

Potentials and Challenges of Applying Blockchain Technology in the Algerian Tax Administration: A Comparative and Foresight Study

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Received: 16/11/2025

Accepted: 23/02/2026

Published: 15/03/2026

Abstract: This article examines the potential integration of blockchain technology into the Algerian tax system, with a particular focus on value-added tax (VAT), one of the taxes most vulnerable to evasion. The study shows that blockchain holds significant transformative potential by enhancing transparency, simplifying procedures, and enabling real-time tax collection. The analysis indicates that the main challenges lie not in the technology itself but in the institutional, legal, and human readiness required for its adoption, especially in Algeria, where digital infrastructure remains limited. The study concludes that adopting blockchain in Algeria's tax administration is not merely a technical issue but depends on the state's capacity to invest in digitalization, update legislation, and develop human capital. Consequently, blockchain emerges as both a strategic pathway for tax reform and a productive direction for future research.

Keywords: Blockchain technology, tax administration, value-added tax, digital transformation, Algerian tax system.

Jel Classification Codes: O33, H20, H26

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1. INTRODUCTION

In recent decades, tax systems around the world have undergone profound transformations driven by the wave of digitalization, which has become one of the main pillars in the modernization of public administration in general—and tax administration in particular. Digital technologies have evolved into strategic tools for enhancing transparency, broadening the base of voluntary compliance, and curbing tax evasion and fraud.

Within this context, blockchain technology emerges as one of the most prominent contemporary innovations capable of redefining tax control mechanisms, given its unique technical attributes—most notably decentralization, high transparency, and an almost absolute resistance to data manipulation or alteration.

However, despite these promising prospects, a crucial question remains in the Algerian context, where the tax system continues to grapple with several structural challenges. Among the most significant are the inadequacy of traditional control tools, the slow pace of digital transformation, and the widespread prevalence of the informal economy. These factors give rise to complex issues regarding the extent to which such advanced technologies can be integrated into the national tax framework.

1.1 Research Problem

This study is guided by the following central question:

To what extent can blockchain technology contribute to building a more transparent and effective tax control system in Algeria?

From this main question, several sub-questions emerge:

- To what extent are the characteristics of blockchain technology compatible with the requirements of the Algerian tax system?
- What are the main technical and institutional barriers that may hinder the adoption of this technology?
- How can successful international experiences be leveraged to design a model suited to the Algerian context?

1.2. Research Hypotheses

- The integration of blockchain technology into the tax system is expected to enhance transparency and reduce tax evasion.

- The weakness of digital infrastructure and the absence of an adequate legal framework constitute the main obstacles to the adoption of blockchain technology.
- Drawing on international experiences can enable the formulation of a preliminary implementation framework adaptable to the Algerian context.

3.1. Research Objectives

- To analyze the theoretical potential offered by blockchain technology in the field of tax auditing and control.
- To explore the current state of the Algerian tax system and the limitations of its traditional control mechanisms.
- To assess the readiness of the Algerian tax administration to adopt emerging digital technologies.
- To formulate a preliminary framework for integrating blockchain technology into the invoicing and tax declaration systems.

1.4. Significance of the Study

The significance of this research lies in its attempt to open a scientific and institutional dialogue on the potential adoption of an emerging technology capable of fundamentally transforming traditional tax practices. Moreover, the study carries a practical dimension by contributing to the development of a foundation for tax reform in Algeria—particularly in light of the challenges posed by the widespread informal economy and the persistently low levels of tax compliance.

1.5. Scope of the Study

- **Spatial Scope:** The study focuses on the Algerian tax system, encompassing both central and local institutions, with particular emphasis on the tax administration and its various associated stakeholders.
- **Temporal Scope:** The study covers the period 2020–2025, regarded as a crucial phase that marked the onset of digital transformation within Algeria’s public administration and the growing discourse surrounding the digitization of public institutions.

1.6. Study Methodology

The research relied on a theoretical analysis of recent literature in the fields of tax digitalization and blockchain technology, supported by a foresight-based study that enabled the formulation of a comprehensive vision balancing theoretical foundations and practical dimensions. This integration contributes, on one hand, to enriching the scientific debate, and on the other, to guiding policymakers toward the adoption of innovative digital tools capable of enhancing the efficiency of tax administration.

7.1. Previous Studies

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Despite the growing institutional and academic interest in blockchain technology over the past decade, its applications in Algeria have remained largely confined to the realms of financial transactions, the banking sector, and e-commerce—sectors that are most affected by the imperatives of transparency and the need to mitigate uncertainty risks. However, the tax sector has remained largely excluded from this discussion, as the fiscal applications of this technology have received neither theoretical treatment nor empirical analysis. Consequently, this research gains heightened economic significance, as it seeks to explore the potential role of blockchain as a tool for restructuring and enhancing the efficiency of the Algerian tax system—particularly within an environment characterized by the prevalence of the informal economy, low tax compliance, and the challenges of transitioning toward a more transparent and sustainable economy.

2.The Concept of Blockchain Technology

This section provides an introductory overview of blockchain technology, conceptualized as a decentralized and immutable digital ledger based on the peer-to-peer (P2P) principle. It discusses the fundamental characteristics of this technology, its main types, and some of its practical applications, with the aim of highlighting the foundational elements that can serve as a basis for designing blockchain-based systems tailored to tax administration.

2.1.Definition of Blockchain

Contracts, transactions, and records constitute fundamental pillars of our economic, legal, and political systems. They safeguard assets, define regulatory frameworks, establish identities, document events, and govern relationships among states, organizations, individuals, and communities. However, these instruments—along with the bureaucratic structures that manage them—have increasingly struggled to keep pace with the rapid digital transformation of the global economy, rendering them more as constraints on innovation than as enablers of it. In response, the need has emerged for new models of organization and governance aligned with the dynamics of the digital economy. Within this context, blockchain technology has emerged as one of the leading technological approaches capable of providing effective and sustainable solutions.

Blockchain technology was introduced in October 2008 as part of the proposal for Bitcoin, a virtual currency designed to eliminate the need for a central authority to issue money, transfer ownership, or validate transactions. Bitcoin thus represents the first practical application of blockchain technology. At its core, the blockchain is a distributed digital ledger characterized by a high degree of transparency, allowing all participants to view and verify records directly without the need for intermediaries. It enables the recording of transactions between two parties with exceptional efficiency and permanent reliability. Moreover, it can be programmed to automatically execute transactions through what are known as smart contracts. Thanks to these attributes, one can envision a system in which contracts, procedures, and payments are stored in shared, highly transparent databases that are immune to deletion or manipulation. Every agreement and transaction carries a unique digital signature that facilitates verification and sharing. In such a system, the need for traditional intermediaries—such as lawyers or financial brokers—may significantly decline, as individuals, institutions, and intelligent systems would be able to interact directly with greater flexibility, efficiency, and at a lower cost (Iansiti & Lakhani, 2017, p. 04) .

At its core, blockchain technology is a decentralized system for storing and managing data that operates on a peer-to-peer (P2P) basis and is characterized by transparency and security. Legal studies often conflate blockchain technology with digital currencies; however, the applications of blockchain extend far beyond Bitcoin. Today, it is employed in finance, supply chain

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management, healthcare, and public record administration. As reliance on digital data continues to grow, blockchain emerges as a more secure alternative to centralized databases. Nonetheless, most tax-related studies still focus exclusively on cryptocurrencies, overlooking the potential of blockchain to enhance tax compliance and information management. Although some skeptics argue that blockchain has been overhyped by the media, the overwhelming majority of business leaders anticipate that the technology will reach a stage of broad adoption in the near future. Therefore, it becomes both politically and strategically prudent to prepare early for the next phase of blockchain development, as its widespread availability and adoption appear much closer than commonly imagined (Kim, 2024, p. 04).

Blockchain is commonly viewed as a system of distributed digital ledgers containing cryptographically signed transactions that are grouped into blocks. Each block is cryptographically linked to the preceding one after undergoing verification and reaching a consensus among network participants. As new blocks are added, earlier blocks become increasingly difficult to alter, thereby creating a strong resistance to manipulation or tampering. The newly added blocks are replicated across multiple copies of the ledger within the network, and any discrepancies or conflicts are automatically resolved according to predefined consensus rules (DYLAN, PETER, NIK, & KAREN, 2019, p. 13).

Blockchain is also described as a shared ledger of transactions among participants within a digital network, characterized by the absence of a single central authority. In principle, it resembles a traditional ledger that records and preserves transactions in a chronological sequence; however, its distinctiveness lies in the fact that the ledger is not managed by any single entity, as is the case in banks. Instead, all participants in the network, known as nodes, maintain identical copies of the ledger—thereby enhancing transparency and preventing manipulation or monopolization (OECD, 2019, p. 04).

At its core, blockchain is also described as a distributed and immutable database used to record and monitor data across a network of nodes. Specialized algorithms organize the chain of blocks according to a set of logical rules defined by the blockchain protocol. Each block contains a sequence of valid transactions executed within a specific time frame. When proposed transactions meet the required verification criteria, they are deemed authentic and legitimate. Blocks are added to the blockchain through a consensus protocol, managed by specific nodes within the network. The nodes responsible for verifying transactions are known as “miners,” and the verification and structuring process itself is called “mining.” Upon receiving a transaction proposal, a node verifies its validity before incorporating it into a block. With each new block of legitimate transactions added to the preceding ones, a continuous chain of transactions—the blockchain—is formed. Every node in the system maintains an identical copy of the blockchain, serving as a comprehensive record of all transactions. Verification within this system does not require any

third party, as the process is considered valid only when all nodes reach consensus on the transaction's authenticity (Laturkar & Laturkar, 2024, p. 06).

Blockchain technology is considered one of the most suitable tools for public sector applications that require data replication, transparency, immutability, and collective consensus mechanisms. Based on these criteria, tax administration emerges as one of the key areas most likely to benefit from this technology, given its continual reliance on at least three of these factors—data replication, information transparency, and data stability. In certain tax-related contexts, a fourth factor—consensus mechanisms—also becomes essential due to the lack of complete trust among the various parties involved. From this perspective, blockchain represents a promising solution to address these challenges and enhance the efficiency and reliability of the tax system. One prominent example is the payroll and withholding tax system, where the need for consistent, transparent, and immutable data is particularly evident. In such systems, employers or financial institutions are responsible for reporting individuals' income and withholding the corresponding taxes on behalf of the state. However, the same data are often transmitted separately to multiple government entities—such as tax authorities, social security institutions, and financial regulators—resulting in data duplication across different records and reducing the overall efficiency of the system. In this context, blockchain technology offers an innovative mechanism to overcome these inefficiencies by creating a unified and transparent ledger shared among all relevant parties. This not only minimizes redundancy but also enhances data reliability, ensures immutability, and effectively prevents manipulation or inconsistencies within the tax administration framework. (Kim, 2024, p. 05).

Although cryptocurrencies, led by Bitcoin, attract significant media attention and public debate, their intrinsic value does not lie in the currencies themselves, but rather in the underlying technology—blockchain. Blockchain represents an innovative technological framework with broad potential and a wide range of applications that extend far beyond the financial uses of cryptocurrencies, encompassing diverse economic, administrative, and legal domains (don & Alex, 2016, p. 04).

Based on the foregoing, blockchain technology can be described as a decentralized system built on a distributed and transparent ledger, enabling the permanent and tamper-proof recording and verification of transactions through encryption and collective consensus mechanisms. As such, it represents one of the leading technological pillars capable of overcoming the limitations of traditional systems and enhancing efficiency and reliability across various domains, particularly in public administration and the tax sector.

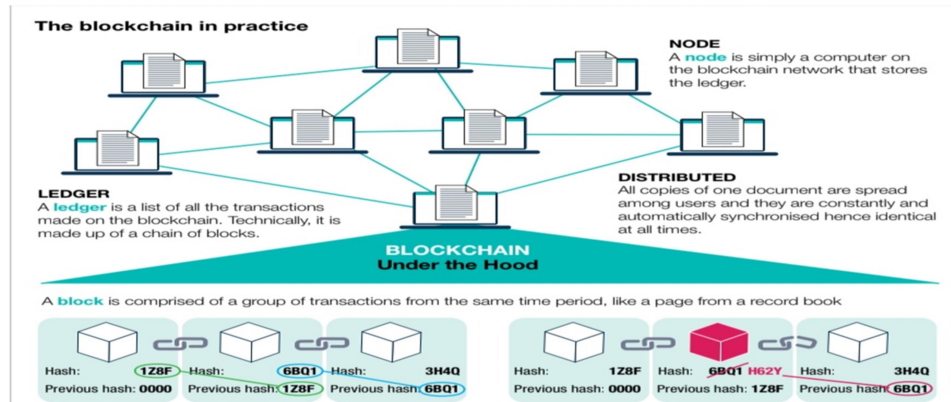
2.2. Practical Implementation of Blockchain Functionality and Its Classifications

Building on the discussion above, blockchain can be understood as a distributed ledger for recording transactions among parties within a digital network, without reliance on a single central authority. This ledger resembles a traditional accounting book, where all transactions between users are recorded in chronological order, and all nodes in the network maintain identical copies.

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This structure ensures transparency, tamper-resistance, and synchronous updating of data across all participants, as illustrated in the following figure :

Figure 01: The Operational Mechanism of Blockchain Technology



Source: (OECD, 2019, p. 04)

It is evident from this figure that blockchain technology relies on three fundamental pillars, which are:

2. 2. 1. The Node

A node is a computer connected to the blockchain network that maintains a copy of the digital ledger containing all transactions and participates in verifying their accuracy and reliability. In the absence of a central authority, the network relies on nodes to cooperate through a consensus mechanism to validate new transactions and update the ledger uniformly, thereby enhancing the system's security and transparency. To illustrate this concept, a node can be compared to a group of friends who record all their expenses and incomes in a shared notebook. Each friend keeps a personal copy of this notebook, and whenever someone wants to record a new transaction, all members must agree on its validity before it is added. In this analogy, each friend represents a node in the blockchain, and the shared notebook represents the digital ledger of all transactions. Through this system, no individual can alter past entries without the others noticing, which ensures transparency and security—precisely reflecting how nodes function within a blockchain network.

2.2.2. The Ledger

In blockchain, the ledger is a digital record that contains a complete list of all transactions carried out within the network. Its contents are organized into a chain of interconnected blocks, each block grouping a set of verified transactions. This can be simplified through the example of an accounting notebook in a small shop, where every sale or purchase is recorded in chronological

order. Each page represents a set of transactions, and all pages together form a complete, coherent ledger. Similarly, in blockchain, transactions are grouped into successive blocks that collectively form a secure and transparent ledger that anyone within the network can verify.

2.2.3. The Block

A block in blockchain is a unit that contains a set of transactions occurring within a specific time frame. It can be compared to a page in an accounting ledger where several operations are recorded at once. What distinguishes a block is that it not only includes transaction data but also contains a unique digital fingerprint (hash), along with the hash of the previous block. This structure links each block to the one before it, forming a continuous and interconnected chain. If someone attempts to alter a transaction in an older block, its hash will change and will no longer match the hash stored in the subsequent block, exposing the tampering immediately. This mechanism ensures the security, integrity, and reliability of the entire blockchain.

2.2.4. Distributed

In blockchain networks, the digital ledger is not stored in a single location nor controlled by a central authority. Instead, all copies of the ledger are distributed across all users or nodes in the network, and they are automatically and continuously synchronized to remain identical at all times. This can be illustrated through the example of a shared accounting notebook among a group of friends, where each friend keeps a complete copy of the notebook. Whenever a new transaction is recorded, all copies are updated automatically. In this setting, if one friend attempts to alter an old transaction on their own, the discrepancy will be detected by the other copies, which will reject the modification. This ensures the security, reliability, and transparency of the ledger for all participants in the network.

The lower part of the figure shows that each block not only possesses its own unique digital fingerprint (hash) but also contains the hash of the preceding block, ensuring a stable and sequential linkage between all blocks. The figure further illustrates that each block includes the following elements:

2.2.5. The Digital Fingerprint (Hash)

A hash is a unique sequence of letters and numbers generated from a given text or set of data using a complex mathematical algorithm. This sequence represents the original data in a compressed and highly abstracted form, such that it is practically impossible to reconstruct the original input from the hash alone. A key feature of hashing is that any alteration, even a very small one, produces a completely different hash. For example, if we input the word "BLOCK" into a hashing algorithm, it will generate a distinct digital fingerprint. If we change only the last letter and input "BLOCH", the algorithm will produce a completely different fingerprint. This demonstrates how hashing ensures data integrity and immediately detects any modification or tampering, making it an essential component of technologies such as blockchain.

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Blockchain relies on the SHA-256 hashing algorithm to generate a unique digital fingerprint for each input, producing an output of fixed length that changes completely with any alteration **to** the data, no matter how small. For example, when the word "OECD" is input into the algorithm, it produces the following digital fingerprint:

879D5ACDCDA51A6F1B00EBFE77513D9B19F574499C867997EE1FB6B1FA6DDBB0

When a similar word with just one letter changed, such as "OeCD", is input, the algorithm produces a completely different fingerprint:

19C91C8433AC66422E8B13A468B3E96D5D7924BEB1164F8412484900C7C1EDC

This example illustrates that even a single-character change produces a completely different hash, enabling the nodes in the network to detect any tampering immediately. In this way, hashing serves as a digital fingerprint that ensures the integrity and reliability of data within the blockchain, making the ledger secure and transparent for all participants (OECD, 2019, p. 07).

2.2.6. Previous Block's Hash

The previous block's hash is a unique value generated through a mathematical algorithm and stored within each block in the blockchain. Each block contains its own hash as well as the hash of the immediately preceding block, linking the blocks together like the links of a strong chain. This linkage ensures that if any party attempts to alter the data in a previous block, its hash will change immediately and no longer match the value stored in the subsequent block, thereby exposing the tampering. This concept can be likened to a numbered notebook, where each page contains the number of the previous page. If someone tries to delete or modify a page in the middle, the gap is instantly revealed, preserving the notebook's integrity. Through this mechanism, blockchain gains the property of immutability and enhances trust in the data stored within it

2.2.7. Mining

In some blockchain networks, before blocks can be added to the ledger, transactions must go through a process called mining. Mining refers to the method by which transaction records are included in blocks and added to the public ledger. This task is performed by miners, who are nodes within the network responsible for verifying the validity of transactions contained in a block. In particular, miners ensure that the sender has not previously spent the same funds before transferring them to the recipient. Once the verification is complete, miners must obtain network approval to add the block to the ledger, a process governed by the consensus mechanisms adopted on the platform

2.2.8. Consensus Mechanism

Consensus mechanisms are a fundamental component of blockchain technology, used to ensure collective agreement within the network. Achieving consensus among nodes regarding the state of the ledger is essential for the proper functioning and continuity of the blockchain. For example, the Bitcoin blockchain relies on a consensus model known as Proof of Work (PoW), where miners compete to create blocks and broadcast them for approval. Successful miners are rewarded with Bitcoin. Other consensus mechanisms include Proof of Stake (PoS), Proof of Authority (PoA), Proof of Elapsed Time (PoET), and Proof of Burn (PoB). While these models differ in methodology, they all serve the same fundamental purpose: enabling the network to reach agreement on any changes made to the ledger

2.2.9. Smart Contracts

Smart contracts are computer programs that represent digital agreements executed automatically when their programmed conditions are met. They aim to eliminate the need for intermediaries and enable parties to conduct transactions directly and securely online. They can be likened to a vending machine: when a user inserts money and presses a button, the product is delivered automatically according to the predefined agreement, without the involvement of any third party. Unlike traditional contracts, which rely on printed documents and enforcing authorities such as banks or governmental bodies, smart contracts are fully digital, self-executing, and define the obligations and rights of each party automatically and precisely, ensuring the agreement is carried out without the need for intermediaries (DELOITTE, 2017, p. 10).

3. Core Features of Blockchain Technology (A Distributed, Decentralized, and Immutable Ledger)

After introducing blockchain technology and understanding its fundamentals, it becomes essential to highlight the core features that distinguish it from traditional data storage and management systems. These characteristics are not merely technical advantages; they form the foundation that enables blockchain to build trust, ensure transparency, and provide security, thereby opening up broad possibilities for its applications across various fields.

Blockchain is a modern system whose most defining feature is its ability to store data securely and transparently. It is built on the principle of decentralization, meaning that no single entity controls the information; instead, it is distributed across a wide network of users. Blockchain consists of a chain of interconnected blocks, each containing a set of transactions that have been verified by network participants.

This technology is founded on three fundamental principles:

- **Decentralization:** Data is distributed across multiple nodes, preventing any single party from having control over it.
- **Transparency:** All transactions are recorded in a public ledger accessible to everyone, ensuring openness and traceability.

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- **Security:** Relying on encryption techniques and consensus mechanisms such as Proof of Work (PoW) and Proof of Stake (PoS), blockchain prevents tampering and guarantees the reliability of every transaction.

These core features make blockchain technology a pivotal tool applicable across a wide range of domains (Judijanto, Budiaji, & Fkun, 2024, p. 301).

Here, blockchain technology can be viewed as a distributed ledger, with copies stored on all participating nodes in the network. Each node verifies the validity of transactions and participates in consensus mechanisms to approve them, eliminating the need for a central authority and enhancing the security of the system. Blockchain is also characterized by immutability, meaning that recorded transactions cannot be altered or deleted, thereby ensuring trust in the data. Consensus mechanisms ensure the accuracy of each block, maintain a unified ledger among participants, and incentivize nodes to act honestly. Collectively, these features form the foundation for the security and reliability of blockchain networks (OECD, 2019, p. 06).

Owing to this extraordinary capability, blockchain is redefining the traditional roles of intermediaries, who have long monopolized significant market power by imposing high fees and slowing transaction processes, often without ensuring the reliability or integrity of data management. While its most common applications remain concentrated in the realm of digital financial assets, such as Bitcoin, its potential extends far beyond this scope, enabling deep structural transformations across multiple sectors, enhancing economic efficiency, and reshaping patterns of institutional interaction in the global economy.

It is worth noting, however, that these characteristics are not absolute. Blockchain does not allow its users to remain completely anonymous; identities are often pseudonymous, meaning that accounts and transactions remain visible to all participants. While blockchain is described as immutable, in rare cases, data can be modified if multiple nodes cooperate, or in certain private networks where a central authority's nodes are permitted to alter the ledger. Additionally, quantum computing poses a potential challenge to some current encryption methods; nevertheless, blockchain is expected to adapt and remain secure as these technologies evolve (OECD, 2019, p. 06).

In this context, recent studies identify four key criteria for assessing the feasibility of blockchain implementation in specific areas of the public sector: data replication, information transparency, data immutability, and consensus mechanisms. Experts recommend deploying blockchain in sectors that satisfy at least three of these factors. In cases where a sector relies on only one or two factors, blockchain may still offer potential benefits, albeit more limited. Given the data- and

record-intensive nature of tax compliance systems, examining the application of blockchain in tax administration appears both relevant and worthy of academic exploration and evaluation (DYLAN, PETER, NIK, & KAREN, 2019, p. 43).

In this regard, other studies indicate that effective tax administration systems incorporate all the features mentioned above. Here, blockchain technology emerges as a promising solution to address these challenges, as it inherently embodies all these characteristics, thereby enhancing the reliability and efficiency of tax management systems. Moreover, these features open the door to exploring practical blockchain applications for improving tax data collection, monitoring compliance, and facilitating information exchange among different authorities (Kim, 2024, p. 40).

Blockchain technology also demonstrates substantial transformative potential in the field of tax administration, as it enables the realization of parallel benefits for both tax authorities and taxpayers. At the level of tax authorities, this technology facilitates the establishment of a more efficient and transparent system for managing tax data, capable of processing information in real time, in addition to its role in reducing the information asymmetry gap between the administration and taxpayers. For taxpayers, the adoption of blockchain alleviates administrative burdens by eliminating the need to repeatedly submit the same data to multiple entities, while simultaneously enhancing the protection of tax information through a design that ensures its use exclusively by authorized authorities and institutions (Kim, 2024, p. 41).

Many researchers in this field argue that if blockchain technology were to be adopted in tax administration, the tax system would become highly positioned to benefit from it, given the involvement of numerous governmental agencies and financial institutions—each of which collects the same data and maintains its own centralized records. Payroll tax compliance, in particular, is considered an ideal area for blockchain implementation due to the complexity of calculations and the need to reconcile contributions between employers, as well as the centralized storage of data across multiple regulatory bodies responsible for auditing it. Moreover, compliance with regulations could be verified more easily through immutable records. This analysis aligns with the view of Professor Christian Catalini of the Massachusetts Institute of Technology (MIT), who emphasizes that although structural challenges still exist before the technology can be widely deployed, these obstacles are being overcome rapidly. Once the transition is complete, the efficiencies enabled by blockchain are expected to surpass those of traditional payroll management systems (Richard T & Ville, 2017, p. 03).

According to the views of many researchers, blockchain is considered one of the most promising technologies due to its ability to provide accurate and instantaneous information to a wide range of entities, making it particularly suitable for advancing tax systems at both the local and international levels. A survey conducted at the 2016 World Economic Forum in Davos, which included 816 observers and technology specialists, indicated that blockchain technology has the potential to significantly disrupt and reshape accounting practices and the processing of tax payments. Despite existing challenges, the governmental benefits of this technology are evident and cannot be overlooked. Blockchain can serve as a catalyst for implementing automated and real-time tax operations, efficiently and transparently supporting both small and large enterprises (DELOITTE, 2017, p. 11). In most advanced economies, payroll management processes have

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become largely digital. However, payroll tax systems still suffer from structural deficiencies arising from the involvement of multiple governmental bodies, each maintaining its own records, which results in substantial duplication of data. Adopting a blockchain-based system would eliminate the employer's role as an intermediary responsible for calculating taxes and social security contributions and transferring them to the relevant institutions. This can be achieved by integrating smart contracts through the following steps:

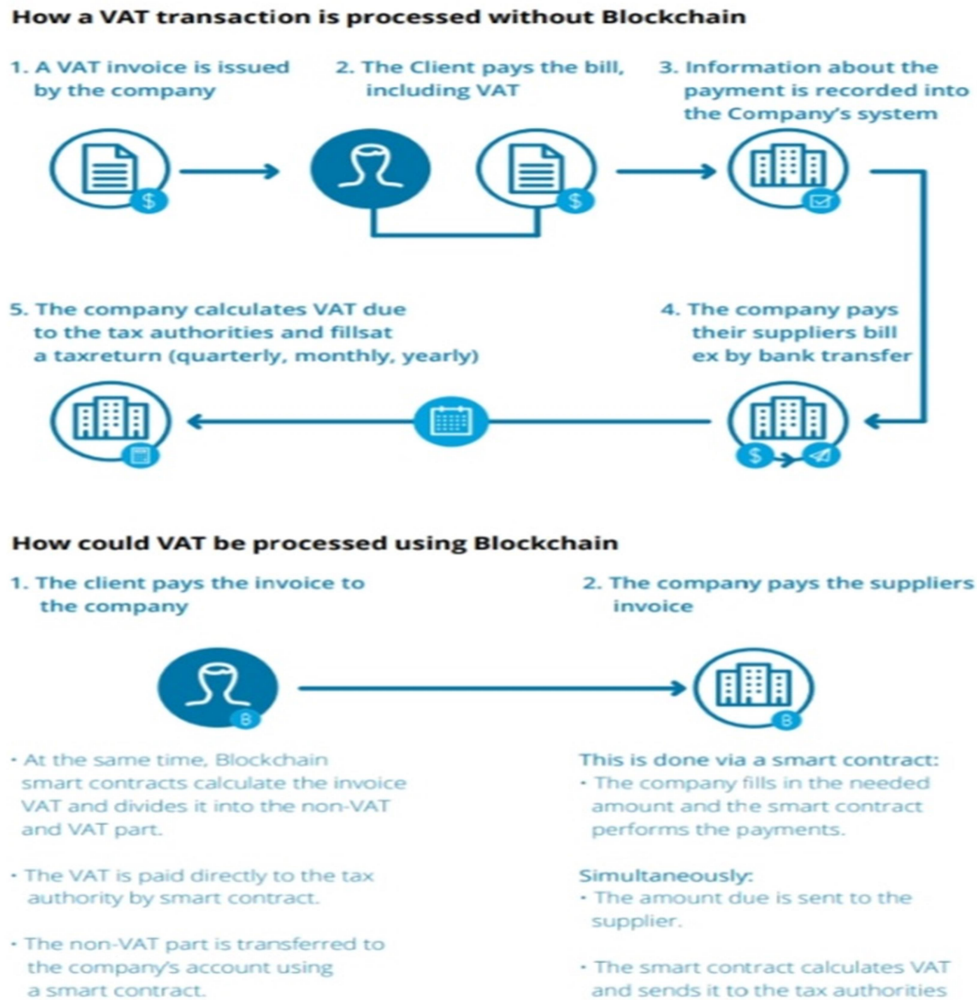
- The employer enters the gross wage into the system.
- The blockchain network—accessible only to the tax administration, banks, and other essential entities—matches the tax data with the payment process and calculates the correct amounts for taxes and social security contributions.
- The net wage is transferred directly to the employee's account, while the calculated withholdings are transferred to the public treasury.
- This results in a faster and less costly process, with more efficient cash-flow management (DELOITTE, 2017, p. 11).

4. Benefits of Blockchain in Tax Oversight

- Significantly reducing the administrative burden on businesses, thereby saving time and accounting service costs.
- Enabling all transactions to be conducted in real time.
- Ensuring that all transactions executed through smart contracts are tamper-proof and transparent.
- Minimizing the risks of fraud and errors.
- Providing immediate visibility into a company's financial position.
- Accelerating the transfer of funds between businesses and the government.
- Relieving taxpayers of the burden of calculating value-added tax (VAT) amounts at the invoice level or for the tax declaration.
- Substantially reducing opportunities for VAT fraud, as the same system that processes the tax at the transaction level allows for simultaneous multidimensional verification and auditing of the transaction, its parties, and its associated legal and commercial context.

The following figure provides a graphical illustration of the substantial difference between the processing of value-added tax (VAT) under the current traditional system without the use of blockchain technology, and its processing under a blockchain-based system :

Figure (02): Comparison Between Traditional VAT Processing and Blockchain-Based VAT Processing



Source: (Deloitte, 2017, p. 13)

The figure illustrates how value-added tax (VAT) is processed without the use of blockchain, as follows:

➤ Invoice Issuance

- The seller issues an invoice to the buyer, including the value-added tax (VAT) amount, for example, 19%.
- The buyer pays the net price plus the VAT to the seller.

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➤ Tax Collection

- The seller temporarily retains the value-added tax (VAT) collected on behalf of the government in their accounts.
- This creates a time gap between collection and the actual transfer to the tax authorities.

➤ Periodic Reporting

- At the end of the tax period (monthly or quarterly), the seller prepares a value-added tax (VAT) return.
- This involves calculating:
 - Output tax collected from customers.
 - Input tax paid to suppliers.
- The seller then remits the net tax (output minus input) to the tax authorities

➤ Declaration to Tax Authorities

- The tax return is submitted, and even if done electronically, it relies on manual or accounting records.
- The tax authorities are assumed to depend on the accuracy and correctness of the data provided by the taxpayers.

➤ Verification and Audit

- The authorities may subsequently audit the company's accounts to ensure their accuracy.
- This process is time-consuming, prone to fraud (such as falsified invoices and tax evasion), and lacks real-time oversight.

In contrast, the processing of value-added tax (VAT) using blockchain involves two main steps:

□ **Invoice Issuance and Payment:** Upon issuing and paying the invoice, the smart contract automatically calculates the value-added tax (VAT) and separates it from the net amount.

□ **Fund Transfer:** The net portion is transferred directly to the company's account, while the tax amount is simultaneously transferred to the tax administration

It can be observed that, in the absence of blockchain, the value-added tax (VAT) processing system remains largely based on self-reporting by companies, which creates opportunities for inaccuracies in the submitted data. Moreover, the time gap between collecting the tax from consumers and remitting it to the tax authorities weakens oversight and increases the risk of manipulation. In addition, the system remains vulnerable to fraud, accounting errors, or invoice

tampering, which limits its transparency and effectiveness. For small and medium-sized enterprises, the administrative complexities associated with periodic tax returns impose high compliance costs, making the system more burdensome and less efficient.

In contrast, the deployment of blockchain technology through smart contracts enables a qualitative transformation in the processing of value-added tax (VAT). These contracts automatically calculate the tax at the moment the invoice is issued and paid, separating the tax directly from the net transaction amount. The tax portion is transferred to the tax authorities simultaneously with the transfer of the net amount to the company's account. This instantaneous digital mechanism provides a more efficient and reliable framework, reducing human intervention and accounting errors while enhancing transparency. It also significantly minimizes opportunities for manipulation or fraud. Furthermore, it allows tax authorities to obtain accurate, real-time data on tax flows, thereby strengthening oversight effectiveness and improving the efficiency of financial transactions between taxpayers and the tax administration.

5. Theoretical Constraints and Challenges to Implementing Blockchain Technology in the Algerian Tax System

Despite the revolutionary potential of blockchain technology in enhancing tax transparency and reducing levels of evasion and fraud, its adoption in the Algerian context raises a series of complex theoretical constraints and challenges that must be addressed before moving to any experimental or practical implementation phase :

Firstly: The legal and institutional dimension emerges as one of the most prominent constraints. The current legislative framework in Algeria remains structured around traditional centralized mechanisms, which are not fully compatible with the philosophy of blockchain, based on decentralization, immutability, and the use of smart contracts as an automatic mechanism for fulfilling obligations. This discrepancy raises fundamental questions regarding the legal recognition of distributed digital records as tax evidence, as well as the determination of legal responsibility in the event of a dispute arising from a software error or technical malfunction.

Secondly: The challenge relates to the national digital infrastructure. Integrating blockchain requires high-performance communication networks, interconnected information systems across various tax and financial administrations, and unified databases secured against cyberattacks. However, the reality in Algeria reveals significant gaps in this regard, both in terms of high-speed internet coverage and the weak integration between governmental databases. These technical limitations may render the implementation of blockchain a complex and costly endeavor in the short term.

Thirdly: There is a clear shortage of national expertise in areas such as cryptography, cybersecurity, and distributed network development. Blockchain is not merely an operational technology but an integrated system that requires specialized knowledge for its design, maintenance, and adaptation to the local context. This knowledge gap increases Algeria's reliance

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on foreign consultancy, potentially creating a form of "technological dependency" in a sensitive sector such as tax administration.

Fourthly: Economic constraints cannot be overlooked. The initial investment required to develop a blockchain-based tax infrastructure demands substantial financial resources, whether for acquiring equipment, training human resources, or updating regulatory frameworks. Given the economic priorities related to diversification and addressing social challenges, decision-makers may hesitate to allocate significant resources to a technological project whose positive outcomes are only realized in the long term.

Finally: The sociological and cultural dimension remains highly significant. Transitioning from a traditional tax system to a distributed digital system requires a high level of trust and acceptance from taxpayers. In the absence of effective awareness campaigns and clear legal safeguards, the technology may be perceived as an additional surveillance tool that threatens privacy, rather than as a means to simplify transactions and achieve tax fairness.

Based on these considerations, it can be argued that the implementation of blockchain in the Algerian tax system remains contingent upon addressing these theoretical challenges through a comprehensive strategic vision. This vision should encompass legal reforms aligned with digital transformation, targeted investments in infrastructure, and ongoing training of local expertise. Furthermore, lessons can be drawn from leading international experiences, such as Italy's implementation of the Redditometro system to combat tax evasion or Brazil's widespread adoption of electronic invoicing. Adapting these experiences to national specificities could provide a foundational basis for the success of any future initiative to adopt blockchain in the tax sector.

6. Conclusion

Despite the tangible progress achieved by blockchain technology, it remains in an early stage of maturity, facing complex technical and institutional challenges. More than sixteen years after the launch of its first large-scale practical application in the form of cryptocurrencies (Bitcoin), no other model has yet emerged with comparable levels of adoption and impact across economic or administrative domains. This is primarily due to two main factors: first, the technical complexity of the technology, which requires advanced resources in terms of infrastructure and computational capacity; and second, the relative scarcity of human expertise capable of developing specialized blockchain networks in sensitive sectors such as tax administration.

In the case of Algeria, these challenges are particularly pronounced, as the tax administration still relies heavily on disparate traditional systems and non-unified databases, with weak information integration across various financial and tax institutions. Nevertheless, Algeria can gradually benefit from this technology if reforms are based on updating information systems, enhancing database integration, and adopting more transparent mechanisms for tax exchanges, thereby reducing gaps in tax compliance and improving taxpayers' trust in the administration.

Based on the study's hypotheses, the adoption of blockchain in Algeria could theoretically contribute to improving tax transparency by reducing the scope for manipulation in declarations, lowering administrative costs for taxpayers, and ensuring real-time tax collection—particularly for value-added tax (VAT), which represents one of the most important sources of public revenue. However, these potentials remain conditional on Algeria's ability to overcome current constraints, whether through upgrading digital infrastructure, implementing legislative reforms that recognize digital transactions as legal evidence, or investing in the development of specialized national expertise.

In light of these findings, the study demonstrates that the blockchain revolution in the Algerian tax system is not merely a theoretical possibility but a feasible path in the medium term, provided there is clear political will and a comprehensive reform strategy. From a research perspective, there is a pressing need for in-depth field studies to assess the readiness of tax administrations to adopt this technology, alongside comparative research drawing on the experiences of countries such as Brazil and Italy in tax digitalization, with the aim of adapting these lessons to the Algerian context. Such future research could bridge the gap between the theoretical potential of blockchain and its practical implementation locally, thereby paving the way for a more effective and equitable tax reform.

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