

The Role of Blockchain Technology in the Development of Accounting in Iran

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Abstract: The purpose of the present study is to propose a model of the drivers and barriers of blockchain technology influencing the development of accounting. A mixed-methods approach combining qualitative (grounded theory) and quantitative phases was employed. In the qualitative phase, using the snowball sampling method, semi-structured interviews were conducted with 17 experts and specialists in the fields of accounting and information technology in Iran, and data were collected until theoretical saturation was achieved. Data analysis through open, axial, and selective coding led to the identification of 55 concepts and 12 categories. The identified categories in this phase included political, social, legal, environmental, technological, and economic drivers, as well as political, social, legal, environmental, technological, and economic barriers. In the quantitative phase, a questionnaire was developed based on the conceptual model and distributed among 329 accountants and auditors who were members of the Iranian Association of Certified Public Accountants, as well as experts and managers in the field of financial technologies in fintech companies. The results obtained from the Interpretive Structural Modeling (ISM) indicated that among the blockchain drivers, the most influential factors were economic drivers, followed by social and environmental drivers. Finally, technological, legal, and political drivers were identified as the most influenced ones. Moreover, the findings related to blockchain barriers revealed that the most influential barriers were political, followed by social, environmental, and technological ones. The most influenced barriers were legal and economic. The findings of this study can be beneficial for managers and policymakers in the accounting and auditing sectors in effectively implementing blockchain-based programs.

Keywords: Blockchain, Accounting Development, Drivers, Barriers.

1. Introduction

Over the last decade, blockchain has moved from a cryptographic novelty to a foundational digital infrastructure that promises immutable record-keeping, programmable business logic, and near real-time assurance—capabilities that align closely with the information integrity and stewardship missions of accounting and auditing. Systematic field reviews trace the diffusion of distributed ledger technologies (DLTs) from financial services into enterprise functions, noting both momentum and fragmentation in adoption pathways, governance models, and regulatory responses [1, 2]. In accounting, this momentum is often framed as part of a broader digital transformation of reporting and assurance, where technologies such as blockchain, artificial intelligence (AI), and data analytics reconfigure processes, roles, and the

locus of trust [3-5]. At the same time, scholars caution against “technology push” narratives that outpace organizational readiness, market structure realities, and institutional constraints [6-8].

Within the accounting domain, the anticipated benefits of blockchain—immutability of entries, shared single source of truth, and smart contract automation—map directly onto pain points such as reconciliation overhead, latency in verifications, susceptibility to manipulation, and fragmented audit trails [9-11]. Systematic reviews document a fast-growing but heterogeneous research stream spanning conceptual frameworks, proofs of concept, and early empirical evaluations [12-14]. These reviews also underscore gaps: a dominance of technical and normative analyses over mature field evidence, a paucity of research in emerging and transition economies, and unresolved questions about control allocation, liability, and standards alignment [8, 12, 15].

Auditing use cases often headline the blockchain conversation because continuous, tamper-evident ledgers promise to shift assurance from periodic ex post verification to near real-time validation of controls and transactions [16, 17]. Exploratory accounts of practice highlight potential reductions in sampling risk, enhanced population testing, and streamlined confirmations; however, they also demonstrate new dependencies on node governance, consensus design, and interface integrity [18, 19]. The auditing standards ecosystem—still largely document-centric and evidence-oriented around traditional systems—faces tensions when engaging with cryptographic attestations, oracles, and smart-contracted processes [15]. Scholars propose pathways such as permissioned blockchains with fine-grained access control and verifiable audit evidence, but they emphasize that these designs introduce fresh risks and responsibilities for auditors as “assurance over code” becomes routine [20, 21].

In accounting information systems (AIS), blockchain is often positioned as an infrastructural layer enabling synchronized ledgers across organizational boundaries, thereby compressing the “record-to-report” cycle and reducing reconciliation costs [11]. Case analyses and bibliometric mappings show convergence with other digital building blocks—AI for anomaly detection, Internet of Things (IoT) for event capture, and APIs for inter-system orchestration—suggesting that blockchain’s impact is amplified when embedded within a stack of complementary innovations [2, 22]. That said, practical adoption is mediated by permissioning choices (public vs. private), scalability and latency constraints, and the governance mechanisms that arbitrate write rights, protocol upgrades, and dispute resolution [8, 9]. Evidence from Middle East and North Africa (MENA) contexts illustrates how regional regulatory trajectories, infrastructure maturity, and talent ecosystems condition the feasibility and form of deployments [23].

Empirical research is beginning to profile determinants of adoption among accounting professionals and organizations. Models extending technology acceptance and use frameworks report that performance expectancy, facilitating conditions, normative pressures, and perceived risks jointly shape intention to adopt, with notable heterogeneity across demographics, firm size, and market structure [24-26]. Studies in governmental and professional contexts further show that institutional pressures—coercive (regulatory), mimetic (peer adoption), and normative (professional bodies)—interact with technical characteristics to accelerate or stall uptake [6, 7]. In parallel, workforce dynamics matter: attracting and preparing accounting talent for data-centric, control-by-design environments remains a strategic challenge, especially under tight labor markets and evolving competency models [27]. These adoption determinants are particularly salient for emerging economies where infrastructural asymmetries and policy uncertainties can exacerbate risk perceptions [18, 28].

On the benefits side, research has documented conceptual and pilot-level evidence that blockchain can enhance audit trail integrity, reduce reconciliation workloads, and enable continuous controls monitoring via smart contracts [5, 16]. In fraud-prone processes, immutable logs and programmable checks create deterrence and earlier

detection windows, though design decisions about privacy, off-chain data, and key management can reopen attack surfaces [29, 30]. The “permissioned vs. permissionless” debate remains central: permissioned networks, often favored in enterprise accounting, can deliver more predictable throughput, governance, and compliance alignment, at the cost of decentralization and openness [14, 20]. Literature reviews caution that oversimplified claims of “tamper-proof accounting” overlook endpoint vulnerabilities, oracle risks, and the socio-organizational work of embedding new controls into routines and roles [8, 9].

Risk and compliance themes pervade the scholarship. Crypto-asset activity introduces valuation, ownership, and existence challenges for auditors, who must reconcile cryptographic proofs with fair value measurement, custody arrangements, and control testing over wallets and exchanges [31]. Standard-setting and guidance are evolving but still leave gaps when evidence originates from consensus protocols rather than traditional third-party confirmations [15]. For internal controls, blockchain’s “controls by design” potential is counterbalanced by the need for robust change management over smart contracts, key lifecycle management, and segregation of duties in decentralized environments [10]. Access control research proposes blockchain-based authorization models, but integration into legacy identity and access management (IAM) stacks remains a nontrivial engineering and governance task [21]. In operational accounting cycles, feasibility analyses emphasize fit: not every workflow benefits from a distributed ledger, and decision frameworks help practitioners determine when blockchain’s coordination gains exceed its coordination costs [7, 11].

From a reporting perspective, blockchain is implicated in the ongoing digitization of corporate reporting—structured data, real-time disclosures, and machine-readable assurance—raising questions about the role of controllers, auditors, and regulators in data governance ecosystems [3]. Reviews of smart technologies in accounting argue for four research pathways: process redesign, assurance innovation, governance and ethics, and capability development [22]. Bibliometric and systematic mappings corroborate the dispersal of topics across journals and geographies, signaling a maturing but still fragmented field [12–14]. Within this dispersion, country-level studies contribute contextual nuance on readiness dimensions—legal frameworks, infrastructural prerequisites, and professional body engagement—that shape trajectories of adoption [23, 28].

In the Iranian context, prior work on accounting development identifies structural and institutional drivers—governance quality, standard-setting, human capital, and technological capability—whose interactions condition reform outcomes [32]. Against this backdrop, exploratory analyses examine the feasibility and implications of blockchain in accounting and financial reporting, with attention to local regulatory regimes, infrastructure, and professional readiness [33]. Complementing this perspective, studies link blockchain and AI to audit quality improvements through enhanced evidence reliability and analytics-enabled anomaly detection, yet they also flag capacity gaps and the necessity of phased integration strategies [5, 34]. Recent work in the region further reports practitioners’ perceptions of blockchain’s impact on AIS effectiveness, underscoring benefits in timeliness and reliability alongside concerns about cost, interoperability, and regulatory clarity [35].

International practice-oriented evidence remains mixed. Surveys and case studies from Saudi Arabia indicate growing awareness and experimentation, but they also reveal divergence in perceived readiness across firm sizes and sectors, highlighting the catalyzing role of regulatory vision and professional training [36]. Malaysian experiences with crypto and blockchain point to audit and accounting process implications that hinge on standard interpretation and supervisory expectations, again illustrating the co-evolution of technology and institutions [37]. Studies from Ukraine and Kazakhstan add a transition-economy perspective, where infrastructural discontinuities and policy volatility complicate enterprise adoption despite strong interest among professionals [28]. Broader

MENA analyses emphasize the heterogeneity of readiness and underscore that cross-border standardization, legal harmonization, and public-sector exemplars can de-risk private adoption [23].

At the microlevel, adoption among accounting professionals is mediated by perceived usefulness, ease of use, facilitating conditions, and social influence, but also by perceived regulatory support and data governance assurances—factors captured in extended UTAUT and related models [24, 25]. Meta-analytic evidence on IT acceptance in auditing suggests that task-technology fit, organizational support, and training quality are reliable predictors of adoption, reinforcing the importance of complementary investments beyond the ledger itself [26]. The literature on challenges consistently cites scalability constraints, interoperability with legacy AIS, privacy-preserving data sharing, and the cost/benefit balance of deployment and maintenance [8, 14]. Risk lenses extend to crypto-asset auditing, where evidence gathering, rights and obligations, and valuation complexities require new procedures and, potentially, new standard-setting [15, 31].

Technical proposals and architectures continue to evolve. Designs for automated data integrity verification systems demonstrate how on-chain proofs and off-chain storage can be orchestrated to achieve both evidence robustness and operational efficiency [30]. Access control models using blockchain seek to distribute trust and improve traceability of permissions, with implications for segregation of duties and audit trails in multi-party processes [21]. In parallel, decision heuristics help organizations assess whether blockchain is warranted, guiding them through criteria such as multi-party data sharing, need for disintermediation, and tolerance for latency and throughput profiles [7]. These streams intersect with accounting governance debates, which emphasize accountability for code, assurance over oracles, and the ethics of embedding policy in smart contracts [4, 10].

Notwithstanding the promise, adoption studies stress practical barriers: cost of implementation, scarcity of specialized talent, unclear return on investment, and uncertainties about legal enforceability of smart contracts and on-chain records [8, 18]. Reviews of the “state of play” in finance reinforce that enterprise blockchain projects frequently stall at pilot stages due to governance disagreements, interoperability hurdles, and shifting regulatory guidance [1]. For audit transformation, commentators argue that permissioned architectures, coupled with robust API gateways and standardized data schemas, may provide a more feasible path for enterprise-grade deployment than open, permissionless networks—especially where confidentiality and performance are nonnegotiable [16, 20]. However, scholars also warn that permissioning can reproduce centralization risks and may reduce some of the very assurance benefits that blockchain purports to offer [9, 14].

The cumulative insight from these streams is twofold. First, blockchain’s relevance to accounting and auditing is less about replacing double-entry bookkeeping wholesale and more about re-architecting interorganizational processes to reduce reconciliation, enhance provenance, and embed controls into transaction flows [5, 11]. Second, successful adoption is contingent on context: regulatory clarity, standards evolution, professional competencies, and ecosystem coordination are necessary complements to technical capability [12, 13]. Country-level and sector-specific studies are therefore critical for moving beyond generic narratives to actionable models that surface drivers and inhibitors particular to a given institutional environment [23, 28, 32].

Given these dynamics—and the strategic importance of accounting information quality, auditability, and trust in financial reporting—there is a clear need for empirical, context-sensitive models that identify and structure the salient drivers and barriers to blockchain adoption in accounting. Such models can inform policy prioritization, capability development, and sequencing of implementation projects across public and private actors [8, 14]. They can also support professional education and talent strategies attuned to emerging roles at the intersection of accounting, analytics, and distributed systems [22, 27]. Against this background, and building on regional and

international evidence—including feasibility analyses, practitioner perceptions, and adoption frameworks—this study aims to develop and empirically validate an interpretive structural model that maps the drivers and barriers of blockchain adoption in accounting.

2. Methodology

The present study is an applied research in terms of its objective. Furthermore, from the perspective of data collection and analysis methods, this research follows a mixed exploratory design (qualitative followed by quantitative). In mixed exploratory studies, the researcher seeks to combine literature analysis, interviews with specific individuals regarding their experiences, focus groups, and case studies. Ultimately, considering its nature and type of investigation, the present research is a cross-sectional survey.

For the selection of the population and sample in the qualitative section, the principle of judgment and purposive sampling with theoretical sampling technique was applied. The statistical population in the qualitative phase consisted of experts in the fields of accounting and technology, including the following three groups:

- Academic experts and university professors from scientific and research centers;
- Experts and managers of policymaking and executive institutions in financial technologies;
- Specialists and professionals in the field of financial technologies.

The selection of experts in the qualitative phase was based on the criteria of having at least five years of relevant professional experience, continuous activity in accounting and technology-related positions, and holding at least a master's degree. The number of participants was determined according to theoretical saturation and repetition of data in interviews. Accordingly, the final number of qualified experts in the sampling design was 17 participants, consistent with the condition of theoretical saturation.

In the quantitative phase, the statistical population included all accountants and auditors who were members of the Iranian Association of Certified Public Accountants, as well as experts and managers in the field of financial technologies working in fintech companies. The total number of active accountants and auditors in 2024 was 2,186, while the group of fintech experts and managers included 119 individuals. Moreover, based on Cochran's sampling formula, the minimum required sample size was determined to be 329 individuals. To ensure this number, and considering a return rate of less than 1 for the distributed questionnaires, a total of 371 questionnaires were distributed among the statistical population, resulting in 329 valid and complete responses returned to the researcher.

It is noteworthy that, due to the heterogeneity of the population across two groups with distinct functional roles, stratified sampling with proportional allocation was employed. In this method, the sample size of each stratum is determined based on its proportion in the total population. Accordingly, the required sample size among auditors and accountants who were members of the Iranian Association of Certified Public Accountants was determined to be 312, while the sample size among experts and managers of fintech companies was 17. Within each group, non-probability convenience sampling was used to select participants.

The data collection process in this study comprised two parts. In the first part, to gather information related to the research literature, and to design the interview protocol and questionnaire, a library research method was employed. In the second part, to collect analytical data required for addressing the research questions, field and survey methods were applied. In the qualitative phase, data were collected through semi-structured interviews. All interviews were recorded, and the audio files were fully transcribed. Theoretical saturation was achieved after the last two interviews; however, additional interviews were conducted to ensure data adequacy. In each interview,

the research objectives and the interview process were explained to the participant. Both closed and open-ended questions were used during the interviews.

To obtain the required information, in-depth interviews were conducted, encouraging participants to narrate all components of a grounded theory-based approach for modeling the efficiency of blockchain technology in accounting and auditing units. The analysis of each interview was performed step by step immediately after its completion. After transcription, the textual data were conceptualized, and through successive analysis, key themes and categories were progressively extracted.

3. Findings and Results

This section seeks to provide a general understanding of the data within the studied statistical population. In the qualitative phase of the research, semi-structured interviews were conducted, and the interview process continued until theoretical saturation was achieved. The number of interviewed experts in the qualitative phase was 17. The average duration of each interview was approximately 90 minutes, and a total of more than 1,500 minutes of interviews with accounting and investment experts were conducted over a two-month period. The minimum professional experience of the experts in the relevant field was at least five years, while the maximum experience among them was 22 years. Table (1) presents the frequency distribution and percentage of the demographic characteristics of the experts.

Table 1. Demographic Characteristics of Experts

Demographic Characteristic	Levels	Frequency	Percentage
Work Experience	5–10 years	2	11.7%
	11–15 years	4	23.5%
	15–20 years	6	35.3%
	Over 20 years	5	29.5%
Gender	Male	10	58.8%
	Female	7	41.2%

As shown in Table (1), 11.7% of the experts had between 5 and 10 years of work experience, 23.5% between 11 and 15 years, 35.3% between 15 and 20 years, and 29.5% had more than 20 years of professional experience. In addition, the gender distribution of the experts indicates that out of 17 participants, 10 were men and 7 were women.

Furthermore, in order to validate the findings derived from the expert analysis, the opinions of accountants and auditors were utilized. Therefore, the statistical population in the quantitative phase consisted of these individuals. In this section, the demographic characteristics of this group are presented. These characteristics include gender, age group, education level, and work experience in the field of accounting and auditing. Table (2) presents the frequency distribution and percentage of these demographic characteristics.

Table 2. Frequency and Percentage Distribution of Accountants' Demographic Characteristics

Demographic Characteristic	Levels	Frequency	Percentage
Gender	Male	284	86.3%
	Female	45	13.7%
Age Group	Under 30 years	119	36.2%
	30–40 years	83	25.2%
	40–50 years	74	22.5%
	Over 50 years	53	16.1%
Education Level	Bachelor's	117	35.6%

Work Experience in Accounting and Auditing	Master's	184	55.9%
	Ph.D.	28	8.5%
	Less than 5 years	26	7.9%
	5–10 years	65	19.8%
	10–15 years	102	31.0%
	15–20 years	108	32.8%
	Over 20 years	28	8.5%

According to the results in Table (2), 86.3% of the total sample were men and 13.7% were women. Regarding age distribution, 36.2% of the participants were under 30 years old, 25.2% were between 30 and 40 years old, 22.5% were between 40 and 50 years old, and 16.1% were over 50 years old. Concerning education, 35.6% of respondents held a bachelor's degree, 55.9% held a master's degree, and 8.5% held a Ph.D. degree. In terms of work experience in accounting and auditing, 7.9% had less than 5 years of experience, 19.8% between 5 and 10 years, 31% between 10 and 15 years, 32.8% between 15 and 20 years, and 8.5% had more than 20 years of experience.

Blockchain Drivers in the Development of Accounting in Iran

For the explanation of each indicator, key points aggregated from the interviews were utilized. The key points used in identifying and naming the indicators are as follows:

1. Economic Drivers:

- *Transaction Costs*: Assessment of reduced transaction costs through the use of blockchain.
- *Efficiency in Financial Processing*: Speed and accuracy of financial transaction processing.
- *Market Adoption*: Number and type of organizations and industries adopting blockchain.
- *Effectiveness in Fraud Reduction*: Examination of reductions in financial fraud and accounting errors.
- *Time Savings*: Amount of time saved in accounting operations through blockchain implementation.

2. Political Drivers:

- *Government Acceptance*: Government policies regarding the adoption or regulation of blockchain.
- *Political Stability*: Impact of political stability or instability on blockchain development in accounting.
- *Government Regulations*: Presence or absence of supportive regulatory frameworks for blockchain in accounting systems.
- *Support for Innovation*: Level of governmental support for the development and adoption of new technologies such as blockchain.
- *Global Demand for Transparency*: Global trends toward increased transparency in financial and accounting systems.

3. Social Drivers:

- *Public Awareness*: Degree of public awareness of the benefits and challenges of using blockchain.
- *Digital Culture Adoption*: Acceptance of new technologies in society, particularly in financial sectors.
- *Trust in Digital Systems*: Public trust in the security and reliability of blockchain systems.
- *Workforce Readiness*: Workforce capability to adopt and utilize blockchain technology.
- *Social Demand for Financial Transparency*: Growing societal demand for financial transparency and accountability.

4. Legal Drivers:

- *Compliance with Financial and Accounting Regulations:* Alignment of blockchain with existing accounting and financial reporting laws.
- *Legal Support for Smart Contracts:* Impact of legislation on the establishment and enforcement of smart contracts.
- *Anti-Money Laundering Laws:* Blockchain's capacity to prevent money laundering and financial fraud.
- *Data Ownership Laws:* Regulation of data ownership and information rights in blockchain systems.
- *Regulatory and Legal Frameworks:* Existence or absence of specific legal frameworks for blockchain in accounting.

5. Environmental Drivers:

- *Energy Consumption Impact:* Assessment of blockchain's energy use and its environmental implications.
- *System Sustainability:* Potential for using blockchain in sustainable and environmentally friendly accounting systems.
- *Supply Chain Impact:* Application of blockchain to enhance sustainability and transparency in supply chains.
- *Environmental Reporting:* Blockchain's capacity to facilitate more accurate environmental and social reporting.
- *Data Recyclability:* Use of blockchain for data recovery and reduction of environmental harm from data loss.

6. Technological Drivers:

- *Cybersecurity:* Level of blockchain's protection against cyber threats and hacking attempts.
- *Scalability:* Ability of blockchain networks to handle large volumes of transactions without performance degradation.
- *Technological Innovation:* Degree of advancement and development of new blockchain applications in accounting.
- *Integration with Other Technologies:* Ability of blockchain to integrate with technologies such as artificial intelligence and the Internet of Things (IoT).
- *Compatibility with Legacy Systems:* Capability of blockchain to interface with existing accounting systems and software.

Blockchain Barriers in the Development of Accounting in Iran

For the explanation of each indicator, key points aggregated from the interviews were referenced. The key points used in identifying and naming the indicators are as follows:

1. Political Barriers:

1. *Government Support for Blockchain Technology:* Extent of governmental financial, regulatory, and legal support for promoting blockchain adoption.
2. *Political Stability and Risks:* Evaluation of the stability of the political environment and the likelihood of sudden changes affecting blockchain adoption.
3. *Intergovernmental and International Cooperation:* Degree of international collaboration among governments to establish blockchain standards.

4. *Financial Regulations and Policies*: Flexibility and alignment of fiscal and economic policies with blockchain utilization.
2. **Social Barriers:**
 1. *Cultural Readiness for Blockchain Adoption*: Assessment of public and professional readiness to embrace new technologies, particularly in accounting.
 2. *Public Awareness and Education*: Level of public knowledge regarding the benefits and risks of using blockchain in accounting.
 3. *Trust in Technology*: Degree of trust in decentralized systems and blockchain transparency.
 4. *Social Resistance to Change*: Level of societal and organizational resistance to adopting innovative technologies like blockchain.
3. **Legal Barriers:**
 1. *Existence of Blockchain-Related Laws and Regulations*: Evaluation of the presence or absence of explicit laws for blockchain use in accounting.
 2. *Data Protection and Privacy*: Examination of regulations governing the protection of financial and personal data in blockchain-based systems.
 3. *International Legal Agreements*: Alignment of blockchain-related legislation across countries and barriers arising from legal discrepancies.
 4. *Legal Gaps and Deficiencies*: Assessment of deficiencies in existing laws that may hinder blockchain implementation in accounting.
4. **Environmental Barriers:**
 1. *Environmental Impact of Blockchain Technology*: Measurement of blockchain networks' energy consumption and negative environmental effects.
 2. *Infrastructure and Technical Readiness*: Evaluation of whether sufficient infrastructure and technical resources exist for blockchain deployment in organizations.
 3. *Availability of Natural Resources for Technological Support*: Analysis of access to natural resources necessary for blockchain operations (e.g., electricity, hardware).
 4. *Complexity and Need for Process Optimization*: Assessment of the need to optimize current processes to minimize blockchain's environmental footprint.
5. **Technological Barriers:**
 1. *Information Security and Protection*: Evaluation of blockchain's security levels and capacity to prevent cyberattacks.
 2. *Blockchain Network Scalability*: Ability of blockchain to manage and process large volumes of financial data and transactions.
 3. *Compatibility with Existing Systems*: Assessment of blockchain's ability to integrate with legacy accounting systems and technologies.
 4. *Technical Challenges in Blockchain Development*: Evaluation of technological difficulties in designing and implementing blockchain for accounting purposes.
6. **Economic Barriers:**
 1. *Implementation and Development Costs*: Assessment of financial expenditures required for blockchain implementation in accounting.

2. *Financial Resources and Investment in Projects*: Evaluation of access to financial resources for blockchain-related investments.
3. *Return on Investment (ROI)*: Analysis of long-term financial benefits and profitability of blockchain adoption in accounting.
4. *Impact on Operational Costs*: Examination of how blockchain adoption may reduce or increase organizations' operational costs.
5. *Competition with Other Technologies*: Comparison of blockchain's costs and benefits relative to other existing technologies in the accounting industry.

In this section, the results derived from the Interpretive Structural Modeling (ISM) that governs the dimensions of the research model are presented. The findings for each group of drivers and barriers are explained separately, and the analysis for each group of factors consists of four parts. In the first part, the Structural Self-Interaction Matrix (SSIM) and the initial reachability matrix are provided to explain the causal relationships among the model's components. In the second part, after computing the final structural matrix of the components, the driving power and dependence of the model's components are calculated. Finally, the relationships and level partitioning of the model's components are determined.

The SSIM is constructed from the model components and their pairwise comparisons under four conceptual states. This matrix is formed based on the mode (most frequent value) of expert opinions regarding the type of relationships among the components. In this matrix, four relational symbols are encoded for each cell in row i and column j as follows:

Symbol V: Component i influences component j .

Symbol A: Component j influences component i .

Symbol X: Components i and j influence each other (bidirectional).

Symbol O: Components i and j have no relationship.

Table (3) presents the results of the experts' assessments and the prevailing views on the structural relationships among blockchain drivers in the development of accounting in Iran.

Table 3. Structural Self-Interaction Matrix (SSIM) of the Drivers

Component	Political Drivers	Economic Drivers	Social Drivers	Environmental Drivers	Legal Drivers	Technological Drivers
Political Drivers	X	A	A	A	X	A
Economic Drivers	V	X	V	V	V	V
Social Drivers	V	A	X	V	V	V
Environmental Drivers	V	A	A	X	V	A
Legal Drivers	X	A	A	A	X	V
Technological Drivers	V	A	A	V	A	X

In this matrix, diagonal elements are not valued and are assigned the value 1 in the final self-interaction matrix. By valuing the relational symbols in this matrix, the initial reachability matrix for the components is obtained. In this conversion, the relational symbols X and V are assigned the value 1, and the symbols O and A are assigned the value 0. Table (4) shows the valued entries of this matrix as the initial reachability matrix.

Table 4. Initial Reachability Matrix of the Drivers

Component	Political Drivers	Economic Drivers	Social Drivers	Environmental Drivers	Legal Drivers	Technological Drivers
Political Drivers	1	0	0	0	1	0
Economic Drivers	1	1	1	1	1	1
Social Drivers	1	0	1	1	1	1
Environmental Drivers	1	0	0	1	1	0
Legal Drivers	1	0	0	0	1	1
Technological Drivers	1	0	0	1	0	1

After forming the initial reachability matrix, the indirect relationships among the components must be corrected. For this purpose, the secondary reachability matrix is constructed. In this matrix, the following rule is applied: if component A leads to component B, and component B leads to component C, then component A must lead to component C. Table (5) presents the values of the secondary reachability matrix for the model's components.

Table 5. Secondary Reachability Matrix of the Drivers

Component	Political Drivers	Economic Drivers	Social Drivers	Environmental Drivers	Legal Drivers	Technological Drivers	Driving Power
Political Drivers	1	0	0	0	1	1	3
Economic Drivers	1	1	1	1	1	1	6
Social Drivers	1	0	1	1	1	1	5
Environmental Drivers	1	0	0	1	1	1	4
Legal Drivers	1	0	0	1	1	1	4
Technological Drivers	1	0	0	1	1	1	4
Dependence	6	1	2	5	6	6	26

As shown in Table (5), a considerable number of the relationships examined in the model have been modified and corrected under the secondary matrix so that the indirect relationships among the model's components are incorporated into the final structural matrix. Based on the dependence values of the components, it is observed that economic drivers have the lowest dependence on other components. The highest dependence among the model's components pertains to political drivers, legal drivers, and technological drivers. The results for driving power indicate that economic drivers exert the greatest influence on the other components of the model, whereas political drivers have the lowest level of influence.

To evaluate the driving power and dependence of the components jointly, their power–dependence scatter plot was drawn, as shown in Figure (1).

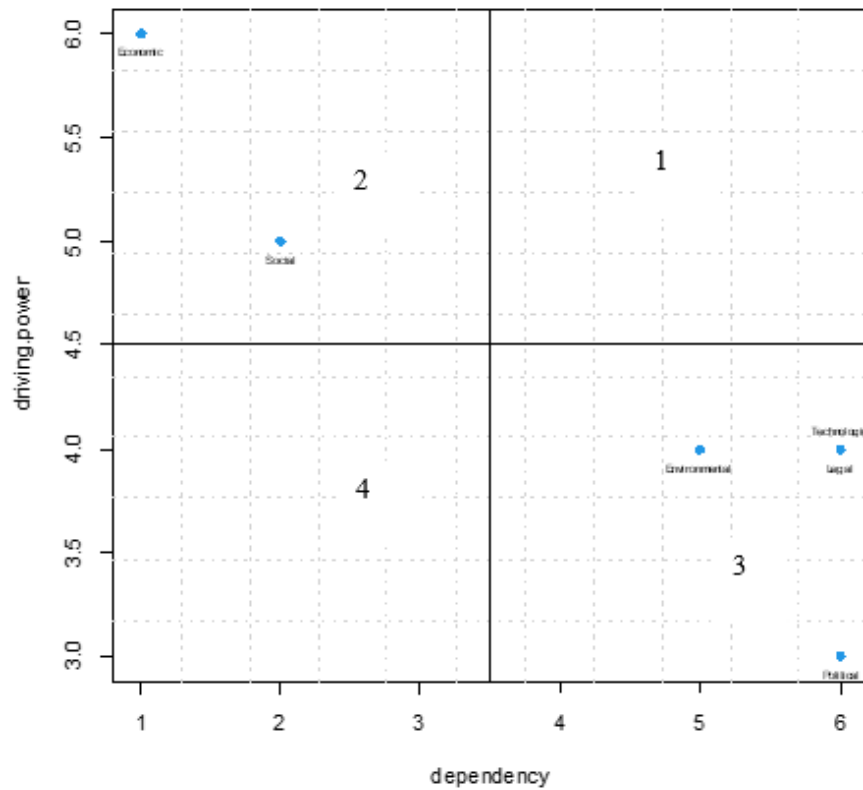


Figure 1. Power–Dependence of Blockchain Drivers in the Development of Accounting

According to Figure (1), which evaluates the pairs of driving power (vertical axis) and dependence (horizontal axis) for the components, none of the model’s components fall into the “linkage factors” group (Quadrant 1 of the figure) or the “autonomous factors” group (Quadrant 4 of the figure). Environmental, political, technological, and legal drivers are located in the “dependent factors” group (Quadrant 3), while social and economic drivers are located in the “independent factors” group (Quadrant 2).

To determine the relationships and level partitioning of the model’s components, the sets of influencing and influenced components corresponding to each component were used, and commonalities between the influencing and influenced dimensions were identified. Table (6) reports the results of this assessment.

Table 6. Level Partitioning of Blockchain Drivers in the Development of Accounting

Drivers	Component Level
Political Drivers	1
Legal Drivers	1
Technological Drivers	1
Environmental Drivers	2
Social Drivers	3
Economic Drivers	4

According to the results in Table (6), it is observed that, in the first iteration of level partitioning, political drivers, legal drivers, and technological drivers are prioritized. Thereafter, environmental drivers are prioritized in the second iteration, social drivers in the third iteration, and economic drivers in the fourth iteration. Therefore, in the final level partitioning of the components, the order of importance of the components in terms of being influenced and exerting influence is as follows:

1. Political drivers, legal drivers, and technological drivers.

2. Environmental drivers.
3. Social drivers.
4. Economic drivers.

Accordingly, the final model of blockchain drivers in the development of accounting in Iran can be depicted — based on the secondary reachability matrix — as shown in Figure (2).

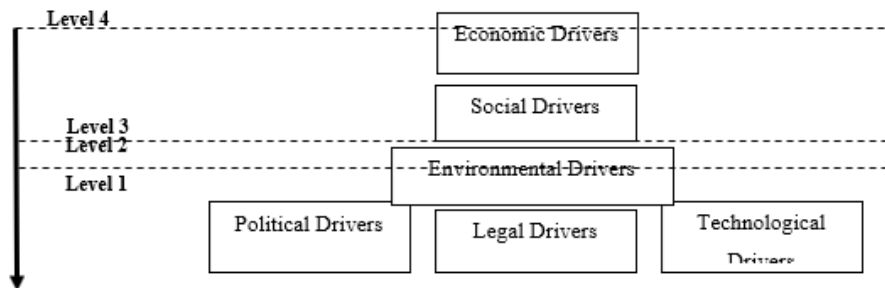


Figure 2. Interpretive Structural Model of Blockchain Drivers in the Development of Accounting

The Structural Self-Interaction Matrix (SSIM) of the model components and their comparisons were constructed in four conceptual states. This matrix was developed based on the mode (most frequent value) of expert opinions regarding the types of relationships among the components. Table (7) presents the results obtained from expert evaluations and the dominant opinions concerning the structural relationships among blockchain barriers in the development of accounting in Iran.

Table 7. Structural Self-Interaction Matrix (SSIM) of Barriers

Component	Political Barriers	Economic Barriers	Social Barriers	Environmental Barriers	Legal Barriers	Technological Barriers
Political Barriers	X	V	V	V	X	V
Economic Barriers	A	X	O	O	A	V
Social Barriers	A	O	X	X	V	O
Environmental Barriers	A	O	X	X	X	O
Legal Barriers	X	V	A	X	X	A
Technological Barriers	A	A	O	O	V	X

By assigning values to the relational concepts in this matrix, the initial reachability matrix for the components was obtained. In this matrix, the relational symbols **X** and **V** were assigned a value of 1, while **O** and **A** were assigned a value of 0. Table (8) displays the valued entries of this matrix in the form of the initial reachability matrix.

Table 8. Initial Reachability Matrix of Barriers

Component	Political Barriers	Economic Barriers	Social Barriers	Environmental Barriers	Legal Barriers	Technological Barriers
Political Barriers	1	1	1	1	1	1
Economic Barriers	0	1	0	0	0	1
Social Barriers	0	0	1	1	1	0
Environmental Barriers	0	0	1	1	1	0
Legal Barriers	1	1	0	1	1	0
Technological Barriers	0	0	0	0	1	1

After forming the initial reachability matrix, the indirect relationships among the components needed to be corrected. For this purpose, a secondary reachability matrix was developed. Table (9) presents the values of the secondary reachability matrix for the model's components.

Table 9. Secondary Reachability Matrix of Barriers

Component	Political Barriers	Economic Barriers	Social Barriers	Environmental Barriers	Legal Barriers	Technological Barriers	Driving Power
Political Barriers	1	1	1	1	1	1	6
Economic Barriers	0	1	0	0	1	1	3
Social Barriers	1	1	1	1	1	0	5
Environmental Barriers	1	1	1	1	1	0	5
Legal Barriers	1	1	1	1	1	1	6
Technological Barriers	1	1	0	1	1	1	5
Dependence	5	6	4	5	6	4	30

Based on the dependence power values of the components, it is observed that technological and social barriers have the lowest level of dependence on other components. The highest dependence among the model's components pertains to economic and legal barriers. The results of driving power values indicate that legal and political barriers exert the greatest influence on other barriers, whereas economic barriers have the least influence.

To evaluate the driving power and dependence of the components simultaneously, a driving power–dependence diagram was plotted, as illustrated in Figure (3).

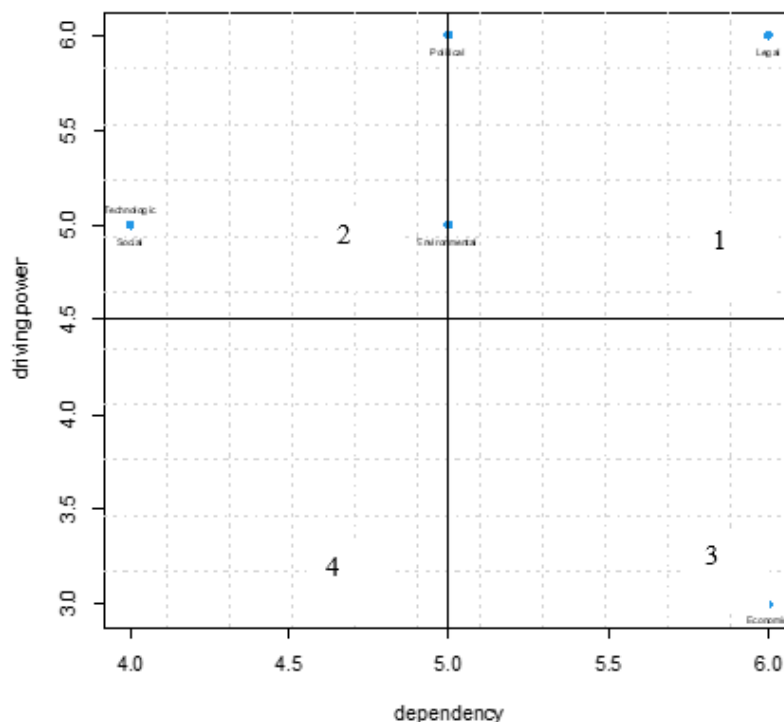


Figure 3. Driving Power–Dependence of Blockchain Barriers in the Development of Accounting

According to the above figure, which evaluates the components as ordered pairs of driving power (vertical axis) and dependence (horizontal axis), it is observed that none of the model components fall into the *autonomous factors* group (Quadrant 4) or the *dependent factors* group (Quadrant 3). Technological and social barriers are located in the

independent factors group (Quadrant 2), legal barriers are located in the *linkage factors* group (Quadrant 1), and environmental and political barriers are positioned along the boundary between the independent and dependent zones.

To determine the relationships and hierarchical levels of the model's components, both the influencing and influenced components corresponding to each element were analyzed, and the intersections between influencing and influenced sets were identified. Table (10) presents the results of this evaluation.

Table 10. Level Partitioning of Blockchain Barriers in the Development of Accounting

Barriers	Component Level
Economic Barriers	1
Legal Barriers	1
Social Barriers	2
Environmental Barriers	2
Technological Barriers	2
Political Barriers	3

According to the results in Table (10), in the first iteration of the level partitioning process, economic and legal barriers were prioritized. In the second iteration, social, environmental, and technological barriers were prioritized, followed by political barriers in the third iteration. Therefore, in the final hierarchical structure, the order of importance of the components in terms of their degree of influence and susceptibility is as follows:

1. Economic and legal barriers.
2. Social, environmental, and technological barriers.
3. Political barriers.

Accordingly, the final interpretive structural model of blockchain barriers in the development of accounting in Iran can be represented—based on the secondary reachability matrix—as shown in Figure (4).

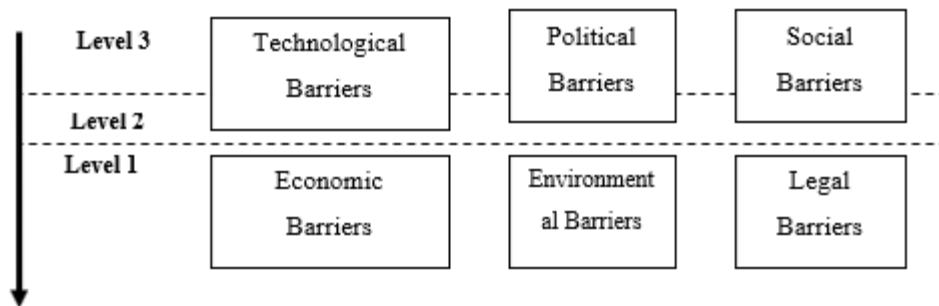


Figure 4. Interpretive Structural Model of Blockchain Barriers in the Development of Accounting

4. Discussion and Conclusion

The findings of this study, which aimed to model the drivers and barriers of blockchain technology in the development of accounting in Iran, reveal a multidimensional structure in which economic, social, environmental, technological, legal, and political factors interact to shape adoption pathways. The interpretive structural modeling (ISM) results indicate that economic drivers hold the strongest influence over other dimensions, while political drivers exhibit the least. Conversely, political, legal, and technological dimensions appear most dependent on other variables. Among the barriers, political and legal obstacles exert the greatest influence, whereas economic and technological barriers are among the most affected dimensions. These outcomes underscore the complexity of

blockchain implementation in the Iranian accounting environment, where structural, regulatory, and infrastructural asymmetries condition the rate and depth of adoption.

The prominence of **economic drivers** as the most influential factor aligns with international literature suggesting that cost efficiency, transaction transparency, and the potential for automation are primary motivators for adopting blockchain in accounting and auditing processes [8, 14]. Economic considerations dominate organizational decision-making, especially in developing economies where financial constraints dictate the viability of technology investments. The reduction of reconciliation costs, fraud-related losses, and audit overhead through distributed ledger systems is consistently documented as a compelling value proposition [11, 17]. Moreover, by automating verification and validation through smart contracts, blockchain enhances the timeliness and reliability of accounting data [5, 20]. This study's finding that economic drivers exert systemic influence across other factors reinforces the notion that perceived financial benefits underpin organizational commitment to blockchain integration. Similar results were reported in studies from Saudi Arabia and Egypt, where the cost–benefit ratio and operational efficiency were key predictors of adoption intention [18, 36].

The **social and environmental drivers**, ranking immediately after economic factors, reveal that societal awareness, digital readiness, and public trust are crucial in shaping attitudes toward blockchain adoption. This finding echoes prior studies emphasizing that organizational and societal culture can either enable or constrain innovation diffusion [25, 26]. In contexts with limited digital literacy, skepticism toward data transparency and decentralized systems may dampen acceptance. However, as public trust in digital systems grows, the willingness to rely on blockchain for accounting operations strengthens [18, 19]. Environmental drivers, including sustainability and energy efficiency considerations, have gained relevance in recent years as enterprises face mounting pressure to report environmental performance transparently. Blockchain's potential to enhance traceability in supply chains and support sustainable reporting is increasingly recognized [12, 13]. Thus, the interplay between social legitimacy and environmental accountability appears to be an emergent enabler of blockchain legitimacy in accounting systems, particularly where environmental, social, and governance (ESG) reporting is expanding.

On the other hand, the study found that **technological, legal, and political drivers** are more dependent than influential within the structural model. This finding implies that the effectiveness of these factors is contingent upon the maturation of economic and social infrastructures. Technological readiness—including scalability, interoperability, and cybersecurity—is a recurrent constraint noted in global analyses of blockchain adoption [8, 20]. In Iran's context, legacy systems, limited blockchain expertise, and insufficient infrastructure exacerbate these constraints. Legal and regulatory factors also remain reactive rather than proactive; the absence of standardized frameworks and guidelines for smart contracts and distributed ledgers introduces uncertainty and limits institutional confidence [15, 23]. Political drivers, similarly, depend heavily on the policy environment. Governments' openness to innovation and their commitment to digital transformation determine whether blockchain adoption is encouraged or hindered [7, 24]. The dependency of these factors suggests that technical and legal readiness alone cannot trigger blockchain integration unless they are anchored in economic feasibility and social acceptance.

The findings regarding **blockchain barriers** reveal that political and legal obstacles are the most influential deterrents. This aligns with evidence from multiple jurisdictions where uncertainty about regulations, taxation of crypto-assets, and the legal status of blockchain-based records impede diffusion [29, 31]. Political instability, inconsistent policy frameworks, and fragmented governance structures often translate into regulatory ambiguity, which in turn discourages investment in blockchain systems [18, 23]. The strong influence of legal barriers observed

here parallels findings from Malaysia and the MENA region, where compliance gaps and the absence of audit standards for blockchain transactions delayed implementation [37]. These findings underscore the necessity of coherent legal frameworks, professional guidance, and interagency collaboration to create an enabling environment for innovation.

The **economic and technological barriers**, which were the most affected in this model, illustrate a dependence on broader institutional readiness. The high cost of deployment, scarcity of technical expertise, and uncertain return on investment remain the most cited deterrents worldwide [3, 8]. In developing economies, initial costs of infrastructure and training are magnified due to foreign software reliance and limited local capacity [28, 33]. Technical limitations—such as throughput constraints, energy consumption, and interoperability issues—compound these challenges, especially when organizations attempt to integrate blockchain with legacy accounting systems [14, 30]. Prior research similarly demonstrates that technological maturity evolves only when supported by political will, market incentives, and regulatory clarity [6, 7]. Therefore, the positioning of these barriers as “dependent” in the ISM hierarchy mirrors the broader global finding that technological barriers are symptoms rather than root causes of adoption resistance.

The results further show that **social and environmental barriers** occupy an intermediate position—neither fully independent nor fully dependent. This indicates that societal awareness, resistance to change, and environmental concerns evolve alongside other systemic factors. Cultural readiness and trust in digital mechanisms are critical determinants of technology acceptance in professional domains like accounting [25, 26]. Where transparency is perceived as threatening established hierarchies or discretionary control, resistance emerges [18]. Environmental concerns, such as blockchain’s energy footprint, also moderate adoption enthusiasm, especially when sustainability narratives clash with resource realities [5, 13]. These mid-level barriers thus function as adaptive filters, amplifying or dampening the influence of structural enablers like economic feasibility and technological capacity.

An intriguing insight from the level partitioning is the clustering of **economic and legal barriers** at the foundational level. This suggests that unless these foundational barriers are addressed, higher-order obstacles—technological, social, and political—will remain persistent. The centrality of economic-legal constraints echoes previous frameworks that treat regulatory design and financial feasibility as the “twin pillars” of blockchain transformation [10, 15]. Effective legal governance enhances investor confidence, while cost efficiency ensures sustainability of operations [8, 18]. The hierarchical model derived from this study thus validates prior claims that blockchain’s disruptive potential can only be realized through synergistic evolution of regulatory policy, professional standards, and organizational learning [4, 12].

Comparatively, the hierarchical relationship found in this study—economic → social → environmental → technological/legal/political—resembles the staged adoption models proposed in earlier research. For example, Pedersen et al. (2019) describe a sequential “ten-step decision path” where economic feasibility and stakeholder alignment precede technical and regulatory deployment phases [7]. Similarly, Janssen et al. (2019) emphasize institutional and market readiness as preconditions for sustainable adoption [6]. By corroborating these frameworks, the present study strengthens the view that blockchain adoption in accounting is not a purely technological transition but an institutional and socio-economic one. In this sense, the Iranian experience mirrors global tendencies while exhibiting context-specific nuances shaped by governance and infrastructural maturity [32, 33].

Another significant finding is the positioning of **political drivers and barriers** as boundary factors—both influencing and being influenced by other variables. This ambivalent role reflects the dual nature of government:

as both regulator and adopter. Government endorsement can accelerate diffusion through signaling and standardization, yet overregulation or policy inconsistency can suppress innovation [23, 37]. The study by Oraby Salah (2025) in Saudi Arabia similarly found that political commitment to digital transformation was decisive in encouraging blockchain adoption among accountants [36]. Conversely, the lack of consistent policy support in certain jurisdictions has led to fragmented experimentation and low scalability [18]. Thus, the political dimension acts as a “control lever” in the blockchain adoption ecosystem, influencing the velocity and direction of institutional change.

The strong interdependence observed between **legal and technological components** further supports prior research emphasizing that technological functionality must coevolve with legal enforceability. Blockchain’s trust mechanism replaces certain forms of procedural control, but legal frameworks must clarify accountability for coding errors, smart contract failures, and data immutability conflicts [15, 20]. Without legal codification, the perceived risks of liability and compliance breach remain deterrents. This echoes the argument by Akter et al. (2024) that blockchain adoption in accounting is as much a governance transformation as it is a technical upgrade [8]. In countries with evolving regulatory landscapes, legal agility and interagency coordination are critical for balancing innovation with assurance.

Finally, the model developed in this research contributes theoretically by integrating economic, social, legal, technological, environmental, and political factors into a hierarchical framework that clarifies causal pathways. This multidimensional articulation expands earlier conceptualizations that treated adoption drivers in isolation [12, 13]. By distinguishing between influencing and dependent factors, it aligns with contemporary systems-thinking approaches in accounting technology research, positioning blockchain adoption as a function of dynamic interdependencies rather than discrete variables [14, 22]. Empirically, the results also validate the significance of contextualized modeling for developing countries, where infrastructural, institutional, and human capital constraints differ markedly from those in developed economies [23, 28].

Despite its contributions, this study has certain limitations that should be acknowledged. First, the sample size of experts and accounting professionals, while diverse, remains limited to the Iranian context, which restricts the generalizability of the findings to other economies with different institutional frameworks. Second, data collection relied on self-reported perceptions through interviews and questionnaires, which may be influenced by social desirability bias or participants’ subjective experiences with technology. Third, the interpretive structural modeling approach, while effective in revealing hierarchical relationships, does not quantify causal strength or test predictive validity. Future studies could enhance precision by integrating ISM with structural equation modeling (SEM) or other multivariate techniques. Lastly, the dynamic evolution of blockchain technology and accounting standards means that findings represent a snapshot in time and may need updating as regulatory frameworks, market infrastructures, and professional practices evolve.

Future studies should replicate and extend this model across different cultural, institutional, and economic contexts to test the robustness of the identified hierarchies. Comparative cross-country analyses could reveal how distinct governance regimes and regulatory systems shape blockchain adoption patterns. Researchers could also incorporate longitudinal designs to examine the temporal dynamics of adoption, identifying how drivers and barriers evolve through different implementation phases. Additionally, integrating perspectives from complementary technologies—such as AI, big data analytics, and IoT—would provide a holistic understanding of the digital accounting ecosystem. Expanding stakeholder participation to include regulators, technology

developers, and educators could yield a richer multi-actor perspective, while simulation modeling could test intervention scenarios to forecast adoption trajectories under varying policy and economic conditions.

Practitioners and policymakers can leverage these findings to prioritize interventions that address high-influence drivers and barriers first. Strengthening economic incentives—through subsidies, tax breaks, or innovation grants—can accelerate adoption readiness. Policymakers should focus on creating coherent legal frameworks for smart contracts and blockchain auditing standards to reduce uncertainty and enhance investor confidence. Accounting firms should invest in digital upskilling, collaborative pilot projects, and hybrid governance models that balance transparency with confidentiality. Professional bodies can play a pivotal role by integrating blockchain literacy into certification curricula and by issuing practice guidelines that align with international standards. Finally, a phased, ecosystem-based approach that aligns technological, institutional, and human capital development will be critical to transforming blockchain potential into tangible accounting innovation.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

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

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Conflict of Interest

The authors report no conflict of interest.

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