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Analyzing Institutional and Structural Barriers to Blockchain Adoption in Supply Chains of Developing Countries: Evidence from Iran

Mobin Sabbaghi Rostami[1], Saber Khandan Alamdari[2,*], Mohammad Hadi Asgari[3]

Given global reports of a 92% failure rate for blockchain projects, this study aims to quantitatively validate the challenges of adopting this technology within the Iranian supply chain. The primary research question seeks to explain why, despite its numerous theoretical advantages, Iranian organizations have failed to progress from theoretical discourse to operational implementation and to identify where the roots of this failure lie.

This study employed a quantitative approach and a survey strategy. The required data were collected through a researcher-developed questionnaire utilizing a Likert scale, administered via cluster sampling to experts and practitioners active in the supply chain field. The validity of the measurement instrument was assessed using confirmatory factor analysis (CFA), while its reliability was determined by calculating Cronbach's alpha coefficient. In the inferential statistics section, structural equation modeling (SEM) was applied to validate the proposed conceptual model, and a one-sample t-test was used to examine the current status of each component under investigation within the statistical population.

The results of the confirmatory factor analysis revealed that "legal and regulatory barriers," with a factor loading of 0.64, play the most decisive role in the formation of adoption challenges. However, the analysis of the current situation indicated that "organizational and cultural factors," with a mean score of 2.125 and a negative t-statistic of -3.25, represent the most critical weakness and primary bottleneck within the Iranian supply chain. The findings further suggest that while "perceived benefits" are at their highest level, a pronounced weakness in organizational culture and professional readiness prevents this positive perception from being translated into actual implementation.

The findings of this study elucidate that the root cause of the high failure rate of blockchain projects lies not in technical deficiencies or a lack of perceived usefulness, but rather in the substantial gap between benefit perception and organizational structural incompetence. For senior managers, these results imply that investing solely in hardware infrastructure, without concurrently rebuilding organizational culture and providing specialized employee training, will inevitably lead to project failure. It is recommended that organizations, prior to entering the technical implementation phase, develop change management strategies aimed at reducing employee resistance and enhancing technical knowledge across various organizational levels.

***Keywords**: Blockchain adoption, supply chain, project failure, organizational and cultural factors, structural equation modeling, Iran.*

* Corresponding Author.
[1]Department of Management, Ro.C., Islamic Azad University, Roudehen, Iran., Email: st.m_sabbaghi@iau.ac.ir.
[2]Department of Management, Ro.C., Islamic Azad University, Roudehen, Iran., Email: sabersum@outlook.com.
[3] Department of Management, To.C., Islamic Azad University, Tonekabon, Iran., Email: drasgari13@iau.ac.ir.

1. Introduction

In the present era, rapid technological developments have affected all pillars of the global economy and business, such that the adoption of digital innovations is not merely a competitive advantage but a necessity for survival in today's complex environments. Among these innovations, blockchain technology has garnered particular attention due to its capacity to transform traditional structures, enhance process transparency, and create novel business models. By establishing a decentralized platform, this technology has fundamentally reshaped supply chain management and, through the immutable recording of transactions, has significantly minimized errors and fraud. Furthermore, the utilization of smart contracts has contributed to reduced operational costs and increased accuracy in fulfilling commercial obligations by eliminating intermediaries and automating processes. Nevertheless, the practical implementation of blockchain faces profound challenges; global reports indicate that the failure rate of blockchain projects has reached a concerning 92%. This statistic underscores that the theoretical appeal of this technology has yet to overcome the operational complexities inherent in its real-world application.

This situation is particularly critical in developing countries, and especially within the Iranian economic context. While international organizations are transitioning toward operational implementation, in Iran, discussions surrounding blockchain have largely remained at the theoretical level, and most businesses have failed to achieve full implementation. This failure in Iran is not solely attributable to technical limitations but is also deeply rooted in "institutional uncertainty," wherein frequent warnings from the Central Bank and profound ambiguities in existing laws have significantly increased operational risk for managers. A review of the literature reveals that traditional technology adoption models, such as the Technology Acceptance Model (TAM), emphasize two primary components: "perceived usefulness" and "perceived ease of use." Although these models prove effective in stable contexts, they are insufficient for analyzing blockchain adoption within the Iranian supply chain. Classical models overlook critical variables including international sanctions, foreign exchange restrictions, and specific legal ambiguities in the domain of smart contracts in Iran.

In other words, there is an urgent need to localize blockchain adoption models to determine how external pressures and traditional organizational structures in Iran hinder the transformation of a "positive perception of benefits" into "actual performance." Despite numerous international studies, such as those conducted by Agi and Jha [3] and Queiroz et al. [12], as well as several studies focusing on specific Iranian industrial sectors, a significant research gap remains in the quantitative and comprehensive validation of blockchain adoption challenges across the entire Iranian supply chain. Most studies conducted in the Iranian context lack a systematic approach that simultaneously examines technical, legal, financial, and organizational dimensions under Iran-specific environmental conditions, such as economic sanctions. Therefore, the main research question of this study is: What are the principal drivers of blockchain adoption challenges within the Iranian supply chain, and how is the status of each driver assessed among experts in this field? The ultimate objective of this paper is to quantitatively validate a model that provides robust empirical evidence for policymakers and managers to overcome the current impasse and reduce the failure rate of blockchain projects.

2. Literature Review and Theoretical Foundations

2.1. Theoretical Foundations of Technology Adoption

Previous research in the field of emerging technology adoption has predominantly focused on classical models such as the Technology Acceptance Model (TAM), which emphasize the two dimensions of "perceived usefulness" and "perceived ease of use." However, the disruptive nature of

blockchain in the supply chain extends beyond individual-level dimensions and necessitates analysis at macro and organizational levels (Abdelsalam [1]). Therefore, by transcending traditional models, this study grounds its conceptual framework in two complementary theories:

1. Institutional Uncertainty Theory: This theory posits that in environments characterized by high legal ambiguity, operational risk significantly hinders the adoption of innovation. This aligns directly with the findings of the present study, which identify "legal and regulatory barriers" (factor loading = 0.64) as the primary determinant of adoption challenges.
2. Technology-Organization Fit Theory: According to this perspective, the success of a technology depends on the alignment between the technical capabilities of the system and the organizational structure. The results of the present study indicate a severe "mismatch" within the Iranian context, wherein, despite a high perception of benefits, weaknesses in "organizational and cultural factors" (mean score = 2.125) have prevented the convergence of technology and organization.

2.2. Synthesis of the Research Background and Identification of Research Gaps

Studies conducted at both international and domestic levels can be categorized into three general groups. While foreign studies, such as those by Agi and Jha [3], Queiroz et al. [12], Aslam et al. [6], and Garg et al. [9], have emphasized external pressures and facilitating conditions, domestic studies, including Henri et al. [10], Afshari-Nejad-Roodsari et al. [2], Fathi et al. [7,8], and Yavari and Mirghafouri [16], have predominantly focused on technical and attitudinal aspects within specific industries.

Blockchain has emerged as a potential technology that can significantly improve traceability in complex supply networks, due to its core capabilities in providing an immutable, traceable, and secure platform for information sharing among dispersed parties (Saberi et al. [13]). Blockchain enables the collection of traceability information and environmental impact data, while product quality can be monitored and verified to ensure authenticity and prevent counterfeiting. It also facilitates product recall processes when non-compliance is detected, and helps promote sustainable practices (Saberi et al. [13]). However, this technology is still in its early stages of adoption.

Moreover, a systematic review by AlShamsi et al. [4] confirmed that TAM and TOE were the most common models for studying Blockchain adoption, and identified trust, perceived cost, and social influence as the most frequent external factors affecting Blockchain adoption across various sectors.

Vu et al. [15] conducted a systematic literature review of 69 high-quality, peer-reviewed articles to capture Blockchain adoption drivers and barriers, applications, and implementation stages within food supply chains. Following innovation adoption theory, they developed a three-stage conceptual framework for Blockchain implementation, including initiation, adoption decision, and implementation phases. Their findings identified key internal drivers such as enhancing food traceability, transparency, and efficiency, while external drivers included pressure from consumers, buyers/suppliers, and regulations. Major barriers to adoption comprised high implementation cost, lack of knowledge and expertise, scalability issues, and the transparency versus privacy dilemma.

Kumar et al. [11] conducted a comprehensive review of blockchain technology in supply chain management, examining its applications across transportation, manufacturing, food and beverages, and healthcare industries. Their study identified key challenges to widespread blockchain adoption, including scalability issues, interoperability problems, regulatory uncertainty, and lack of standardization. Additionally, they highlighted the environmental impact of blockchain, particularly the energy-intensive proof-of-work mechanisms, and discussed potential mitigation strategies. The

study also emphasized that the integration of artificial intelligence and 5G networks will further reshape supply chain management, unleashing new efficiencies and capabilities.

The innovation of the present study, compared to previous research, lies in the integration of context-specific environmental variables (such as sanctions and national considerations) alongside the simultaneous analysis of the current status via one-sample t-tests and structural relationships through structural equation modeling (SEM), as summarized and compared in the table below:

Table 1. Comparison of Key Variables of the Present Study with Previous Studies

Study Category	References	Main Variables / Framework Investigated	Primary Focus / Industry	Research Gap and Contribution of the Present Study
Foreign Studies	Agi and Jha [3]; Queiroz et al. [12]; Aslam et al. [6]; Garg et al. [9]	External pressures, facilitating conditions, perceived benefits, relative advantage, trust, social influence, effort expectancy, and adoption-related factors	Global supply chains and emerging economies	Previous studies have mainly identified general drivers of blockchain adoption; however, they have not incorporated country-specific institutional conditions—such as sanctions, regulatory limitations, and national environmental factors—into their analyses.
Domestic Studies	Henri et al. [10]; Afshari-Nejad-Roodsari et al. [2]; Fathi et al. [7,8]; Yavari and Mirghafouri [16]	Technical factors, attitudinal factors, perceived usefulness, perceived ease of use, organizational factors, and industry-specific barriers	Specific industries in Iran, including insurance, automotive, tourism, and management accounting	Existing Iranian studies are largely confined to individual industries and fail to provide an integrated cross-industry framework that comprehensively covers technical, organizational, financial, legal, and institutional barriers.
Systematic Review Studies	AlShamsi et al. [4]	Technology Acceptance Model (TAM), Technology–Organization–Environment (TOE) framework, trust, perceived cost, and social influence	Cross-sector blockchain adoption research	Previous systematic reviews have identified major blockchain adoption factors, but they have not empirically examined the current status of adoption challenges and their structural interrelationships within a specific national context.
	Vu et al. [15]	Three-stage blockchain implementation framework (initiation, adoption decision, and implementation phases); internal drivers (traceability, transparency, efficiency) and external drivers (consumer, buyer/supplier, and regulatory pressures)	Food supply chains	Existing frameworks are primarily designed for global supply chain environments and have not considered specific institutional barriers—such as sanctions and national regulatory constraints—as independent adoption challenges.

	Kumar et al. [11]	Blockchain applications and challenges, including scalability, interoperability, regulatory uncertainty, lack of standardization, energy consumption, and integration with AI and 5G technologies	Transportation, manufacturing, food and beverage, and healthcare industries	Previous reviews have extensively discussed technological challenges, yet they provide limited insight into the interaction between institutional barriers, organizational readiness, and blockchain adoption in developing countries.
Present Study	The present study	Technical, organizational, financial, and legal barriers; perceived benefits; institutional factors (sanctions and national considerations); organizational readiness	Iranian supply chain across multiple industries	This study develops an integrated blockchain adoption framework by incorporating Iran-specific environmental variables, assesses the current status of challenges using one-sample t-tests, and examines causal relationships among factors through structural equation modeling (SEM).

2.3. Formulation of Hypotheses in Relation to Theoretical Foundations

In this section, the research hypotheses are formulated based on the linkage between the extracted dimensions and the reference theories (Saed et al. [14] and Al-Yasin [6]):

Hypothesis 1 (Legal and Regulatory Barriers): According to institutional uncertainty theory, legal and regulatory ambiguities, as the primary institutional obstacle, exacerbate the challenges of blockchain adoption.

Hypothesis 2 (Organizational and Cultural Factors): In accordance with technology-organization fit theory, weaknesses in organizational culture and a lack of technical expertise lead to structural mismatch and the failure of blockchain projects.

Hypothesis 3 (Readiness and Technical Infrastructure): Consistent with fit theory, deficiencies in hardware and software infrastructure prevent the potential benefits of technology from being operationalized within the supply chain.

Hypothesis 4 (Perceived Benefits): Based on the TAM model, positive perceptions of technical and functional benefits serve as the primary drivers of adoption, although they are overshadowed by institutional barriers.

Hypothesis 5 (Financial and Economic Factors): Given the specific context of Iran, financial constraints arising from economic pressures and sanctions increase the costs of exchange and technology implementation.

3. Research Methodology

3.1. Research Approach and Process

This research is developmental-applied in terms of its purpose and descriptive-survey in terms of its nature, employing a quantitative approach. The paradigm governing this study is positivism, which is designed with the objective of empirically validating the model of blockchain technology adoption challenges within the supply chain. The research process involves transferring qualitative findings to

a quantitative platform in order to measure the factor loadings of the components and assess their current status within the target industry.

3.2. Population and Sampling Method (Focus on the Automotive Industry)

The statistical population of this study includes all managers, specialists, and experts active within the supply chain of the Iranian automotive industry. Given the breadth of this field, the cluster random sampling method was employed to ensure accurate representation across the various pillars of this industry. The selected clusters include the following: (1) Original Equipment Manufacturers (OEMs), comprising major automotive companies; (2) parts suppliers (Tier 1 and Tier 2), encompassing different layers of supply responsible for providing technical and complex components; and (3) logistics and distribution services, which include companies managing the physical flow of goods within the country's automotive network.

Regarding the determination of the sample size, although the initial basis was established using standard tables, consideration of the requirements of structural equation modeling (SEM) necessitated that the number of respondents be selected in a manner that ensured the optimal ratio between the number of estimated parameters and the sample size (item-to-response ratio). This sample size provided the requisite statistical power to achieve the desired fit indices (e.g., RMSEA = 0.044 and CMIN/DF = 2.59), and the stability of the results was subsequently confirmed within the AMOS software environment.

3.3. Data Collection Tool and Validity and Reliability Assessment

The primary research instrument was a researcher-developed questionnaire based on a 5-point Likert scale, the items of which were directly adapted from the components identified in the literature and the qualitative phase. This questionnaire comprises 20 items spanning five main themes: financial, organizational, technical, legal, and perceived benefits factors. To ensure the scientific validity of the instrument:

Construct validity was assessed through confirmatory factor analysis (CFA), the results of which indicated a high level of convergence between the observed variables and their corresponding latent constructs.

Reliability was confirmed by calculating Cronbach's alpha coefficient, which demonstrated a high degree of internal consistency, thereby affirming the questionnaire's accuracy in measuring the challenges associated with blockchain adoption.

3.4. Statistical Analysis Techniques

Data analysis was conducted in two main phases using SPSS and AMOS software: (1) structural equation modeling (SEM) was employed to test the structural relationships among the drivers and to confirm the factor loadings of the primary and secondary themes at both the first and second levels; and (2) a one-sample t-test was utilized to compare the mean of respondents' opinions against the standard midpoint and to identify the most critical bottlenecks (such as organizational and cultural factors, with a mean score of 2.125) within the automotive supply chain.

4. Research Findings

4.1. Results of First-Order Confirmatory Factor Analysis

The results of the first-order confirmatory factor analysis revealed that all factor loadings were calculated above 0.53, indicating a significant relationship between the latent variables and their observed indicators. Among the dimensions, "barriers to organizational integration and coordination" exhibited the highest factor loading (0.74), while "management support and leadership" demonstrated the lowest (0.53). All t-statistics exceeded the critical threshold of 1.96, confirming the statistical significance of the relationships at the 0.05 level.

Table 2. Summary of First-Order Confirmatory Factor Analysis Results

Sub-theme	Factor Loading	t-value
Challenges of technical knowledge and expertise	0.63	5.416
Barriers to education and culture-building	0.58	6.081
Technological infrastructure and hardware challenges	0.63	7.789
Organizational integration and coordination barriers	0.74	8.986
Technology complexity and scalability	0.68	9.602
Legal challenges	0.58	12.913
Regulatory challenges	0.63	9.600
Juridical challenges	0.58	11.652
Financial and economic barriers	0.58	11.101
Organizational and cultural resistance	0.58	9.416
Trust and system reliability challenges	0.58	10.304
Impact of sanctions and national considerations	0.63	8.882
Management support and leadership	0.53	7.276
Perceived technical advantages	0.58	9.097
Financial and economic advantages	0.63	7.932
Functional and social advantages	0.58	10.456
Ecosystem and convergence barriers	0.58	8.851
Implementation solutions and strategies	0.58	9.097
Organizational readiness and level of complexity	0.63	7.932
Cultural barriers	0.63	12.750

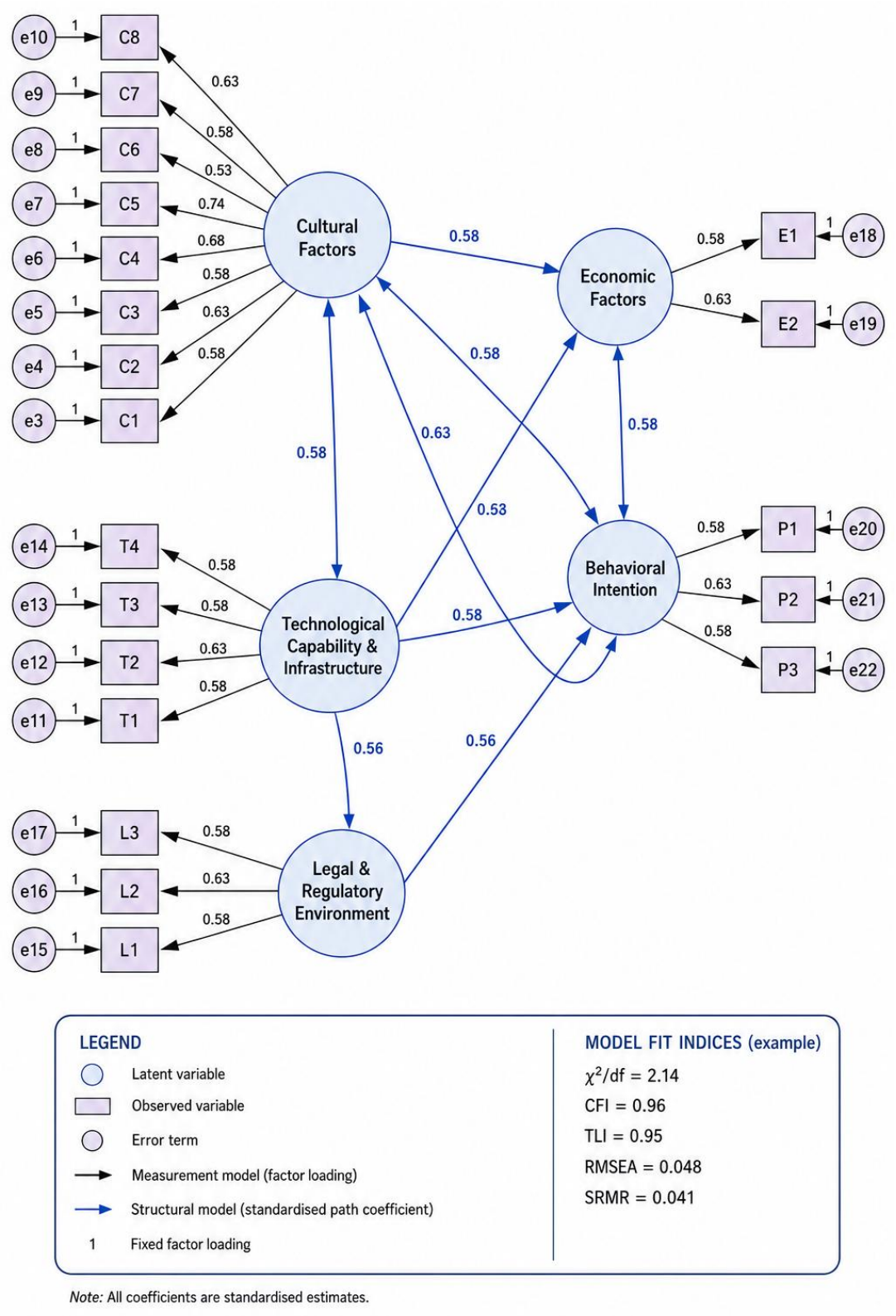

Figure 1. Fitted measurement model (first-order confirmatory factor analysis) based on standard coefficients

The fit indices of the first-order measurement model are presented in Table 3.

Table 3. Fit Indices of the Measurement Model (First-Order)

Index	Value	Status
TLI	0.902	Confirmed
NFI	0.946	Confirmed
IFI	0.953	Confirmed
CFI	0.952	Confirmed
χ^2/df	2.890	Confirmed
GFI	0.970	Confirmed
RMSEA	0.062	Confirmed
RMR	0.052	Confirmed

All fit indices are at a satisfactory level. The RMSEA value is 0.062 (less than 0.08) and the CMIN/DF value is 2.890 (less than 3) indicating a good fit of the model.

4.2. Analysis Results of Second-Order Confirmatory Factor Analysis

The results of the second-order confirmatory factor analysis for the five main themes are presented in Table 4.

Table 4. Confirmatory Factor Analysis of the Impact of Drivers on Blockchain Adoption in the Supply Chain

Symbol	Main Theme	Factor Loading	Critical Ratio	Significance Level	Status
C	Financial and economic factors	0.52	6.12	0.001	Confirmed
F	Organizational and cultural factors	0.57	6.18	0.001	Confirmed
U	Technical readiness and infrastructure	0.63	7.12	0.001	Confirmed
P	Legal and regulatory barriers	0.64	7.13	0.001	Confirmed
PS	Perceived benefits	0.53	6.14	0.001	Confirmed

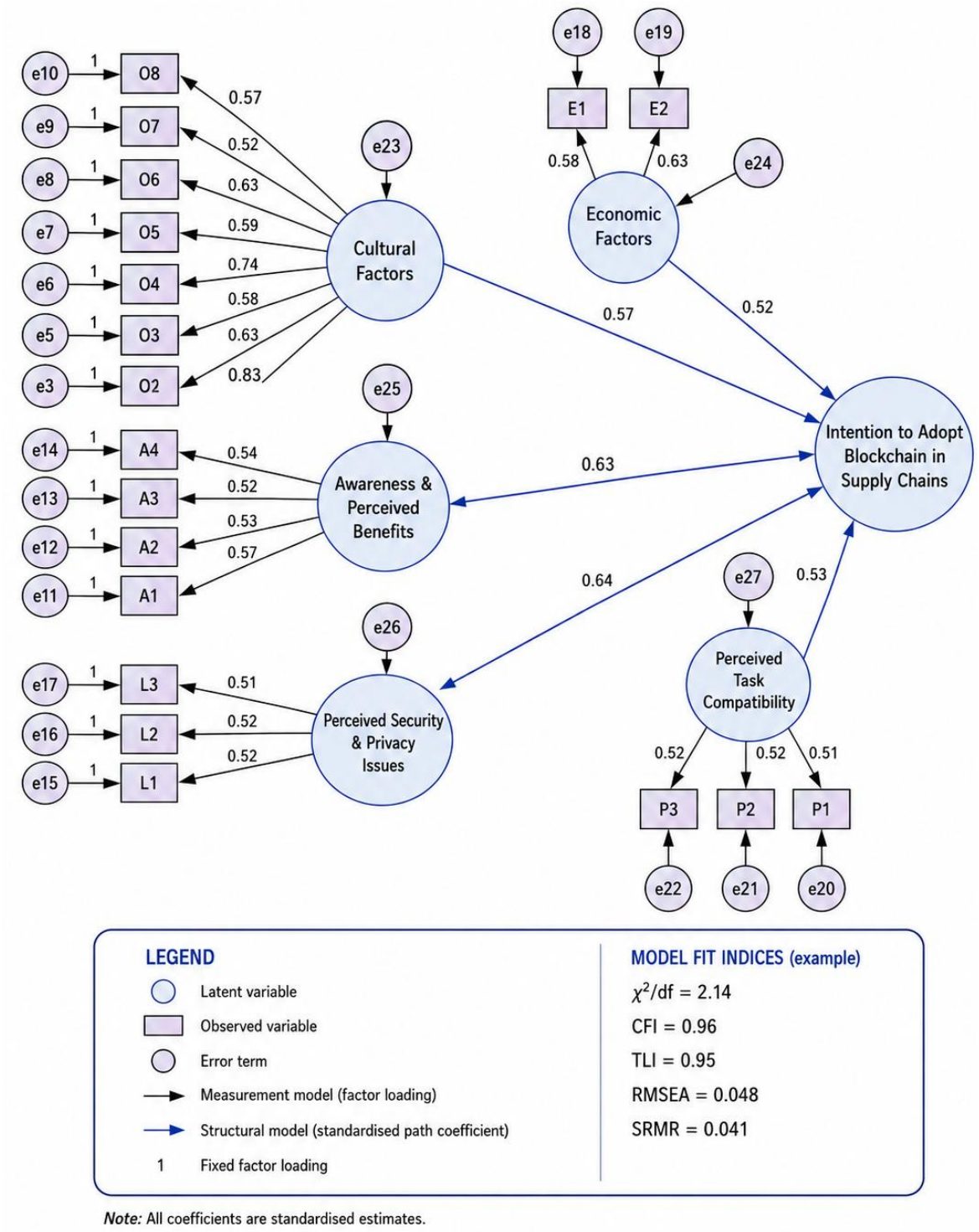

Figure 2. Fitted measurement model (second-order confirmatory factor analysis) based on standard coefficients

Based on the above table, all relationships between the latent variables (main themes) and their observed indicators (subthemes) were confirmed at a significance level of less than 0.001. Among the dimensions, "legal and regulatory barriers" exhibited the highest impact on blockchain adoption, with a factor loading of 0.64, while "financial and economic factors" demonstrated the lowest impact, with a factor loading of 0.52. The fit indices for the structural model are presented in Table 5.

Table 5. Fit Indices of the Structural Model (Second-Order)

Index	Value	Status
TLI	0.981	Confirmed
NFI	0.98	Confirmed
IFI	0.98	Confirmed
CFI	0.94	Confirmed
χ^2/df	2.59	Confirmed
GFI	0.98	Confirmed
RMSEA	0.044	Confirmed
RMR	0.000	Confirmed

As presented in the table above, all examined fit indices fall within acceptable ranges, indicating a good model fit. The RMSEA value was calculated at 0.044, and the Chi-square-to-degrees-of-freedom ratio (CMIN/DF) was 2.59, both of which lie well within their respective recommended thresholds. Furthermore, all other fit indices exceeded the 0.9 benchmark, further confirming the adequate fit of the measurement model.

4.3. Results of the population mean test

The results of the one-sample t-test to examine the status of the research indicators are presented in Table 6.

Table 6. Examination of Research Indicators Status (One-Sample t-test).

Variable Name	Mean	Test Statistic	Significance Level	Lower Bound	Upper Bound
Financial and economic factors	3.45	4.586	0.002	0.256	0.458
Organizational and cultural factors	2.125	-3.25	0.001	0.256	0.358
Technical readiness and infrastructure	3.24	4.576	0.000	0.358	0.245
Legal and regulatory barriers	3.652	5.485	0.000	0.265	0.356
Perceived benefits	3.746	6.586	0.000	0.235	0.635

The results indicate that the test statistic values for all indicators, with the exception of "organizational and cultural factors," are positive and exceed the critical threshold of 1.96. This suggests that the status of these indicators is assessed as above average. However, "organizational and cultural factors" yielded a negative test statistic of -3.25, indicating that the status of this indicator

is significantly below average. Based on these results, the status of the indicators can be interpreted at three distinct levels:

Level One (Above Average): "Perceived benefits," with the highest mean score (3.746) and test statistic (6.586), emerges as the leading driver. Additionally, "legal and regulatory barriers" (mean = 3.652) and "financial and economic factors" (mean = 3.45) also fall within the above-average range.

Level Two (Moderate): "Readiness and technical infrastructure," with a mean score of 3.24 and a test statistic of 4.576, exceeds the population average and is considered desirable; however, it occupies a comparatively lower position relative to perceived benefits.

Level Three (Below Average): "Organizational and cultural factors," with a notably low mean score of 2.125 and a negative test statistic of -3.25, represents the sole indicator whose status is assessed as significantly below average.

5. Discussion and Interpretation

The results of structural equation modeling and the one-sample t-test collectively provide a comprehensive picture of the complexities surrounding blockchain adoption within the Iranian supply chain. The data reveal that, contrary to the common perception that blockchain challenges are predominantly technological in nature, institutional and structural variables play a far more decisive role in the Iranian context. In this study, "legal and regulatory barriers" (factor loading = 0.64) demonstrated the highest impact on adoption, a finding that is readily explained by institutional uncertainty theory, as the lack of legal transparency substantially increases operational risk for managers. Furthermore, the unfavorable status of "organizational and cultural factors," with a notably low mean score of 2.125, was identified as the most critical weakness. This stands in contrast to "perceived benefits," which recorded the highest mean score (3.746), thereby underscoring the paradox between "mental inclination" and "executive capability" within Iranian organizations.

5.1. Scientific contribution and innovation of the research

By presenting a validated model within the context of the Iranian supply chain, this research transcends traditional and purely technology-oriented approaches to blockchain technology. The scientific contribution and added value of this study in the field of supply chain management can be articulated along the following axes:

Paradigm Shift from a Technical to an Institutional Perspective: While a substantial portion of the existing literature attributes blockchain challenges primarily to technical and infrastructural complexities, the findings of this research—by identifying "legal and regulatory barriers" as the most decisive factor (factor loading = 0.64)—demonstrate that in the Iranian economic context, legal and regulatory institutions exert a governing influence over the acceptance or rejection of technology. This finding, grounded in institutional uncertainty theory, constitutes a significant contribution to the development of technology adoption models and substantiates that, in the absence of legal transparency, even the most robust technical infrastructure will fail to facilitate adoption.

Root Cause Explanation of Project Failure from an Organizational Perspective: By identifying a pronounced gap between "perceived benefits" (with the highest mean score of 3.746) and "organizational and cultural factors" (with the lowest mean score of 2.125), this study provides a scientific explanation for the 92% failure rate of blockchain projects. The principal innovation here lies in demonstrating that the primary obstacle is not a lack of appreciation for the technology's benefits, but rather structural bottlenecks and cultural resistances. This finding redirects managerial focus from "sole investment in hardware" toward "change management and the reconstruction of organizational culture."

Localization of the Model within the Context of International Constraints: This study is among the few that has successfully integrated and validated context-specific environmental variables—such

as "the impact of sanctions and national considerations"—within a structural model, achieving a significant factor loading (0.63). This contributes to the enrichment of the technology management literature in emerging markets and offers a model that addresses the unique challenges of technology transfer under conditions of international constraints.

6. Discussion and Conclusion

6.1. Analysis of the Causes of the Crisis in Organizational and Cultural Factors

The statistical findings of this study revealed that "organizational and cultural factors," with a mean score of 2.125, represent the sole component that falls significantly below the average level. Conversely, while "perceived benefits" recorded the highest mean score (3.746), this profound gap between "knowing" and "being able" is deeply rooted in the underlying layers of Iranian organizational culture. The primary reasons for this critical situation can be analyzed along several axes:

The Conflict Between Blockchain Transparency and Traditional Structures: Blockchain possesses a disruptive nature that engenders maximum transparency by eliminating intermediaries and recording immutable transactions. Within the Iranian organizational context, which is predominantly characterized by vertical hierarchical structures and centralized power, this level of transparency may be perceived as a threat to traditional management layers, thereby giving rise to organized "organizational resistance."

Lack of Expertise and Skills Gap: The results indicated that the scarcity of qualified experts in the fields of cryptography and smart contracts constitutes a major barrier. In Iran, academic curricula and organizational training programs have yet to align with the pace of technological advancements, resulting in a form of "technological apprehension" at the expert level.

Culture of "Patience and Waiting": Owing to prevailing environmental uncertainties, Iranian managers tend to adopt a wait-and-see approach toward pioneering projects—preferring to observe their success or failure rather than proactively embrace innovation. This cautious posture has caused many projects to remain stalled at the level of theoretical discourse.

6.2. Policy and Operational Suggestions (Government and Central Bank)

Given that "legal and regulatory barriers," with a factor loading of 0.64, play the most decisive role in creating challenges, the elimination of legal ambiguity should be regarded as the foremost priority for governance. Accordingly, the following suggestions are presented:

1. Suggestions for the Government and Legislative Institutions: Development of a Legal Framework for Smart Contracts: The government, in collaboration with the judiciary, should formally recognize the legal validity of "smart contracts" within domestic courts, thereby assuring companies of the automatic enforcement of obligations without reliance on traditional guarantors. Regulatory Sandboxes: The establishment of test environments for blockchain projects in the supply chain should be facilitated, enabling companies to operationalize their models under governmental supervision and with temporary legal exemptions.
2. Suggestions for the Central Bank: Distinction Between Cryptocurrencies and Distributed Ledger Technology (DLT): Instead of issuing blanket warnings, the Central Bank should clearly delineate the boundary between "volatile digital currencies" and "industrial applications of blockchain in the supply chain." This distinction would enable supply chain managers to leverage the traceability and transparency capabilities of this technology without apprehension regarding

financial sanctions. Adoption of Digital Assets in Supply Chain Transactions: Given the impact of sanctions (factor loading = 0.63), it is recommended that the Central Bank develop the requisite protocols for utilizing asset tokens in inter-organizational settlements within the supply chain, thereby reducing financial costs arising from banking restrictions.

6.3. Final Conclusion

This study has demonstrated that the path to overcoming the 92% failure rate of blockchain projects does not lie in refining hardware infrastructure. Rather, success within Iran's supply chain necessitates an "institutional leap" in legal frameworks and a "cultural renewal" within organizations. As long as legal ambiguity—identified as the strongest barrier—and organizational weakness—recognized as the most critical bottleneck—remain unaddressed, the perceived benefits of this technology will persist solely at the theoretical level. Final Recommendation for Managers: Organizations should develop comprehensive "change management" strategies prior to entering the operational phase and, through targeted investment in specialized cryptography training, cultivate the requisite mental readiness within their human resources.

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