Explaining the Blockchain Acceptance Indices in Iran Financial Markets: A Fuzzy Delphi Study

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This study was designed to explain the Blockchain acceptance indices in Iran's financial markets aimed at identifying different angles for the implementation of Blockchains. The Blockchain acceptance indices were extracted in 4 levels, 12 variables, and 53 indices of related research literature in the field of e-commerce and mobile banking. To validate the research indicators, the Fuzzy Delphi technique was used to refine the indices in addition to the documentary study. The survey was conducted in three stages and the results of each stage were refined. Based on data analysis, 39 indicators were confirmed. The results of this study can provide useful insights for researchers and policymakers of Iran's financial markets to understand the prerequisites and effects of the Blockchain implementation on financial markets, and thereby, they would be able to change business models to take advantage of Blockchain capabilities in the infrastructure of Iran's financial markets by considering different aspects.

Keywords: Blockchain Acceptance, Financial Markets, Fuzzy Delphi.
JEL Classification: G02

1 Introduction

Over the past years, many banks have had in-depth discussions about Blockchain capabilities in their board meetings. Currently, some large banks are gradually becoming more active in the area of Blockchain and investing significant resources to further advance available banking infrastructures (MacDonald, Allen, & Potts, 2016). Furthermore, no other industry, like the

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financial and banking industry, is allocating considerable funds to research Blockchain. The Blockchain emerged through Bitcoin to meet the need for financial institutions (Morabito, 2017).

Blockchains does not do much to save the people's time but can do a lot to improve transparency when approving transactions (Mougayar, 2016). The Blockchain has drawn the attention of banks due to its capacity to simplify the payments, and they simultaneously reduce the risk and costs in this process. The Blockchain advocates argue that as it eliminates intermediaries and is faster, it is safer and more reliable than today's systems and can bring billions of dollars in cost savings for banks (G. Peters, Panayi, & Chapelle, 2015). The discovery of the Blockchain has led banks to act in a variety of ways, from searching for fully decentralized systems that actuate bitcoin or other virtual tokens in which the authorized and valid users are allowed to access the network. Although this model, which the mentioned industry is likely to adopt, is not yet transparent, it is clear that the world's major banks are working on the Blockchain to exploit it (G. W. Peters & Panayi, 2016).

The Blockchain chain can make the operations more efficient by improving service delivery and increasing trust in the financial markets (Batubara, Ubacht, & Janssen, 2018). The Blockchain is a distributed ledger that is shared among all groups participating in the network and is used to record transactions that are verified by an understanding mechanism. The understanding mechanisms are to build trust in the network (Peck, 2017). Most network participants need to agree to confirm the transaction. Once a file is verified and saved, it is challenging to manipulate its data on the Blockchain since the changes are immediately copied to all versions of the headquarters on the network and linked to the previous transaction as well (Nakamoto, 2008). In this case, the distributed ledger will create an invariant file, which ensures the traceability of transactions (Batubara et al., 2018). Therefore, the Blockchain can be transformational since it can change the method of recording transactions (Ølnes, Ubacht, & Janssen, 2017). Despite all the abilities and capabilities of Blockchain technology, trusting a computer network, which performs mathematical calculations on behalf of a well-known and trusted group, needs a new mental model that we have not still got used to. Finally, we have to face the fact that trust is in the network and it is a new form of trust. We have to remember that during the early years of the Internet (1994-1998), there was no trust in the Internet-based payments; but very soon, pay on the web with a credit card became very popular and most internet users probably do not remember the first days of these cases, which were full of fear and doubt (Mougayar, 2016).

Recently, the Blockchain is seen as a new paradigm for financial markets. The Blockchain is a new technology that will change the future. The World Economic Forum (WEF) predicted in 2016 that the Blockchain will create a revolution in the financial services and will turn into a platform for connecting the consumer and the producer. Hence, many countries and companies have invested in the Blockchain section in related markets and increased the funding scale and participated in international development research (Soonduck Yoo, 2017).

Given the importance of this technology in the financial market and the novelty of the Blockchain technology, the acceptance indices of Blockchain have not been well elucidated in the studies conducted so far. According to the surveys made, due to the newness of the Blockchain technology, most of the studies carried out on the Blockchain are conceptual studies and have focused on introducing the Blockchain applications (Heidari, Mousakhani, Alborzi, Divandari & Radfar, 2018). Thus, there is a shortcoming in the literature on "What are the acceptance indices of the Blockchain?" Hence, to address this gap in the literature, this research, aimed at identifying and validating the Blockchain acceptance indices in Iran's financial markets, sought to provide an insight from the Blockchain experts panel about the Blockchain acceptance indices by using a fuzzy Delphi methodology. Accordingly, by identifying these indicators and validating them through expert opinions, we may provide the necessary context for assessing the acceptance of the Blockchain in the country's financial markets. Therefore, a poll was conducted in this study among the Blockchain experts active in the financial markets or those with sufficient knowledge about the financial markets. The research consists of five main sections. After the introduction, in the second part, the background of the study is described. In the third section, the research methodology is explained. Then, in the fourth section, the results of the fuzzy Delphi analysis are presented. Finally, the fifth section includes the discussion and conclusion of the results obtained.

2 Research Background

2.1 Theoretical Background
Satoshi Nakamoto first introduced the Blockchain in 2008 (Nakamoto, 2008). The Blockchain is a combination of existing technologies such as distributed ledger, cryptography, hashing, and understanding protocols. All transaction records in the Blockchain are stored in a chain of blocks and distributed across

the peer-to-peer network (Peck, 2017). All nodes involved in this network also have a copy of the blocks (Pilkington, 2016).

Each transaction must be verified using a specific understanding mechanism. The understanding mechanism consists of a set of rules and procedures that make it possible to maintain and update the ledger and ensure the integrity of records in the ledger (Pilkington, 2016). The understanding mechanisms in the Blockchain technology differ from each other. Each understanding mechanism has advantages and disadvantages based on different features; for example, the transaction speed, energy efficiency, scalability, censorship, and resistance to change (Tasca, Thanabalasingham, & Tessone, 2017). If the majority of network participants approves the transaction through an understanding mechanism, we use Timestamp; the transaction is recorded in a new block and links to the previous blocks chain with a hash marker as a link to the last block (Back et al., 2014; Crosby, Pattanayak, Verma, & Kalyanaraman, 2016). In this case, the Blockchain provides a secure, decentralized, permanent, error-tolerant and auditable platform, which allows the transaction to be performed in a decentralized manner without the need for a centralized intermediary (Buterin, 2014).

In a general model, the overall chain has the following key features (Zheng, Xie, Dai, Chen, & Wang, 2017):

−   Decentralized: Unlike traditional transactions that are authenticated through a centralized trusted entity, any node on the network can verify the transaction and have a copy similar to the ledger.

−   Stability: Using a mechanism of understanding, a timestamp and a cypher (coded stamp) means that invalid transactions will not be approved and editing, deleting, or copying the transactions already recorded in the Blockchain become impossible.

−   Anonymity: The transaction based on Blockchain technology takes place between two persons using public-key cryptography, through which their identities are registered semi-anonymously.

−   Auditability: All transactions in the Blockchain are stored in chronological order, including the hash of the previous block and the storage of the current transaction hash that are to be added to the next block. With this mechanism, the transactions can be verified and tracked.

2.2 The Blockchain Applications in Financial Markets

The Blockchain has the potential to reduce the costs resulting from the banks' traditional infrastructures. Through this technology, the cost of liquidation processing and transactions' reconciliation is reduced (Brennan & Lunn,

2017). The point-to-point payment can be made using the Blockchain technology; thus, the intermediary link of financial institutions will be eliminated, services efficiency will improve, and the bank transaction costs will be reduced. It also enables banks to provide fast and convenient payment requirements for cross-border commercial activities. McKenzie has estimated that the cost of any transaction in the cross-border businesses can be significantly reduced using the Blockchain (Guo & Liang, 2016). According to Santander Innoventures, the Blockchain can save up to 20 billion $ a year for the bank on the infrastructure costs (Perez, 2015). Also, according to Accenture, the Blockchain can save up to 12 billion $ annually on infrastructure costs for investment banks. The automation of the process of off-set and transaction clearing is one of the saving methods for banks. The stock markets around the world are testing the use of Blockchain to expedite the liquidation process and eliminate managerial barriers. Taken together, many stock markets have moved towards exploiting the benefits of the Blockchain (Ikeda & Hamid, 2018).

Wholesale banking is another place where the Blockchain can be used to save money at high costs. Wholesale banking refers to banking services between banks and large financial institutions. These include large transactions that require a lot of human activities. The Blockchain can automate the process of providing service for these activities. The Blockchain offers a very novel method of supplying money through the elimination of intermediaries in this process. Nowadays, many companies use the initial coin offerings (ICO) to supply money with a peer-to-peer method manner without boundary constraints. The Blockchain can provide tremendous speed and precision for liquidation in the capital markets (Ikeda & Hamid, 2018).

One of the significant challenges for traditional banks is diversifying their customers and assigning them a proper authentication process. Due to rigid regulations to prevent money laundering or fraud, they had to maintain the integrity of their customers' identities. This process caused costly losses in terms of infrastructure costs. The Blockchain alongside the biometric authentication system can increase the efficiency of this process through shared digital identity storage that any financial institution can access (Ikeda & Hamid, 2018).

2.3 Experimental Background
Various features have been described for the Blockchain in studies conducted on the Blockchain. To identify these features, we reviewed the known articles, whose results are presented in the table below.

Table 1

The Blockchain characteristics in the conducted research

Researchers	Trust	Transparency	Researchers	Encryption	Unchangeable	Decentralized	Identity	Automation
Beck, Czepluch, Lollike, & Malone, 2016	*	*	*	*	*	*		*
Böhme, Christin, Edelman, & Moore, 2015		*			*	*	*	*
Cai & Zhu, 2016	*	*	*	*	*			
Cucurull & Puiggalí, 2016	*	*	*	*	*	*		
Eyal, Gencer, Sirer, & Van Renesse, 2016			*			*		
Garman, Green, & Miers, 2014	*	*	*		*	*	*	
Guo & Liang, 2016						*		*
Herrera-Joancomartí & Pérez-Solà, 2016		*	*			*	*	
Hull et al., 2016	*	*		*		*	*	*
Idelberger, Governatori, Riveret, & Sartor, 2016		*	*		*	*		*
Kosba, Miller, Shi, Wen, & Papamanthou, 2016	*		*	*		*		
Kraft, 2016	*	*		*		*		
McCorry, Shahandashti, Clarke, & Hao, 2015	*	*	*		*		*	
Sun, Yan, & Zhang, 2016	*	*	*	*		*	*	
Tschorsch & Scheuermann, 2016	*	*	*			*	*	
Wang, Chen, & Xu, 2016	*		*			*		
Weber et al., 2016	*	*	*	*	*	*		*
Xu, 2016	*	*	*	*	*	*		*
Zhao, Fan, & Yan, 2016	*	*	*	*	*	*	*	*
Zyskind & Nathan, 2015	*	*	*	*		*	*	

2.4 The Blockchain Acceptance Indices

In the first part of this study, the research conducted on similar areas, including mobile banking and e-commerce were used to understand the readiness

indicators of Blockchain acceptance in Iran's financial markets. We used such studies since the readiness indicators of Blockchain acceptance have not been well explained so far in the research done in this area. Therefore, we used similar fields to identify the research indicators. To this end, the Blockchain acceptance readiness levels were selected based on the TOE model (Baker, 2012). The three levels of technology, environment, and organization are the levels forming the Blockchain acceptance readiness. The variables creating each level have been obtained based on the DOI (Innovation Influence) theory (Rogers, 2010) and NIP (National Institutional Perspective) (Zhou & Thatcher, 2010). Accordingly, at the organizational readiness level, the effects of perceived benefits and perceived organizational sovereignty on the acceptance were studied. At the level of environmental readiness, the impacts of recognized standards and structure and perceived environmental pressure on acceptance were examined. Finally, at the technology readiness level, the roles of information technology infrastructure, IT skills, and IT policies in the acceptance were evaluated. In the second part, the research by Olnes et al. (2017) was used to identify the consequences of Blockchain acceptance (Olnes et al., 2017). According to this study, the variables of Blockchain acceptance consequences include strategic consequences, organizational consequences, economic consequences, information consequences, and technological consequences.

– Organizational readiness

In this study, organizational readiness was defined in terms of perceived organizational governance and perceived benefits. To consider technology acceptance, policymakers must be convinced that the benefits of accepting technology are related to the current state of the business environment, and these benefits can offset the costs and risks (Kim and Pae, 2007). The concept of perceived benefits is one of the distinguishing features of innovation influence theory and is broadly associated with the acceptance of technology (Rogers, 2010). Moreover, policymakers need to make sure that their organizations have sufficient resources, which include the ability to manage and handle the acceptance and use of technology. It can be argued that these two factors are among the most fundamental factors at the organizational level and encompass many other organizational factors reported in articles in this field.

– Financial industry readiness

The second level of preparedness in this study is the readiness of the financial industry. This level indicates the willingness of the industry to strengthen the acceptance of the technology. This level is related to the

interaction between the host organizations and the institutions external to the organization, their interdependence and power relations, which is generally related to the structure of the industry (Damsgaard & Lyytinen, 1998). Besides, technology acceptance requires adaptability in the goals and interests between the trader partners and their willingness to cooperate and participate (Kurnia & Johnston, 2003). Therefore, setting standards is useful in helping organizations align the goals and provide a framework for facilitating the partnership. Environmental pressure can also be caused by the customer, supplier, government demand, market pressure, or changes in the external environment. These factors put pressure on organizations to adopt certain technologies (Qu, Yang & Wang, 2011).

−   Technological readiness

Technological readiness is associated with organizational resources that influence an organization's decision to adopt new technology. Organizational resources include IT infrastructure and IT staff (Oliveira & Martins, 2010). Technology infrastructure refers to the availability of support in the organization (Mutula & Van Brakel, 2006). The answer to the question of whether the existing ICT infrastructure is capable of running a new system or not has a significant impact on the decision to adopt the technology. Implementing a new information system in the organization requires skilled and experienced staff. The competence of employees in the IT unit increases the likelihood of successful implementation of the new system. The adoption and implementation of a new system in the organization are also influenced by government regulations and policies and the legislation about the IT field (AlShehri & Drew, 2010). Also, policy-making in the area of information technology refers to organizational and governmental requirements in the form of regulations, standards, guidelines, instructions, or rules, which evaluate the information technology issues in the areas of accessibility, availability, security, and privacy.

−   The consequences of accepting Blockchain technology

The effects are interdependent, and whether we achieve them or not depends on the making decision regarding the type of design in the Blockchain architecture and the use of the development process. The primary outcomes related to the improved integration of data and transactions are undeniable, which, in return, can track changes and ultimately support initiatives to reduce organizational corruption (Olnes, 2016).

It is predicted that information retention will be improved by mechanisms that guarantee that the information will only change when all groups agree about the matter. Security is created through distributed ledgers that are more

difficult to manipulate. The design architecture determines whether the users are anonymous or have an identity. In many governmental applications, identity management is one of the critical aspects. Thus, the Blockchain must be connected to the identity management systems, which may be achieved at the expense of other interests such as privacy. Identity control is one of the main challenges when dealing with a large number of users (Olnes et al., 2017).

According to the above, Table 2 shows the indicators extracted from the literature for validation based on the experts' opinions. This table indicates the Blockchain acceptance indices at three levels derived from the literature of research conducted in the areas of e-commerce, mobile banking, and Blockchain.

Table 2
The levels, variables, and indicators extracted from the literature

Readiness Levels	Variables	Indicators	
Organizational readiness	Perceived advantages	Banks' awareness of Blockchain opportunities and threats	(Sayal et al., 2004; Looi, 2005; Kurnia, Choudrie, Mahbubur, & Alzougool, 2015; Gibbs & Kraemer, 2004)
		Banks' awareness of the potential advantages of the Blockchain in financial markets	
		Compatibility of and proportionality of Blockchain with the banks' values and needs	
	Perceived organizational governance	The need for specific criteria for evaluating Blockchain innovations in financial markets	(Lawson, Alcock, Cooper, & Burgess, 2003; Kurnia et al., 205; Kurnia, 2008)
		The need for a systematic process to manage issues related to changes resulting from the Blockchain in financial markets	
		The readiness of financial markets' managers for change	
		The power of information technology policymakers in the financial markets to take the decisions and actions needed to change the banking business model	
		The support of the central bank and securities and exchange organization (SEO) for innovations of the Blockchain	
		Defining roles and responsibilities in Blockchain-based banking business models	

Readiness Levels	Variables	Indicators	
Environmental readiness	Perceived standards and structure in the financial markets	Adaptation of Blockchain applications in financial markets to the needs of other business sectors	(Kurnia et al., 2015; Kurnia, 2008; Gregory & Johnson, 2000; Crowston & Myers, 2004)
		The readiness of different business segments to share relevant information through Blockchain technology	
		Necessary standards for applying Blockchain in financial markets	
		The presence of necessary mechanisms in the Blockchain technology for solving problems	
		The possibility of decentralized control over banking processes with the Blockchain technology	
	Perceived environmental pressure	The pressure of new financial technologies on financial markets to use the Blockchain capabilities	(Kou et al., 2011; Kurnia et al., 2015; Kuan & Chau, 2001; Qobakhlou et al., 2011)
		Government policy to utilize Blockchain capabilities in the financial markets	
		The society's tendency to use the Blockchain capabilities in financial markets	
		The rivals' pressure on the financial market policymakers	
		Decline in the financial institutions performance, a pressure on financial institutions to change banks' business model based on Blockchain	
		The awareness of financial market policymakers on the superiority of Blockchain-based business model	
Technical readiness	Information technology infrastructure	The banks' enjoyment of necessary technical requirements to use the Blockchain-based platforms	(Mohammed, Ibrahim, Nilashi, 2017; Espadanal, 2012; Bennett & Savani, 2011)
		The banks' enjoyment of proper internet connection speed	
		Banks' maturity in using the Internet and related technologies	
		The banks' need to restructure their business based on the Blockchain-based platforms	
		The banks' need to the Blockchain technology to meet their IT-based banking needs	

Readiness Levels	Variables	Indicators	
Readiness Levels (spanned)	IT skills	The enjoyment of the Blockchain technology knowledge among banking executives at all levels	(Mohammed et al., 2017; Spadanal, 2012; Bennett & Savani, 2011)
		Enjoyment of a high level of skills and technical knowledge related to the Blockchain in banks	
		The familiarity of the banks' IT sector with banking business processes to identify the real uses needed by the banks	
		The ability of the banks' IT specialists to develop Blockchain-based systems	
		The existence of skills required in the body of financial institutions to use Blockchain-based services	
	Information Technology Policies	Security rules, procedures, and privacy protection laws in the Blockchain-based platforms	(Mohammed et al., 2017; Spadanal, 2012; Alshamaila, 2013)
		The possibility of losing control over data by banks in case of using the Blockchain-based platforms to execute transactions	
		The need for rules to use the Blockchain-based platforms	
		Inadequacy of current laws and regulations to support the Blockchain use	
Acceptance Consequences	Strategic Consequences	Transparency and access to the trades history	(Underwood, 2016; Olnes et al., 2017; Kshetri, 2017; Cai & Zhu, 2016; Atzori, 2015)
		Preventing fraud and manipulation	
		Reducing corruption	
	Organizational Consequences	Increasing trust	(Zyskind & Nathan, 2015; Yermack, 2017; Olnes et al., 2017; Atzori, 2015)
		Increasing the capability of tracking the transactions	
		Increasing the predictability	
		Increasing the control	
	Economic consequences	Transparent ownership in financial structures	(Tapscott & Tapscott, 2016; Olnes et al., 2017; Olnes et al., 2016; Gervais et al., 2016)
		Reducing the transactions' costs	
	Informational consequences	Increasing the strength against DDOS attacks	(Tapscott & Tapscott, 2016; Swan, 2015; Olnes et al., 2017; Curry & Zhou, 2016; Asgari & Heidari, 2015)
		Integration and enhancement of the quality of financial information	
		Reducing human error	
		Increasing the speed of access to financial information	

Readiness Levels	Variables	Indicators	
		Increasing the users' privacy due to the anonymous and semi-anonymous identity of users in the Blockchain-based platforms	
		Increasing the user's reliability due to the adaptive understanding mechanism in the Blockchain-based platforms	
	Technological consequences	Resistance to destructive behaviors	(Underwood, 2016; Tapscott & Tapscott, 2016; Olnes et al., 2017; Geravis et al., 2016; Atzori, 2015)
		Increasing security and reducing hacking of databases	
		Preventing the modification or deletion of data stored in the Blockchain-based databases	
		Reducing the network power consumption through increasing the efficiency and automated trading mechanism	

3 Research Methodology

In terms of objective, this is applied research. In this research, based on the library method, the research background, and the Blockchain acceptance indices in the financial market were extracted by reviewing articles. A questionnaire was used to obtain the experts' opinions. The descriptive statistics and fuzzy rules were used to screen the components in the data analysis phase. After reviewing the conducted research, a list of the Blockchain acceptance indices in Iran's financial markets was prepared and provided to the university professors for validation. After approval by the scholars and making necessary adjustments to the proposed indices, we had to choose the experts and implement the fuzzy Delphi method. In this method, the experts usually present their opinions in the form of verbal variables; then, the mean of expert's opinions and the disagreement rate of each expert with the mean values are calculated. Subsequently, this information is sent to experts to get new ideas. In the next step, each expert will make a new comment or modify his previous one based on the information obtained from the previous step. This process continues until the mean of the fuzzy numbers becomes sufficiently stable (Toloie-Eshlaghy & Peydaie, 2011).

The first step in the fuzzy Delphi method is to select the experts. In this study, the expert was referred to someone who is working in the field of Blockchain. The experts are also required to be proficient in the financial

market processes. Appropriate sample size in the Delphi method depends on factors such as accessibility to individuals, time, and the budget available to the researcher. In most of the previous studies, the number of members has been between 10 and 20 people. Some also believe that no new information will be obtained with increasing the number of experts, and the responses become duplicated (Hoseini, Dehnavi, Ghorbanizadeh, Amiri, & Rajayi, 2018). The sampling in this study was non-random and purposeful, and 16 experts were selected accordingly.

The next step is to send the questionnaire to the experts and receive their comments for analysis. This stage involves multiple surveys of the selected experts to reach a consensus. After determining the experts, a questionnaire was developed to obtain their opinions regarding their rate of agreement with each of the Blockchain acceptance indices in Iran's financial markets so that the experts can present their views in the form of verbal variables. We used Su and Young method (2000) in this study. They used the triangular fuzzy number to incorporate the experts' views and create the fuzzy Delphi method. Hence, we considered the maximum and minimum values of the expert's opinions as to the boundary points of the fuzzy triangular numbers and used the geometric mean as the membership degree of the fuzzy triangular numbers and to eliminate the effect of the boundary points (Hsu & Yang, 2000).

These variables were defined as triangular fuzzy numbers, according to Table (3). In fuzzy triangular numbers, L represents the lower limit, M represents the midpoint, and U represents the upper limit.

Table 3
The scope definition of scales and their corresponding definite numbers

Verbal variables	Triangular fuzzy numbers		
	U	M	L
Very low	0.25	0	0
Low	0.5	0.25	0
Average	0.75	0.5	0.25
High	1	0.75	0.5
Very high	1	1	0.75

Creating the fuzzy triangular number T_{ij} for each expert: In each criterion, T_{ij} reflects the desired expert as follows.

$$T_{ij} = (L_{ij}.M_{ij}.U_{ij})$$

Wherein,

$$L_{ij} = Min\{L_{ij}\} \quad \forall_j$$
$$U_{ij} = Max\{U_{ij}\} \quad \forall_j$$
$$M_{ij} = \sqrt[n]{\prod_{i=1}^{n} M_{ij}}$$

The index i refers to the expert i, and the index j refers to the criterion j in such a way:

X_{ij} is the value of the ith expert evaluation in the criterion j (i=1, 2, …, n & j=1, 2, …, m).

The geometric mean of Mij in the triangular fuzzy number was used to refer to the consensus of experts on each criterion. The maximum and minimum values of the expert opinions are used as the two endpoints of the fuzzy triangular numbers (Chang, 1998). The minimum and maximum values of the expert's views are not a good representative of the entire range of changes and reduce the calculation accuracy (Mikhailov, 2003). The geometric mean of the beginning and end values was used to correct this defect in the aggregation of the experts' opinions (Davies, 1994).

$$L_{ij} = \sqrt[n]{\prod_{i=1}^{n} L_{ij}}$$
$$U_{ij} = \sqrt[n]{\prod_{i=1}^{n} U_{ij}}$$

Defuzzification: The simple central gravity point formula was used for defuzzification.

$$S_{ij} = \frac{L_{ij} + 4M_j + U_{ij}}{6}$$

Selecting the threshold value: A threshold value of α was selected to screen for inappropriate factors.

A. The component is accepted if:

$$\boldsymbol{S_{ij}} \geq \alpha$$

B. The component is not accepted if:

$$S_{ij} < \alpha$$

If the defuzzificated number of any of the indices is greater than 0.7, it means each of the model's indices has been confirmed (Hosseini et al., 2018).

Out of the 16 questionnaires sent to the experts in the first round of the survey, only 12 questionnaires were completed by the experts, which were used as the analysis basis. The return rate of the questionnaires in the first round was 75%. After collecting the results of the first stage survey, the expert's opinions were analyzed, and the mean value of the experts' opinions, along with the answers of each expert compared with the mean, were added to the second-round questionnaire. The second-round questionnaire was distributed among the experts without making any changes in the indices. Based on their responses in the first round of the survey and the mean value of the experts' opinion, the experts adjusted their answers in the second round and answered the questions again. After collecting the results of the second stage survey, the responses were re-analyzed. Accordingly, the mean of experts' opinions in the second round, as well as the difference between the mean values of the first and second rounds were calculated. Then, the survey was stopped on indicators whose mean difference has become less than 0.1. The third round of the survey was conducted only with the presence of indicators that the mean value difference between their first and second rounds was more than 0.1. As in the second round, the mean of the experts' opinions and the responses of each expert were added to the questionnaire. A third-round questionnaire was distributed among them to converge the experts' views. The same 12 previous experts participated in the survey in the second and third rounds of the survey. Therefore, the return rate of the questionnaire in the second and final rounds was 100%. The results obtained in the third round were analyzed and the mean difference of the second and third rounds was calculated. In the same round, the survey was stopped due to the convergence of the experts' opinions.

4 Research Findings

4.1 Sample Demographic Analysis

The experts in this study consisted of 12 people, including 7 PhDs and 5 MAs. All experts also had more than 5 years of work experience related to the research area, and five of them have been working exclusively in the Blockchain area for more than a year. Three of the experts were directly involved in the Central Bank Blockchain platform development project.

Five of the experts were academics and researchers in the field of Blockchain. One of the experts was one of the founders of a platform startup based on Iranian Blockchain, and the remaining three were capital market experts active in the Blockchain study area. Due to the purposeful selection of

experts, we tried to select people from all sectors related to this field to be surveyed.

4.2 Analysis of the Research Data

4.2.1 Step I Survey

At this stage, the indicators were sent to the members of Iran's expert group, and their agreement rate on each of the indices was obtained in accordance with Table 4. Then, the mean of the experts' opinions for each indicator was determined and the difference between each expert's opinion and the mean was calculated. It should be noted that the experts did not add any component in the open-ended questions section. Therefore, no indicator was added to the questionnaire of the second stage survey.

Table 4

First step survey results

Variables	Index	Uij	Mij	Lij	Sji
Perceived advantages	Banks' awareness of Blockchain opportunities and threats	1	0.931	0.679	0.900
	Banks' awareness of the potential advantages of the Blockchain in financial markets	1	0.887	0.635	0.864
	Compatibility of and proportionality of Blockchain with the banks' values and needs	1	0.867	0.614	0.847
Perceived organizational governance	The need for specific criteria for evaluating Blockchain innovations in financial markets	0.879	0.698	0	0.612
	The need for a systematic process to manage issues related to changes resulting from the Blockchain in financial markets	0.931	0.765	0.499	0.748
	The readiness of financial markets' managers for change	0.953	0.791	0.529	0.774
	The power of information technology policymakers in the financial markets to take the decisions and actions needed to change the banking business model	0.953	0.772	0.511	0.759
	The support of the central bank and securities and exchange organization (SEO) for innovations of the Blockchain	1	0.909	0.656	0.882
	Defining roles and responsibilities in Blockchain-based banking business models	0.931	0.802	0.534	0.779
Perceived standards and structure in the financial markets	Adaptation of Blockchain applications in financial markets to the needs of other business sectors	0.976	0.799	0.542	0.786
	The readiness of different business segments to share relevant information through Blockchain technology	0.976	0.762	0.506	0.755
	Necessary standards for applying Blockchain in financial markets	1	0.846	0.574	0.826

Variables	Index	Uij	Mij	Lij	Sji
	The presence of necessary mechanisms in the Blockchain technology for solving problems	0.830	0.608	0	0.543
	The possibility of decentralized control over banking processes with the Blockchain technology	0.810	0.587	0	0.527
Perceived environmental pressure	The pressure of new financial technologies on financial markets to use the Blockchain capabilities	0.922	0.783	0	0.676
	Government policy to utilize Blockchain capabilities in the financial markets	0.976	0.818	0.560	0.801
	The society's tendency to use the Blockchain capabilities in financial markets	0.870	0.698	0	0.610
	The rivals' pressure on the financial market policymakers	1	0.846	0.593	0.830
	The decline in the financial institutions' performance, pressure on financial institutions to change banks' business model based on Blockchain	0.765	0.524	0	0.477
	The awareness of financial market policymakers on the superiority of the Blockchain-based business model	0.953	0.791	0.529	0.774
Information technology infrastructure	The banks' enjoyment of necessary technical requirements to use the Blockchain-based platforms	0.891	0.688	0	0.607
	The banks' enjoyment of proper internet connection speed	0.802	0.602	0	0.535
	Banks' maturity in using the Internet and related technologies	0.891	0.722	0	0.630
	The banks' need to restructure their business based on the Blockchain-based platforms	0.931	0.783	0.516	0.763
	The banks' need to the Blockchain technology to meet their IT-based banking needs	0.976	0.799	0.542	0.786
IT skills	The enjoyment of the Blockchain technology knowledge among banking executives at all levels	1	0.807	0.555	0.797
	Enjoyment of a high level of skills and technical knowledge related to the Blockchain in banks	0.922	0.712	0	0.628
	The familiarity of the banks' IT sector with banking business processes to identify the real uses needed by the banks	1	0.887	0.635	0.864
	The ability of the banks' IT specialists to develop Blockchain-based systems	0.976	0.838	0.579	0.818
	The existence of skills required in the body of financial institutions to use Blockchain-based services	0.976	0.799	0.542	0.786
Information Technology Policies	Security rules, procedures, and privacy protection laws in the Blockchain-based platforms	0.976	0.818	0.560	0.801
	The possibility of losing control over data by banks in case of using the Blockchain-based platforms to execute transactions	0.740	0	0	0.123

Variables	Index	Uij	Mij	Lij	Sji
	The need for rules to use the Blockchain-based platforms	0.900	0.722	0	0.631
	Inadequacy of current laws and regulations to support the Blockchain use	0.922	0.729	0	0.640
Strategic Consequences	Transparency and access to the trades history	0.976	0.818	0.593	0.807
	Preventing fraud and manipulation	0.976	0.818	0.560	0.801
	Reducing corruption	0.953	0.830	0.566	0.806
Organizational Consequences	Increasing trust	0.976	0.818	0.560	0.801
	Increasing the capability of tracking the transactions	1	0.826	0.574	0.813
	Increasing the predictability	0.810	0.587	0	0.527
	Increasing the control	0.783	0.555	0	0.500
Economic consequences	Transparent ownership in financial structures	1	0.826	0.574	0.813
	Reducing the transactions' costs	0.891	0.705	0	0.619
Informational consequences	Increasing the strength against DDOS attacks	0.922	0.747	0	0.651
	Integration and enhancement of the quality of financial information	0.976	0.818	0.560	0.801
	Reducing the human error	0.900	0.705	0	0.620
	Increasing the speed of access to financial information	0.691	0	0	0.115
	Increasing the users' privacy due to the anonymous and semi-anonymous identity of users in the Blockchain-based platforms	0.659	0	0	0.110
	Increasing the user's reliability due to the adaptive understanding mechanism in the Blockchain-based platforms	0.953	0.772	0.511	0.759
Technological consequences	Resistance to destructive behaviors	0.953	0.754	0.494	0.744
	Increasing security and reducing hacking of databases	0.976	0.818	0.560	0.801
	Preventing the modification or deletion of data stored in the Blockchain-based databases	1	0.887	0.635	0.864
	Reducing the network power consumption through increasing the efficiency and automated trading mechanism	0.563	0	0	0.094

4.2.2 Step II Survey

At this stage, the second stage questionnaire was prepared, and together with the previous point of view of each individual and their differences with the mean of other experts were again sent to the expert group members. The experts then answered the questions back. The results of counting responses in the second step were analyzed as in the first step. Considering the views presented in step one and comparing them with the results of step two, if the difference between the two steps is less than the threshold level (0.1), in this case, the polling process will stop (Toloie-Eshlaghy & Peydaie, 2011). Thus, at this stage, the experts came to consensus except for indicators 13, 14, 47, 48 and 53 and the survey on them was stopped. Also, at this stage, except

for the indicators 4, 17, 19, 21, 22, 23, 32, 40, 41, 43, and 46, the experts agreed with the rest and since the score obtained for these indices was less than 0.7, they were eliminated.

Table 5
Second Step Survey Results

Variables	Index	Uij	Mij	Lij	Sji	Mean difference
Perceived advantages	Banks' awareness of Blockchain opportunities and threats	1	0.931	0.679	0.900	0.000
	Banks' awareness of the potential advantages of the Blockchain in financial markets	1	0.931	0.679	0.900	0.036
	Compatibility of and proportionality of Blockchain with the banks' values and needs	1	0.909	0.656	0.882	0.035
Perceived organizational governance	The need for specific criteria for evaluating Blockchain innovations in financial markets	0.922	0.729	0	0.640	0.028
	The need for a systematic process to manage issues related to changes resulting from the Blockchain in financial markets	0.976	0.838	0.579	0.818	0.070
	The readiness of financial markets' managers for change	0.976	0.838	0.579	0.818	0.043
	The power of information technology policymakers in the financial markets to take the decisions and actions needed to change the banking business model	0.976	0.858	0.599	0.835	0.076
	The support of the central bank and securities and exchange organization (SEO) for innovations of the Blockchain	0.976	0.879	0.620	0.852	-0.030
	Defining roles and responsibilities in Blockchain-based banking business models	0.976	0.799	0.542	0.786	0.007
Perceived standards and structure in the financial markets	Adaptation of Blockchain applications in financial markets to the needs of other business sectors	1	0.826	0.574	0.813	0.028
	The readiness of different business segments to share important information through Blockchain technology	0.976	0.762	0.506	0.755	0.000

Variables	Index	Uij	Mij	Lij	Sji	Mean difference
	Necessary standards for applying Blockchain in financial markets	1	0.846	0.593	0.830	0.003
	The presence of necessary mechanisms in the Blockchain technology for solving problems	0.931	0.679	0.422	0.678	0.135
	The possibility of decentralized control over banking processes with the Blockchain technology	0.900	0.672	0.478	0.678	0.151
Perceived environmental pressure	The pressure of new financial technologies on financial markets to use the Blockchain capabilities	0.976	0.780	0.524	0.770	0.094
	Government policy to utilize Blockchain capabilities in the financial markets	1	0.867	0.614	0.847	0.045
	The society's tendency to use the Blockchain capabilities in financial markets	0.922	0.747	0	0.651	0.041
	The rivals' pressure on the financial market policymakers	1	0.887	0.635	0.864	0.034
	The decline in the financial institutions' performance, pressure on financial institutions to change banks' business model based on Blockchain	0.765	0.511	0	0.468	-0.008
	The awareness of financial market policymakers on the superiority of the Blockchain-based business model	1	0.826	0.574	0.813	0.039
Information technology infrastructure	The banks' enjoyment of necessary technical requirements to use the Blockchain-based platforms	0.944	0.736	0	0.648	0.041
	The banks' enjoyment of proper internet connection speed	0.841	0.585	0	0.530	-0.005
	Banks' maturity in using the Internet and related technologies	0.891	0.705	0	0.619	-0.011
	The banks' need to restructure their business based on the Blockchain-based platforms	0.976	0.838	0.579	0.818	0.054
	The banks' need to the Blockchain technology to meet their IT-based banking needs	1	0.807	0.555	0.797	0.011
IT skills	The enjoyment of the Blockchain technology knowledge among banking executives at all levels	1	0.846	0.593	0.830	0.033
	Enjoyment of a high level of skills and technical knowledge related to the Blockchain in banks	0.953	0.702	0.447	0.701	0.073

Variables	Index	Uij	Mij	Lij	Sji	Mean difference
	The familiarity of the banks' IT sector with banking business processes to identify the real uses needed by the banks	1	0.909	0.656	0.882	0.018
	The ability of the banks' IT specialists to develop Blockchain-based systems	0.976	0.858	0.599	0.835	0.017
	The existence of skills required in the body of financial institutions to use Blockchain-based services	1	0.826	0.574	0.813	0.028
Information Technology Policies	Security rules, procedures, and privacy protection laws in the Blockchain-based platforms	0.976	0.858	0.599	0.835	0.033
	The possibility of losing control over data by banks in case of using the Blockchain-based platforms to execute transactions	0.747	0	0	0.124	0.001
	The need for rules to use the Blockchain-based platforms	0.953	0.719	0.462	0.715	0.084
	Inadequacy of current laws and regulations to support the Blockchain use	0.953	0.719	0.462	0.715	0.075
Strategic Consequences	Transparency and access to the trades history	1	0.867	0.614	0.847	0.040
	Preventing fraud and manipulation	1	0.909	0.656	0.882	0.081
	Reducing corruption	1	0.909	0.656	0.882	0.076
Organizational Consequences	Increasing trust	0.976	0.858	0.599	0.835	0.033
	Increasing the capability of tracking the transactions	1	0.909	0.656	0.882	0.069
	Increasing the predictability	0.846	0.608	0.347	0.604	0.077
	Increasing the control	0.818	0.587	0	0.528	0.028
Economic consequences	Transparent ownership in financial structures	0.976	0.818	0.560	0.801	-0.012
	Reducing the transactions' costs	0.944	0.719	0	0.637	0.018
Informational consequences	Increasing the strength against DDOS attacks	0.953	0.754	0.494	0.744	0.093
	Integration and enhancement of the quality of financial information	1	0.887	0.635	0.864	0.063
	Reducing the human error	0.944	0.736	0	0.648	0.028
	Increasing the speed of access to financial information	0.818	0.587	0	0.528	0.413
	Increasing the users' privacy due to the anonymous and semi-anonymous identity of users in the Blockchain-based platforms	0.736	0.478	0	0.441	0.332

Variables	Index	Uij	Mij	Lij	Sji	Mean difference
	Increasing the user's reliability due to the adaptive understanding mechanism in the Blockchain-based platforms	0.953	0.772	0.511	0.759	0.000
Technological consequences	Resistance to destructive behaviors	0.976	0.799	0.542	0.786	0.041
	Increasing security and reducing hacking of databases	1	0.846	0.593	0.830	0.028
	Preventing the modification or deletion of data stored in the Blockchain-based databases	1	0.887	0.635	0.864	0.000
	Reducing the network power consumption through increasing the efficiency and automated trading mechanism	0.659	0.422	0	0.391	0.297

4.2.3 Step III Survey

Since the experts did not agree on indicators 13, 14, 47, 48, and 53, the survey on these five indicators continued. Therefore, a questionnaire consisting of these five indices was then sent to them along with the mean of comments and responses of each expert. The results obtained from this step were also analyzed and Table 6 shows the average of the comments and their differences with the second round. According to the results, the experts agreed on these five indicators as well. Accordingly, indices 3, 4, and 5 were also removed for scoring less than 0.7.

5 Discussion & Conclusion

Some of the acceptance readiness indices did not gain the required scores at three environmental, organizational, and technical levels, according to the experts. "Banks' enjoyment of necessary technical requirements for using Blockchain-based platforms", "Banks' enjoyment of proper Internet connection speed", and the "Banks' maturity in using the Internet and its related technologies" are some of the factors that, according to the experts, are needed to accept the Blockchain in financial markets, but we do not need them given the level of maturity of Iran's financial markets. "The decline in the financial institutions performance due to the pressure on financial institutions to change banking business model based on the Blockchain" is a factor that was not approved by experts since they believe that the pressure on the banks is not due to the real need and is caused mostly to keep up with the Joneses. "The community's willingness to use Blockchain capabilities in financial

markets" was another factor that was not approved. It seems that the strategies adopted in the financial markets of Iran are mostly of the pressure type than the pull-type; thus, the public's willingness to accept Blockchain will not affect the financial markets. "The need for specific criteria for evaluating the Blockchain innovations in financial markets" and "The possibility of losing control over data by banks in case of using the Blockchain-based platforms for executing transactions" were other factors that didn't get the necessary scores from the experts. It seems that the decentralized thinking approach can play a more crucial role in the acceptance of Blockchain in the financial markets than the acceptance criteria and control mechanisms. Therefore, the start of innovative actions will take place in the non-financial sectors in the banks and the evaluation and control mechanisms will come after the implementation and acceptance.

Table 6
Third Step Survey Results

Variable	Index	Uij	Mij	Lij	Sji	Mean difference
Perceived standards and structure in the financial markets	The presence of necessary mechanisms in the Blockchain technology for solving problems	0.953	0.702	0.447	0.701	0.023
	The possibility of decentralized control over banking processes with the Blockchain technology	0.931	0.712	0.451	0.705	0.027
Informational consequences	Increasing the speed of access to financial information	0.846	0.622	0.359	0.616	0.088
	Increasing the users' privacy due to the anonymous and semi-anonymous identity of users in the Blockchain-based platforms	0.736	0.478	0.000	0.441	0.000
Technological consequences	Reducing the network power consumption through increasing the efficiency and automated trading mechanism	0.659	0.402	0.000	0.378	-0.013

"Increasing predictability", "reducing transaction costs", "reducing human error", "increasing the speed of access to financial information", "increasing the users' privacy due to the anonymous and semi-anonymous nature of users in the Blockchain-based platforms", "increasing control and reducing the power consumption in the network by increasing efficiency and automated trading mechanism" were outcomes that, according to the experts, did not earn the necessary scores. Given that the technology is in its infancy

and there are still no operational examples to compare with the centralized systems, it is not easy to comment on the increase in the rate of predictability. However, this index scored above 0.6 but was not confirmed. Also, considering the free-fee model of the POSs for end customers and the low-cost domestic financial transfers in Iran, the acceptance of the charge-based Blockchain does not reduce the cost of domestic transactions and only reduces the cost of international transactions. Due to the integrated mobile and electronic banking systems, the financial information is provided to customers on a real-time basis; hence, the speeding up access to financial information has not gained the necessary score.

On the other hand, due to the transparency of transactions, it is possible to access trading history for everyone. Thus, the only thing left is to identify the identity of the target. Also, in centralized systems, the financial institutions have the highest rate of control and there will be no increase in the control rate with the acceptance of the Blockchain. Ultimately, according to experts, the cost of the current centralized network is not high enough to be reduced by Blockchain adoption.

The present study sought to explain the Blockchain acceptance indices in Iran's financial markets. Accordingly, the research indicators were extracted based on the existing literature and previous research. In this regard, we benefited from similar studies literature in the area of e-commerce and mobile banking adoption to explain the indicators of Blockchain acceptance in Iran financial markets due to the newness of the Blockchain technology and the lack of literature tailored to the approval of this technology. Also, given that most of the Blockchain studies have so far focused on its features and applications, we extracted and developed a proper classification based on these studies for the consequences of Blockchain acceptance in financial markets, which was added to the table of research indicators. Finally, 53 indices were extracted from the literature. In this study, the perceived benefits, perceived organizational governance, perceived standards and structure in financial markets, perceived environmental pressure, IT infrastructure, IT skills, and IT policies were selected as variables of the Blockchain acceptance readiness in financial markets. Also, strategic, organizational, economic, informational, and technological consequences were selected as the consequences of Blockchain acceptance in financial markets. The fuzzy Delphi method was used to explain the essential parameters. The research questionnaire was provided to 12 industry and university experts active in the Blockchain area who had enough knowledge about the financial markets. The experts' opinions reached a consensus in the third round. Of the 53 indices

extracted, 39 indices were finally accepted, including 27 indices of the Blockchain acceptance readiness in the Iran financial markets and 12 indices as consequences of the Blockchain acceptance in Iran.

Based on the results of this study, banks need to first perform a SWOT analysis on using Blockchain in financial markets to implement the Blockchain applications in the financial markets. The results of this analysis will show that what the opportunities, threats, strengths, and weaknesses of banks for applying the Blockchain would be. The cost-benefit analysis should also be performed on applied cases to determine how the launching of Blockchain-based applications would be compared to the centralized banking services in terms of cost and benefit. For example, as the banks' charge model in Iran is free for users in many cases, the cost of micro-transactions is not economical for banks. Therefore, it seems that the use of Blockchain capability in this regard can reduce the cost of microtransactions for banks. However, the risk assessment must also be done in addition to the cost-benefit analysis. For example, the risk of using Blockchain in applications with financial burdens should be assessed. Another important issue to be considered in implementing Blockchain applications in financial markets is to evaluate the readiness of different parts of the organization for change. This evaluation should include various aspects, including the manager's willingness, human resources, required infrastructure, required procedures, and standards. The implementation of Blockchain applications in the financial markets increases the tracking capability due to creating transparency. Also, given that the recorded information cannot be manipulated and is resulted based on collective understanding, fraud can be prevented and corruption would be reduced. Moreover, due to the decentralization of the Blockchain structure, security is increased and the possibility of hacking is reduced.

One of the limitations of this study was the small number of real experts in the Blockchain domain, as only 12 experts responded to the questionnaire in this study despite great efforts. Also, most of the studies done in the field of Blockchain are in the conceptual stage, and they can only be used to understand the applications and properties of the Blockchain. Therefore, similar areas should be used to research the conceptual level. In this study, other readiness indicators such as the ability rate of additional human resources, organizational environment, organizational culture, or legal and social consequences were not considered, which can be explored in future research. Also, in case of access to a decent number of IT experts in the financial markets, considering the identification and validation of essential indicators in this study, it is suggested that researchers in future studies will

explain and measure the readiness of Iran financial markets for accepting the Blockchain. In this study, since the Blockchain technology is in its infancy and the experts in the field are limited, we could not assess the financial markets' readiness to accept Blockchain.

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