Blockchain, Smart Contracts, and Financial Transparency: Opportunities for Startups in Algeria

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Abstract :

Blockchain technology is transforming accounting and finance by providing transparency, traceability, and reliability of financial information. This research examines its potential in Algeria, focusing on the role of smart contracts in supporting startups. The objectives are to explore blockchain's theoretical contributions, identify adoption areas such as banking, taxation, accounting, and auditing, and analyze benefits including fraud reduction, data security, and improved accountability.

Findings suggest that smart contracts could simplify financial transactions, reduce costs, and increase trust for startups operating in a challenging business environment. However, major barriers persist, including regulatory uncertainty, weak digital infrastructure, high implementation costs, and limited expertise. The study concludes that blockchain adoption in Algeria should start with pilot projects, combining institutional reforms with targeted support for startups.

Keywords: Blockchain, Smart Contracts, Accounting Innovation, Financial Transparency, Startups.

JEL classification codes: M41; G32; O33; G38

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Introduction:

Blockchain technology has emerged as a transformative force in global accounting and financial reporting, offering solutions to persistent issues such as fraud, weak data integrity, and lack of trust in reporting systems. Its defining features, immutability, decentralization, traceability, and the ability to embed smart contracts, are widely recognized by scholars and practitioners as capable of reshaping how accounting information is generated, shared, and verified. Research suggests that in countries with less mature financial infrastructures, blockchain can automate accounting controls and enhance transparency (Bellucci, Cesa Bianchi, & Manetti, 2022). Smart contracts, which execute predefined contractual clauses without intermediaries, add to this potential by reducing transaction costs and reliance on manual enforcement (Taherdoost, 2023). Despite these opportunities, the integration of blockchain in accounting still faces significant barriers, particularly regarding regulation, infrastructure, and organizational readiness.

In Algeria, the economic context makes the debate particularly relevant. The country is in a process of economic diversification, aiming to reduce reliance on hydrocarbons while encouraging the development of startups and innovative firms. Yet many of these startups face structural difficulties : limited access to financing, weak contractual security, and challenges in producing transparent and credible financial statements. These issues are compounded by the persistence of a large informal sector, limited digital infrastructure, and regulatory frameworks not yet aligned with new technologies. Abdelouahed (2021) highlights that blockchain could enhance transparency and credibility in Algerian accounting practices, but stresses that legal incompatibilities remain a major obstacle. At the same time, Algerian firms are increasingly pressured by the broader trend of digital transformation, which demands accounting systems that are more transparent, reliable, and technologically advanced (Meraghni, Bekkouche, & Demdoum, 2021).

This environment leads to a central problem: to what extent can blockchain and smart contracts improve the transparency, reliability, and trustworthiness of financial information in Algerian startups, and what are the major barriers to their adoption? Addressing this problem requires bridging theory and practice. While studies from other developing economies provide insights into the benefits and challenges of blockchain adoption, the Algerian institutional and economic setting introduces specific factors that may alter both opportunities and constraints. To guide the investigation, three hypotheses are proposed : first, that blockchain adoption improves transparency and reliability of accounting

information for startups ; second, that smart contracts streamline financial and contractual processes by reducing costs and intermediaries ; and third, that key barriers are regulatory uncertainty, infrastructure limitations, high costs, and lack of adequate technical skills.

The methodology adopted in this research combines a review of existing scientific literature with an empirical study in the Algerian context. The literature review helps to identify global trends, conceptual frameworks, and prior findings on blockchain and smart contracts in accounting (Bellucci et al., 2022). The empirical component explores the perceptions and readiness of Algerian startups, accounting professionals, and regulatory stakeholders through surveys and interviews. This mixed approach makes it possible to compare international insights with local realities, highlighting both convergences and divergences. The study combines qualitative and quantitative tools, including surveys to collect numerical data, semi-structured interviews to capture in-depth insights, and a review of scientific articles to provide theoretical grounding. These tools ensure the robustness and comprehensiveness of the analysis.

In Algeria, while Information and Communication Technologies (ICT) have gained considerable traction among businesses and startups, blockchain and smart contracts remain largely emergent and under-adopted. ICT broadly encompasses hardware (computers, servers, networks), software (accounting systems, ERP tools, automation), and services (cloud computing, digital communication, data storage). Blockchain, a subset of ICT, is characterized by a distributed ledger technology that enables immutability, transparency, and trust without reliance on centralized authorities (Barakova, Ussatova, & Soğukpinar, 2022). Despite these qualities, studies show that in Algeria the integration of blockchain into accounting systems is constrained by regulatory, legal, and technical challenges (Abdelouahed, 2021).

Given this reality, our practical study adopts a two-step approach. First, we analyze general ICT usage and levels of digitalization among Algerian startups , this gives a baseline of digital maturity and reveals how traditional digital tools are being used. Then, building on this foundation, we investigate the perceptions of startup leaders and managers regarding newer technologies such as blockchain and smart contracts: their awareness, perceived utility, intentions to adopt, and major barriers. This allows us to juxtapose what is happening in practice (with conventional ICT) with what may be possible in future (with more advanced / emerging ICT).

This framework is justified by the literature: despite the recognized benefits of blockchain for transparency, reduction of intermediaries, and improved auditability (Cherif & Azaizia, 2023), the empirical evidence in Algeria indicates limited application thus far. For example, Abdelouahed (2021) finds that while many see potential in blockchain's ledger mechanisms and its promise for triple-entry accounting, actual deployment is hindered by lack of regulatory compatibility with existing accounting laws. Therefore, by first studying general ICT adoption and then perceptions of blockchain and smart contracts, our study attempts to capture both the current state and the future readiness of Algerian startups to embrace these disruptive technologies.

The article is structured into three main parts. The first presents the theoretical and conceptual framework of blockchain and smart contracts in accounting and finance, as well as a synthesis of international experiences. The second analyzes the opportunities that these technologies may offer for Algerian startups, especially in terms of transparency, credibility, and efficiency. The third identifies the barriers and challenges to their adoption, drawing on both local data and international comparisons. The conclusion revisits the hypotheses, summarizes the findings, and offers recommendations for practice and policy, while also suggesting avenues for future research.

I. Conceptual Foundations of ICT, Blockchain, Smart Contracts, and Startups

Information and Communication Technologies (ICT) are broadly defined as a set of technological resources that enable the processing, storage, and exchange of information. They include hardware (computers, servers, networks), software (ERP systems, accounting software, automation tools), and digital services (cloud platforms, online communication, and data storage). According to UNESCO (2020), ICT constitutes "a diverse set of technological tools and resources used to communicate, create, disseminate, store, and manage information." In the accounting and financial sectors, ICT is regarded as a major driver of efficiency, transparency, and innovation, allowing firms to digitalize documentation, automate workflows, and improve data accessibility (Laudon & Laudon, 2020).

Within ICT, blockchain technology and smart contracts are often classified as emerging digital innovations.

A blockchain is a distributed ledger technology that enables the recording of transactions in a decentralized, immutable, and transparent way. Pascual Pedreño (2021) analyses how blockchain could change traditional accounting

systems, noting that with blockchain, the accounting ledger might evolve toward "triple entry accounting," thus transforming the role of accountants and auditors.

Smart contracts are self-executing code deployed on a blockchain that carry out predefined contractual clauses without intermediaries. As Bartoletti & Pompianu (2017) explain, "smart contracts are computer programs that can be consistently executed by a network of mutually distrusting nodes, without the arbitration of a trusted authority." This definition emphasizes automation, trust, and execution without a central trusted entity.

The term startup has been critically examined in academic literature, especially regarding what features make a company a startup. In "Defining a Startup A Critical Analysis" (2021), Zaeem-Al Ehsan shows that scholars generally agree that a startup has characteristics such as novelty (a new venture), potential for growth, innovation, and risk. These attributes distinguish startups from small traditional businesses.

In the framework of this paper, blockchain provides the foundational infrastructure ; smart contracts represent mechanisms of automated, self-enforcing agreements ; and startups are the entities that stand to benefit from such innovations, especially in terms of transparency, trust, and efficiency in financial reporting and contracts. These three concepts together allow us to investigate how startup firms, particularly in contexts with weaker institutional infrastructure, might leverage blockchain and smart contracts to improve financial transparency and accountability.

1. Blockchain Technology : Principles and Implications for Accounting

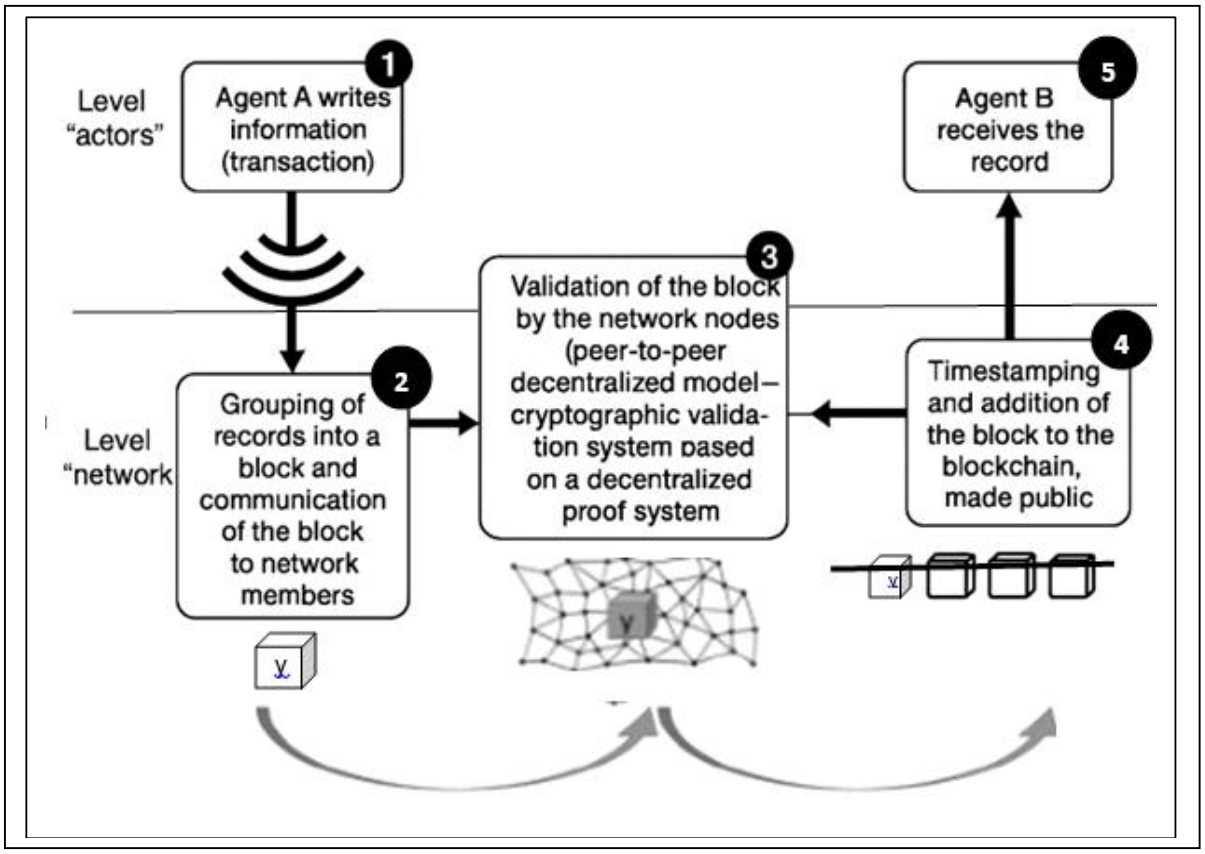
Blockchain has become a central subject in accounting research because of its potential to alter fundamental aspects of how financial records are kept, verified, and audited. Key characteristics such as immutability, decentralization, and automation suggest that blockchain could significantly improve accounting practices, especially in terms of reducing fraud, increasing reliability, and enabling new reporting paradigms. This subsection examines the principles of blockchain technology, its implications for accounting (including concepts like triple-entry bookkeeping), and the challenges that must be addressed for practical adoption.

1.1. Principles of Blockchain

Blockchain is a distributed digital ledger shared among multiple participants, enabling transaction records to be stored in a chained, cryptographically linked format. According to Bellucci, Cesa Bianchi, & Manetti (2022), one of the defining features of blockchain relevant to accounting is "the inalterability of

transactions" which supports reliability and trust in ledger data. Also, blockchain automates many repetitive tasks that do not require discretionary choices, reducing opportunities for human error and manipulation.
The following figure explains the blockchain operating processus :

Figure 01: Blockchain Operating Processus



Source: Translated from: Desplebin et al. 2019, p06.

This figure illustrates the operational process of blockchain technology, highlighting the sequential steps that ensure transparency, security, and decentralization. It shows how a transaction initiated by an agent is grouped into blocks, validated by a peer-to-peer cryptographic system, timestamped, and then added to the blockchain, which is publicly accessible. This decentralized validation mechanism guarantees the integrity of the data and prevents any single participant from altering the information unilaterally.

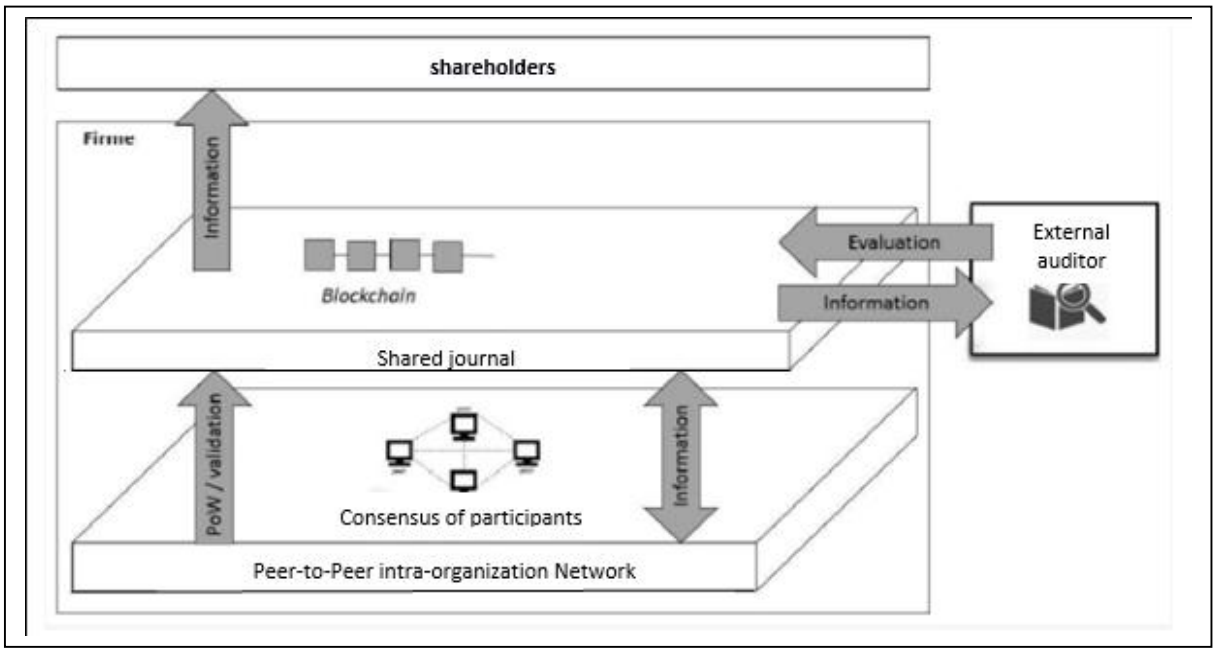
1.2. Triple-Entry Bookkeeping and Real-Time Reporting

A significant implication of blockchain in accounting is the concept of triple-entry bookkeeping, wherein there is a shared third ledger (on the blockchain) that records a transaction in addition to the two parties' ledgers. This shared record enhances mutual visibility and accountability. Bellucci et al. (2022) identify triple-entry bookkeeping as a central area where blockchain has

potential to reduce misstatements and improve financial reporting transparency. Additionally, they note that blockchain could facilitate more real-time or near real-time reporting, diminishing the delays and lag inherent in traditional periodic financial disclosures.

The integration of blockchain technology into accounting practices has opened new perspectives for transparency, reliability, and efficiency in financial reporting. By decentralizing data validation and recording processes, blockchain allows organizations to reduce the risks of fraud and manipulation while providing stakeholders with real-time access to accurate information. The following figure presents a scenario of an intra-organizational accounting system based on blockchain, highlighting the interactions between shareholders, the firm, and the external auditor.

Figure 02: Scenario of an Intra-Organizational Accounting System Based on Blockchain



Source: translated from Rückeshäuser 2017, p. 24

As illustrated, the blockchain ensures that accounting entries are stored in a shared and immutable journal accessible through a peer-to-peer network. This structure strengthens internal control mechanisms and enhances confidence in financial communication. Moreover, the involvement of the external auditor within this framework reinforces compliance with international standards and improves the credibility of organizational reporting. Ultimately, blockchain-based accounting systems provide a robust foundation for more transparent governance and more efficient auditing processes.

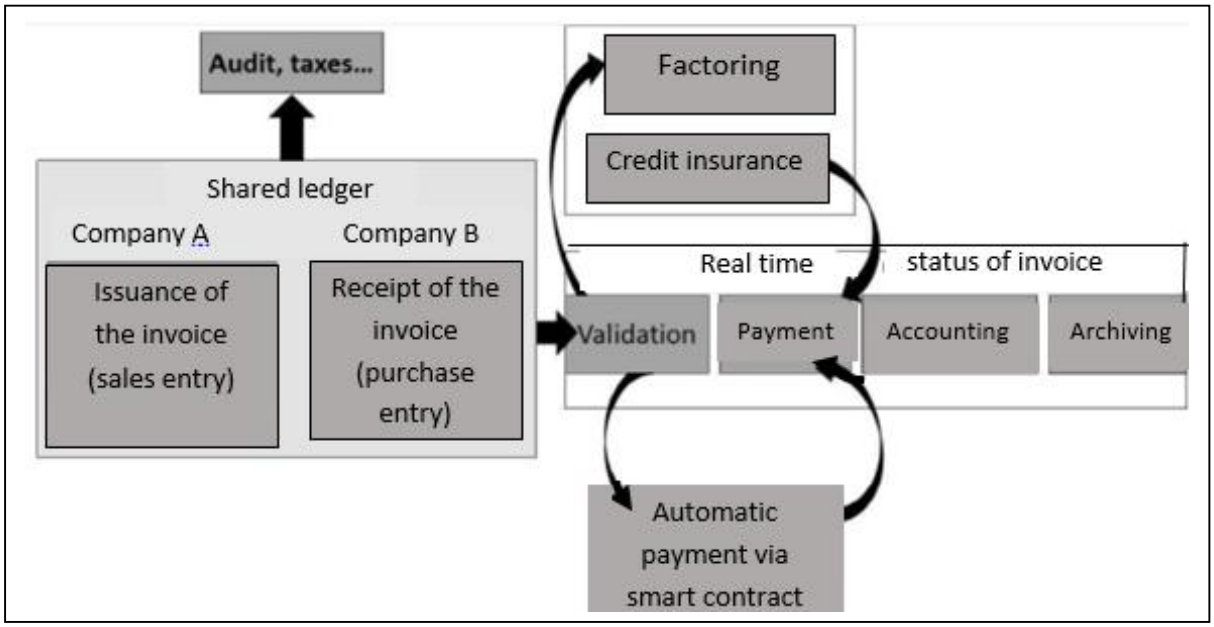
1.3. Implications and Challenges for Accounting Practices

Despite its promise, blockchain's adoption in accounting also faces important obstacles. Bellucci et al. (2022) point to regulatory issues (e.g., how existing accounting and audit standards treat blockchain records), issues of standardization, privacy concerns due to the transparent nature of public blockchains, and scalability challenges when transaction volumes are large. These challenges are particularly acute in emerging markets, where infrastructure may be weaker, and regulatory bodies are slower to adapt to new technologies.

In accounting, the integration of blockchain into commercial operations and the invoicing cycle introduces a decentralized and immutable ledger that records both sales and purchase transactions simultaneously. This mechanism enhances the reliability of accounting records, minimizes reconciliation issues between trading partners, and provides real-time access to financial data. Consequently, blockchain strengthens the principles of transparency, accuracy, and traceability in financial reporting.

The following figure illustrates the contribution of blockchain technology to commercial operations and the invoicing cycle from an accounting perspective.

Figure 03: Contributions of Blockchain to Commercial Operations and the Invoicing Cycle



Source: translated from Postme (2018), cited in Desplebin, Lux, & Petit (2019), p.17.

From an accounting perspective, this process highlights how blockchain facilitates automated recognition of transactions through smart contracts, supports factoring and credit insurance, and ensures accurate validation, posting,

and archiving of invoices. Moreover, it provides auditors and tax authorities with continuous access to reliable information, thereby improving compliance, reducing the risk of fraud, and aligning accounting practices with technological innovation.

2. Smart Contracts : Automation and Financial Innovation

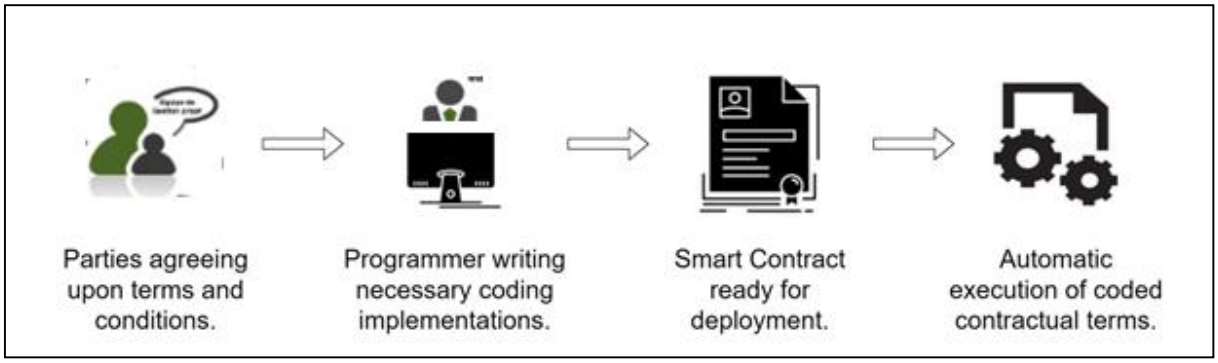
Smart contracts are programs that execute automatically when predetermined conditions are met. Deployed on blockchain platforms, they promise to streamline financial transactions, reduce costs, and improve contractual certainty. However, legal, technical, and operational issues remain. This subsection explores what smart contracts are, how they are applied in finance, and the risks and constraints associated with their use.

2.1. Definition and Key Features of Smart Contracts

Taherdoost (2023) provides a clear critical review of smart contracts as "scripts that are anchored in a decentralized manner on blockchains… making predetermined procedures visible to the outside world." These contracts allow business logic and conditions to be codified so that when conditions are met, the contract self-executes without further human intervention. Key features include automation, predictability, reduced need for intermediaries, and improved transparency of contractual obligations.

The following figure outlines the key steps involved in building a typical smart contract. It provides a virtual representation of the process, from defining objectives and drafting contract logic to coding, testing and deployment.

Figure 04: Steps of Building a Typical Smart Contract



Source: Pranto, Noman, Mahmud, & Haque. 2021. P.118

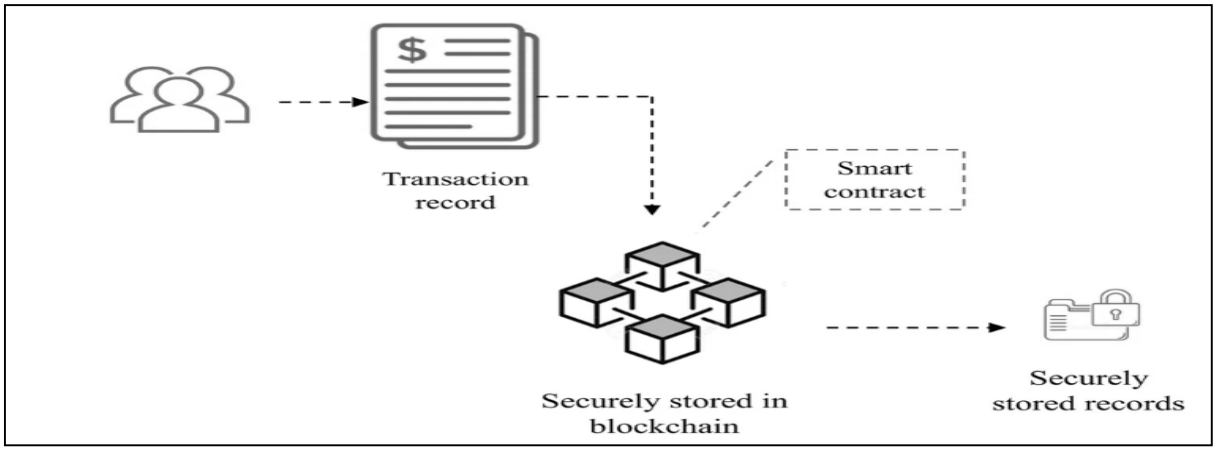
By illustrating each stage, the figure helps to understand how a smart contract is systematically developed to ensure reliability, automation, and secure execution on a blockchain network.

2.2. Financial Applications of Smart Contracts

In finance, smart contracts are used for applications such as automated payments, insurance (parametric insurance), escrow, and supply chain finance. Taherdoost (2023) argues that smart contracts can reduce operational risk and improve efficiency in financial transactions by ensuring that conditions are enforced exactly as written. For example, in supply chain finance, smart contracts can trigger payments automatically once proof of delivery is validated, removing delays and reducing dispute risk.

Smart contracts play a pivotal role in enhancing financial security by automating transactions, ensuring transparency, and reducing the risk of fraud. Their programmable nature allows agreements to be executed automatically and securely on a blockchain network, minimizing human error and reliance on intermediaries. Understanding this connection is essential to evaluating how smart contracts can transform financial systems.

Figure 05: The Role of Smart Contract in Strengthening Financial Security



Source: Prabanand, Thanabal (2025), p.13.

In conclusion, smart contracts significantly contribute to financial security by providing automated, transparent, and tamper-proof execution of agreements. While they offer clear benefits such as reduced fraud risk, increased trust, and lower dependence on intermediaries, it is important to acknowledge their limitations, including technical complexity and energy demands. Overall, understanding both strengths and weaknesses is key to effectively leveraging smart contracts in modern financial systems.

2.3 Risks and Legal-Technical Constraints

The same review by Taherdoost (2023) also highlights various risks and constraints: code vulnerabilities, limited legal clarity about enforceability of

smart contracts in many jurisdictions, scalability challenges, and issues with interoperability between different blockchain platforms. There is also the concern of unintended consequences if smart contract code is buggy or maliciously designed.

Smart contracts represent a significant technological advancement in the field of accounting and finance. These self-executing programs, operating on blockchain platforms, promise to automate and secure complex transactional processes. However, their adoption raises questions regarding their actual efficiency, adaptability to existing regulations, and impact on traditional accounting practices. The table below provides a summary of the main advantages and limitations of smart contracts in this sector.

Table 01: advantages and Limitations of Smart Contracts

Advantages		**Limitations**	
Time saving	It enable fast financial transactions at any time	Energy consumption	The electricity consumption of the blockchain is very high
trust	Two parties who are not familiar with each other can conduct transactions through a reliable protocol	inflexibility	There is no way reverse decisions or seek recourse without incurring additional costs
Lowering intermediation costs	Smart contracts are based on a decentralized system, allowing peer-to-peer transactions	Complexity	The execution of smart contracts remains somewhat opaque due to complex algorithms

Source: translated from Meier, & Sannajust (2021), Harvard Business Review (hbrFrance)

3. Startups and the Demand for Transparency and Innovation

Startups, by nature, operate in environments of high uncertainty with a need to build trust quickly, attract funding, and demonstrate value with limited resources. For these entities, transparent accounting, efficient contracts, and reliable financial reporting are not luxuries but necessities. This subsection considers the essential attributes of startups, why transparency and innovation matter greatly to them, and the challenges they face when adopting technologies like blockchain and smart contracts.

3.1. Characteristics of Startups

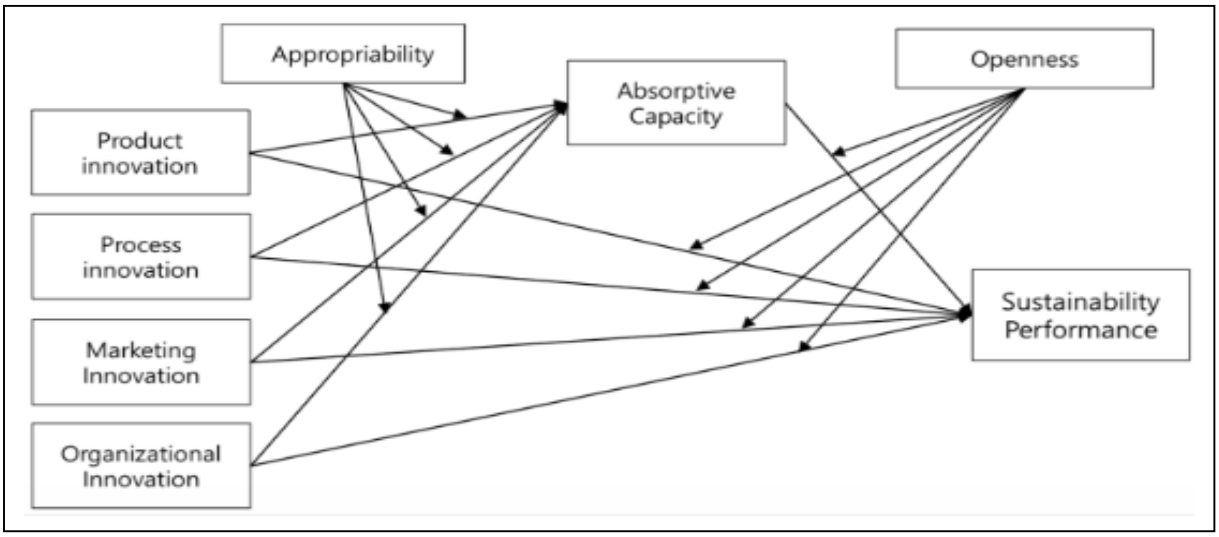
Startups usually are newly founded firms seeking innovation, rapid growth, and scalability. Although empirical research specifically linking blockchain to startup accounting is less abundant, Bellucci et al. (2022) include "business model innovation" among the impacts of blockchain in accounting practice and research, indicating that startups engaging with blockchain may redesign accounting processes or business models to leverage automated, transparent contracting and reporting.

3.2. Importance of Transparency and Innovation for Startups

Transparency in financial reporting and contract execution helps startups in acquiring trust from investors, customers, and regulators. According to Bellucci et al. (2022), blockchain supports transparency by ensuring transaction records cannot be altered, enabling auditing with higher integrity. This aligns with startup needs for credibility and for distinguishing themselves in competitive markets. Innovating accounting practices (e.g., using smart contracts, faster reporting) also helps reduce costs and increase agility.

Innovation within startups often takes multiple forms, including product, process, marketing, and organizational innovation. Each type of innovation not only drives competitiveness and growth but also has direct implications for accounting and finance. For instance, product and process innovation require accurate cost measurement and investment appraisal to assess profitability and sustainability. Marketing innovation impacts revenue recognition, budgeting, and financial forecasting, while organizational innovation often demands new approaches to performance measurement, governance, and internal control.

Figure 06: A Model of Different Types of Innovation Influencing Startup Growth



Source: Jung, Ko, & Kim, (2025), p.206

By linking these innovation dynamics with accounting and financial practices, startups can ensure that their growth strategies are supported by reliable financial information and sound decision-making frameworks.

3.3. Challenges for Startups Adopting Blockchain and Smart Contracts

Despite the benefits, startups face specific barriers: cost of implementing blockchain infrastructure, technical expertise deficits, lack of legal/regulatory frameworks recognizing smart contract enforceability, and uncertainty around operational risks. Taherdoost (2023) identifies legal ambiguity and technical risks as major constraints. Bellucci et al. (2022) also mention that many practitioners are hesitant because standards and audit norms are not yet fully adapted to blockchain-driven accounting.

In summary, blockchain, smart contracts, and startups constitute three interrelated pillars that shape current debates on financial innovation and transparency. Blockchain provides the technological foundation for decentralized and immutable record-keeping, while smart contracts extend its potential by enabling self-executing agreements that reduce transaction costs and reliance on intermediaries. Startups, characterized by innovation, growth orientation, and risk, emerge as key actors capable of experimenting with and adopting these technologies in ways that challenge traditional accounting and financial practices. Together, these concepts form a coherent theoretical framework that not only redefines the boundaries of accounting systems but also highlights the opportunities and challenges for entrepreneurial ecosystems. This foundation paves the way for examining how these tools can be mobilized in practice, particularly in emerging economies, where issues of transparency, accountability, and institutional trust remain central.

II. Applications of Blockchain and Smart Contracts in Accounting and Finance : International Experiences, Startups, and the Algerian Context

Blockchain and smart contracts are transforming accounting and finance by providing transparency, immutability, and process automation. Startups, due to their agility and openness to innovation, are often the first to adopt these technologies. Globally, startups leverage blockchain to automate payments, secure audits, and increase investor confidence. In contrast, Algerian startups face institutional, regulatory, and infrastructural challenges that limit the adoption of these technologies. This section examines international startup

experiences with blockchain, compares these practices to the Algerian context, and outlines a methodology to study adoption and impact locally.

Moreover, analyzing international cases allows us to identify best practices, potential pitfalls, and adaptation strategies. Startups serve as experimental spaces where blockchain can be applied flexibly and iteratively. Understanding how these innovations function in different jurisdictions provides a roadmap for Algerian startups to integrate blockchain and smart contracts into accounting and financial management effectively.

1. International Startup Experiences with Blockchain in Accounting and Finance

Global startup ecosystems have pioneered blockchain applications, offering valuable lessons for accounting and finance. Startups act as incubators for experimentation, applying blockchain to real-time auditing, smart contracts, and financial transparency. Examining these experiences highlights practical models, strategies, and challenges that can inform adoption in Algeria.

International startups also provide insight into how regulatory, technical, and organizational factors interact with innovation. By studying their experiences, Algerian startups can assess feasibility, anticipate barriers, and adopt a phased approach, ensuring sustainable blockchain integration.

1.1. Silicon Valley startups and fintech innovation

In Silicon Valley, fintech startups integrate blockchain to improve accounting reliability and transparency. According to Jun and Vasarhelyi (2017), blockchain enables continuous auditing, real-time verification, and immutable records, fostering investor trust. Startups like ConsenSys and Ripple have automated payments, smart contract enforcement, and ledger management, reducing human error and operational costs. These innovations illustrate the transformative potential of blockchain for financial operations in startups.

Furthermore, Silicon Valley startups demonstrate how integrating blockchain into financial workflows enhances strategic decision-making. Real-time access to verified transaction data allows startups to identify inefficiencies, monitor liquidity, and comply with accounting standards more efficiently. This culture of innovation encourages rapid testing, iterative improvement, and investor engagement, setting a model for startups worldwide.

1.2. European and Asian startup adoption of blockchain

European startups leverage blockchain to improve accounting verification, issuing digitally signed invoices and receipts auditable in real-time (Zhang & Xue,

2019). In Asia, countries such as Singapore and South Korea encourage startups to integrate blockchain in supply chain finance, where smart contracts automate payments and minimize disputes. These applications highlight blockchain's versatility across financial environments.

Moreover, European and Asian startups often collaborate with regulators and academic institutions to ensure compliance and scalability. Blockchain pilots frequently focus on low-risk processes initially, enabling startups to develop technical expertise while demonstrating practical benefits to stakeholders. Such phased adoption reinforces trust in emerging technologies.

1.3. African startup ecosystems and financial inclusion

In Africa, Nigerian and Kenyan startups deploy blockchain to enhance financial inclusion and reduce transaction costs. Ekokotu and Ofor (2024) report that blockchain reduces fraud in supply chain management, while Adebayo, Soyebi, and Oladire (2024) demonstrate improved SME access to financial services through blockchain solutions. These startups show how blockchain can overcome traditional financial barriers in emerging markets.

Additionally, African startups illustrate the role of blockchain in fostering entrepreneurship and social impact. By enabling secure and transparent microfinance, payment systems, and cross-border transfers, startups support financial inclusion, enhance economic participation, and build confidence in decentralized solutions, creating lessons applicable to Algeria.

2. Comparative Perspective: Algerian Startups and Institutional Challenges

While international startups highlight successful blockchain adoption, Algeria presents a contrasting scenario. Regulatory ambiguity, infrastructure limitations, and skills shortages constrain startups' ability to implement blockchain solutions in accounting and finance. Comparing international best practices with the Algerian context provides insights into feasible adoption strategies and systemic gaps.

Understanding Algeria's context also helps identify unique opportunities where blockchain could create value. Local startups face challenges but can leverage growing digital initiatives, entrepreneurial programs, and partnerships with universities to gradually adopt blockchain and smart contracts.

2.1. Opportunities for Algerian startups in financial transparency

Algerian startups could use blockchain to improve financial reporting, attract investors, and comply with international accounting standards. Meraghni,

Bekkouche, and Demdoum (2021) note that digital transformation initiatives positively impact Algerian firms' accounting information systems. Implementing blockchain in contracts and ledgers could enhance transparency, efficiency, and credibility for investors and partners.

Furthermore, blockchain adoption could enable Algerian startups to access global funding sources. Transparent, verifiable financial records increase trust among international investors and financial institutions, supporting scaling and integration into global markets. This aligns with Algeria's broader digital and entrepreneurial development goals.

2.2. Barriers to blockchain adoption in Algeria

Significant barriers remain. Algeria lacks comprehensive legal recognition for digital contracts and blockchain-based records. Infrastructure varies regionally, and expertise in blockchain programming and auditing is limited. Regulatory uncertainty and dependence on traditional banking systems further restrict innovation (Bouchaib & Khelfaoui, 2022). Without institutional support, adoption lags behind other emerging economies.

Additionally, limited awareness among startup founders and financial managers slows adoption. Many perceive blockchain as overly complex or high-risk. Educational initiatives, pilot projects, and collaboration with international experts could mitigate these barriers, creating a supportive environment for gradual adoption.

2.3. Lessons from international startup ecosystems

International lessons emphasize phased adoption, regulatory support, and collaboration with universities and fintech hubs. Pilot blockchain in limited use-cases, payments or invoice verification, allows startups to develop expertise and trust. European and African startups demonstrate that incremental approaches, mentorship, and partnership networks can facilitate adoption even in resource-constrained environments.

By learning from these models, Algerian startups can navigate local constraints strategically. Establishing early success stories and demonstrating measurable benefits will encourage broader uptake, supporting financial transparency and operational efficiency in the Algerian startup ecosystem.

3. Methodology and Research Tools for Startup-Oriented Analysis

Studying blockchain adoption in startups requires an approach integrating international benchmarks and local conditions. Comparative methodology

allows identification of enablers, barriers, and practical insights relevant to Algerian startups.

A robust methodology also ensures reliability and generalizability of findings, balancing qualitative and quantitative perspectives to capture the complex dynamics of startup adoption of blockchain technologies.

3.1. Research design and qualitative approach

A comparative case study design examines international startup cases alongside Algerian startups. Semi-structured interviews with founders, accountants, and regulators provide qualitative insights into perceptions, institutional constraints, and readiness for adoption. Case studies contextualize how blockchain technologies are applied.

This qualitative approach captures nuanced information often missed by surveys alone. Understanding attitudes, motivations, and organizational practices informs practical recommendations and highlights adaptation strategies for local startups.

3.2. Data sources and international comparison

Data sources include peer-reviewed articles documenting blockchain in accounting (Jun & Vasarhelyi, 2017), African startup reports (Technext24, 2025), and Algerian studies on digital transformation (Meraghni et al., 2021). Regulatory documents and startup ecosystem analyses complement primary data, enabling rigorous cross-country comparisons.

Furthermore, triangulating data from multiple sources improves validity. International case studies provide benchmarks, while local interviews reveal context-specific constraints, allowing tailored recommendations for Algerian startups.

3.3. Analytical tools and cross-case interpretation

Content analysis of interviews, thematic coding, and cross-case comparison identify patterns of barriers and enablers. Quantitative survey data measures awareness, readiness, and perceived challenges among Algerian startups. Mixed-method analysis ensures comprehensive understanding of adoption potential.

These tools allow researchers to interpret both qualitative insights and quantitative trends. Combining them strengthens findings, enabling robust

conclusions on how Algerian startups can implement blockchain and smart contracts effectively.

International startup experiences demonstrate that blockchain and smart contracts enhance accounting reliability, transparency, and operational efficiency. Startups in Silicon Valley, Europe, Asia, and Africa provide practical examples, from real-time auditing to cross-border payments, that strengthen investor confidence. Algerian startups face institutional, regulatory, and infrastructural challenges, but opportunities exist through governmental digital initiatives and entrepreneurial programs. A comparative, mixed-method research approach, combining case studies, interviews, and surveys, can provide a nuanced understanding of blockchain adoption potential. By learning from global best practices and adapting to local constraints, Algerian startups can gradually leverage blockchain to improve financial operations, fostering transparency, credibility, and competitiveness

III. Practical Study and Results Analysis : Algerian Startups

This section presents the results of a survey conducted among 10 Algerian startups from various sectors (fintech, e-commerce, digital services, light industry). The objective is to assess the impact of digitalization on accounting processes and the perception of emerging technologies such as blockchain and smart contracts. Data were collected through questionnaires, interviews, and internal reports.

In the Algerian context, blockchain and smart contracts are still not widely adopted, especially among startups. Therefore, in our practical study, we first chose to analyze ICT usage in a general way, focusing on the overall level of digitalization within these startups. This approach allows us to understand the baseline of digital maturity before exploring perceptions of emerging technologies. Information and Communication Technologies (ICT) refer to a set of tools and systems used to manage, process, and exchange information. They are composed of hardware (computers, servers, network devices), software (accounting systems, ERP (Enterprise Resource Planning), automation tools), and digital services (cloud storage, online collaboration platforms).

Once the general ICT adoption and digitalization were assessed, we then examined the perceptions of startup managers and executives regarding blockchain and smart contracts, aiming to capture their awareness, perceived utility, adoption intentions, and potential barriers in the local business environment. This two-step approach ensures that the study reflects both current

digital practices and the readiness for emerging technologies in the Algerian startup ecosystem.

1. ICT Investments and Performance Indicators

Analyzing ICT investments measures the commitment of startups to accounting digitalization and their readiness to integrate advanced technologies.

1.1 Results : Detailed ICT Investments

This table provides a detailed overview of ICT investments made by ten Algerian startups. The "Accounting Software" column shows the financial allocation for purchasing or licensing digital accounting tools, with higher amounts reflecting a strategic focus on automating core accounting functions. The "Automation" column represents investments in workflow automation, including tools for invoicing, payroll, and financial reporting, which directly reduce manual workload. Training costs indicate the resources dedicated to upskilling employees to effectively use the new systems, highlighting the startups' commitment to human capital development. Maintenance covers ongoing costs for software updates, technical support, and infrastructure upkeep, which ensures continuity and reliability of digital systems.

Implementation time (in months) measures how long it took to deploy ICT solutions, indicating the complexity and scalability of the projects. The usage frequency column shows how often these tools are actively used by employees, reflecting the degree of adoption and integration into daily operations. Manager satisfaction, scored from 1 to 5, evaluates the perception of ICT investments in terms of efficiency, usability, and business impact. The percentage of digitalized documents indicates how much of the accounting documentation has transitioned from paper to electronic format, which impacts storage, accessibility, and audit readiness. Finally, the annual ROI (Return on Investment) quantifies the financial benefits of these investments relative to costs, showing that even for small startups, ICT implementation can provide measurable returns.

Table 02: ICT Investments in Algerian Startups

Start up	Accounting Software (MDA)	Automation (MDA)	Training (MDA)	Maintenance (MDA)	Implementation Time (months)	Usage Frequency (days/month)	Manager Satisfaction (1–5)	Digitalized Documents (%)	Annual ROI (%)

S1	4	2	1	0.5	3	20	4	70%	12%
S2	3	1.5	1	0.3	2	15	3	65%	10%
S3	5	2.5	1.5	0.5	4	22	5	80%	15%
S4	6	3	2	0.6	5	25	4	85%	14%
S5	3.5	1.5	1	0.4	2.5	18	4	60%	11%
S6	4.5	2	1.5	0.5	3.5	21	4	75%	13%
S7	2.5	1	0.5	0.2	2	12	3	55%	9%
S8	5.5	2.5	2	0.6	4.5	24	5	82%	16%
S9	4	2	1.5	0.5	3	20	4	70%	12%
S10	5	3	2	0.6	5	25	5	85%	15%

Source: Internal reports, annual reports (2024) and survey (2025)

1.2. Detailed Analysis

- Investment by category: Startups prioritize accounting software (avg. 4.3 MDA) and process automation (avg. 2.05 MDA), reflecting focus on core digitalization.
- Implementation time and usage frequency: Startups with longer implementation periods (S4, S10) report high usage frequency (25 days/month), indicating effective adoption.
- Satisfaction and ROI: High manager satisfaction (4–5/5) aligns with a positive annual ROI (12–16%), showing both operational and financial benefits.

1.3. Discussion

Overall, the table illustrates that startups with higher investments in both automation and training (such as S3, S4, S8, and S10) achieve greater satisfaction, more extensive document digitalization, and higher ROI. It highlights the importance of balancing technology expenditure, staff preparation, and system maintenance to maximize operational efficiency and financial performance.

- Prioritizing software and automation aligns with international startup practices (Blank & Dorf, 2020).
- Less mature startups (S2, S7) show lower ROI and satisfaction, highlighting the role of training and guidance.
- ICT adoption is a strategic lever to enhance competitiveness and reliability in accounting processes.

2. Accounting Performance and Error Reduction

This section evaluates the effects of digitalization on:

- Closing time
- Accounting error rate
- Paper document volume

2.1. Results : Accounting performance

This table shows the impact of ICT adoption on closing time, error rates, and paper document volume. Closing Time Before/After measures how long it takes to complete accounting periods. Errors Before/After capture the frequency of mistakes in accounting records. Paper Documents Before/After indicate the transition from paper-based to digital documentation. Reduction (%) columns quantify the gains, demonstrating efficiency improvements.

Table 03: Impact of Digitalization on Accounting Errors and Reporting Efficiency

Start up	Closing Time Before (days)	Closing Time After (days)	Reduction (%)	Errors Before (%)	Errors After (%)	Error Reduction (%)	Paper Documents Before	Paper Documents After	Document Reduction (%)
S1	10	6	40%	4	1.5	62.5%	5000	1500	70%
S2	9	5	44%	3.5	1	71%	4000	1200	70%
S3	11	6	45%	5	2	60%	6000	2000	66%
S4	12	7	41.6%	5.5	2.5	54.5%	7000	2300	67%
S5	8	5	37.5%	3	1	66.7%	4500	1300	71%
S6	10	6	40%	4	1.5	62.5%	5200	1600	69%
S7	7	4	42.8%	2.5	1	60%	3500	1000	71%
S8	11	6	45%	5	2	60%	6500	2000	69%
S9	9	5	44%	3.5	1.5	57%	4800	1500	68%
S10	12	7	41.6%	5.5	2.5	54.5%	7200	2200	69%

Source: Internal reports, annual reports (2024) and survey (2025)

2.2. Detailed Analysis

- Closing time: Average reduction of 42% demonstrates significant productivity gains.

- Error rate: Average decrease of 58% confirms that automation and appropriate software enhance data reliability.
- Paper documents: Average 68% reduction reflects effective digitization, improving traceability and archiving.

2.3. Discussion

- ICT integration is a key factor for efficiency in startups, aligning with international findings (McKinsey, 2021).
- Gains vary according to technological maturity: higher investment in training and automation yields superior results.
- Reducing errors and paper volume lowers indirect costs and supports compliance with international accounting standards.

3. Employee Productivity

The employee productivity table shows the effect of digitalization on labor efficiency. Hours/Month Before represents total working hours devoted to accounting and administrative tasks. Hours Saved reflects time gained through automation and digital tools. Productivity (%) is calculated as the ratio of hours saved to total hours. Automated Tasks (%) indicates which portion of repetitive activities have been handled by digital tools. The data reveal that automation allows employees to focus on strategic tasks such as financial analysis and planning, while freeing resources previously used for manual operations. Startups with higher automation percentages achieve greater productivity gains, illustrating a strong link between ICT adoption and human resource optimization.

Table 04: Effects of ICT Adoption on Employee Productivity

Startup	Hours/Month Before	Hours Saved	Productivity (%)	Automated Tasks (%)
S1	200	75	37.5%	50%
S2	180	60	33%	40%
S3	220	85	38.6%	55%
S4	240	90	37.5%	60%
S5	190	70	36.8%	50%
S6	210	80	38%	55%

S7	170	60	35%	45%
S8	230	95	41.3%	60%
S9	200	75	37.5%	50%
S10	240	100	41.6%	65%

Source: Internal reports, annual reports (2024) and survey (2025)

3.1. Detailed Analysis

- Saved hours per month account for 35–41% of total time, allowing employees to focus on high-value tasks.
- Automation mainly affects repetitive administrative tasks (40–65%), enhancing overall operational efficiency.

3.2. Discussion

- Automation frees human resources for strategic and innovative tasks, crucial for rapid startup growth.
- Productivity gains indirectly reinforce ROI by increasing output without additional personnel costs.

4. Blockchain and Smart Contracts : Knowledge Perception and Adoption

The blockchain and smart contracts table captures startup awareness, perception, and adoption intentions. Blockchain Knowledge (1–5) and Smart Contract Knowledge (1–5) show the technical familiarity of managers with these technologies. Perceived Utility (1–5) reflects how useful they consider blockchain and smart contracts for their business operations. Short-term Adoption (%) and Long-term Adoption (%) indicate the likelihood of integrating these technologies in the next 1–2 years versus a longer horizon. Key Obstacles highlight the main challenges, such as technology complexity, costs, lack of skills, or regulatory uncertainty. Confidence in Adoption (1–5) measures managerial belief in successful integration.

Table 05: Startup Managers' Perceptions of ICT in Accounting and Finance

Startup	Blockchain Knowledge (1–5)	Smart Contract Knowledge (1–5)	Perceived Utility (1–5)	Short-term Adoption (%)	Long-term Adoption (%)	Key Obstacles (Tech, Cost, Regulation, Skills)
S1	4	3	4	25%	60%	Tech 60%, Skills

						40%
S2	3	2	3	15%	40%	Regulation 50%, Cost 50%
S3	5	4	5	50%	80%	Tech 40%, Skills 30%, Cost 30%
S4	2	2	2	10%	30%	Skills 50%, Tech 50%
S5	4	3	4	30%	70%	Tech 50%, Regulation 50%
S6	3	3	3	20%	50%	Tech 60%, Cost 40%
S7	2	1	2	5%	20%	Skills 70%, Regulation 30%
S8	5	4	5	60%	90%	Tech 30%, Cost 30%, Regulation 40%
S9	3	3	3	20%	50%	Skills 50%, Tech 50%
S10	4	4	4	45%	75%	Tech 50%, Regulation 50%

Source: Internal reports, annual reports (2024) and survey (2025)

4.1. Detailed Analysis

- Knowledge and perceived utility: The average blockchain score is 3.7/5 and smart contract score 3/5, indicating moderate awareness but limited technical mastery for smart contracts.
- Adoption plans: Technologically advanced startups (S3, S8, S10) plan higher long-term adoption (75–90%), confirming that digital maturity influences strategic integration of emerging technologies.
- Key obstacles: Complexity, lack of internal skills, costs, and regulatory uncertainty are the main barriers. Startups cite technology (30–60%) and skills (30–70%) as the largest challenges.

4.2. Discussion

- Blockchain is viewed as a promising but emerging technology in the Algerian startup ecosystem.

- Smart contracts are less known but could significantly enhance transaction reliability and automation if adopted.
- Results suggest that a phased approach; including training, pilot projects, and regulatory guidance; is necessary to overcome adoption barriers.
- These findings align with international studies on blockchain adoption in SMEs and startups (Tapscott & Tapscott, 2016).
- Startups with higher ICT maturity show a greater readiness to experiment with blockchain, indicating that foundational digitalization is a prerequisite for advanced technology adoption.

Conclusion

This study explored the adoption and impact of blockchain and smart contracts in accounting and financial management, focusing specifically on Algerian startups within a broader international context. Combining a theoretical framework with a field-based empirical study, the research aimed to assess both the potential and challenges of these technologies, drawing comparisons between global startup ecosystems and the emerging entrepreneurial landscape in Algeria.

At the international level, blockchain and smart contracts are increasingly adopted in accounting and finance due to their ability to provide transparency, immutability, real-time auditability, and automation of financial processes. Startups, being agile and innovation-driven, serve as early adopters of these technologies. For instance, in Silicon Valley, companies like ConsenSys and Ripple have leveraged blockchain to enable real-time financial reporting and automated payment systems (Jun & Vasarhelyi, 2017). In Europe and Asia, these tools are integrated into invoice management, smart contract enforcement, and cross-border supply chain transactions (Zhang & Xue, 2019).

African startups, particularly in Nigeria and Kenya, have used blockchain to improve financial inclusion, reduce fraud, and facilitate access to microfinance (Ekokotu & Ofor, 2024). These examples demonstrate that even in developing contexts, blockchain can thrive when supported by innovation ecosystems, regulatory flexibility, and digital literacy.

However, successful adoption is never purely technological, it depends on an ecosystem involving skills, institutions, infrastructure, and policies. As Tapscott and Tapscott (2016) emphasize, blockchain's potential is fully realized only when accompanied by systemic change.

In Algeria, the digital transformation of businesses is underway but remains uneven and fragmented, particularly among startups. Despite government initiatives promoting entrepreneurship and digitization, such as the creation of incubators, digital hubs, and support programs, the adoption of blockchain and smart contracts is still at a nascent stage.

Our practical study of 10 Algerian startups across fintech, e-commerce, and services sectors revealed a moderate level of ICT adoption, with substantial investments in accounting software, process automation, and employee training. These investments translated into improved accounting accuracy, reduced error rates, faster reporting, and higher returns on investment, confirming that foundational digitalization is underway.

However, when it comes to blockchain and smart contracts, most startups expressed : limited technical knowledge (avg. 3.7/5 for blockchain, 3/5 for smart contracts); Strong perceived utility (avg. 3.8/5); But low short-term adoption intentions (average under 30%); Citing barriers like lack of local skills, regulatory ambiguity, high costs, and technological complexity.

This highlights a mismatch between perceived potential and practical feasibility, shaped by Algeria's unique institutional and infrastructural constraints. From the synthesis of theoretical and empirical work, three hypotheses were formulated and tested:

- H1: ICT maturity improves accounting performance: Confirmed. Startups with higher digital investments (e.g., S3, S4, S8, S10) achieved better ROI, lower error rates, shorter closing times, and increased document digitalization.
- H2: Blockchain readiness is correlated with digital maturity: Confirmed. Startups with strong ICT systems were more likely to understand and consider blockchain integration, especially over the long term.
- H3: Institutional and technical barriers limit blockchain adoption in Algeria: Confirmed. Survey data showed that regulatory uncertainty, skills shortages, and technical complexity were the top reasons behind low adoption rates, consistent with prior literature (Bouchaib & Khelfaoui, 2022; Crosby et al., 2016).

While the empirical analysis confirms the benefits of digitalization and highlights the potential of blockchain technologies, it also reveals several institutional and technical barriers in the Algerian context. To address these challenges and foster innovation, the following recommendations are suggested.

- Develop a legal and institutional framework
- Invest in education and skills development
- Support pilot projects and low-risk experimentation
- Promote collaboration across the ecosystem

Blockchain and smart contracts represent not only a technological innovation but also a cultural and institutional shift in how organizations handle trust, compliance, and accountability. For Algerian startups, the potential is real, but realization depends on strategic, systemic efforts.

The findings resonate with global studies that warn against a purely technical view of innovation. As Crosby et al. (2016) note, blockchain is not a magic bullet, it is a tool, whose value depends on how well institutions adapt around it. Algeria, with its growing entrepreneurial momentum, stands at a crossroads. It can either follow a reactive, fragmented path, or it can take bold steps to build the regulatory and educational infrastructure needed to foster blockchain-driven finance.

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