smart contracts in Iran’s banking industry by identifying and analyzing key drivers and their potential impacts. Two primary drivers, the level of coordination and integration of national banks in adopting new technologies and contracts, and the level of integration of information systems, were identified as critical influences. From these drivers, four distinct scenarios were developed: Smart Banking, Island Banking, Integrated Banking, and Traditional Banking. These scenarios offer insights into potential future trajectories for the banking sector, reflecting different levels of technological adoption and collaboration among industry players.

The Smart Banking scenario represents the most ideal outcome, with high integration of both banking systems and technology adoption. In this future, banks demonstrate a strong commitment to adopting blockchain technology and smart contracts, collaborating extensively with fintech companies and startups. The high level of coordination among banks ensures seamless implementation of new technologies, reducing costs and improving efficiency. This scenario is consistent with previous studies that have highlighted the benefits of adopting blockchain and smart contracts in enhancing transparency, security, and efficiency in financial transactions [26, 27]. The open innovation approach observed in this scenario is also in line with findings from Ameyaw et al. (2023), who emphasized the importance of cross-industry collaboration in maximizing the benefits of blockchain-enabled smart contracts [8]. Additionally, the balanced regulatory environment in this scenario fosters a robust fintech ecosystem, further contributing to the successful adoption of smart contracts, a finding supported by Abubakar (2023), who discussed the role of standardized contracts in enhancing consumer protection in financial services [4].

The Island Banking scenario, characterized by high integration of information systems but low coordination among banks in adopting new technologies, presents a more fragmented future. In this scenario, banks operate independently in terms of technological adoption, leading to varying strategies and technologies across the industry. This independent behavior increases the role of RegTechs (regulatory technology), which helps banks assess and manage the risks associated with collaborating with fintechs and adopting new technologies. The findings of this scenario align with previous research by Alaba (2023) and Alkhalifah et al. (2021), who emphasized the importance of RegTechs in managing the risks associated with smart contracts and blockchain technologies, particularly in environments where collaboration is limited [11, 28]. However, the lack of unified action in adopting smart contracts results in increased resistance from bank managers, a finding consistent with previous studies that identified managerial resistance as a key barrier to technological innovation [8, 29].

The Integrated Banking scenario, where banks are willing to adopt new technologies but struggle with low integration of their information systems, presents significant challenges. Despite the positive attitude towards technology adoption, the lack of system integration leads to higher costs and numerous post-implementation issues. This scenario highlights the importance of system compatibility and the challenges posed by legacy systems, findings that are supported by previous research [5, 14]. The fragmented information systems create obstacles to realizing the full benefits of smart contracts, a problem that has been well-documented in the literature on blockchain implementation [18, 23]. The need for data-driven technologies and tools, such as the Internet of Things (IoT) and business intelligence, to manage these challenges is also in line with the suggestions of Langaliya and Gohil (2021), who emphasized the role of advanced data analytics in overcoming technological fragmentation [21].

Finally, the Traditional Banking scenario represents the most undesirable future, where both technological adoption and system integration are low. In this scenario, banks continue to rely on traditional methods, showing little interest in collaborating with fintechs or adopting smart contracts. The lack of innovation and competition in this scenario reflects the findings of Duran and Griffin (2020), who warned that the failure to adopt fintech innovations, such as smart contracts, could limit the competitiveness and long-term sustainability of financial institutions [7]. Moreover, the suppressive regulatory environment in this scenario hinders the growth of fintechs, a problem also identified by Busari and Aminu (2021), who explored the negative impact of restrictive regulations on fintech development [30]. The high cultural resistance to change in this scenario further exacerbates the problem, a barrier that has been noted in several studies on technological adoption in traditional industries [16, 17]. The reluctance to adopt blockchain and smart contracts in this scenario highlights the importance of addressing cultural and structural resistance to innovation [31].

In summary, the findings of this study demonstrate the critical role of both technological integration and interbank collaboration in determining the future of smart contracts in Iran's banking industry. While the Smart Banking scenario offers the most promising future, characterized by high levels of innovation and collaboration, the other scenarios highlight potential challenges, such as technological fragmentation, managerial resistance, and regulatory barriers. These findings are consistent with existing literature on the adoption of blockchain and smart contracts in the financial sector, emphasizing the need for coordinated efforts and supportive regulatory environments to maximize the benefits of these technologies.

While this study provides valuable insights into the future of smart contracts in the banking industry, several limitations should be acknowledged. First, the study's focus on Iran's banking sector may limit the generalizability of the findings to other countries or regions. The unique regulatory, cultural, and economic factors influencing the Iranian banking industry may not apply to other contexts, especially in countries with more advanced technological infrastructures or different regulatory environments [14]. Additionally, the study relied on expert opinions to identify and rank the drivers of smart contracts, which, while valuable, may introduce subjective biases. Experts' views may be shaped by their personal experiences and perspectives, potentially limiting the objectivity of the findings [3]. Furthermore, the study used qualitative methods, such as focus group interviews, which may not capture the full complexity of the technological, economic, and social factors influencing the adoption of smart contracts. While qualitative methods offer depth and insight, they may lack the precision and generalizability of quantitative approaches.

Future research should aim to address the limitations of this study by expanding the scope of analysis to include a broader range of countries and regions. Comparative studies that examine the adoption of smart contracts in different banking sectors, particularly in more technologically advanced economies, could provide valuable insights into how contextual factors influence technological adoption [30]. Additionally, future research should incorporate quantitative methods, such as surveys or econometric modeling, to complement the qualitative findings of this study. Quantitative approaches could provide a more objective assessment of the drivers and barriers to smart contract adoption and allow for the analysis of larger datasets, improving the generalizability of the findings [32]. Moreover, future studies could explore the role of specific technologies, such as artificial intelligence and IoT, in enhancing the adoption of smart contracts. Investigating how these technologies can be integrated with blockchain and smart contracts to address the challenges of technological fragmentation and high costs would be an important avenue for future research [21].

For practitioners in the banking industry, this study highlights several important considerations for the successful adoption of smart contracts. First, banks must prioritize the integration of their information systems to ensure that new technologies, such as smart contracts, can be implemented efficiently and cost-effectively. Without high levels of system integration, the benefits of smart contracts may be difficult to realize, as demonstrated by the Integrated Banking scenario [18]. Second, banks should adopt an open innovation approach, collaborating with fintechs and startups to foster a robust ecosystem of innovation, as suggested by the Smart Banking scenario. Such collaboration can help banks overcome the challenges of technological fragmentation and reduce the risks associated with adopting new technologies [8]. Additionally, regulatory bodies should play a proactive role in supporting the adoption of smart contracts by creating a balanced regulatory environment that encourages innovation while managing risks [4]. Finally, bank managers should focus on building a culture of innovation within their institutions, addressing the cultural and structural barriers that may hinder the adoption of smart contracts. By fostering a forward-looking mindset and promoting the benefits of blockchain and smart contracts, banks can position themselves for success in an increasingly digital financial landscape [31].

In conclusion, the adoption of smart contracts in Iran's banking industry will depend on the ability of banks to integrate their information systems, collaborate with fintechs, and navigate the regulatory landscape. The four scenarios developed in this study offer valuable insights into potential future trajectories and highlight the importance of coordinated efforts and supportive policies in shaping the future of smart contracts in the financial sector.

Authors' Contributions

Authors equally contributed to this article.

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Declaration of Interest

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All procedures performed in this study were under the ethical standards.

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