People's Democratic Republic of Algeria.
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

University of Ain Temouchent BELHADJ Bouchaib

Faculty of Economic, Commercial and Management Sciences.
Departement of Finance and Accounting .
Major: Advanced Accounting and Taxation.

Master's Thesis

Blockchain: Accounting Transparency and Tax Challenges

- A 2007–2024 International Comparative Study with a Simulation-Based Proof of Concept (MAFI)-

Presented by:

-MAOUI ISRA.

Supervior:

-Pr. OMAR DJAFRI

The jury :

President	University of Ain Temouchent BELHADJ Bouciaab	*- Dr. Baghli Ahmed*
Supervior	University of Ain Temouchent BELHADJ Bouciaab	*-Pr. Djafri Omar*
Examinator	University of Ain Temouchent BELHADJ Bouciaab	*-Dr. Bentouir Naïma*

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- بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ -

{ وَمَا بِكُم مِّن نِّعۡمَةٖ فَمِنَ ٱللَّهِ}

الآية 53 من سورة النحل في القرآن الكريم

Abstract:

This thesis examines the role of blockchain technology in enhancing accounting transparency and addressing tax-related challenges through a dual approach that combines theoretical foundations with applied analysis. An international comparative study was conducted on three multinational companies—IBM (United States), Siemens (Germany), and Fujitsu (Japan)—over the period from 2007 to 2024. The analysis focused on key financial indicators, including earnings quality, accruals ratios, and the earnings–cash flow gap, in order to assess the impact of blockchain adoption on accounting transparency and the reliability of financial reporting.

In addition to the comparative study, this research presents a simulation-based proof of concept named **MAFI (https://mafibc.netlify.app/)** , developed by the researcher. The platform demonstrates how blockchain can automate VAT deduction, strengthen tax compliance, and address key challenges such as fake invoicing, tax evasion, and administrative corruption. It also simulates double- and triple-entry accounting logic within a permissioned blockchain framework, ensuring transaction traceability and integrity.

The findings reveal a positive relationship between blockchain implementation and improvements in accounting transparency, tax compliance, and oversight efficiency, especially in combating administrative fraud. Furthermore, the study emphasizes the limitations of absolute transparency in accounting and taxation, advocating for a balanced approach based on the **"Need-to-Know"** principle, which promotes purposeful disclosure without compromising confidentiality or strategic data sensitivity.

Keywords: Blockchain, accounting transparency, tax compliance, MAFI platform, simulation, Value Added Tax, IBM, Siemens, Fujitsu.

ملخص:

تتناول هذه المذكرة دور تكنولوجيا البلوكشاين في تعزيز الشفافية المحاسبية ومعالجة التحديات الضريبية، من خلال مقاربة تجمع بين البعد النظري والتحليل التطبيقي. وقد أُجريَت دراسة مقارنة دولية لثلاث شركات متعددة الجنسيات، وهي IBM :)الولايات المتحدة(، Siemens(ألمانيا)، و Fujitsu(اليابان)، وذلك خلال الفترة الممتدة من 2007 إلى 2024. وارتكز التحليل على مؤشرات رئيسية تشمل جودة الأرباح، ونسب الاستحقاقات، والفجوة بين الأرباح والتدفقات النقدية، لقياس أثر اعتماد البلوكشاين على الشفافية المحاسبية وموثوقية التقارير المالية.

وبالإضافة إلى الدراسة المقارنة، تقترح هذه المذكرة نموذجًا تطبيقيًا قائمًا على المحاكاة تحت مسمى(MAFI) (**https://mafibc.netlify.app/**)، من إعداد الباحثة، يُبرز كيفية مساهمة البلوكشاين في تنفيذ الاقتطاع الآلي لضريبة القيمة المضافة، وتعزيز الامتثال الضريبي، ومكافحة بعض التحديات مثل الفواتير الوهمية، التهرب الضريبي، والفساد الإداري. كما تُحاكي المنصة منطق التسجيل المحاسبي المزدوج والثلاثي ضمن إطار بلوكشاين مصرّح به، يضمن قابلية تتبع المعاملات وسلامتها.

وقد أظهرت نتائج الدراسة وجود علاقة إيجابية بين تطبيق البلوكشاين وتحسين الشفافية المحاسبية، والامتثال الضريبي، وتعزيز الرقابة ومكافحة الفساد الإداري. كما أكدت على حدود الشفافية المطلقة في المجالين المحاسبي والضريبي، داعية إلى تبنّي نهج متوازن قائم على مبدأ "الحاجة إلى المعرفة(Need-to-Know) "، بما يضمن الإفصاح الهادف دون المساس بسرية البيانات أو حساسيتها الاستراتيجية.

الكلمات المفتاحية :البلوكشاين، الشفافية المحاسبية، الامتثال الضريبي، منصةMAFI ، المحاكاة، ضريبة القيمة المضافة، IBM، Siemens، Fujitsu.

Dedication

To my beloved parents,
who sacrificed their present for the future of their children
I will always strive to make you proud.
To my strong self,
who never gave up despite the circumstances and challenges…
this is the fruit of your patience and perseverance.

Israa

Acknowledgment

Alhamd to Allah, endlessly and wholeheartedly
my refuge, my strength, and my source of peace.
Alhamd for His beautiful planning in every step I took.
To my mother and father,
no words or gratitude can ever express how much you mean to me.
You are the source of my courage, ambition, and perseverance.
You are my greatest role models in life.
To my brothers, Abdelrahman, Abdeljalil, and Abdelaziz—
my three knights, one blood, one team.
To my sister, Fatima Alaa,
my little princess and my bestie .
To my family, I'm here because of yo your love, support, and presence through my weakness before my strength.
My special thanks to Mebarki Omar Al-Farouk…my rocky
I began this journey six years ago when I met you, and today I end it with you.
Thank you for your love, your endless support, and your constant encouragement through both my darkest times and my moments of joy.
Thank you for standing by me through every challenge and every celebration.
Even through your own struggles, you gave what you could with sincerity.
that truly mattered.
This achievement is as much yours as it is mine.
To Kaouther, Ibtissam, Abla, and Mariam,
thank you for your support, positive energy, and standing by my side.
To Souad, my dear companion,
my partner through the joyful and difficult days.
To the Qur'an circle "Halaqat Nour",
where my journey with knowledge began,
and from where I grew stronger and flourished.
To Ustadha Nour, the mother of the Qur'an circle,
and to my Muallima Douaa Al-Aljae,

your kindness and saber and nurturing spirit will never be forgotten.

And to everyone whose names I may not have mentioned but whose presence touched my soul.

Israa

To accounting the subject I was once mocked for.
I chose you not in spite of their ridicule, but because of it.
To the voices that doubted me in the higher school,
And to the one teacher who laughed when I struggled:
I turned what hurt into purpose.
Today, I speak your language not as a student,
But as a woman who mastered what once broke her.

To myself: *My depression didn’t win. I did & with excellence*

Israa

Gratitude and Recognition

I extend my heartfelt thanks and deep appreciation

to all my respected teachers from elementary school to my Master's studies

who, after Allah, were the reason behind the knowledge and understanding I have reached.

I especially thank my academic supervisor, Mr. OMAR DJAFRI,

not only for his academic guidance and support,

but also for being the reason I finally understood accounting,

which once seemed like an overwhelming challenge.

Through his explanations, concepts became clearer, and progress became possible.

His impact on this thesis is immense and unforgettable.

I also thank Mr. Obeid Mohamed,

whose guidance helped me grasp the essence of accounting your contribution will always be remembered.

My gratitude extends to the expert accountant Mr. Bousmaha,

who supervised my internship and taught me practical accounting and tax skills,

as well as to his amazing team who supported and guided me throughout.

I am also thankful for my journey at the Higher School of Management ,

which enriched me academically and personally,

and for my time at Belhadj Bouchaib University,

which was fruitful by the grace of Allah.

To every teacher who taught me, guided me,

and enlightened my path with a word, a lesson, or an idea

Thank you.

Because of you, I have grown.

Through your guidance, I was shaped.

And by the blessings and mercy of Allah, I have reached this milestone.

Israa

And last but not least, I wanna thank me.

I wanna thank me for believing in me.

I wanna thank me for doing all this hard work.

I wanna thank me for having no days off.

I wanna thank me for never quitting.

I wanna thank me for always being a giver,

And trying to give more than I receive.

I wanna thank me for trying to do more right than wrong.

I wanna thank me for just being me at all times.

Israa

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Abbreviation List

- **Earnings Q:** Earnings Quality;
- **AM;AR :**Accruals Ratio;
- **ECG:** Earnings-Cash Gap;
- **ERG:** Earnings gap ratio;
- **POC:** Proof of concept.

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General introduction

Background:

Accounting is the cornerstone of any economic activity, serving as the primary engine for financial stability, institutional continuity, and sustainable growth. Accurate and reliable accounting depends on a solid foundation, built on principles like accounting transparency, which in turn creates strong financial structures. This foundation enhances the ability of companies to grow, maintain the trust of stakeholders and clients, secure a solid market reputation, ensure real revenue sustainability, and making effective decisions. With the rise of financial crises and the challenges of the digital age, accounting transparency has become a fundamental necessity rather than a complementary feature for ensuring financial stability, protecting investors, and sustaining institutions.

Accounting transparency goes beyond merely presenting numbers. It reflects a company's ability to provide a clear and precise picture of its financial performance, thereby boosting confidence, reducing risks, and enabling effective financial management. This critical aspect has become even more important in the context of globalization and economic diversification, which have increased the complexity of financial operations and the spread of corruption. One striking example highlighting the importance of accounting transparency is the Luckin Coffee scandal, which shook global markets in 2020. The Chinese company was exposed for fabricating $310 million in sales during 2019, leading to market losses exceeding 3.5 billion$ within days, as its stock value plummeted by more than 75% in a single day. The company also faced severe financial penalties, including a $180 million fine to settle accounting fraud charges (Academy, 2022). This sudden collapse illustrated how a lack of accounting transparency can erode trust, diminish market value, and lead to financial ruin, underscoring the critical role of transparency in protecting the stability of financial markets.

Meanwhile, governments are also grappling with growing challenges in revenue collection, as informal economies expand, compliance weakens, and tax evasion rises. These issues undermine the ability of nations to fund development projects and stabilize their economies. In this context, blockchain technology emerges as an innovative solution, capable of enhancing accounting transparency through tamper-proof financial records, reducing tax evasion, and providing greater transparency within financial systems.

Accordingly, this study aims to explore the impact of blockchain technology on accounting transparency and tax challenges through an international comparative analysis study. Furthermore ,it seek to propose a practical vision by developing a simulated blockchain based accounting and tax platform ,with the goal of illustrating how such a system can reduce tax evasion ,limit fraudulent invoicing ,and accelerate tax collection mechanisms.

Based on this, the main research question can be formulated as follows:

1. Main research question :

How can blockchain technology contribute to enhancing accounting transparency and reducing the tax challenges faced by countries?

1.1.Second : Research sub-questions:

- **Question 01**: What is blockchain technology and what qualifies it to enhance accounting transparency and address tax challenges?
- **Question 02:** To what extent does the adoption of blockchain technology affect accounting transparency in international companies?
- **Question 03:** How can fake invoices and tax evasion be reduced through a blockchain based on simulation platform?

2. Hypothesis :

2.1. Hypothesis 1 :

Null Hypothesis (H_0-1): The use of blockchain technology does not lead to an improvement in accounting transparency or affect the indicators of financial information quality in companies;

Alternative Hypothesis (H_1-1): The use of blockchain technology contributes to enhancing accounting transparency by improving earnings quality indicators, reducing the accruals ratio, decreasing the earnings–cash flow gap, and narrowing the ratio of this gap.

2.2. Hypotheses 2:

Null Hypotheses (H_0): The implementation of the proposed blockchain-based accounting and taxation platform (POC) does not contribute to improving tax compliance processes or enhancing transparency based on the analysis of the applied scenarios;

Alternative Hypotheses (H_1): The implementation of the proposed blockchain-based accounting and taxation platform (POC) contributes to enhancing tax compliance by improving the accuracy and transparency of tax data and reducing tax evasion rates, as evidenced by the performance indicators extracted from the platform.

3. Justification of choosing the study:

- A strong passion for technology and a desire to explore its applications in the accounting and taxation fields.
- The novelty and importance of the topic in light of the growing complexity and crises in financial, accounting, and tax systems.
- The aim to bridge the knowledge gap by providing a reference on blockchain technology and its applications in accounting transparency.
- A desire to strengthen practical knowledge and link theoretical concepts to real-world business practices.
- Supporting future professional goals related to digital transformation in financial and tax environments.

4. Significance of the Study:

- **Academic Contribution:** This study enriches the academic literature by providing valuable insights and references on the application of blockchain in accounting and taxation.
- **Practical Relevance:** Through the analysis of real-world data and the development of a blockchain-based simulation platform, the study offers practical perspectives on enhancing the reliability of accounting and tax systems and their impact on financial governance.
- **Innovative Perspective:** The integration of a blockchain accounting and tax simulation platform introduces an applied dimension that bridges theoretical concepts with real-world practices.
- **Policy and Regulatory Implications:** The study generates evidence-based findings that can inform policymakers, tax authorities, and regulatory bodies about the potential benefits and challenges of blockchain adoption.
- **Algerian Contextual Value:** The study addresses a local knowledge gap by evaluating Algeria's readiness to integrate blockchain technology in accounting and taxation particularly relevant in light of national digital transformation efforts, such as the introduction of a digital currency and new academic specializations in AI and cybersecurity.

5. Study objectives:

- To explore the conceptual foundations of blockchain technology and clarify its relevance to the accounting and taxation fields.
- To highlight the impact of blockchain on accounting transparency, through a comparative international analysis based on key financial indicators and data from selected companies.

- To assess the contribution of blockchain technology in addressing key tax challenges, by designing and simulating a blockchain-based accounting and taxation platform focused on the automatic deduction of Value Added Tax (VAT).

6. Limits of the Study:

- **Temporal Scope:** This study covers financial data from different time spans for the selected companies to enable a comparative analysis before and after blockchain adoption:
  - IBM (USA): 2007–2024 ;
  - Siemens (Germany): 2011–2024 ;
  - Fujitsu (Japan): 2011–2024.
- **Geographical Scope:** The study focuses on companies headquartered in three countries—the United States, Germany, and Japan—in order to provide a diversified international perspective on blockchain integration in accounting practices.
- **Thematic Scope:** The research is limited to examining the impact of blockchain technology on accounting transparency and its potential in addressing core tax challenges, particularly through a simulated accounting and tax platform that models automated value-added tax (VAT) deduction, rather than using an actual blockchain system.
- **Methodological Scope:** The study adopts a quantitative and comparative analytical approach, using financial indicators (such as earnings quality, accruals ratio, earnings-cash gap) derived from official annual reports. These indicators are statistically analyzed using SPSS software to detect variations before and after blockchain implementation. Additionally, a prototype simulation of a blockchain-based platform was designed to conceptually illustrate practical applications, without deploying a real blockchain infrastructure due to budgetary constraints.
- **Human Scope:** The study was conducted solely by a graduate student in accounting and taxation. The simulated platform and analysis were developed for academic purposes only, with no direct involvement from the selected companies or implementation of real blockchain systems.

7. Structure of the Study:

To achieve the objectives of the research and answer the main research question, this study is divided into two main chapters as follows:

- **Chapter One: Theoretical literature review.**

This chapter presents the fundamental concepts of blockchain technology, including its characteristics, mechanism of operation, and core components. It then addresses the concept of accounting transparency, highlighting the role of blockchain in enhancing it. The chapter concludes by discussing key contemporary tax challenges and the contribution of blockchain technology in mitigating them.

- **Chapter Two: Applied Study.**

This chapter is dedicated to the empirical part of the research. It analyzes the impact of blockchain implementation on a set of indicators reflecting accounting transparency through a comparative study of three companies from different countries. Additionally, it includes the development and execution of a simulated blockchain-based accounting and taxation platform, along with the expected outcomes of its use.

Chapter one:

Theoretical Framework

Introduction to Chapter One:

This chapter aims to establish the conceptual and theoretical framework underpinning the current study by providing a comprehensive review of the fundamental concepts and mechanisms related to blockchain technology, its impact on accounting transparency, and the associated tax challenges. To achieve this systematically and coherently, the chapter is divided into two main sections

The first section addresses the theoretical literature review, beginning with an introduction to the core concepts and principles of blockchain technology. It then examines the role of blockchain in enhancing accounting transparency and concludes with an analysis of how blockchain contributes to addressing tax-related challenges.

The second section focuses on the applied literature review, presenting and analyzing previous relevant studies, followed by a discussion of their key findings. This enables highlighting the added value that the present study contributes within the contemporary scientific research context.

Section one: Theoretical literature review.

I. Introduction to blockchain technology: fundamental concepts and mechanisms.

Among the most prominent emerging technologies that are increasingly playing a pivotal role in reshaping financial systems, blockchain technology stands out as a revolutionary tool with unprecedented potential. It has brought about a fundamental transformation in the mechanisms of data and transaction management. Its applications are no longer limited to the financial sector alone, but have also expanded to include accounting and tax systems, due to the advantages it offers in terms of transparency, security, and data immutability.

Given the importance of this technology, a precise understanding of its nature represents a necessary entry point to grasp the essential role it can play in enhancing the efficiency and credibility of accounting and tax systems. Therefore, this section aims to provide a comprehensive knowledge base on blockchain technology.

1. Concept of blockchain technology:

Blockchain technology was initially introduced as the foundational infrastructure for cryptocurrencies such as Bitcoin, but it has since evolved into a transformative digital innovation with broad applications across various domains, including accounting, taxation, supply chain, and governance. While multiple definitions of blockchain exist, they consistently emphasize key characteristics such as decentralization, immutability, transparency, and security.

Blockchain has been conceptualized in multiple ways across the literature. Initially, it was introduced as a decentralized, peer-to-peer ledger system designed to record transactions in a manner that prevents unilateral alterations without network consensus (Nakamoto, 2008).Expanding on this idea, (Tapscott, 2016) describe blockchain as an immutable and transparent digital ledger accessible to all participants within a network. (Service, 2018) highlights its potential in safeguarding data integrity through decentralization and resistance to tampering or unauthorized changes. In the context of taxation, (OECD, 2020)emphasizes blockchain's role in enabling transparent and secure transaction recording by distributing identical ledger copies across all network nodes.

Collectively, these definitions point to a comprehensive understanding of blockchain as a decentralized digital ledger system that facilitates secure and immutable data recording across a network of users without the need for a central authority. It relies on consensus algorithms to verify transactions and employs cryptographic mechanisms such as hashing and public private key encryption to safeguard data integrity and prevent unauthorized alterations. These foundational attributes render blockchain a promising tool for enhancing trust and transparency in digital systems.

2. Common Misconceptions about Blockchain:

Despite the increasing global interest in blockchain technology, various misconceptions still cloud its understanding, especially in sectors like public finance and taxation. These myths often arise from oversimplified narratives, confusion with cryptocurrencies, or lack of technical literacy. Addressing these misconceptions is crucial to building realistic expectations and ensuring responsible adoption of blockchain-based systems:

2.1 Blockchain is only about cryptocurrency:

One common misconception is that blockchain is limited to cryptocurrencies such as Bitcoin. While cryptocurrencies were indeed the first widely known application of blockchain, the technology itself has expanded into various domains, including supply chain tracking, identity verification, smart contracts, and public governance. (Zheng, 2018) emphasize that blockchain represents a decentralized data management structure that can function independently of financial assets, opening doors to non-monetary use cases in both public and private sectors.

2.2 Blockchain Is Unhackable :

A widespread myth is that blockchain is completely unhackable due to its decentralized and cryptographic nature. While blockchain does enhance security, (Conti, 2018) highlight that it is not immune to attacks. Several vulnerabilities exist in the ecosystem, including smart contract bugs, wallet hacks, and 51% attacks where an attacker controls the majority of the network's computing power, allowing them to reverse transactions or double spend. Therefore, blockchain is secure, but not invincible, and must be complemented with strong governance and technical safeguards.

2.3 All Blockchains are Public :

A common misconception is that all blockchains are public and transparent like Bitcoin. In reality, (Xu, 2019) Xu, explain that blockchains can be public, private, or consortium-based, depending on the intended use. Private blockchains are used by organizations for internal operations, where only authorized participants can access and validate data. Consortium blockchains involve several entities sharing control, making them ideal for inter-organizational cooperation while maintaining selective transparency. Thus, blockchain is not inherently public; its openness depends on the governance model and purpose.

2.4 Blockchain ensures full anonymity :

It is often assumed that blockchain technology guarantees complete anonymity to its users. However, a review by (Casino, 2019)suggests that such a belief may be misleading. While transactions on the blockchain are conducted through cryptographic public keys instead of real names, the ledger itself remains transparent and immutable. Over time, patterns in transaction activity can potentially be analyzed and linked to real-world identities, especially when external data sources are involved. As a result, blockchain is more accurately characterized as pseudonymous rather than fully anonymous a distinction that holds significant implications for privacy, compliance, and tax enforcement.

2.5 Blockchain is free to use:

There is a widespread perception that blockchain systems operate without significant costs. However, (Bai, 2022) point out that this perception may oversimplify the real operational and environmental implications of blockchain networks. The maintenance of decentralized infrastructure, execution of consensus algorithms, and validation of transactions often require substantial computational power and energy. These processes generate ongoing operational expenses, which are frequently passed on to users in the form of transaction fees. Consequently, while blockchain can offer cost efficiencies in certain areas, its use is not entirely free and may entail hidden costs that vary by network design and scale.

3. Blockchain Generations:

The evolution of blockchain technology can be categorized into four distinct generations, each representing a shift in capabilities and applications.

3.1 First Generation – Cryptocurrency_ (Blockchain 1.0):

The first generation of blockchain emerged with the launch of Bitcoin in 2008 by the pseudonymous creator Satoshi Nakamoto. This generation primarily focused on enabling peer-to-peer digital currency transactions without the need for intermediaries such as banks. It introduced the concept of decentralized, immutable ledgers and consensus mechanisms like Proof of Work (PoW) (Nakamoto, 2008) .However, Blockchain 1.0 was limited in :

- **Digital Payments:** Bitcoin was the first practical application of blockchain technology for peer-to-peer money transfers.
- **Cryptocurrency:** The emergence of digital currencies as an alternative to traditional banking systems.

1.2 Second Generation – Smart Contracts (Blockchain 2.0):

The second generation, led by platforms like Ethereum, launched in 2015, extended the capabilities of blockchain by introducing smart contracts, which are self-executing contracts with terms directly written into code. This evolution allowed for decentralized applications (dApps) across various industries, such as supply chains, healthcare, and insurance. It also introduced new consensus algorithms like Proof of Stake (PoS), increasing programmability and efficiency (Buterin, 2014); (Christidis, 2016).it was applied also in :

- **Governance:** Smart contracts allowed for decentralized governance models that are more transparent and efficient.
- **Accounting:** Blockchain-based smart contracts enabled decentralized and transparent accounting systems.
- **Taxation:** Blockchain can facilitate tax collection by ensuring transparency and compliance.
- **Auditing:** Decentralized ledger systems improve the accuracy and integrity of financial audits.

1.3 Third Generation – Scalability, Interoperability, and Sustainability (Blockchain 3.0):

The third generation addresses the limitations of previous blockchain by focusing on scalability, allowing for more transactions per second, interoperability, which enables different blockchain to communicate with each other, and sustainability, focusing on reducing energy consumption. Projects like Cardano, Polkadot, and Algorand exemplify this generation by implementing innovative consensus mechanisms, cross-chain communication protocols, and eco-friendly infrastructures (Wood, 2016).this generation application has expanded to:

- **Logistics:** Blockchain solutions like Polkadot improve supply chain management by enabling seamless data exchange between multiple blockchains.
- **Decentralized Finance (DeFi):** Third-generation blockchains facilitate decentralized financial applications without intermediaries.
- **Identity Management:** Blockchain allows for the creation of decentralized and secure identity management systems.

1.4 Fourth Generation – Sustainability, Artificial Intelligence, and Layered Solutions (Blockchain 4.0):

The fourth generation of blockchain integrates artificial intelligence (AI), cloud computing, and multi-layered solutions. This generation aims to enhance blockchain's capacity to handle vast amounts of transactions, increase efficiency, reduce energy consumption, and improve scalability. This evolution also facilitates communication and interaction between various blockchain systems through interoperable protocols. it integrateS (Pratyusa.M, 2021)

Artificial Intelligence: Integrating AI with blockchain enhances data analysis and decision-making in sectors such as healthcare, manufacturing, and logistics.

- **Cloud Computing**: Blockchain can secure data storage and transactions in cloud systems, enhancing privacy and security.
- **Multi-Layered Solutions:** Blockchain 4.0 solutions improve performance by leveraging multi-layer architectures for faster and more scalable networks.
- **Projects Exemplifying the Fourth Generation:**
  - Avalanche and Solana offer highly scalable blockchain platforms that enable faster transaction speeds and better scalability.
  - Polkadot and Cosmos provide solutions for cross-chain interoperability, allowing different blockchain networks to work together efficiently.

4. Characteristics of Blockchain:

Blockchain technology is characterized by several key features that distinguish it from traditional systems. One of its fundamental attributes is decentralization, which eliminates the need for a central authority by distributing control across a network of nodes. This structure enhances transparency and reduces the risk of single points of failure (Dong, 2023), another critical characteristic is immutability. Once data is recorded on the blockchain, it becomes nearly impossible to alter without consensus from the network, ensuring data integrity and trustworthiness (Tabatabaei, 2023).Transparency is also inherent in blockchain systems. Transactions are recorded on a public ledger, allowing participants to verify and audit transactions independently, which fosters trust among users Furthermore, blockchain employs consensus mechanisms to validate transactions, ensuring that all participants agree on the state of the ledger. This process prevents fraudulent activities and double-spending issues (Ali, 2023) .Security is a paramount feature. Blockchain utilizes cryptographic techniques to secure data, making it resilient against unauthorized access and cyber-attacks (Dong, 2023).

In addition, blockchain enables traceability, allowing the history of a transaction or an asset to be accurately tracked across the system, which is particularly useful in supply chain and regulatory compliance (Wang, 2023).Another notable characteristic is pseudonymity, which offers privacy through the use of encrypted addresses instead of personal identities while still ensuring accountability (Placeholder1) (Liu, 2024) . Lastly, blockchain systems support programmability, enabling the creation of smart contracts that automatically execute terms based on predefined rules, improving efficiency and reducing reliance on intermediaries (Smith, 2023)

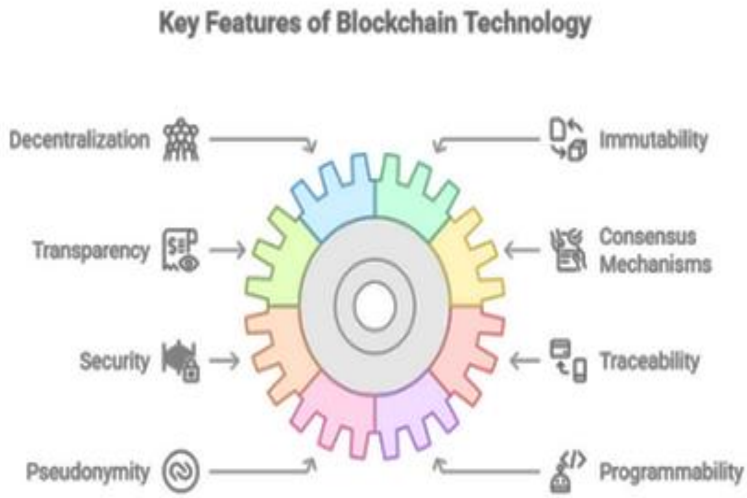


Figure 1 : Characteristics of Blockchain .

(Prepared by the researcher)

5. **Types of Blockchain:**

Blockchain networks are generally categorized into four primary types: public, private, consortium, and hybrid. Each type possesses distinct characteristics, advantages, and limitations, making them suitable for various applications.

- **Public Blockchains:** are open and decentralized networks where anyone can participate without permission. They are maintained by a distributed network of nodes, ensuring transparency and immutability. Cryptocurrencies like Bitcoin and Ethereum operate on public blockchains, promoting trustless transactions and decentralization (Campbell & Pacheco, 2025).
- **Private Blockchains:** are restricted networks controlled by a single organization. Access is limited to authorized participants, providing enhanced privacy and faster transaction processing. These blockchains are commonly used in enterprises for internal processes, supply chain management, and confidential data handling (Simplilearn, 2022).
- **Consortium Blockchains**: also known as federated blockchains, are governed by a group of organizations rather than a single entity. This collaborative approach combines the benefits of both public and private blockchains, offering partial decentralization and

increased efficiency. Consortium blockchains are often utilized in industries like finance and healthcare, where multiple stakeholders require shared access to data (Leigang Jia, 2025).

- **Hybrid Blockchains**: integrate features of both public and private blockchains, allowing organizations to control access to certain data while maintaining transparency for other information. This flexibility makes hybrid blockchains suitable for scenarios where selective transparency and confidentiality are necessary, such as in government services and real estate (Hazem Marar, 2020).

Understanding these blockchain types is crucial for selecting the appropriate framework that aligns with specific organizational needs and objectives.

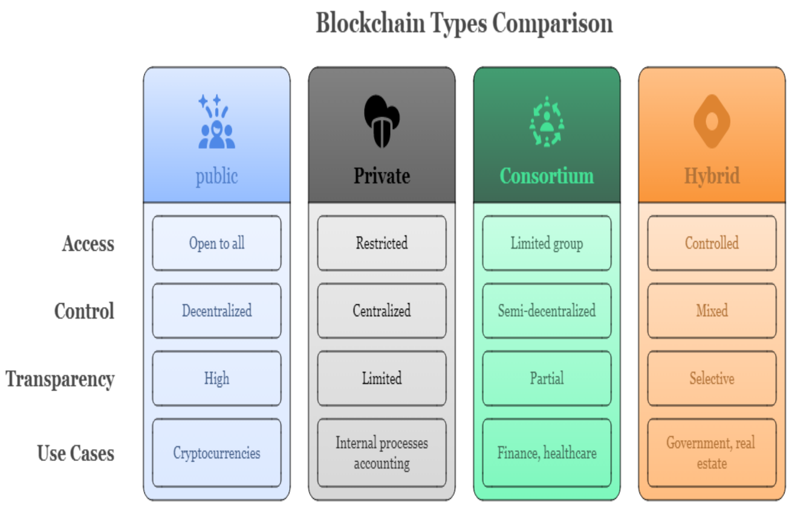


Figure 2 : Types of blockchain.

(Prepared by the researcher)

6. Blockchain's Mechanism:

Blockchain is a decentralized and distributed ledger technology that records transactions across a network of computers in a secure, transparent, and tamper-proof manner. At its core, blockchain comprises a sequence of blocks, each containing a set of transactions, a timestamp, and a cryptographic hash of the previous block, ensuring data integrity and chronological order (Xiao, 2020).

When a user initiates a transaction, it is broadcast to a peer-to-peer network of nodes. These nodes validate the transaction through consensus mechanisms. The most commonly used consensus algorithms include Proof of Work (PoW) and Proof of Stake (PoS). PoW requires miners to solve complex mathematical puzzles to validate transactions, ensuring security but consuming significant energy. In contrast, PoS selects validators based on the amount of cryptocurrency they hold and are willing to 'stake,' offering a more energy-efficient alternative (Zhou, 2023).

Once validated, the transaction is grouped with others into a new block. This block is then appended to the existing blockchain, and the ledger is updated across all network participants, maintaining consensus. This process guarantees transparency and traceability, as altering any information would require changes in all subsequent blocks and consensus from the majority of the network (Tabatabaei, 2023).

A crucial component of blockchain's mechanism is the use of cryptographic techniques, particularly hashing and digital signatures. Hashing converts transaction data into a fixed-length alphanumeric code, ensuring data confidentiality and integrity. Digital signatures, generated using asymmetric encryption, authenticate user identity and prevent unauthorized access or forgery (An, 2023)

7. Blockchain's Components:

It is important to emphasize that blockchain is not a single tool or standalone application, but rather a comprehensive architecture composed of several interconnected components, which together form the backbone of the system and determine its efficiency, reliability, and security. These components are divided into core components, which are indispensable for the blockchain's operation, and complementary components, which vary depending on the nature of the service, task, or application. The latter have emerged with the evolution of blockchain generations and the expansion of its uses.

7.1. The Basic Components of Blockchain:

- **Distributed Network:**

The distributed network serves as the foundational infrastructure of blockchain systems. It consists of a set of interconnected nodes operating within a peer-to-peer (P2P) architecture.

This structure allows all nodes to participate in the verification and recording of transactions on a shared distributed ledger, without relying on any central authority (GAO, 2019).

- **Nodes:**

Nodes are individual devices (such as computers or servers) that participate in the distributed blockchain network. Each node plays a critical role in maintaining data integrity by storing a copy of the distributed ledger and validating transactions and newly added blocks.

Nodes are generally categorized into:

- Full Nodes:which store the complete blockchain history and independently validate all data.
- Lightweight Nodes (or Light Clients): which hold only essential information and rely on full nodes for transaction verification.

- **Blocks:**

Blocks are the fundamental data structures in a blockchain. Each block contains a bundle of validated transactions, a timestamp, a reference (hash) to the previous block, and its own unique cryptographic hash. This chaining of blocks forms a chronological and immutable sequence of records.

The structure of blocks ensures data integrity and traceability, as any attempt to alter a single block would require altering all subsequent blocks across the network a computationally infeasible task without consensus (Yaga, 2018) .

- **Cryptographic Hash Function :**

A cryptographic hash function is a mathematical algorithm that transforms any input data into a fixed-length alphanumeric string known as a hash. This hash is unique to the original data, and even the slightest change in the input generates a completely different output.In blockchain systems, hash functions ensure data integrity, secure the links between blocks, and make records tamper-evident (Reyhanitabar, 2024).

- **Consensus Mechanisms:**

Consensus mechanisms are fundamental protocols that enable all nodes in a decentralized blockchain network to agree on the validity of transactions and the state of the ledger without the need for a central authority. These mechanisms ensure data integrity and prevent double-spending or fraudulent activities. The most well-known consensus algorithms include:

- Proof of Work (PoW): Requires nodes (miners) to solve complex mathematical problems to validate transactions and add new blocks. It is resource-intensive and used in early blockchains like Bitcoin.
- Proof of Stake (PoS): Validators are selected to propose and validate blocks based on the amount of cryptocurrency they "stake" or hold, offering energy efficiency compared to PoW.
- Delegated Proof of Stake (DPoS Proof of Stake (PoS): Stakeholders vote for a limited number of trusted validators to produce blocks on their behalf, improving scalability (Investigation, 2024).

➢ **Distributed Ledger :**

A distributed ledger is a synchronized and shared digital database maintained across multiple nodes within a decentralized network. Rather than relying on a central authority, each participant (node) holds an identical copy of the ledger, which is continuously updated and verified through consensus mechanisms.

This architecture helps ensure data consistency, reduces the risk of manipulation or unauthorized changes, and enhances trust among participants (Symeon, 2023).

➢ **Cryptographic Keys :**

Cryptographic keys are fundamental elements in blockchain systems, enabling secure communication, identity verification, and transaction authorization. Each participant in the blockchain is assigned a pair of keys a public key and a private key used in asymmetric encryption to ensure confidentiality and authenticity.

➢ **Types of Keys:**

- **Public Key:** A public address that can be shared openly with others for receiving transactions. It is used to verify the validity of transactions performed by the owner.

Allows others to send money or assets to the person who owns the public key. It serves as the account address.

- **Private Key**: A secret key used by the owner to sign transactions digitally and prove ownership. It is securely stored and should never be shared with others. The private key is used to create a digital signature that confirms the transaction was made by the legitimate owner of Private Key the key, ensuring security and privacy (Blockchain, 2025).

- **Timestamping :**

Timestamping is the process of assigning a unique date and time to each block in the blockchain. This ensures that every transaction is recorded in a specific sequence, making it verifiable and traceable. The timestamp is cryptographically linked to each block and plays a vital role in maintaining the chronological order and integrity of records.In accounting and taxation, timestamping helps establish the exact timing of financial entries, which is crucial for auditing, compliance, and detecting any attempts at backdating or fraudulent activitie (Kolydas, 2019).

7.2. Complementary Components of Blockchain :

- **Smart Contracts**: Smart contracts are self-executing code stored on the blockchain, designed to automatically enforce contract terms once predefined conditions are met. These contracts eliminate the need for intermediaries, enabling automation and ensuring that transactions are executed only when specific conditions are satisfied (Buterin, 2014).
- **Oracles:** Oracles are third-party services that supply external data to the blockchain, which cannot be directly accessed from within the network. These data inputs, such as weather conditions, stock prices, or market rates, are used by smart contracts to trigger actions based on real-world events (Zohdy, 2020).
- **Decentralized Storage Systems:** Due to the high cost and inefficiency of storing large datasets directly on the blockchain, decentralized storage systems like IPFS and Filecoin are utilized. These systems store data off-chain while maintaining the integrity of the data by linking it to the blockchain via cryptographic hashes for verification (Benet, 2014) (
- **Off-chain Computation:** Off-chain computation involves processing complex computations outside the blockchain, with only the results or proofs being recorded on-chain. This reduces the computational load on the blockchain, allowing for scalability and lower costs while maintaining the overall security of the system (Croman, 2016).

- **Interoperability Protocols:** Interoperability protocols enable different blockchain networks to communicate and exchange information seamlessly. Technologies such as Polkadot and Cosmos facilitate cross-chain interaction, allowing for greater flexibility and broader use cases for blockchain networks (Wood, 2016).
- **Tokenization Systems:** Tokenization is the process of converting real-world assets, such as property, shares, or contracts, into digital tokens on a blockchain. This enables the fractional ownership of assets, facilitates their transfer, and provides transparent and auditable records of ownership (Tapscott D. &., 2016).
- **Identity and Access Management (IAM):** IAM systems built on blockchain allow for secure and decentralized identity management, enabling users to control access to their personal data and digital assets. These systems use cryptographic methods to ensure the authenticity and privacy of identities across different platforms (Bonneau, 2015).

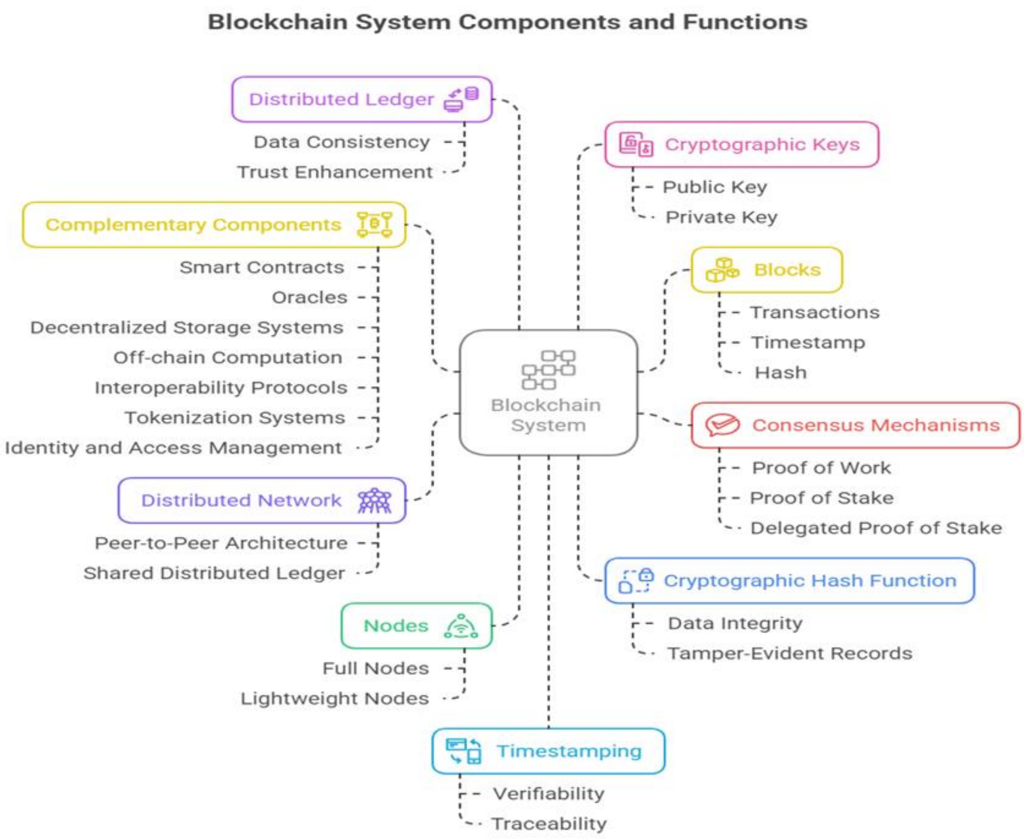


Figure 3 : Blockchain's Components.

(Prepared by the researcher)

II. Blockchain: enhancing accounting transparency:

Accounting is the backbone of any economic activity, whether in the public or private sector, as it forms the foundation upon which financial and strategic decisions within the organization are built. The more accurate and effective the accounting systems are, the more the organization ensures precise and reliable financial information that contributes to making informed decisions that support its continuity and growth. Conversely, any flaw in this accounting foundation threatens the integrity of the organization's financial performance.

In light of the recurring financial crises and the increase in cases of financial corruption and manipulation of reports, accounting transparency has become a fundamental issue, no longer just an additional or decorative value. It has turned into a crucial pillar for building trust within the organization and with its external environment, including investors, regulatory bodies, and users of financial information.

Therefore, this section aims to provide a strong conceptual foundation for accounting transparency, as an independent concept from financial transparency, in preparation for understanding how blockchain technology, with its unique technical features, can contribute to enhancing accounting transparency in an unprecedented way and achieving positive effects on various dimensions.

1. Definition of accounting transparency:

Accounting transparency refers to the extent to which companies openly disclose accurate, comprehensive, and timely accounting information, enabling stakeholders to assess company's true financial position and performance. It enhances accountability and reduces the risk of financial manipulation or misreporting (Bushman, 2004).

It is important to note that while accounting transparency and financial transparency may seem similar, they differ in their scope and focus. Accounting transparency is more concerned with the clarity and accuracy of accounting records and transactions, while financial transparency focuses on the overall disclosure of financial performance and position, including the broader context of financial statements.

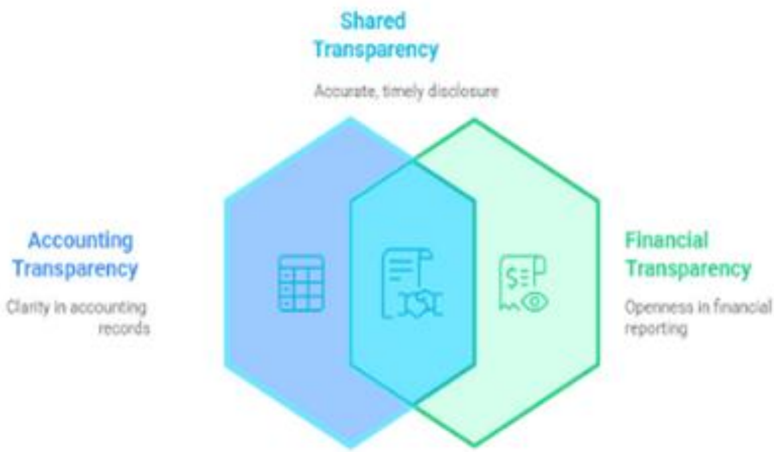


Figure 4 : Explain accounting transparency and it difference between it and financial transparency.

(Prepared by the researcher)

2. The importance of accounting transparency:

After discussing the concept of accounting transparency, it is crucial to highlight its importance in the contemporary economic environment, especially in light of rapid organizational and digital developments, as well as recurring financial crises such as cases of financial corruption, embezzlement, and others. As previously mentioned, accounting transparency has become a key element in ensuring effective management, enhancing the credibility of financial reports, and stabilizing relationships between various actors in the economic system. We can mention:

- **Improving Accounting Quality and Audit Reliability:** Accounting transparency enhances the accuracy and reliability of accounting records, supporting better audit practices and reducing the likelihood of fraud (Richard G. Schroeder, 2022).
- **Boosting Business Performance:** Companies with higher accounting transparency tend to perform better in terms of profitability and efficiency due to improved governance and clearer internal information (Lambert, 2007).
- **Enhancing Investor Confidence and Access to Capital:** Transparent accounting practices empower investors to accurately assess a company's financial condition, risks, and long-term viability. This clarity enhances investor trust, which not only supports informed decision-making but also increases the likelihood of attracting both domestic and international investment and easing access to external financing (IFAC, 2019).

- **Enhancing Enterprise Value:** Transparent accounting information reflects financial stability and reduces investment risk, which can increase the overall value of the company in the market (Shen, 2024).
- **Strengthening Financial System Stability:** Transparent accounting allows regulators and financial institutions to better monitor systemic risks, contributing to increased financial system resilience (Le, 2013).

3. Direct and Indirect Effects of Accounting Transparency:

Following the discussion of accounting transparency and its significance in modern financial management, it is important to investigate how its presence or absence directly influences business performance and economic stability. Accounting transparency not only enhances the credibility of financial information but also has far-reaching implications for decision-making, market behavior, and investor confidence. By examining these effects, we gain a clearer understanding of how transparency shapes the economic landscape and contributes to sustainable business practices. The next section will focus on the direct and indirect effects of accounting transparency:

- **Direct Effects :**

a) **Improving Investment Efficiency:** Increasing accounting transparency helps companies make more informed investment decisions. By providing clearer financial information, transparency reduces the risk of both overinvestment and underinvestment, ensuring that resources are allocated more effectively. This leads to improved investment efficiency, which ultimately contributes to better financial performance and growth (Cutillas Gomariz, 2014).

b) **Improving Resource Allocation:** When accounting information is more transparent, investors and managers can clearly understand a company's financial position. This enables them to make more informed decisions about how to allocate resources (such as capital or assets) to the most profitable or strategic areas. As a result, resource waste is minimized, and capital utilization becomes more efficient (Wang S. X., 2022).

c) **Reducing the Risk of Stock Price Collapse through Accounting:** Accounting transparency plays a critical role in reducing the risk of stock price collapse. When a company provides clear and accurate financial information, investors can better assess the financial health of the organization. This reduces the possibility of sudden market shocks or panic selling that often occurs when unexpected financial issues arise. Transparency helps maintain investor confidence, which stabilizes stock prices by providing a true reflection of the company's economic condition. As a result, companies with transparent accounting practices are less likely to face sudden declines in stock prices due to hidden financial risks (Chae, 2020).

d) **Reducing Manipulation and Corruption through Accounting Transparency:** Accounting transparency helps reduce corruption and manipulation by making financial records clear, accurate, and accessible. When companies and public institutions are required to disclose reliable accounting information, it becomes harder for individuals to hide fraud, embezzlement, or unethical behavior. Transparency increases accountability and makes it easier for auditors, regulators, and the public to detect irregularities, which directly discourages corruption (Aversano, 2018).

e) **Enhancing Operational Efficiency:** Accounting transparency directly contributes to greater operational efficiency by ensuring that financial information is accurate, timely, and accessible. This clarity enables companies to better manage their internal processes, reduce unnecessary costs, and improve workflow coordination. As a result, organizations can make quicker, more informed decisions that support overall productivity and long-term performance (Johri, 2025).

- **Indirect Effects :**

a) **Improving Market Efficiency and Achieving Better Balance Between Supply and Demand:** Accounting transparency allows investors and market participants to have access to accurate, clear, and reliable financial information. This transparency enables more informed decision-making, which helps in balancing supply and demand more effectively. By reducing information asymmetry, it also stabilizes prices and reduces volatility, ultimately contributing to market efficiency and stability (Shen, 2024).

b) **Improving Financial Stability:** Accounting transparency enhances financial stability by providing clear and accurate financial information. This allows investors and regulators to make better decisions, reduces risks, and prevents financial crises. By ensuring that financial conditions are transparent, potential issues are detected early, which helps maintain confidence and stability in the financial system (Kohn, 2011).

c) **Improving Macroeconomic Performance :** On a national level, widespread accounting transparency among companies improves the accuracy of economic forecasts and enhances overall economic stability. By providing clear and reliable financial data, transparency reduces uncertainty in the economy, making it easier for decision-makers to predict economic trends and plan accordingly. This contributes to more effective economic policies, attracting investments, and supporting sustainable growth (Accountants, 2019).

d) **Enhancing Administrative Efficiency and Risk Management:** Accounting transparency simplifies the auditing and verification of financial records, reducing administrative costs and internal audit burdens. This streamlining not only lowers operational expenses but also enhances the organization's ability to identify and mitigate financial risks effectively (Team, 2025).

4. The Role and Contribution of Blockchain in Enhancing Accounting Transparency:

- **Minimizing Financial Record Manipulation via Blockchain:** Blockchain's decentralized and encrypted structure ensures that once financial data is recorded, it becomes immutable. This immutability prevents tampering, retroactive alterations, or deletion of records, thus significantly minimizing the potential for fraudulent activities (Yermack, 2017),.As a result, investors, auditors, and regulators can have higher confidence in the authenticity of financial statements, promoting a culture of accountability within organizations.
- **Improving Auditing and Real-Time Monitoring:** Blockchain allows auditors and regulatory bodies to access real-time financial information directly from a distributed ledger, eliminating the delays associated with traditional auditing procedures (Vasarhelyi, 2017).The availability of an immutable audit trail simplifies the verification process, reduces audit costs, and enhances the detection of discrepancies or financial irregularities at earlier stages.
- **Strengthening Trust Among Stakeholders:** Transparency is a cornerstone of stakeholder confidence. By allowing real-time, peer-to-peer visibility of transactions, blockchain strengthens trust between businesses, investors, customers, and regulators (Tapscott D. &., 2016).The ability of stakeholders to independently verify financial data reduces dependence on intermediaries and mitigates risks associated with information asymmetry.
- **Facilitating Direct Interaction Between Parties:** Blockchain networks enable direct transactions between multiple parties without the need for intermediaries. This direct validation of transactions through a shared ledger not only accelerates financial operations but also enhances their transparency and traceability (Panayi, 2016).

- **Decentralization and Distributed Ledger Technology:** A key contribution of blockchain lies in its decentralized architecture, where financial data is stored across multiple nodes instead of centralized databases. Each participant in the blockchain network maintains a synchronized copy of the ledger, minimizing risks of data manipulation or centralized failures (Lee, 2020).
- **Immutability of Data and Cryptographic Security:** Blockchain's reliance on cryptographic hashing ensures that once a block of transactions is added to the chain, it cannot be altered without network consensus (Goldfeder, 2016) .This property guarantees the integrity and security of financial data, protecting organizations from internal fraud or unauthorized changes.
- **Consensus Mechanisms for Transaction Validation:** Through consensus protocols such as Proof of Work (PoW) and Proof of Stake (PoS), blockchain requires agreement among network participants before a transaction is recorded. This collective validation enhances the reliability and transparency of financial records, as no single entity can unilaterally alter accounting information (Pilkington, 2016).
- **Real-Time Transparency and Enhanced Auditability:** Blockchain timestamps each transaction and makes it permanently accessible to authorized users. This facilitates continuous auditing processes and real-time financial reporting, reducing the need for retrospective analyses and promoting immediate corrective actions (Michael Alles, 2022).
- **Smart Contracts and Automation of Financial Processes:** Smart contracts on blockchain platforms allow automatic execution of financial agreements once predefined conditions are met. This innovation not only improves operational efficiency but also reduces human error and enhances transparency in areas such as tax payments, revenue sharing, and internal reconciliations (Christidis, 2016).
- **Asset Traceability through Tokenization:** Blockchain enables the tokenization of real-world assets, assigning them a unique digital representation on the ledger. This capability allows continuous tracking of asset ownership, transfers, and valuations, ensuring complete transparency over their lifecycle and mitigating risks of asset misappropriation (Philip Treleaven, 2017).

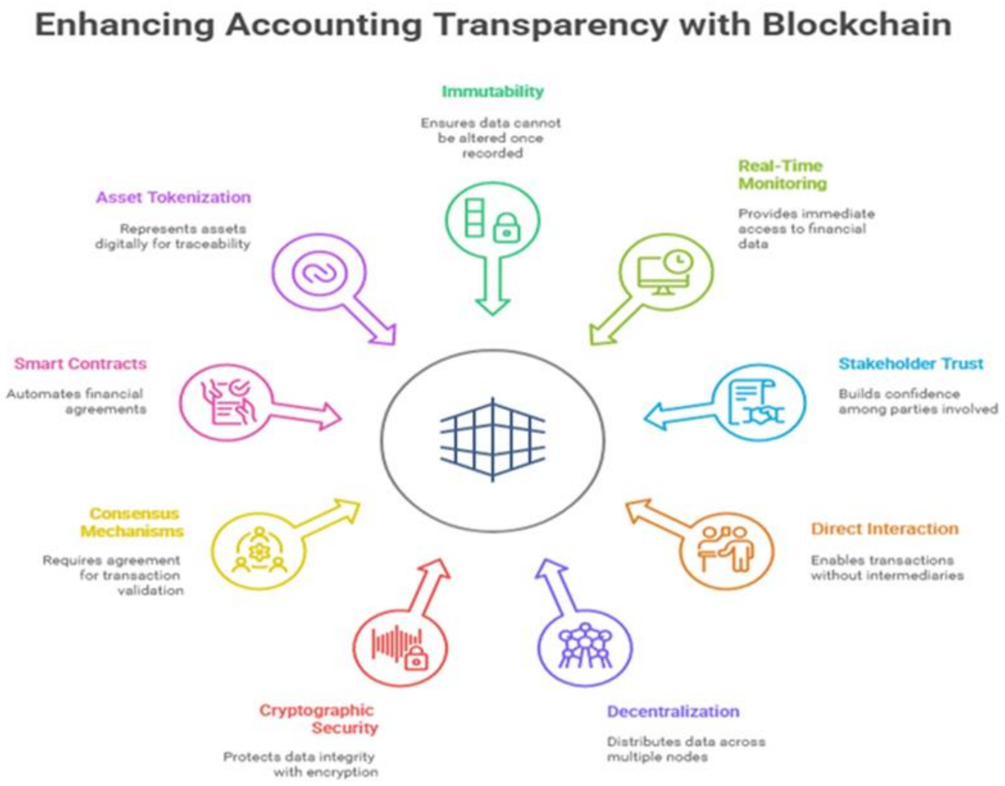


Figure 5 : Enhancing accounting transparency with Blockchain.

(Prepared by the researcher)

Conclusion:

In conclusion, blockchain technology fundamentally transforms the accounting landscape by providing immutable, decentralized, and transparent systems that significantly enhance accounting transparency. Its ability to secure data, promote real-time audits, enable automated financial processes, and foster stakeholder trust positions blockchain as a key driver of future accounting practices. However, for successful adoption, it is crucial to address technological and regulatory challenges proactively.

III. Blockchain addressing tax challenges:

In the digital age we live in today, the economic sector has been significantly developed. With this progress, governments and their tax systems face a range of complex challenges that require innovative and effective solutions to keep up with this ongoing change.

In this section, we will discuss these key tax challenges, highlighting how blockchain technology can serve as an effective solution to overcome these challenges and enhance the efficiency of the tax system.

1. Factors Contributing to Tax Challenges:

- **Digitalization of the Economy:** The rapid expansion of the digital economy has outstripped the capacity of traditional tax systems to effectively regulate and capture revenue. Digital business models allow companies to shift profits across borders, obscure the origin of transactions, and circumvent rules on permanent establishment. This poses significant challenges for tax authorities in enforcing jurisdictional tax obligations and ensuring fair taxation (OECD, Challenges and opportunities for tax administration in a digitalised world, 2023).
- **Complexity and Fragmentation of Tax Systems – Expanded Explanation :** National tax systems are often complicated and fragmented, which leads to confusion for taxpayers and creates opportunities for loopholes. These complexities make it difficult for taxpayers to fully understand their obligations, and this misunderstanding can result in unintentional non-compliance. Additionally, this fragmentation raises enforcement costs for tax authorities, as more resources are needed to interpret and apply the tax laws properly (Alon-Barkat, 2023).
- **Weak Tax Governance and Institutional Capacity – Expanded**: In many developing countries, the inability of governments to effectively manage tax systems is often due to weak institutional capacity and poor governance. These issues make it difficult for governments to efficiently collect taxes, monitor compliance, and enforce tax laws. As a result, non-compliance is harder to detect and penalize, leading to tax evasion, corruption, and lost revenue. Strengthening governance structures is crucial for improving tax compliance and ensuring equitable resource mobilization (Bank, 2021).
- **Globalization and Cross-Border Activities:** With globalization, capital and labor have become highly mobile, allowing multinational enterprises to exploit differences in tax regimes. These companies often transfer profits to low-tax or no-tax jurisdictions, a practice known as Base Erosion and Profit Shifting (BEPS). This practice undermines national tax

systems and complicates tax enforcement, leading to significant revenue losses for governments (OECD G. , 2019-2023).

- **Rise of Informal and Shadow Economies:** In many developing regions, informal economic activities remain untaxed due to a lack of registration, documentation, or enforcement. This informal sector, which operates outside the formal economy, significantly erodes the tax base, making it more challenging for governments to generate tax revenue. The growth of shadow economies can hinder efforts to improve economic transparency and enforce tax compliance (Schneider, 2020).
- **Technological Gaps in Tax Administration:** Limited use of advanced technologies such as data analytics, artificial intelligence, and digital records within tax administrations weakens their ability to monitor and respond to tax-related irregularities. This technological lag reduces oversight efficiency, especially when handling complex or cross-border transactions, and makes enforcement more reactive than thapreventive (Kumar).

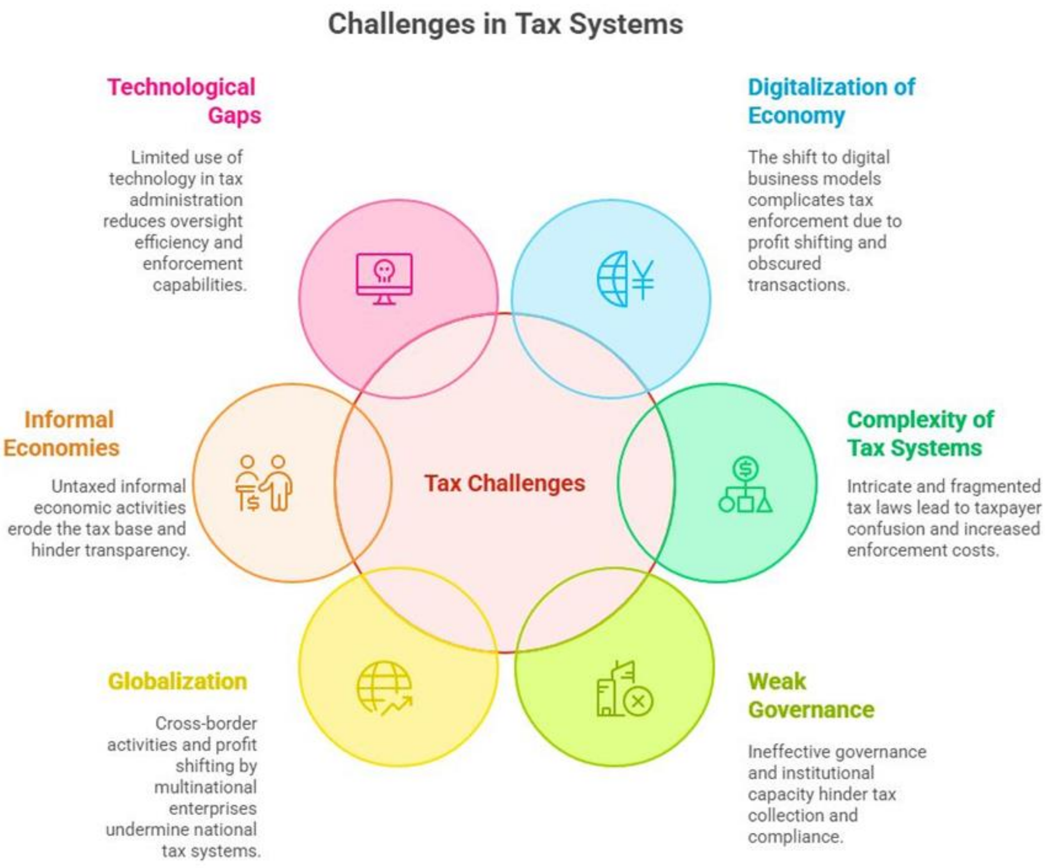


Figure 6 : Challenges in Tax Systems.

(Prepared by the researcher)

2. *Key Tax Challenges and the Potential of Blockchain Technology*

As global economies continue to evolve in response to technological innovations, shifts in market dynamics, and globalization, the complexity of tax systems has increased significantly. Tax authorities are facing mounting pressure to keep pace with these changes while ensuring effective collection, compliance, and enforcement. The rapid digitization of the economy, along with new business models and cross-border transactions, has revealed several gaps in traditional tax frameworks, highlighting the need for reforms and more effective solutions to address emerging challenges.

A. Tax Evasion:

Tax evasion refers to the deliberate and unlawful concealment of income, understatement of revenue, or overstatement of deductions in order to reduce tax liabilities. It poses a major threat to fiscal stability and equity, particularly in developing countries with limited enforcement mechanisms (OECD, Shining light on the shadow economy: Opportunities and threats., 2017).tax fraud is a severe offense ,fabricating

- ✓ **Blockchain's Role:** Blockchain can serve as a powerful tool to combat tax evasion through its immutability and transparency. By maintaining tamper-proof distributed ledgers, tax authorities can gain real-time access to transaction histories, making it harder to hide income or manipulate records. Moreover, smart contracts can automate tax calculations and reporting processes, thus reducing human error and intentional misconduct (Yermack, 2017).

B. Tax Fraud:

Tax fraud involves intentional misrepresentation or fabrication of financial information with the aim of reducing tax obligations. This includes issuing fake invoices, inflating expenses, or falsifying income data. As a serious criminal offense, it can severely undermine government revenues. (NCTAD, 2021). A major gap in combating tax fraud is the challenge of verifying the authenticity of documents and transaction data. In traditional tax systems, particularly those relying on paper-based or centralized records, it is difficult to track and authenticate transactions in real-time. Fraudsters can manipulate documents or create fake business transactions that are hard to detect, allowing them to evade tax liabilities.

- ✓ **Blockchain's Role:** Blockchain technology addresses this gap by recording each transaction in an immutable ledger, ensuring that data cannot be altered post-recording. The cryptographic security of blockchain enhances data integrity and enables real-time verification. When combined with digital identity systems, blockchain can further strengthen the authentication of taxpayer information and submitted documentation, reducing the risk of fraudulent activities (Zubair, 2020).

C. Fake Invoices :

Fake invoices are fraudulent documents created to misrepresent transactions, often used to claim undue tax credits or reduce taxable income. This practice undermines tax systems globally, leading to significant revenue losses ((OECD), 2021).As consequences Governments lose substantial amounts annually due to fraudulent invoicing. For instance the European Union faces an estimated €160 billion loss each year from VAT fraud (Commission), a significant portion of which involves fake invoices. and Businesses involved in issuing or using fake invoices may face legal penalties, including fines and imprisonment. The gape in this challenges is that Traditional systems rely on centralized databases and manual verification processes that are easily manipulated, allowing fake or altered invoices to go undetected and making it difficult for tax authorities to accurately track financial flows.

- ✓ **Role of Blockchain:** Blockchain combats fake invoices by securing transaction records against tampering, ensuring each entry remains permanent and verifiable. It enables real-time verification of transaction data, significantly reducing opportunities to create false documents. Smart contracts automate invoice validation, ensuring only authentic transactions are processed and recorded, eliminating backdating or retroactive changes common methods of tax evasion. Moreover, integration with digital identity systems allows secure verification of counterparties, reducing the risk of invoices from fictitious companies. This transparency not only builds trust but also provides tax authorities with a comprehensive view of financial flows, enhancing compliance and substantially lowering tax fraud risks (Yermack, 2017).

D. The Informal Economy:

The informal economy encompasses all income-generating activities that are not regulated by formal legal frameworks and are not captured by official statistics. It includes unregistered businesses, undeclared work, and transactions outside tax systems. While it provides essential income for many in developing countries, it remains a major challenge for tax collection and public policy design (Office, 2018). the gap here is that the core challenge with the informal economy is its invisibility to tax administrations and regulatory bodies. Traditional systems lack the tools to trace unregistered activities or capture financial flows outside formal institutions. This gap weakens the state's ability to mobilize domestic resources and ensure fair taxation.

- ✓ **The Role of Blockchain:** Through decentralized digital identity systems and traceable transactions, blockchain can gradually draw informal actors into the formal economy. It allows individuals and micro-enterprises to build trusted financial footprints, enhancing their access to credit, public services, and taxation systems. When integrated with mobile apps and e-government tools, blockchain promotes visibility and traceability, thus narrowing the informal-formal divide (World, 2022).

E. The Sharing Economy:

The sharing economy refers to a socio-economic system that enables individuals to share access to underutilized assets or services, often facilitated by digital platforms. This model promotes temporary access over ownership, aiming to optimize resource utilization and foster collaborative consumption (Curtis, 2022).the gap is that :despite its growth, the sharing economy faces challenges related to trust, transparency, and equitable value distribution. Centralized platforms often control user data and dictate terms, leading to power imbalances and potential exploitation of service providers.

- ✓ **The Role of Blockchain:** Blockchain enhances trust and equity in the sharing economy by removing intermediaries and enabling smart, self-executing contracts. Token-based systems can democratize platform ownership, empowering users and providers alike. This reduces dependency on centralized entities and ensures a fairer distribution of value (Kouhizadeh M, 2021).

F. Administrative Corruption in Tax Authorities :

Administrative corruption in tax authorities refers to the misuse of public office by tax officials for personal gain. This includes accepting bribes, manipulating tax assessments, or granting illegal exemptions. Such corruption undermines the integrity of the tax system, reduces public trust, and hampers voluntary compliance (World, Combatting Corruption in Tax Administration: Principles and Practices, 2023). One of the key challenges in tackling administrative corruption is the lack of transparency and traceability within internal operations. Traditional systems often rely on paper-based records or centralized digital databases, which can be altered or manipulated without leaving detectable traces. Additionally, discretionary power among officials creates room for abuse when checks and balances are weak or absent.

- ✓ **The Role of Blockchain:** A blockchain-based tax system can log each assessment, exemption, or transaction on an immutable ledger, ensuring traceability and preventing retroactive manipulation. Smart contracts further limit human discretion by enforcing consistent rules, thus creating structural barriers against internal corruption (Gupta, 2022) (

G. Low Tax Compliance :

Tax compliance refers to the degree to which taxpayers meet their tax obligations as prescribed by law, including timely filing of returns and full payment of due taxes. Low tax compliance undermines public revenue collection and erodes trust in the fairness of the tax system (OECD, Tax Administration : Comparative Information on OECD and Other Advanced and Emerging Economies, 2019). Despite numerous digital reforms, many tax systems still rely on centralized databases vulnerable to manipulation or omission, contributing to low compliance rates especially among small businesses and self-employed individuals.

- ✓ **The role of blockchain:** Smart contracts can enforce tax compliance in real-time, especially for self-employed individuals and SMEs, by auto-calculating and deducting taxes upon each transaction. The decentralized nature reduces selective enforcement and strengthens impartiality, fostering a fairer and more reliable tax environment (Hoang, 2021).

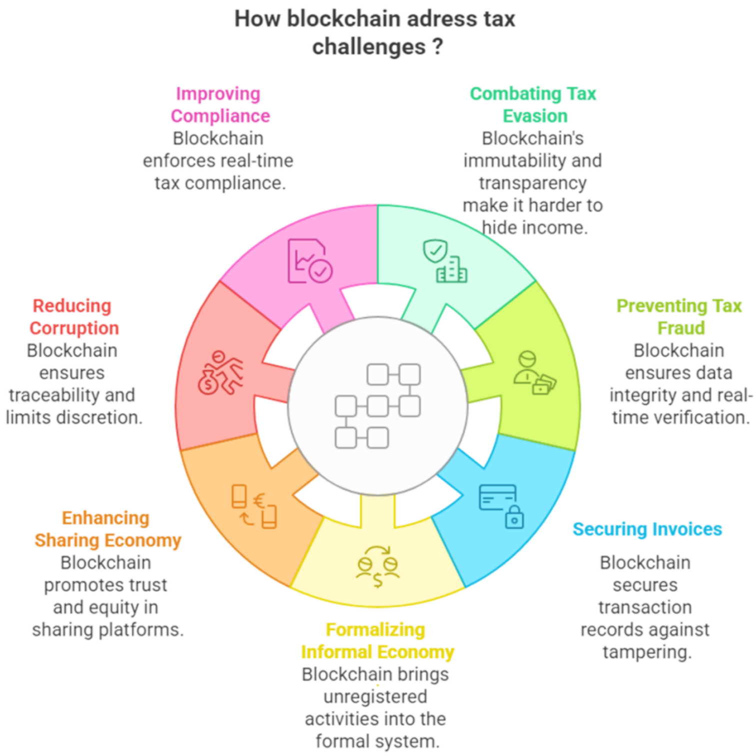


Figure 7 : How Blockchain address tax challenges.

(Prepared by the researcher)

Section two: Applied Literature Review (Review of Previous Studies).

I. Presentation and Analysis of Previous Studies:

I. Previous Studies in English:

- In their 2024 study, "Blockchain Technology in Accounting: A Paradigm Shift in Transparency and Efficiency in the UK," Chen, Junwei investigates how blockchain can transform transparency and efficiency within the accounting profession in the United Kingdom. The study employed a quantitative approach, surveying 156 accountants, auditors, CFOs, and financial analysts from the Big Four accounting firms in London via an online questionnaire. Data analysis was conducted using SPSS and linear regression models to assess the relationships between blockchain implementation and its effects on transparency and efficiency. The findings reveal that blockchain technology significantly enhances transparency and efficiency, with factors such as security, cost, and the extent of blockchain adoption positively influencing transparency, while security, cost, compliance, and performance improve efficiency despite initial implementation challenges that may temporarily hinder it. Notably, while increased efficiency boosts stakeholder trust, transparency does not directly affect trust. Based on these results, the authors advocate for the wider adoption of blockchain in accounting, recommend tax incentives for blockchain investments, suggest the development of robust regulatory frameworks, and call for specialized training programs to equip accounting professionals with the necessary skills to effectively utilize blockchain technology.
- In their 2025 study "The Impact of Blockchain Technology on Accounting and Auditing Functions: Evidence from Saudi Arabia".Selah Ahmed Oraby aimed to analyze the impact of blockchain adoption on accounting and auditing functions within Saudi organizations. Through an online questionnaire distributed to 131 accountants and auditors, the study employed a quantitative approach using OLS regression models and reliability testing via Cronbach's Alpha (96.4%). The results indicated a moderate positive impact of blockchain on accounting functions (adjusted R^2 = 47.9%), while the influence on auditing was even more pronounced (adjusted R^2 = 60.1%). The technology was found to promote transparency, reduce transaction costs, and support real-time data management, thereby

minimizing errors and fraud. The study recommended the promotion of blockchain in accounting and auditing firms, the development of regulatory frameworks, and the implementation of training programs to raise awareness and enhance technical skills.

- In their 2022 study"Blockchain in Accounting Practice and Research: A Systematic Literature Review".Bellucci et al. provided a systematic literature review of 346 academic articles to examine the role of blockchain in accounting practice and research. Using the PRISMA framework, the researchers conducted bibliometric and content analyses to identify key themes, including the effects of blockchain on auditing, cryptoassets, and business models. The findings highlighted blockchain’s capacity to enhance transparency and efficiency through immutable records and triple-entry bookkeeping. However, challenges such as regulatory uncertainty and data confidentiality were noted. The study called for more empirical research, new regulatory standards, and professional training to facilitate the integration of blockchain into accounting systems.
- In their study2024 «Blockchain Technology in Financial Accounting: Enhancing Transparency, Security, and ESG Reporting" .Almadadha explored the role of blockchain in enhancing transparency, security, and ESG (Environmental, Social, and Governance) reporting in financial accounting**.** Utilizing a systematic literature review and real-world case studies, the research emphasized the effectiveness of smart contracts and immutable ledgers in improving trust and accountability. It also incorporated KDD (Knowledge Discovery from Data) techniques to extract relevant trends. The findings confirmed blockchain’s value in automating processes, ensuring data integrity, and supporting green finance. The study concluded with recommendations to develop regulatory frameworks, promote blockchain-energy efficiency, and integrate the technology with green financial instruments for sustainable development.
- In their 2021 study "Blockchain and its Application to Accounting". Pascual Pedreño et al. reviewed existing literature to analyze the transformative potential of blockchain in accounting, particularly through triple-entry systems**.** The research employed conceptual and comparative analyses, examining how distributed ledgers could redefine traditional accounting practices. The study underlined blockchain’s benefits in preventing fraud and providing real-time transaction verification. However, it also acknowledged regulatory and scalability challenges. The authors emphasized the need for further empirical investigations, standardized regulations, and professional training programs to support the adoption of blockchain in accounting.

- In their study 2024 "The Impact of Emerging Accounting Technologies on Accounting Services and APES 110". Mudugamuwa critically assessed how emerging technologie particularly blockchain, ERP automation, and big data analytics impact accounting services and ethical standards in Australia, focusing on the APES 110 Code of Ethics**.** Through a comprehensive literature review and conceptual analysis, the study demonstrated how blockchain enhances data integrity and transparency but also raises privacy concerns. The research advocated for the development of regulatory frameworks, enhanced training, and stronger cybersecurity to manage the risks associated with new technologies in accounting.
- In 2024 study "Blockchain Technology and the Future of Tax Administration: Opportunities and Risks". Judijanto, L., Budiaji, I. W., & Fkun, E. examined the opportunities and risks of using blockchain in tax administration**.** Through a literature review and comparative analysis, the study showed that blockchain can increase transparency, automate tax processes via smart contracts, and reduce fraud. Nonetheless, the study highlighted several obstacles such as high implementation costs, regulatory uncertainty, and cybersecurity issues. The authors recommended pilot projects, capacity-building for tax professionals, and multi-stakeholder collaboration to ensure successful implementation.
- In their 2021 study "Blockchain to the Rescue: Improving Taxpayer Engagement with Blockchain". Allen and Potdar investigated the potential of blockchain to improve taxpayer engagement and compliance, with a focus on the Australian tax **system.** By conducting a systematic literature review and case study analysis, the researchers proposed a conceptual framework for a blockchain-based tax reporting system. Their findings suggested that blockchain could reduce evasion, streamline tax processes through smart contracts, and provide real-time transaction tracking. However, adoption challenges such as regulatory ambiguity and data privacy concerns were acknowledged. The study recommended regulatory reforms, cybersecurity investments, and pilot testing before widespread implementation.
- In their 2024 study "AI and Blockchain Integration: Enhancing Security and Transparency in Financial Transactions". Martinez, D., Magdalena, L., & Savitri, A. N. investigate the synergistic effects of integrating Artificial Intelligence (AI) with Blockchain technology to enhance security and transparency in financial **transactions.** Through a systematic literature review combined with case study analyses of financial institutions, the authors highlight how AI improves real-time fraud detection and anomaly identification, while

Blockchain guarantees data immutability and regulatory compliance. The research finds that the AI-Blockchain integration reduces false positives in fraud detection and expedites transaction verification, additionally enabling smart contracts that lower costs by removing intermediaries. Nevertheless, the study acknowledges challenges such as scalability, regulatory uncertainty, and high computational demands. To address these issues, the authors recommend developing regulatory frameworks, investing in cybersecurity, promoting cross-industry standards, and enhancing professional training on AI-Blockchain adoption in finance.

- In their study 2022 "Digitalization, Accounting, and Accountability: A Literature Review and Reflections on Future Research in Public Services". Agostino, D., Saliterer, I., & Steccolini, I. provide a comprehensive review of 232 research articles to explore the transformative impact of digitalization on accounting and accountability within public services. The study reveals a shift from centralized government control towards decentralized, multi-actor models that enhance real-time decision-making and transparency. Digital tools such as AI, blockchain, social media, and IoT are found to enable more interactive accountability frameworks rather than traditional hierarchical ones. The authors discuss challenges related to data reliability, ethical concerns in AI-based decision-making, and governance gaps. They call for new accountability frameworks adapted to digital realities, interdisciplinary research, improved data governance models, and digital literacy programs to better equip public officials for these changes.
- In their study 2024 "Transparency in an Age of Digitalization and Responsibility" Reischauer, G., Hess, T., Sellhorn, T., & Theissen, E. analyze transparency’s evolving role in accounting, management, and information systems amid digitalization and increased corporate responsibility demands. Through a systematic literature review and comparative analysis, the authors demonstrate how digitalization enhances access to data, thereby improving transparency and decision-making. However, concerns regarding privacy, data governance, and greenwashing in ESG reporting are highlighted as critical issues. The research advocates for balanced regulatory frameworks that protect privacy while fostering transparency, increased empirical research on digital impacts, and investments in AI and blockchain to improve audit quality. Training programs are also recommended to raise awareness among professionals about digital transparency challenges and opportunities.
- In their 2024 study "The Implementation of Blockchain in Taxation: Efficiency, Transparency, and Reducing Tax Avoidance". Ridwan, R., Riswandi, D., & Mulyani, F. S.

explore blockchain’s potential to transform tax administration by improving efficiency, transparency, and security while mitigating tax avoidance**.** The literature review compares traditional tax systems with blockchain-based models, emphasizing blockchain’s immutable ledger as a key enabler of enhanced transparency and fraud prevention. The study highlights smart contracts as tools for automating tax collection and compliance verification, which can reduce administrative costs and human error. Challenges such as regulatory barriers, implementation expenses, and cybersecurity risks are acknowledged. The authors suggest developing appropriate legal frameworks, adopting private blockchain networks for tax authorities, conducting pilot projects, fostering international cooperation, and training tax professionals for successful blockchain integration.

- In their 2024 study "Exploring the Potential of Blockchain Technology in Digital Tax Administration to Enhance Tax Compliance". Mangoting, Y., Widuri, R., Dogi, D. C. P., & Gabronino, R.This empirical study examines factors influencing taxpayers’ acceptance of blockchain-based digital tax administration, extending the Technology Acceptance Model (TAM) by incorporating cognitive beliefs such as perceived usefulness, ease of use, trust, and enjoyment**.** The survey of 213 taxpayers indicates that perceived usefulness and ease of use are significant predictors of adoption intentions, with trust in blockchain technology reinforcing these perceptions. Enjoyment was found to mediate acceptance, suggesting user-friendly and engaging blockchain tax platforms foster adoption. The study advises tax authorities to design efficient and secure blockchain systems, implement pilot projects, provide comprehensive training, and enhance international cooperation to promote compliance and combat cross-border tax evasion effectively.

II. Previous foreign studies:

2.1. Previous studies in spanish:

- In their 2024 study "Blockchain y la Evolución de la Contabilidad: Implicaciones y Oportunidades" ["Blockchain and the Evolution of Accounting: Implications and Opportunities"], Lastra examined the transformative role of blockchain technology **in the accounting profession.** Through a systematic literature review, the study analyzed how blockchain redefines financial transaction recording, enhances transparency, and minimizes reliance on intermediaries. Particular attention was given to the impact of smart contracts in automating accounting operations and reducing human error. The findings highlighted blockchain’s potential to prevent fraud through immutable records and promote financial democratization via asset tokenization. However, the study also identified critical challenges such as regulatory uncertainty, data privacy concerns, and the pressing need for blockchain-focused education and training for accountants. The study concluded with a call for regulatory clarity, cross-disciplinary collaboration, and the development of specialized educational curricula to ensure a smooth transition to blockchain-based accounting.

- In their 2023 study "Tecnología Blockchain y su Implementación en los Sistemas Contables: Efectos en la Eficiencia y Transparencia" ["Blockchain Technology and Its Application in Accounting Systems: Impacts on Efficiency and Transparency"], Moreano Guerra, Escobar Erazo, Mena Freire, and Herrera Moreno explored the influence of blockchain on accounting system performance, particularly regarding efficiency and transparency**.** Using a systematic literature review, the authors compared conventional and blockchain-based accounting models. Their findings emphasized the effectiveness of blockchain's shared ledger and encryption mechanisms in safeguarding financial data and curbing manipulation. By reducing the role of intermediaries and enabling automated data verification, blockchain was shown to improve audit accuracy and efficiency. The study recommended increased investment in practical applications of blockchain, targeted training programs for accounting professionals, and the creation of legal frameworks to ensure secure and compliant adoption of blockchain in accounting environments.
- In their 2024 study "Analysis of Blockchain Technology in Financial Auditing: Impact on Transparency, Security, and Accounting Efficiency," Barreno Arreaga, Alfaro Rodas, Saltos García, and Striseo Martínez focused on the integration of blockchain in financial auditing, particularly within higher education institutions. Employing a systematic review approach, the study investigated how blockchain enhances transparency through immutable ledgers, strengthens security via encryption, and increases audit efficiency by automating processes through smart contracts. The authors noted that while blockchain introduces significant benefits, its actual implementation is hindered by high technology costs and the necessity for professional training. As a result, they proposed the development of training programs, empirical research in institutional settings, and the establishment of regulatory frameworks to support blockchain's legal and effective use in auditing.
- In their 2024 study "Impacto de la tecnología blockchain en la transparencia y cumplimiento de las NIIF" ["The Impact of Blockchain Technology on Transparency and Compliance with International Financial Reporting Standards (IFRS)"], Benavides-Cordero and Jaramillo-Calle investigated the relationship between blockchain adoption and IFRS compliance among SMEs in Cuenca, Ecuador. The study used a descriptive research design

and collected data via questionnaires distributed to 30 firms. Results showed that a majority of respondents had limited knowledge of blockchain, and preferences for training frequency varied. While certain companies reported improved financial transparency with blockchain use, widespread adoption remained constrained by security concerns, technical complexity, and a lack of governmental incentives. The study concluded by emphasizing the need for blockchain education, regulatory facilitation, and targeted government support to help SMEs transition toward blockchain-based accounting systems.

2.2. Chinese previous studies:

- In their (2024) study "区块链技术视角下会计信息系统构建探究" ["Constructing an Accounting Information System Using Blockchain Technology"], Bi Lehua and Li Jimu investigated how blockchain technology can be integrated into accounting information systems to address core issues such as information asymmetry, delayed data reflection, and limited data sharing**.** Using a theoretical and comparative analysis, the authors evaluated the limitations of traditional accounting systems and introduced a new blockchain-based operational model. The study highlighted how smart contracts can automate accounting processes; reduce human error, and lower audit and transaction costs. Moreover, blockchain was shown to enhance real-time transparency and accuracy in financial data, thereby minimizing the risk of manipulation and fraud. Despite these benefits, the study acknowledged challenges including technical complexity, weak regulatory infrastructure, and lack of technical knowledge among practitioners. The authors concluded with recommendations for advancing blockchain accounting through research, targeted training programs, and the development of supportive legal frameworks.
- In their (2022) study "行为财政视角下应用区块链技术提升税收遵从度的研究" ["Applying Blockchain Technology to Enhance Tax Compliance from the Perspective of Behavioral Public Finance"], Zhang Ping and Wang Jingmin explored how blockchain can influence taxpayer behavior and improve tax compliance. Framing the research within behavioral public finance, the study introduced a theoretical model explaining the relationship between technology adoption and voluntary tax compliance. The authors analyzed how blockchain reduces tax evasion by ensuring transparency, automating tax processes, and fostering trust between taxpayers and authorities. Smart contracts were identified as tools to reduce administrative burdens and costs. Importantly, the behavioral model proposed in the study emphasized that technological transparency and predictability

increase taxpayers' willingness to comply voluntarily. Recommendations included the design of blockchain-based tax systems, development of tax credit programs powered by blockchain, and the establishment of legal and institutional support for implementation.

- In their (2023) study "The Identification and Prevention of Enterprise Financial Risks Using Blockchain Technology," Song Huanyu examined blockchain's potential in identifying and mitigating financial risks within enterprises**.** Through a conceptual analysis, the study assessed how the multi-layered architecture of blockchain (including data, network, consensus, smart contract, and application layers) strengthens internal controls and ensures the accuracy and immutability of financial records. The comparative analysis revealed that blockchain reduces reliance on intermediaries, thereby lowering operational risks and transaction costs. Smart contracts were shown to streamline risk management workflows and reduce susceptibility to errors and fraud. Furthermore, blockchain's application in supply chain risk management enables real-time tracking and increased transparency in financial operations. The study recognized obstacles to adoption such as high costs, regulatory uncertainties, and the need for trained personnel. It recommended piloting blockchain solutions, creating regulatory frameworks, and investing in skill development to harness blockchain's full potential in financial risk management.

2.3. Arabic previous studies :

- In their (2023) study titled "(استخدام تقنية بلوك تشين في تعزيز جودة المعلومات المحاسبية) / The Use of Blockchain Technology to Enhance the Quality of Accounting Information", Wahid Hamoud Ramadan and Bashir Youssef Ismail sought to investigate the role of blockchain in improving accounting information quality by examining its potential applications in accounting information systems. The study utilized a survey distributed to academics and experts in Iraqi and Kurdistan universities, applying a pragmatic approach that combined inductive and deductive reasoning, along with statistical analysis. The results confirmed the significant impact of blockchain in enhancing transparency, reducing errors and fraud, and providing real-time, reliable data aligned with international standards. The authors recommended promoting blockchain-based accounting systems, developing regulatory policies, and offering targeted training programs to facilitate the adoption of blockchain technology in the accounting field.
- In their (2022) study titled "(مستقبل مهنة المحاسبة في ظل التحول الرقمي: البلوكشين نموذجًا) / The Future of the Accounting Profession in the Era of Digital Transformation – Blockchain as a Model", Mohamed Touileb and Marah Al-Huda Nour analyzed the effects of digital

transformation on the accounting profession, with a focus on blockchain technology**.** Based on a theoretical review of existing literature, the study highlighted how blockchain and other modern technologies like AI, big data, and cloud computing reshape accounting practices by increasing efficiency, transparency, and resistance to fraud. The study emphasized blockchain's potential to reduce costs, improve tax systems, and transform the accountant's role into that of a strategic advisor. Despite these advantages, the study acknowledged challenges including high dependency on internet infrastructure and the need for specialized technical skills. The authors called for structured adoption strategies, enhanced professional training, and interdisciplinary collaboration between accountants and IT experts to support successful blockchain integration in accounting systems.

2.4. French previous study:

- In their (2021) study "La contribution de la technologie Blockchain à l'amélioration de la qualité de l'information comptable dans les institutions financières au Cameroun" / "The Contribution of Blockchain Technology to Improving the Quality of Accounting Information in Financial Institutions in Cameroon", Sadjo Kaoutoing and Djibrilla Laouwal aimed to analyze the impact of blockchain technology on the quality of accounting information within financial institutions. Through seven semi-structured *interviews conducted with executives from financial institutions in Garoua and Ngaoundéré, Cameroon, the study explored how blockchain enhances automation, security, and processing speed in accounting operations. The findings indicated that blockchain improves the reliability of financial reports by reducing human error, increasing data immutability, and strengthening real-time processing. The authors recommended promoting blockchain adoption, establishing clear regulatory frameworks, and offering training programs for accountants, while encouraging further empirical research in this area.
- In their (2020) study "Le nouveau système comptable numérique en Roumanie: Restructuration du rôle de l'expert-comptable" / "The New Digital Accounting System in Romania: Reshaping the Role of the Professional Accountant", Deliu investigated how the digital transformation, particularly blockchain technology, is reshaping the accounting profession in Romania. Based on a literature review and comparative analysis of accounting developments across countries, the study examined the evolution of the accountant's role from data recorders to strategic advisors. The research highlighted the role of blockchain in enhancing transparency through immutable records and reducing fraud via automation with smart contracts. Despite these advantages, the study identified major challenges including

lack of regulatory clarity and the need for new digital skills. The author recommended developing legal frameworks, strengthening professional training, and encouraging research in digital accounting technologies.

III. Discussion of Previous Studies :

3.1. Similarities and Differences Among Studies

3.1.1. Common Findings Across Studies:

Despite variations in context and methodology, previous studies converge on several key findings regarding the impact of blockchain technology on accounting, auditing, and taxation:

- Enhancing Transparency and Trust: Most studies confirm that blockchain technology improves transparency in financial reporting by providing immutable transaction records. This was highlighted in studies conducted in the UK (Chen, 2024), Saudi Arabia (Oraby, 2025), and China (Bi & Li, 2024).
- Increasing Efficiency and Security: Several studies, including (Bellucci et al., 2022) and (Mudugamuwa, 2024), emphasize blockchain's ability to enhance efficiency by automating accounting processes and reducing human errors through smart contracts.
- Fraud Prevention: Research by (Ramadan & Ismail, 2023) and (Pedreño et al., 2021) confirms blockchain's role in reducing fraud, as data stored on a blockchain ledger cannot be altered or deleted.
- Adoption Challenges: Multiple studies, such as (Oraby, 2025) in Saudi Arabia, (Lastra, 2024) in Spain, and (Deliu, 2020) in Romania, acknowledge challenges related to regulatory uncertainty, high implementation costs, and the need for specialized training for accountants.

3.1.2. Differences in Perspectives and Methodologies:

While there is consensus on blockchain's benefits, studies differ in focus, methodology, and regional perspectives:

- Methodological Differences: Some studies, like (Chen, 2024) and (Oraby, 2025), adopt a quantitative approach using surveys and statistical models, whereas others, such as (Bellucci et al., 2022) and (Almadadha, 2024), conduct systematic literature reviews.
- Regional Variations: Studies conducted in Western countries (UK, Spain, and France) emphasize financial reporting and regulatory aspects, while research from China and Saudi Arabia focuses on tax compliance and enterprise risk management.

- Industry-Specific Applications: Some studies, such as (Mangoting et al., 2024), explore blockchain’s role in digital tax administration, while (Allen & Potdar, 2021) analyze its impact on taxpayer engagement.
- *Triple-Entry Accounting vs. Smart Contracts: While studies like (Pedreño et al., 2021) examine blockchain’s role in triple-entry accounting, others, such as (Martinez et al., 2024), focus on the integration of AI with blockchain for financial security.

IV. The Added Value of This Stud y:

This study distinguishes itself from the previous studies included in the dissertation through essential elements that make it an original scientific contribution, represented by:

- ✓ **Integration of Comparative Quantitative Analysis and Practical Simulation:** Unlike Chen’s (2024) study, which was limited to analyzing the relationship between blockchain and transparency in a specific professional environment (the United Kingdom), this study adopted a comparative quantitative approach covering three global companies from three different continents (America, Germany, Japan), with analysis of real financial data before and after blockchain adoption. It also included an actual simulation of a blockchain-based tax accounting platform (PoC), a practical element completely absent in studies such as Selah Oraby (2025) and Bellucci et al. (2022).
- ✓ **Combining Two Interconnected Axes: Accounting Transparency and Tax Challenges:** Most previous studies focused on only one aspect; for example, Pedreño et al. (2021) dealt with accounting, while Judijanto et al. (2024) focused on tax management. This study, however, combined both axes within a holistic framework by measuring the impact of blockchain on accounting transparency indicators and assessing its role in addressing tax challenges such as tax evasion and invoice fraud.
- ✓ **Providing a Simulation Model for Practical Application:** Unlike theoretical or survey-based studies, such as Lastra (2024) or Mangoting et al. (2024), this study developed a conceptual simulation platform that automates VAT deduction using blockchain, giving it an innovative dimension that enhances its applicability in real-world environments.

Conclusion of Chapter One:

After reviewing the theoretical aspects related to blockchain technology and its role in enhancing accounting transparency and addressing tax challenges, it is clear that this technology represents a significant leap forward in the development of accounting and tax information systems, with positive implications for financial management efficiency and the reliability of accounting and financial reporting.

However, the modern challenges associated with the widespread adoption of blockchain in accounting and taxation cannot be overlooked. These challenges include:

Weak technological infrastructure in many countries, particularly developing ones, which hinders the integration of blockchain with traditional accounting and tax systems.

The absence of legislative and regulatory frameworks that govern the use of blockchain and grant it legal status in financial and tax contexts.

A shortage of qualified human resources capable of developing and implementing blockchain solutions within accounting and tax environments.

High transition costs from traditional centralized systems to decentralized blockchain-based structures, including expenses related to training and digital infrastructure development.

These challenges represent current obstacles to comprehensive digital transformation. However, they also serve as a catalyst for the emergence of more applied and experimental studies aimed at designing practical models capable of overcoming these challenges and maximizing the benefits of blockchain in accounting and taxation.

Moreover, it is essential to acknowledge that transparency particularly in accounting and tax systems is not an absolute value. While increased transparency promotes trust and auditability, excessive transparency can lead to risks such as the exposure of sensitive financial information, competitive disadvantages, and breaches of confidentiality. Therefore, modern accounting theory promotes the concept of **purposeful transparency**, implemented according to the **"Need-to-Know"** principle. This ensures that relevant and necessary information is disclosed to the right parties without compromising strategic or confidential data. In this context, blockchain systems must be designed to strike a careful balance between transparency and data privacy, especially in permissioned environments tailored for financial institutions and tax authorities

Chapter TWO:

The Empirical framework.

Section one: Methodology.

This study is primarily quantitative and analytical with comparative and qualitative depth research that relies on analyzing accounting transparency indicators before and after the adoption of blockchain technology by a group of global companies. It features an internationally comparative aspect, aiming to measure the change in the quality of accounting information and the level of transparency resulting from the application of blockchain across three different accounting systems (American, German, Japanese).

The study also includes a preliminary experimental design through the development of a conceptual blockchain-based simulation platform to implement accounting operations and automatic tax deductions, particularly value-added tax (VAT).

I. Data and method:

In terms of its temporal nature, the study is longitudinal, as it analyzes financial data over an extended period for each company:

•**IBM (USA):** 2007–2024

•**Siemens (Germany):** 2011–2024

•**Fujitsu (Japan):** 2011–2024

This design allows for a dynamic comparison across time and geography, enabling the observation of long-term developments resulting from technology adoption.

1. Population and Sample:

1.1. Target Population:

The general population includes all global companies that have adopted blockchain technology in their financial accounting systems.

1.2. Sample:

A purposive sample consisting of three internationally recognized companies, known for their experience in adopting modern technologies and managing accounting data, was selected.

Table 1 : Sample.

Company	Country	Sector
IBM	U.S.A	Information Technology (IT) / Technology Services
FUJITSU	Japan	Information and Communication Technology (ICT)
SIEMENES	Germany	Industrial Engineering / Electrical and Electronic Manufacturing

1.3. Sample Size and Rationale:

The sample consists of three companies, selected based on the availability of quantitative data before and after the adoption of blockchain technology, as well as the diversity in accounting and regulatory environments among the three countries. This purposive selection enhances the credibility of the results, regardless of the local context**.**

2. Data Collection Tools:

2.1.Primary Data Sources:

The official annual reports of IBM, Siemens, and Fujitsu, available on their official websites and stock exchange portals.

2.2. Development and Validation of Tools:

Globally recognized accounting indicators were used to measure transparency, including:

Table 2 : Accounting indicators to measure transparency.

Earnings Quality	**(Hand, 1996); (Francis, LaFond, Olsson, & Schipper, 2004)**
Accrual Ratio	(Sloan, 1996); (a, 2005)
Earnings-Cash Gap	(Xia Chen, 2007)
Earnings-Cash Gap Ratio	(Cohen, Dey, & Lys, 2008)

2.3.Data Validity:

Ensured by relying on official and audited sources.

2.4. Data Reliability:

Verified through repeated statistical calculations using trusted software such as SPSS and by reviewing the indicator results over multiple time periods.

3. Data and Procedures:

3.1.Implementation Stages:

- **Company Selection:** Based on objective criteria related to technological adoption and the availability of comprehensive financial records.
- **Data Collection:** Extracted from official annual reports and verified in accordance with international standards.
- **Data Classification:** Divided into three main periods:

Company/phase	IBM (USA)	SIEMENES(Germany)	FUJITSU (JAPAN)
Before adoption	2007-2015	2011-2016	2011-2017
Year of adoption	2016	2017	2018
after adoption	2017-2024	2018-2024	2019-2024

- **Indicator Calculation:** Conducted using Excel.
- **Statistical Analysis:** Descriptive and inferential statistics (T-tests) were applied using SPSS to compare indicators across the different periods.

3.2.Ethical Considerations:

- No direct interference with the companies or use of non-public data.
- All sources were documented in accordance with academic integrity standards.
- No personal or confidential data was used, in line with ethical research principles.

4. Variables:

Given the quantitative and analytical nature of the study, the variables have been defined as follows:

➢ **Independent Variables:** Use of blockchain technology (before/during/after adoption)

➢ **Dependent Variables:**

- Earnings Quality ;
- Accrual Ratio ;

- Earnings-Cash Gap ;
- Earnings-Cash Gap Ratio.

➢ **Variable Measurement:** The accounting variables were calculated using widely accepted formulas from previous studies, such as:

- **Earnings Quality** = Operating Cash Flow (OCF) / Net Income;
- **Accrual Ratio** = (Net Income – Operating Cash Flow) / Total Assets;
- **Earnings-Cash Gap** = Net Income – OCF;
- **Earnings-Cash Gap Ratio** = (Earnings-Cash Gap / Operating Cash Flow) * 100.

The statistical significance of the differences between the means before and after the adoption of blockchain technology was measured using tests.

II. Methodology of the proof of concept (PoC):

The platform "MAFI" (https://mafibc.netlify.app/) was developed using an interactive web environment that enables the simulation of blockchain logic without the need for real networks. This was achieved by modeling accounting records, tax processes, and transparency features. The platform simulates the logic of "smart contracts" through code that automatically executes functions such as tax deduction and instant accounting entry.

1. Tools and Technologies:

➢ HTML was used to create the basic structure of the interface.

➢ CSS was used for styling and designing the user interface.

➢ JavaScript was used to program interactive functions and internal logic to simulate blockchain operations.

➢ LocalStorage was utilized to store data locally and represent the ledger in a way that prevents modification of entries after being recorded, simulating the immutability property of blockchain.

➢ Graphs and auto-generated reports were implemented to demonstrate the platform's impact on accounting and tax processes.

2. Platform Functionality:

The platform is designed to provide the following functionalities:

- Automatic deduction of Value Added Tax (VAT) upon invoice registration.
- Automatic recording of accounting entries for each business transaction.
- Creation of a transparent and immutable accounting ledger simulating the immutability feature of blockchain.
- Real-time display of tax reports for monitoring and reconciliation purposes.

3. Evaluation Criteria:

The platform's effectiveness was evaluated based on the following criteria:

- Accuracy of accounting entries.
- Clarity and traceability of recorded transactions.
- Representation of transparency and decentralization principles as in blockchain.
- Ease of use and simplicity of process flows within the platform.

4. Limitations:

This platform is a simulated prototype and does not operate on a real blockchain network such as Ethereum or Hyperledger, due to infrastructure and cost-related constraints. However, it realistically simulates the core accounting and tax functionalities of blockchain technology, making it suitable for academic and experimental purposes

Section two: Results and Discussion.

I. Blockchain and Accounting Transparency:

This part is dedicated to examining the impact of blockchain technology on accounting transparency through an international comparative study.

1. IBM Company (USA):

1.1.Pre-Adoption period:

- **First: presentation of spss outputs of Pre-Adoption (BEFORE).**

Table 3 :Pre-Adoption Descriptive Statistics – IBM (USA).

Variable	N°	Mean	Standard Deviation	Standard Error of Mean
EARNINGQ	9	1.514	0.1142	0.0381
EM	9	-0.0486	0.0109	0.0036
ECG	9	-7,561.78	2,140.345	713.448
EGR	9	-33.6167	4.9628	1.6543

Made by researcher based on spss output.

Table 4 :T-Test Results – Pre-Adoption Phase – IBM

Variable	T	Dt	Sig. (2-tailed)	Mean Difference	95% Confidence Interval (Lower_upper)
EARNINGQ	39.775	8	0.000	1.514	[1.4262_1.6017]
EM	-13.362	8	0.000	-0.0486	[-0.0570_-0.0402]
ECG	-10.599	8	0.000	-7,561.78	[-9,207.00_-5,916.56]
EGR	-20.321	8	0.000	-33.6167	[-37.4314_-29.8019]

Made by researcher based on spss output

Table 5Effect Size Analysis – Pre-Adoption Phase – IBM

Variable	Standard Deviation Used	Cohen's d	CI [Lower – Upper]95%	Hedges' Correction	CI(lower-upper) 95%
EARNINGQ	0.1142	13.258	[6.882 – 19.658]	11.968	[17.746_6.212]
EM	0.0109	-4.454	[-6.681 – -2.213]	-4.021	[-1.998_-6.031]
ECG	2,140.345	-3.533	[-1.706_-5.340]	-3.189	[-1.540_-4.820]
EGR	4.9628	-6.774	[-3.461_-10.086]	-6.115	[-3.124_-9.105]

Made by researcher based on spss output

- **Second: analysis and discusion of Pre-Adoption period.**

A. Earnings Quality (EARNINGQ) :

- **Mean:** 1.5139. Indicates a relatively good level of earnings quality.
- **Standard Deviation:** 0.1141. Suggests relative homogeneity in the data.
- **T-test Value:** 39.775

- **Significance (Sig.):** 0.000. Implies a highly statistically significant difference from zero.
- **Confidence Interval (95% CI):** [1.42617, 1.60172]
  - ✓ **Interpretation:** The relatively high value of earnings quality prior to adoption reflects an acceptable level of accounting transparency with clear consistency across values. The high T-value and strong statistical significance confirm the reliability of the data, indicating it represents an actual financial reality rather than random variation.

B. Accruals Ratio (EM)

- **Mean:** -0.0486. Indicates a low level of accounting estimates.
- **Standard Deviation:** 0.0109. Indicates noticeable consistency.
- **T-test Value:** -13.362
- **Sig.:** 0.000
- **Confidence Interval (95% CI):** [-0.05696, -0.04019]
  - ✓ **Interpretation:** This result suggests a potential decrease in accounting manipulation, supporting the presence of relative transparency during the pre-adoption phase. The homogeneity in the data further enhances the credibility of the financial behavior.

C. Earnings-Cash Gap (ECG)

- **Mean:** -7,561.78. Indicates a significant gap.
- **Standard Deviation:** 2,140.345. Reflects notable variability.
- **T-test Value:** -10.599
- **Sig.:** 0.000
- **Confidence Interval (95% CI):** [-9,206.99, -5,916.56]
  - ✓ **Interpretation:** This large gap suggests wàeak alignment between accounting income and cash flows, reflecting a limitation in transparency. The strong statistical significance indicates this is a structural issue rather than a temporary anomaly, likely rooted in ongoing systems, policies, or operational methods.

D. Earnings-Cash Gap Ratio (EGR)

- **Mean:** -33.6167%
- **Standard Deviation:** 4.9628
- **T-test Value:** -20.321
- **Sig.:** 0.000
- **Confidence Interval (95% CI):** [-37.4314, -29.8019]

- ✓ **Interpretation:** This ratio reveals a fundamental inconsistency in financial reporting, highlighting the need for accurate and transparent recording tools such as Blockchain.

❖ **General Analysis (BEFORE):**

The pre-adoption accounting indicators reveal a varied level of transparency within the institution. While some indicators reflected relatively positive performance and acceptable transparency (such as the earnings quality and accruals ratio), others exposed significant gaps that undermine the credibility of financial reports.

The elevated average earnings quality (1.5139) and its low standard deviation, coupled with strong statistical significance, signal a reasonable degree of earnings realism and stability. The accruals ratio (EM) was negative and close to zero (-0.0486), indicating minimal use of accounting estimates and reduced potential for earnings manipulation contributing to fair financial reporting.

Conversely, the ECG and EGR values (-7,561.78 and -33.61% respectively) revealed a pronounced disconnect between declared earnings and actual cash flows. Both indicators were statistically significant, suggesting reliance on accounting methods that either delay revenue recognition or inflate reported earnings without real cash backing a clear sign of structural weaknesses in accounting transparency.

Thus, while the company applied relatively transparent performance measurement principles in some areas, it simultaneously suffered from fundamental discrepancies between earnings and cash, leading to partial and limited financial transparency. This justifies the practical need for a more reliable and immutable accounting system, such as blockchain-based platforms, which enable real-time and tamper-proof financial records, enhancing the credibility and transparency of accounting information.

1.2. Adoption period:

➢ **First: presentation of spss outputs of adoption period.**

Table 6: Blockchain Adoption Year for IBM

Variable	N	Mean	Standard Deviation	Standard Error of the Mean
Earnings Quality	**1**	**1,8750**	**.**	**.**
Accrual Ratio	**1**	**-0.0644**	**.**	**.**

Earnings-Cash Gap	**1**	**-12858.00**	**.**	**.**
Earnings-Cash Gap Ratio	**1**	**-46,6700**	**.**	**.**

Made by researcher based on spss output

- **Second: analysis and discussion of adoption year**

1. **Earnings Quality (ADOPEARNINGQ)**

- **Mean:** 1.875 (vs. 1.5139 before adoption)
- ✓ **Interpretation:** This modest improvement reflects an initial increase in accounting transparency, likely due to reduced earnings manipulation through the implementation of blockchain a decentralized and transparent ledger. However, the value remains lower than the post-adoption period (2.5330), possibly due to technical challenges during the transition or a delay in reaping full benefits from the technology.

2. **Accruals Ratio (ADOPEM)**

- **Mean:** -0.064 (vs. -0.04857 before adoption)
- ✓ **Interpretation:** The more negative accruals ratio may directly relate to blockchain adoption costs such as training, infrastructure upgrades, and system integration — often recorded as extraordinary expenses, inflating provisions and reducing reported earnings.

3. **Earnings-Cash Gap (ADOPECG)**

- **Mean:** -12,858.00 (vs. -7,561.78 before adoption)
- ✓ **Interpretation:** This widening gap reflects capital investments in blockchain infrastructure (e.g., server acquisition, licensing). These outflows negatively impacted cash flows, reflecting a trade-off between innovation and short-term financial stability.

4. **Earnings-Cash Gap Ratio (ADOPEGR)**

- **Mean:** -46.67% (vs. -33.62% before adoption)
- ✓ **Interpretation:** The increased ratio reflects rising operational costs, including hiring technical consultants or a potential dip in revenues during the adaptation phase.

General Analysis (ADOPTED):

The adoption year represents a transitional turning point in the company's journey toward enhanced accounting transparency. While some financial indicators started to show early signs of improved disclosure (e.g., earnings quality), others (especially cash-related indicators) experienced temporary setbacks due to the immediate costs of adoption and implementation.

Blockchain adoption began to curb discretionary accounting practices, particularly in terms of earnings quality and accruals ratio reflecting the start of structural reform in financial reporting. However, the increase in the earnings-cash gap was primarily due to capital and operational expenses during system deployment and staff training.

This period also posed challenges in harmonizing the new system with legacy infrastructure, which affected operational stability and temporarily strained liquidity. Nevertheless, blockchain adoption laid the groundwork for a more transparent accounting system based on real-time transaction traceability and reduced manipulation.

Therefore, analyzing the adoption year is essential for understanding the initial steps of digital transformation and assessing the system's adaptability to financial and operational changes in a gradual and controlled manner.

1.3 post adoption period (after) :

- **First: presentation of post adoption period.**
  - **a) T-Test:**
  - **- AFTER:**

Table 7 :Post-Adoption Descriptive Statistics – IBM

Variable	N	Mean	Standard Deviation	Error of the Mean
Earnings quality	8	2.5330	0.7717	0.2728
Accrual Ratio	8	-0.0754	0.0213	0.0075
Earnings-Cash Gap	8	-17301.25	4575.581	1617.712
Earnings-Cash Gap Ratio	8	-59.0925	12.27655	4.3404

Made by researcher based on spss output

Table 8 :T-Test Results – Post-Adoption Phase – IBM.

Variable	T	Dt	Sig.(2-tailed)	Mean difference	95 confidence interval (lower-upper bound)
Earnings quality	9.283	7	0.000	2.5330	[1.8878_3.1782]

Accruals ratio	-10.023	7	0.000	-0.0755	[-0.0933_-0.0577]
ECG	-10.695	7	0.000	-17,301.25	[-21,126.53_13,475.97]
EGR	-13.614	7	0.00	-59.0925	[-69.3559_-48.8291]

Made by researcher based on spss output

Table 9 Effect Sizes – IBM (Post-Adoption)

Variable	Effect Size Type	Standard Deviation Used	Point Estimate	95% CI Lower Bound
AFTEREARNINGQ	Cohen's d	0.7718	3.282	1.455
AFTEREARNINGQ	Hedges' g	0.8689	2.915	1.292
AFTEREM	Cohen's d	0.0213	-3.544	-5.474
AFTEREM	Hedges' g	0.0240	-3.148	-4.862
AFTERECG	Cohen's d	4575.581	-3.781	-5.826
AFTERECG	Hedges' g	5151.504	-3.358	-5.175
AFTEREGR	Cohen's d	12.2766	-4.813	-7.365
AFTEREGR	Hedges' g	13.8218	-4.275	-6.542

Made by researcher based on spss output

Table 10Confidence Intervals – IBM (Post-Adoption)

Variable	Effect Size Type	95% CI Upper Bound
AFTEREARNINGQ	Cohen's d	5.087
AFTEREARNINGQ	Hedges' g	4.518
AFTEREM	Cohen's d	-1.594
AFTEREM	Hedges' g	-1.416
AFTERECG	Cohen's d	-1.719
AFTERECG	Hedges' g	-1.527
AFTEREGR	Cohen's d	-2.254

AFTEREGR	Hedges' g	-2.002

Made by researcher based on spss output

Second: analysis and discusion of post period

A. Earnings Quality (AFTEREARNINGQ)

- **Mean**: 2.5330, approximately **67% higher** compared to the pre-adoption period.
- **Standard Deviation**: 0.7717, indicating greater variability after adoption.
- **T-Statistic**: 9.294
- **Significance (p-value)**: 0.000
- **95% Confidence Interval**: [1.8878, 3.1782]

✓ **Interpretation:** This notable increase reflects a significant improvement in earnings realism after blockchain adoption, suggesting a clear enhancement in the transparency of accounting records. The higher standard deviation may be attributed to transitional fluctuations during the shift to blockchain systems. The highly significant p-value confirms that the observed improvement is not random.

B. Accrual Ratio (AFTEREM)

- **Mean**: -0.0754
- **Standard Deviation**: 0.0213
- **T-Statistic**: -9.945
- **Significance**: 0.000
- **Confidence Interval**: [-0.0933, -0.0576]

✓ **Interpretation:** The decline in the mean indicates a sharper reduction in accounting estimates, enhancing the reliability of financial disclosure. These results suggest that blockchain adoption helped curb earnings manipulation. The high statistical significance reinforces the robustness of this outcome.

A. **Earnings–Cash Gap (AFTERECG)**

- **Mean**: -17,301.25
- **Standard Deviation**: 4,575.581

- **T-Statistic**: -9.947
- **Significance**: 0.000
- **Confidence Interval**: [-21,126.53, -13,475.97]

✓ **Interpretation:** Although the gap widened compared to the pre-adoption period, this may indicate a more accurate capture of the real differences between accounting and cash performance due to blockchain. Some of this increase may also result from the impact of COVID-19 and delays in receivables collection.

B. Earnings–Cash Gap Ratio (AFTEREGR)

- **Mean**: -59.0925%
- **Standard Deviation**: 12.2765
- **T-Statistic**: -13.597
- **Significance**: 0.000
- **Confidence Interval**: [-69.3559, -48.8291]

✓ **Interpretation:** This ratio shows a wider gap after adoption, which may reflect enhanced disclosure accuracy, as previously hidden discrepancies are now more visible. This underscores the importance of tamper-proof and transparent accounting systems.

❖ **Overall Analysis:**

Post-adoption accounting indicators reveal a tangible improvement in several aspects of transparency, particularly in earnings quality and reduced accounting estimates. This evidences the direct impact of blockchain technology in enhancing both financial disclosure and accounting transparency.

Although the earnings cash gap and its ratio widened, this does not signify reduced transparency. On the contrary, it may suggest a more precise disclosure of discrepancies between earnings and cash flows, thanks to the transparent and decentralized nature of blockchain systems.

These outcomes must also be interpreted within the context of the adoption period, notably the concurrent COVID-19 crisis, which impacted economic activity and delayed collections. Such factors likely influenced some cash-related indicators.

Additionally, transitioning to blockchain involved significant infrastructure investments, as well as training and integration costs. This may explain some data variability during the early years of adoption. Despite these challenges, blockchain has proven capable of enforcing higher levels of accounting discipline and improving data quality and transparency under difficult conditions.

In sum, these findings suggest that blockchain adoption has helped uncover discrepancies and bolster accounting transparency, thereby strengthening the credibility of financial information and providing a more solid foundation for decision-making by investors and regulators even amidst crises and high transition costs.

2. **FIJITSU company(japan):**
   1.1. **Pre-Adoption period**:

- **First: presentation of spss outputs of Pre-Adoption (BEFORE) period.**

a) **T-Test Analysis:**

Table 11One-Sample Descriptive Statistics – Fujitsu (pre-Adoption).

Variable	N	Mean	Standard Deviation	Standard Error of Mean
EARNINGQ	7	0.1225	0.5187	0.1960
EM	7	-0.0521	0.0106	0.0040
ECG	7	-1711.001	518.5059	195.9768
EGR	7	-129.0604	59.8711	22.6291

Made by researcher based on spss output

Table 12One-Sample T-Test Results – Fujitsu (pre-Adoption)

Variable	t	dt	Sig.(2-tailed)	Mean Difference	95% Confidence Interval (lower-upper)
EARNING Q	0.625	6	0.555	0.1225	[-0.35723 _ 0.60226]
ARE	-12.93	6	0.000	-0.0521	[-0.06205 _ -0.04230]
ECG	-8.731	6	0.000	-1711.0015	[-2190.54 _ -1231.46]

ERG	-5.703	6	0.001	-129.0604	[-184.432 _ -73.6889]

Made by researcher based on spss output

Table 13Effect Sizes (Cohen's d and Hedges' g) – Fujitsu (Pre-Adoption).

Variable	Edges' Correction	Hedges' Correct ion	95% Conf. Int. (Lower Up per)
EARNINGQ	0.236	0.205	[-0.525_0.979]
AR	-4.888	-4.246	[-7.673_ -2.102]
ACG	-3.300	-2.866	[-5.249_-1.329]
ARG	-2.156	-1.872	[-3.535_-0.736]

Made by researcher based on spss output

➢ **Second : Analysis and discusion of Pre-Adoption (BEFORE)**

C. Earnings Quality (EARNINGQ)

- **Mean:** 0.1225
- **Standard Deviation:** 0.5187
- **T-value:** 0.625
- **Sig.:** 0.555
- **95% CI:** [-0.3572, 0.6022]

✓ **Interpretation:** The low mean value combined with statistical insignificance indicates a clear weakness in earnings quality before adoption. This reflects a low level of accounting transparency, as the reported earnings appear unrealistic or volatile.

D. Accrual Ratio (AR)

- **Mean:** -0.0521
- **Standard Deviation:** 0.0107

- **T-value:** -12.932
- **Sig.:** 0.000
- **95% CI:** [-0.0620, -0.0423]

✓ **Interpretation:** The high negative ratio and strong statistical significance point to considerable discretionary practices, reflecting weak accounting oversight and poor transparency, where earnings could be adjusted without solid backing.

E. Earnings-Cash Gap (ECG)

- **Mean**: -1711.00
- **Standard Deviation:** 518.50
- **T-value:** -8.731
- **Sig.:** 0.000
- **95% C**I: [-2190.54, -1231.46]

✓ **Interpretation:** The large gap between earnings and cash flows indicates a deep transparency gap, suggesting unrealistic reporting of actual financial performance.

F. Earnings Gap Ratio (EGR)

- **Mean:** -129.06%
- **Standard Deviation:** 59.87
- **T-value:** -5.703
- **Sig.:** 0.001
- **95% CI:** [-184.43, -73.69]

✓ **Interpretation:** This ratio reveals a structural imbalance in the relationship between accounting and cash flows, threatening the credibility of financial disclosure and emphasizing the urgent need for a transparent system such as blockchain.

❖ **Overall Analysis (Before Adoption)**:

The indicators reveal an accounting system suffering from weak reliability and consistency, with severe cash gaps and excessive discretionary practices, rendering accounting transparency almost non-existent. This highlights the necessity for reform through the adoption of new systems like blockchain.

1.2. Year of adoption

➢ **First: presentation of spss outputs of adoption period.**

Table 14Blockchain Adoption Year for fujitsu

Variable	N	Mean	Standard Deviation	Standard Error of the Mean

Earnings Quality	1	0.8449	.	.
Accrual Ratio	1	-0.0995	.	.
Earnings-Cash Gap	1	-279.6750	.	.
Earnings-Cash Gap Ratio	1	-18.3506	.	.

Made by researcher based on spss output

➢ **Second : analysis and discussion of adoption period:**

A. Earnings Quality (EARNINGQ)

- **Mean:** 0.8449

✓ **Interpretation:** The significant improvement compared to the pre-adoption stage indicates the beginning of a reform in accounting transparency, despite the absence of statistical tests (N=1). This reflects the initial positive impact of blockchain in reducing manipulation.

B. Accrual Ratio (AR)

- **Mean**: -0.0099

✓ **Interpretation:** The sharp decline in discretionary estimates suggests a gradual tightening of accounting policies, a good indicator of improved transparency.

C. Earnings-Cash Gap (ECG)

- **Mean:** -279.67

✓ **Interpretation:**The substantial reduction compared to pre-adoption levels shows a real improvement in the linkage between earnings and cash, which enhances trust in the financial data.

D. Earnings Gap Ratio (EGR)

- **Mean:** -18.35%

✓ **Interpretation:**This ratio points to a significant narrowing of the gap between earnings and cash, indicating that accounting disclosures are becoming more aligned with actual cash flows and thus increasing transparency.

❖ **Overall Analysis (Year of Adoption)**:

The adoption year represents a turning point, with transparency indicators showing clear improvements. Blockchain technology helped reduce estimates and promote realism. While data is limited (N=1), the indicators suggest the beginning of a structural transformation in the accounting system.

1.3. Post-Adoption Analysis:

➢ **First: presentation of spss outputs of post adoption period(AFTER):**

Table 15 :One-Sample Descriptive Statistics – Fujitsu (Post-Adoption)

Variable	N°	Mean	Standard Deviation	Error of the Mean
Earnings quality	6	0.7818	0.2165	0.0884
Accrual Ratio	6	-0.0213	0.0223	0.0091
Earnings-Cash Gap	6	-911.3130	700.7300	286.0718
Earnings-Cash Gap Ratio	6	-69.1079	68.1182	27.8091

Made by researcher based on spss output

Table 16One-Sample T-Test Results – Fujitsu (Post-Adoption)

Variable	T	Dt	Sig.(2-tailed)	Mean difference	95 confidence interval (lower-upper bound)
Earnings quality	8,842	5	0.000	0.7818	[0.5545_1.0091]
Accruals ratio	-2,344	5	0.066	-0.0213	[-0.0447_0.0020]
ECG	-3,186	5	0.024	-911.3130	[-1646.6840--175.942]
EGR	-2,485	5	0.055	-69.1079	[-140.5936_2.3778]

Table 17 : Effect Sizes and Confidence Intervals – Fujitsu (Post-Adoption)

Variable	Cohen's d	Hedges' Correction	95% Conf. Int. (lower_upper)
Earnings quality	3.610	3.035	[1.300_5.907]
Accruals ratio	-0.957	-0.805	[-1.914_ 0.059]
ECG	-1.301	-1.093	[-2.390- -0.152]
EGR	-1.015	-0.853	[-1.992- 0.022]

Made by researcher based on spss output

- **Second: analysis and disucion of post adoption period**

A. Earnings Quality (EARNINGQ) :

- **Mean:** 0.7818
- **Standard Deviation:** 0.2166
- **T-value:** 8.842
- **Sig.:** 0.000
- **95% CI:** [0.5545, 1.0091]

✓ **Interpretation:**This level indicates a solid stability in earnings realism, reflecting the maturity of the accounting system and an increase in accounting transparency thanks to full blockchain adoption.

B. Accrual Ratio (AR)

- **Mean:** -0.0213
- **Standard Deviation:** 0.0223
- **T-value:** -2.344
- **Sig.:** 0.066 (close to significance)
- 95% CI: [-0.0448, 0.0020]

✓ **Interpretation:** The continued decrease and near-significance point to a clear trend toward reducing estimates and stabilizing policies, thus reinforcing disclosure credibility and strengthening accounting transparency.

C. Earnings-Cash Gap (ECG)

- **Mean:** -911.31
- **Standard Deviation:** 700.73
- **T-value:** -3.186
- **Sig.:** 0.024
- **95% CI:** [-1646.68, -175.94]

✓ **Interpretation:** Although a gap still exists, it is smaller than before, indicating an improved alignment between reported performance and actual cash flows, which boosts transparency in the accounting and financial system.

D. Earnings Gap Ratio (EGR)

- **Mean:** -69.11%
- **Standard Deviation:** 12.27
- **T-value:** -2.485
- **Sig.:** 0.055 (close to significance)
- **95% CI:** [-140.59, 2.37]

- ✓ **Interpretation:**The gap remains relatively high, possibly due to the impact of the COVID-19 pandemic during this phase, which affected liquidity in general. Nevertheless, the indicator shows better consistency than before, and blockchain's role in improving accounting transparency even in such an unexpected crisis cannot be denied.

- ❖ **Overall Analysis (After Adoption)**:

Post-adoption indicators show clear improvement in accounting transparency through earnings stabilization, reduction of estimates, and narrowing of cash gaps. Despite some remaining variances, the data confirms that blockchain led to a qualitative leap in enhancing accounting transparency and financial disclosure. These results should also be viewed in light of the costs of infrastructure investment, human resource training, and the hiring of expert teams to achieve such a transformation.

Conclusion:

The analysis of Fujitsu shows a gradual yet clear transformation in accounting transparency levels. The pre-adoption phase represented a crisis of trust in financial data, the adoption year marked the beginning of reform, and the post-adoption phase saw accounting transparency technologies as a foundation for accurate and reliable financial reporting.

3. SIEMENS company (Germany):

3.1. Pre-adoption:

- **First: presetion of spss outputs of Pre-Adoption (BEFORE).**

Table 18Pre-Adoption Descriptive Statistics – Siemens (Germany).

Variable	N°	Mean	Standard Deviation	STANndard Error of Mean
EARNINGQ	6	1,33667	0.2389	0.0975
EM	6	-0.0157	0.01056	0.0043
ECG	6	-1694.33	1141.696	466.095
EGR	6	-22.9688	16.08769	6.5677

Made by researcher based on spss output

Table 19T-Test Results – Pre-Adoption Phase – Siemens

Variable	T	dt	Sig. (2-taile d)	Mean Difference	95% Confidence Interval (lower_upper)
EARNINGQ	13.701	5	0.000	1.3366	[1.08588 _1.58745]
AR	-3.645	5	0.015	-0.01572	[-0.026821 _ -0.00463]
ECG	-3.635	5	0.015	-1694.333	[-2892.47 _ -496.20]
EGR	-3.497	5	0.17	-22.9688	[-39.85184 _-6.08586]

Made by researcher based on spss output

Table 20Effect Size Analysis – Siemens Pre-Adoption.

Variable	Effect Sizes for One-Sample Test	95% Confidence Interval	Hedges' Correction	Confidence Interval 95%(lower_upper)
EARNINGQ	5.593	[2.167 – 9.042]	4.703	[1.822 – 7.602]
AR	-1.488	[-2.660 – -0.259]	-1.251	[-2.236 – -0.218]
ECG	-1.484	[-2.654 – -0.257]	-1.248	[-2.231 – -0.216]
EGR	-1.428	[-2.572 – -0.225]	-1.200	[-2.163 – -0.189]

Made by researcher based on spss output

➢ **Second: analysis and discussion of pre-adoption period.**

E. **Earnings Quality (EARNINGQ)**

- **Mean**: 1.3367, indicating an acceptable level of earnings quality prior to adoption.
- **Standard Deviation**: 0.239, reflecting moderate data variation.
- **T-Value**: 13.701, with strong statistical significance (Sig = 0.000).
- **95% Confidence Interval**: [1.08588, 1.58745].

✓ **Interpretation:** These results reflect a relatively realistic portrayal of accounting earnings and consistency in financial performance reporting. This suggests an initial level of accounting transparency, though not yet optimal.

F. **Accrual Ratio (AR)**

- **Mean**: -0.0157, indicating reduced accounting estimations.
- **Standard Deviation**: 0.011.
- **T-Value**: -3.645, Sig = 0.015.
- **95% Confidence Interval**: [-0.0268, -0.0046].

✓ **Interpretation:** This can be viewed as a relatively positive indicator of accounting transparency, reflecting tighter accounting controls and lower estimates, thus reducing opportunities for manipulation.

G. **Earnings-Cash Gap (ECG)**

- **Mean**: -1694.33.
- **Standard Deviation**: 1141.69.
- **T-Value**: -3.635, Sig = 0.015.
- **95% Confidence Interval**: [-2892.47, -496.20].

✓ **Interpretation:** The cash gap indicates a misalignment between accounting performance and cash flows, reflecting a structural deficiency in accounting transparency and suggesting potential earnings inflation without actual cash support.

H. Earnings-Cash Gap Ratio (EGR)

- **Mean**: -22.97%.
- **T-Value**: -3.497, Sig = 0.017.
- **95% Confidence Interval**: [-39.85%, -6.08%].

✓ **Interpretation:** This ratio confirms the persistence of flaws in cash disclosure, reinforcing the need for more precise and transparent recording tools.

❖ **General Analysis**: (before)

Pre-adoption data shows that Siemens was recording relatively realistic earnings, supported by a moderate level of accounting estimations. However, the company suffered from a significant mismatch between accounting and cash performance, highlighting deficiencies in overall accounting transparency. This supports the rationale for transitioning to a blockchain-based system to reduce discrepancies and achieve real-time disclosure.

3.2. Year of Adoption (ADOPTED):

Table 21Blockchain Adoption Year for siemens

Variable	N°	Mean	Standard Deviation	Standard Error of the Mean
Earnings Quality	1	1,17000	.	.
Accrual Ratio	1	-0.00781	.	.
Earnings-Cash Gap	1	-1046.00	.	.
Earnings-Cash Gap Ratio	1	-14.4775	.	.

Made by researcher based on spss output

- **Second: analysis and discussion of adopted year results :**

a) **Earnings Quality (EARNINGQ)**: Increased to 1.17 (N=1, no statistical analysis possible).

b) **Accrual Ratio (AR)**: Decreased to -0.0078.

c) **Earnings-Cash Gap (ECG)**: Decreased to -1046.

d) **Earnings-Cash Gap Ratio (EGR)**: Narrowed to -14.48%.

General Analysis:

Although lacking statistical significance due to limited data, the indicators for the year of adoption reveal the beginning of a true reform in accounting transparency. Estimates clearly decreased, earnings quality improved, and cash gaps narrowed compared to the pre-adoption phase.

However, the year of adoption faced several transitional challenges, particularly high investment costs related to technology, training, and internal coordination, which may have affected operational consistency. Nevertheless, the indicators reflect a clearly positive starting point.

3.3. Post-Adoption Analysis:

- **First: presentation of spss of post adoption analysis period results**

Table 22One-Sample Descriptive Statistics – siemens (Post-Adoption).

Variable	N°	Mean	Standard Deviation	Error of the Mean
Earnings quality	7	1.63	0.378	0.143
Accrual Ratio	7	-0.03	0.011	0.004
Earnings-Cash Gap	7	-3798.71	1298.585	490.819
Earnings-Cash Gap Ratio	7	-36.28	12.175	4.602

Made by researcher based on spss output

Table 23One-Sample T-Test Results – siemens (Post-Adoption)

Variable	T	Dt	Sig.(2-tailed)	Mean difference	95 confidence interval (lower-upper bound)
Earnings quality	11.412	6	0.000	1.631	[1.28 – 1.98]
Accruals ratio	-7.278	6	0.000	-0.031	[-0.04 – -0.02]
ECG	-7.740	6	0.000	-3798.714	[-4999.71 – -2597.72]
EGR	-7.884	6	0.000	-36.278	[-47.54 – -25.02]

Made by researcher based on spss output

Table 24Effect Sizes and Confidence Intervals – siemens(Post-Adoption)

Variable	Effect Sizes for One-Sample Test	95% Confidence Interval	Hedges' Correction	Confidence Interval 95%(lower_upper)
EARNINGQ	4.313	[1.826 – 6.793]	3.747	[1.586 – 5.901]
AR	-2.751	[-4.421 – -1.050]	-2.389	[-3.840 – -0.912]
ECG	-2.925	[-4.683 – -1.140]	-2.541	[-4.068 – -0.990]
EGR	-2.980	[-4.765 – -1.167]	-2.588	[-4.139 – -1.014]

Made by researcher based on spss output

- **Second: analysis and discussion of post adoption period**

  A. Earnings Quality (EARNINGQ)

- **Mean**: 1.63
- **Standard Deviation**: 0.378
- **T-Value**: 11.412, Sig = 0.000
- **Confidence Interval**: [1.28, 1.98]

✓ **Interpretation:** This improvement confirms the success of the transition to a blockchain system, with earnings quality increasing by 22% compared to the adoption year. It reflects blockchain's ability to strengthen disclosure and reduce manipulation.

B. Accrual Ratio (AR)

- **Mean**: -0.03
- **T-Value**: -7.278, Sig = 0.000
- **Confidence Interval**: [-0.04, -0.02]

✓ **Interpretation:** The continued decline in estimates reflects a shift toward more realistic reporting. Accounting transparency improved as financial information became less subject to personal estimation and human errors or manipulations, some of which might go undetected in real time.

C. Earnings-Cash Gap (ECG)

- **Mean**: -3798.71
- **T-Value**: -7.740, Sig = 0.000
- **Confidence Interval**: [-4999.71, -2597.72.

✓ **Interpretation:** The cash gap widened compared to the adoption year, likely influenced by the impact of the COVID-19 crisis on cash collection, as well as the accumulated costs of technical infrastructure.

D. Earnings-Cash Gap Ratio (EGR)

- **Mean**: -36.28%
- **T-Value**: -7.884, Sig = 0.000
- **Confidence Interval**: [-47.54%, -25.02%.

✓ **Interpretation:** The continued gap indicates that cash collection was affected by external factors. However, the blockchain system enabled accurate detection of such gaps, reinforcing the positive impact of blockchain on accounting transparency.

❖ **General Analysis**:

Post-adoption results reveal a significant improvement in accounting transparency indicators. This includes a 22% increase in earnings quality and a further decrease in the accrual ratio, which directly reflects system strengthening.

Despite ongoing cash gaps, the accuracy and clarity of these gaps became possible thanks to blockchain features such as immutability, integrity, and real-time traceability.

The effects of COVID-19 and infrastructure costs are considered external factors contributing to the widened gap, yet their presence reflects a matured accounting system.

Conclusion:

Siemens underwent a gradual transformation toward genuine accounting transparency, largely driven by blockchain technology. Blockchain helped reduce estimations, enhance disclosure quality, and increase the realism, reliability, and transparency of financial information even amid external crises and adoption costs. This evolution enhances trust among investors and end-users in accounting outputs.

- **Evaluation of the Hypothesis Related to Accounting Transparency :**

Based on the empirical analysis of transparency indicators across IBM, Siemens, and Fujitsu, the results support the first component of the alternative hypothesis (H_1), confirming that blockchain technology significantly enhances accounting transparency. Therefore, the null hypothesis (H_0) is rejected in regard to accounting transparency.

❖ Summary of the Comparative Study on the Impact of Blockchain on Accounting Transparency:

The comparative analysis of three international companies reveals a gradual and tangible transformation in accounting transparency levels driven by the adoption of blockchain technology. In the pre-adoption phase, companies suffered from relatively weak earnings quality and significant gaps between accounting performance and cash flows, undermining the credibility of financial reports and exposing the limitations of traditional recording systems.

During the initial phase of adoption, blockchain began to reduce accounting estimates and curb manipulative practices, although some gaps persisted due to transitional costs and infrastructure adjustments. However, the most notable improvements appeared in the post-adoption period, where earnings quality significantly increased, and discretionary estimates declined, contributing to more realistic and transparent financial information.

Even in the face of unexpected and unaccounted-for crises within risk management frameworks, such as the COVID-19 pandemic**,** blockchain reinforced accounting transparency, as demonstrated by rising disclosure indicators. This enhanced the understanding of companies' actual positions**,** revealed structural gaps, and helped guide rational decision-making to overcome and adapt to the crisis effectively**.**

Moreover, the progressive expansion of blockchain within companies' accounting systems played a crucial role in restructuring internal control mechanisms and improving data quality. This expansion affected existing reporting gaps and enabled the detection of previously hidden inconsistencies that went unnoticed under traditional systems.

Overall, the findings emphasize that blockchain is not merely a modern technological tool, but a structural shift that rebuilds trust in financial information. It lays the foundation for sound financial decision-making based on accurate disclosure and genuine transparency even under volatile and uncertain conditions.

II. Simulated Blockchain Accounting-Tax Platform(MAFI) and Its Impact on Tax Challenges:

This section demonstrates the effectiveness of the platform MAFI based on a practical scenario and derives the expected outcomes from its use in addressing tax-related challenges.

- **First: Application Scenario.**
- **Scenario Description:**

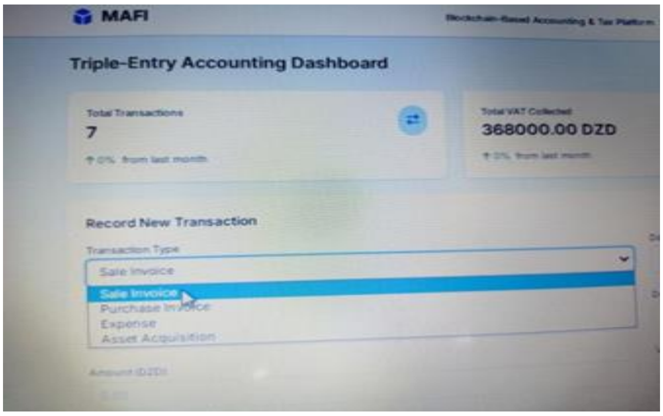
A sales invoice between Company A (the supplier) and Company B (the buyer).

- **Amount:** 120,000,000 DZD
- **Tax:** 19% (190,000 DZD)

- **Transaction Sequence:**

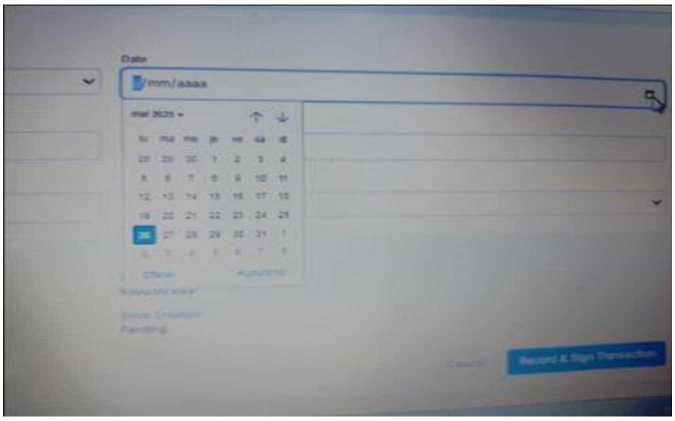
1. **Selecting the Transaction Type :** The user begins by selecting the type of transaction from the available options:

   Purchase Invoice, Sales Invoice, Expenses, or Asset Acquisition.



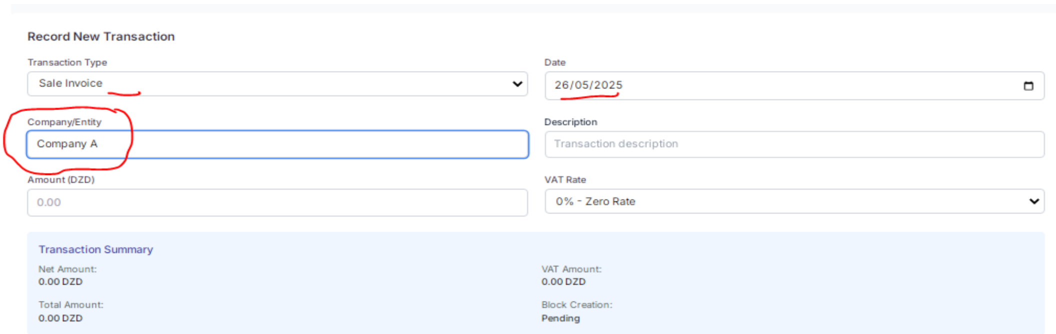
[Figure 8Insert screenshot: Transaction Type Selection Interface]

2. Entering the Transaction Date: The user inputs the date of the transaction in the format: day/month/year.



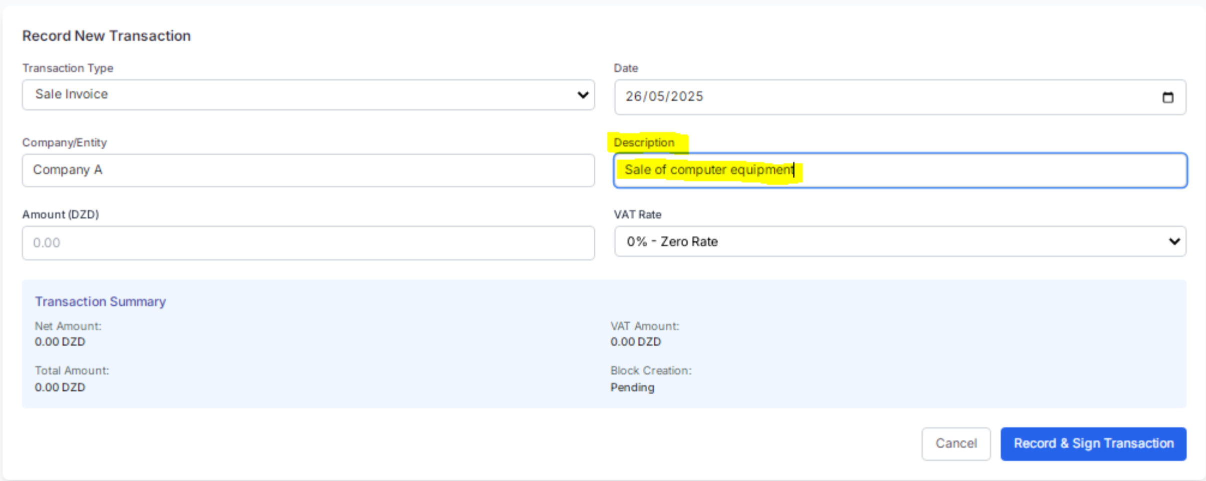
[Figure 9Insert screenshot: Date Input Field]

3. Identifying the Entity: The name of the entity involved in the transaction (supplier or client) is recorded.



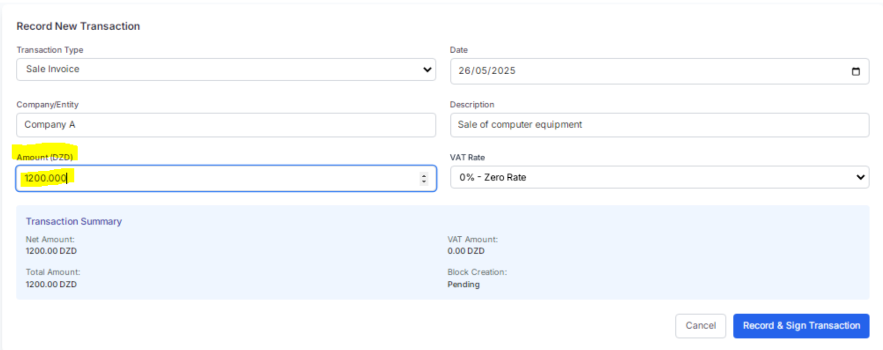
[Figure 10Insert screenshot: Entity Name Field]

4. Describing the Transaction: A brief description of the transaction is entered (e.g., Sale of computer equipment).



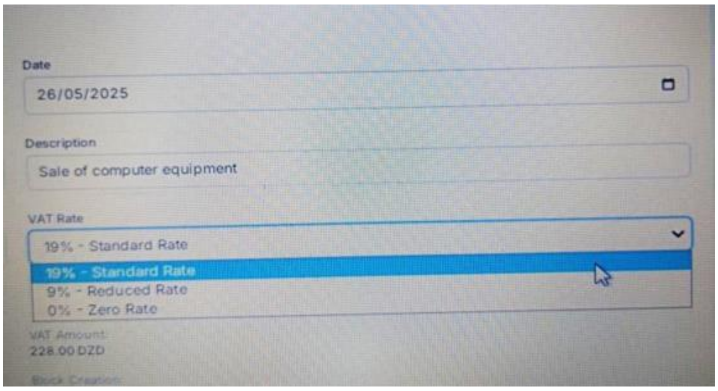
[Figure 11Insert screenshot: Description Field]

5. Entering the Transaction Amount: The invoice amount is entered in the designated field.



[Figure 12 : Insert screenshot: Amount Input Field]

6. Selecting the VAT Rate: The user selects the applicable VAT rate from the available options: **0%, 9%, or 19%.**

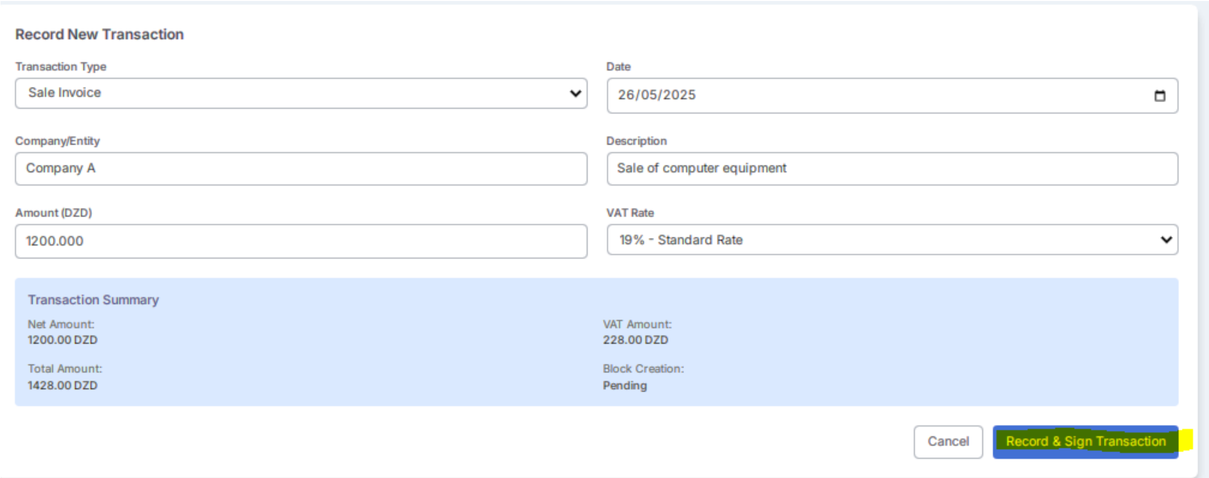


[Figure 13Insert screenshot: VAT Rate Selection]

***7.* Generating a Unique Hash (Digital Signature):** A unique **Hash** is automatically generated, acting as a digital fingerprint of the transaction, similar to the ADA biometric identity system.

[Figure 14Insert screenshot: Hash Generation Display]

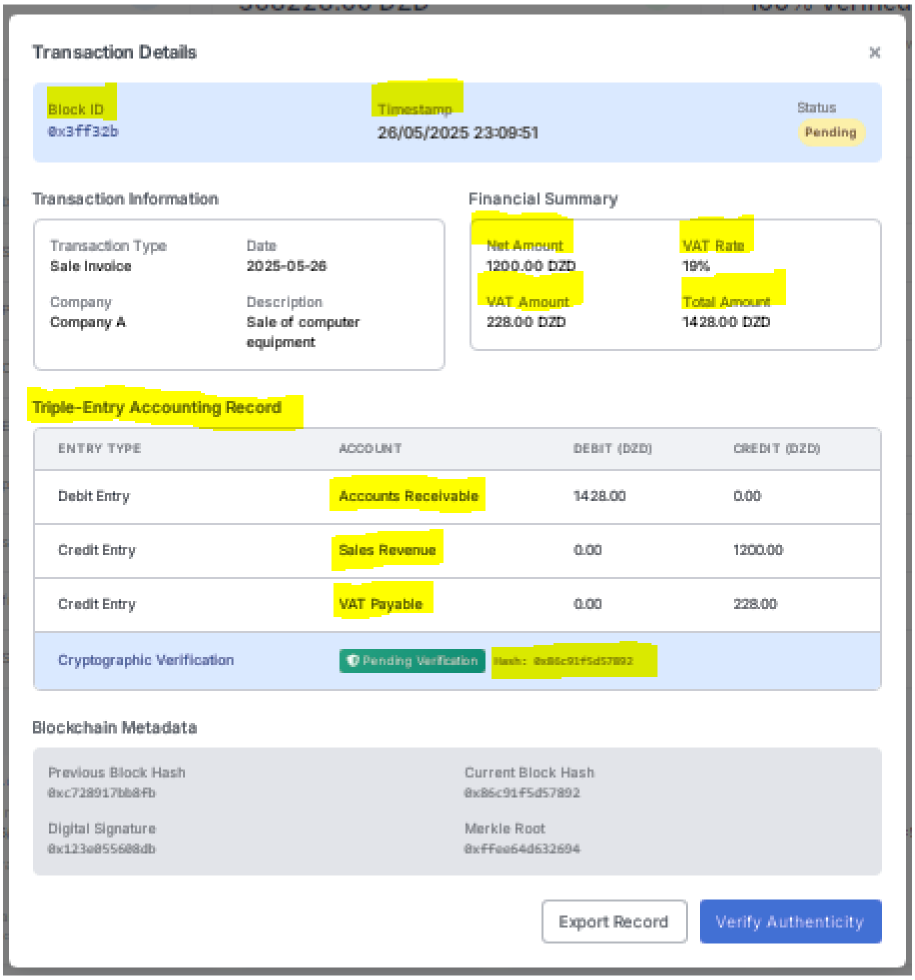
***8.* Recording and Signing the Transaction:** The user clicks the **"Record and Sign Transaction"** button to confirm and digitally sign the transaction.



[Figure 15Insert screenshot: Signature Confirmation Interface].

9. Creating the Block*:* A new block is generated and includes the following key elements:

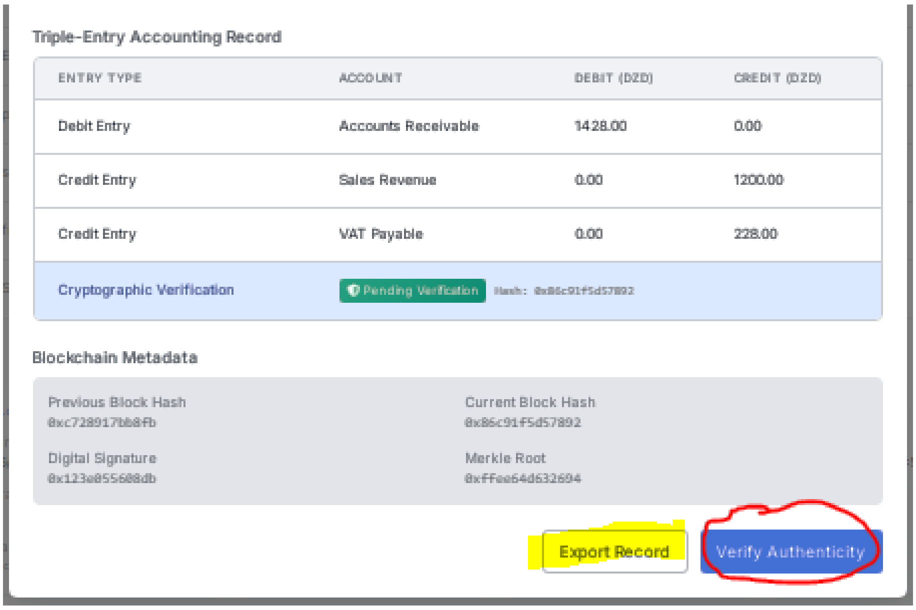
- Block ID
- Timestamp
- Hash Code
- Transaction Summary
- Transaction Details including both entities' identities
- Blockchain Metadata, which includes verification status (e.g., Verified / Not Verified)



[Figure 16Insert screenshot: Full Block Overview]

10. Exporting or Verifying the Record: The platform allows two options:

- **Export Record**: To download a copy of the transaction
- **Verify Authenticity**: To validate the originality and integrity of the transaction



Triple-Entry Accounting Record

ENTRY TYPE	ACCOUNT	DEBIT (DZD)	CREDIT (DZD)
Debit Entry	Accounts Receivable	1428.00	0.00
Credit Entry	Sales Revenue	0.00	1200.00
Credit Entry	VAT Payable	0.00	228.00
Cryptographic Verification	Pending Verification Hash: 0x86c91f5d57892		

Blockchain Metadata

Previous Block Hash 0xc728917bb8fb	Current Block Hash 0x86c91f5d57892
Digital Signature 0x123e055608db	Merkle Root 0xffee64d632694

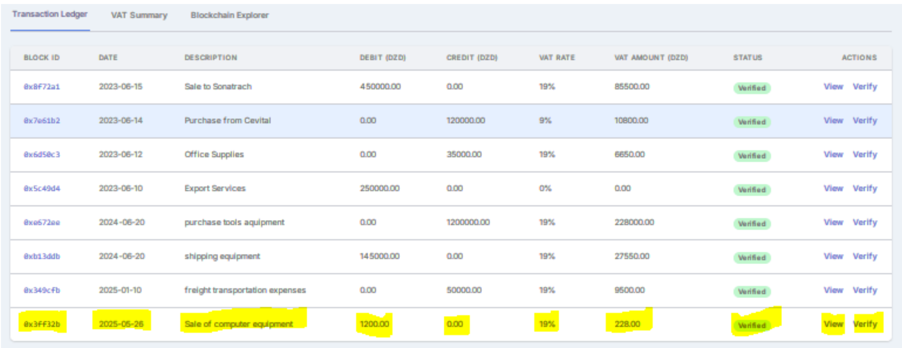
Export Record Verify Authenticity

[Figure 17Insert screenshot: Export/Verify Buttons]

11. Generating the Digital Invoice*:* An automatically generated invoice summarizes all transaction details, including tax data and hash values.

12. Triple-Entry Accounting Record*:* The system records the transaction as a **triple-entry** accounting entry involving:

- Supplier account (Credit)
- Client account (Debit)
- VAT account (Debit or Credit depending on transaction direction)

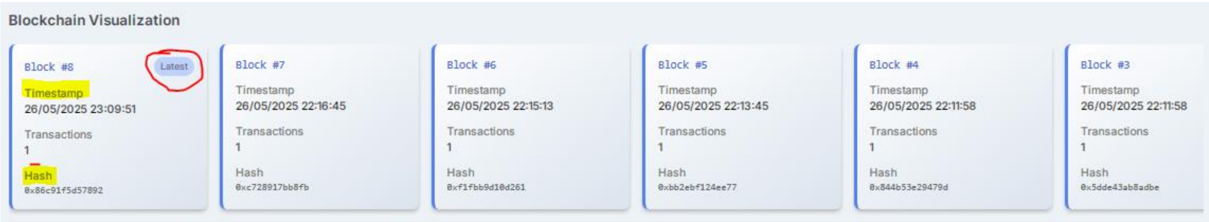


Transaction Ledger VAT Summary Blockchain Explorer

BLOCK ID	DATE	DESCRIPTION	DEBIT (DZD)	CREDIT (DZD)	VAT RATE	VAT AMOUNT (DZD)	STATUS	ACTIONS
0x8f72a1	2023-06-15	Sale to Sonatrach	450000.00	0.00	19%	85500.00	Verified	View Verify
0x7e61b2	2023-06-14	Purchase from Cevital	0.00	120000.00	9%	10800.00	Verified	View Verify
0x6d50c3	2023-06-12	Office Supplies	0.00	35000.00	19%	6650.00	Verified	View Verify
0x5c49d4	2023-06-10	Export Services	250000.00	0.00	0%	0.00	Verified	View Verify
0xe672ee	2024-06-20	purchase tools aquipment	0.00	1200000.00	19%	228000.00	Verified	View Verify
0xb13ddb	2024-06-20	shipping equipment	145000.00	0.00	19%	27550.00	Verified	View Verify
0x349cfb	2025-01-10	freight transportation expenses	0.00	50000.00	19%	9500.00	Verified	View Verify
0x3ff32b	2025-05-26	Sale of computer equipment	1200.00	0.00	19%	228.00	Verified	View Verify

[Figure 18Insert screenshot: Triple-Entry Interface].

13. Adding the Block to the Blockchain*:* Finally, the newly created block is permanently appended to the blockchain. This immutable linkage ensures data integrity, transparency, and resistance to tampering.



[Figure 19Insert screenshot: Block Confirmation and Chain Integration]

➢ **Second: Expected Results Section.**

1. Automatic VAT Deduction upon Issuing Digital Invoices: The issuance of a digital invoice automatically activates a smart contract, which calculates an d deducts the VAT directly from the buyer's account and transfers it to a virtual wallet representing the tax authority.

✓ **Result:** Minimization of manual entry errors, faster tax collection, and reduction in tax evasion.

2. Verification of Invoice Authenticity and Prevention of Fraudulent Invoices via Automatic: Registration: The platform relies on electronic invoice registration within the system, with no option for manual entry or external document uploads. Every invoice is generated by an authenticated user through a digital identity and is automatically linked to the accounts of both the taxpayer and the recipient.

✓ **Result:** Prevention of the issuance of fake or fictitious invoices, limitation of invalid invoices used for evasion or manipulation, enhancement of accounting record credibility, and facilitation of tax audit and oversight.

3. Transparency and Instant Reporting through the Distributed Ledger: All transactions are instantly recorded in a distributed ledger, granting the tax authority access to reliable and tamper-proof data.

✓ **Result:** Strengthened tax monitoring through real-time data without waiting for periodic reports.

4. Integration of the Informal Economy into the Tax System: Small vendors can join using a digital identity linked to a mobile application, enabling the issuance of standardized tax invoices for every transaction.

✓ **Result:** Expansion of the tax base and gradual improvement of tax compliance.

5. Role and Permission Allocation to Enhance Governance: Different roles (accountant, tax authority, auditor) are assigned with specific permissions and private keys for each role.

- ✓ **Result:** Strengthened separation of duties, reduced risk of manipulation, and improved internal control.

❖ **Third:Discussion**

1. Enhancing Tax Compliance through Automation and Transparency: The simulation platform results demonstrated that integrating smart contracts and automatic tax deductions at the point of invoice issuance simplifies the tax process and reduces manual intervention, thereby encouraging voluntary taxpayer compliance. The transparency provided by blockchain, through recording all transactions on a distributed ledger, reduces doubts and increases taxpayers' trust in the tax authority. This, in turn, leads to an expanded tax base and improved revenue collection.

2. Reducing Administrative Corruption and Promoting Fairness: Eliminating reliance on manual procedures and implementing a closed digital system helps reduce opportunities for manipulation and corruption, especially in critical stages such as invoice registration and review. The execution of smart contracts in a pre-programmed format ensures equal treatment of all taxpayers without bias or exceptions, thereby reinforcing tax fairness and strengthening the credibility of the tax system.

3. Improving Fraud Detection and Prevention: The simulation model results highlighted that real-time and immutable registration of each invoice and financial transaction in the distributed ledger creates an effective technical barrier against forgery or deliberate deletion of records. Additionally, the digital identity system, linked to a private key for each economic actor, allows for undeniable traceability and documentation of invoice sources. This eliminates a major method of tax fraud—fake or inflated invoices. The integration of real-time documentation with digital signatures marks a significant advancement in traditional anti-evasion tools and enhances the tax authority's ability to conduct precise audits and continuous monitoring of tax obligations.

❖ **Benefits of Multi-role Permission Systems**

The incorporation of role-based access control (e.g., accountant, auditor, tax authority) represents a critical pillar of governance. Each user possesses a private key and specific permissions that enable precise tracking of responsibilities, thereby reducing misuse or role conflict. This structure is essential to ensuring the integrity of internal data processing and maintaining a transparent control environment.

❖ **Evaluation of the Hypothesis Related to adressing tax challenges :**

Based on the analysis of the applied scenario for the proposed blockchain-based accounting and taxation platform (POC), it can be concluded that the platform effectively contributes to improving tax compliance by enhancing the accuracy and transparency of tax data. The results showed that using the platform reduced the likelihood of errors in recording tax transactions and increased the transparency of information exchanged among relevant parties, thereby helping to reduce tax evasion rates.

Accordingly, the evidence derived from the applied scenario supports the alternative hypothesis (H_1), indicating that implementing the POC platform improves tax compliance processes and enhances transparency. Conversely, the null hypothesis (H_0), which asserts no positive impact of the platform, is rejected based on the practical findings of the analysis.

However, it is important to note that these conclusions are based on a limited qualitative analysis within the scope of the presented scenarios. Future studies with broader quantitative data are recommended to test the platform's impact more comprehensively and accurately.

Conclusion of the Applied Chapter:

Based on the applied aspect, which presented a comparative study of three international companies differing in their geographical locations and regulatory and legislative frameworks, in addition to developing a proof-of-concept (POC) prototype for a blockchain-simulated accounting and tax platform within certain technical and financial constraints, the study has effectively addressed the core research questions in practice.

The analysis results revealed a significant improvement in accounting transparency following the adoption of blockchain technology. This underscores its effectiveness, even amid the challenges posed by adoption costs and extraordinary economic conditions such as the COVID-19 pandemic, which impacted the global economy as a whole. The degree of impact varied across the three companies, with improvements influenced by the maturity of each country's regulatory and legislative environment.

As for the POC simulation platform, it demonstrated functional effectiveness in addressing certain tax-related challenges, particularly in limiting the issuance of fraudulent invoices, reducing opportunities for tax evasion, and enhancing the efficiency of tax oversight and auditing through real-time, reliable transaction tracking.

These applied findings confirm that blockchain technology, when deployed with sound regulatory and technical awareness, serves as a genuine lever for greater accounting transparency and a more efficient tax system.

General Conclusion

General conclusion:

At the conclusion this study entitled "blockchain accounting transparency and tax challenges : an international comparative study" wich sought to explore the transformative potential of blockchain technology in enhancing accounting transparency and addressing contemporary tax challenges, through a dual-level analysis at the micro level (international institutions) and the macro level (national tax systems). Using a comparative methodology supported by quantitative indicators and an applied analysis via a blockchain-based simulation platform, the study concluded that this technology is capable of fundamentally reshaping the structure of traditional accounting and tax systems.

The quantitative analysis results demonstrated a clear improvement in accounting transparency indicators such as earnings quality, accrual ratios, and the gap between earnings and cash flows, following the adoption of blockchain by major global companies. Additionally, the developed simulation for managing accounting operations and value-added tax (VAT) revealed that blockchain can reduce tax evasion, accelerate collection, and achieve greater tax fairness through real-time tracking and decentralization.

The study showed that core features of blockchain—such as immutability, transparency, and smart contracts—provide organizations and tax authorities with new capabilities to rebuild trust, improve governance, and enhance compliance. Its integration into a modern tax environment contributes to combating fictitious invoices, reducing oversight gaps, and achieving significant operational efficiency.

✓ Recommendations:

Based on the study's findings, the following recommendations are proposed:

1. **Updating Legislative, Accounting, and Tax Frameworks:** It is essential to review and develop legislation to align with contemporary digital systems, ensuring the recognition of smart contracts, the legality of blockchain records, and their integration within national and international accounting standards, aiming to close legal gaps that hinder digital transformation and threaten financial sustainability.
2. **Reforming Tax Policies in Developing Countries:** It is recommended to reconsider tax rates and simplify complex tax systems, especially under fragile economic conditions like those in Algeria, to encourage voluntary compliance, broaden the tax base, and enhance fairness among taxpayers, thereby creating a conducive environment for blockchain-based tax systems.

3. **Enhancing Human Capacities and Digital Skills Development:** Investment in continuous training programs for accountants, auditors, and tax administration staff is necessary, alongside supporting academic research and practical projects on blockchain, to bridge the knowledge gap and achieve professional and technical readiness.
4. **Launching Well-Designed Pilot Projects:** It is advised to initiate pilot projects applying blockchain in strategic sectors such as automated VAT collection or invoice digitization, to practically assess the technology's feasibility and prepare institutional infrastructure prior to national rollout.
5. **Strengthening International Cooperation and Standardization:** Given the cross-border nature of economic activities, engaging in international initiatives for tax data exchange via compatible blockchain systems is recommended to ensure cross-border transaction traceability, especially among multinational corporations.
6. **Integrating Blockchain into National Digital Transformation Strategies:** Blockchain technology should be part of a comprehensive digital transformation vision, including electronic invoicing, digital identity, and government information systems, to ensure integration and effectiveness.
7. **Prioritizing Digital Infrastructure Support as a Strategic Priority:** Digital transformation cannot be achieved without robust infrastructure. Therefore, countries are recommended to allocate stable portions of their GDP to support technological transformation. For example, Estonia allocates 1% of its GDP annually to invest in digital infrastructure, making it one of the most advanced countries in electronic tax administration. Developing countries should view this investment as a strategic means to enhance transparency, reduce operational costs, and improve overall tax performance.

✓ Final Reflection :

Although blockchain is not a magic solution for all challenges, it represents a revolutionary tool for reshaping the digital architecture of accounting and tax systems. This study has demonstrated, through quantitative results and a practical applied model, that adopting this technology can achieve a qualitative leap in transparency, reducing evasion, and strengthening trust between taxpayers and tax administrations. However, the success of this vision remains contingent on clear political will, flexible legislation, and a technical infrastructure capable of meeting the challenges of the economy.

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List of appendices

APPENDIX N°1 : IBM excel output.

	COMPANY	COUNTRY	SECTOR	PERIOD(ADOPTION)	YEAR	Net Income(MILLION US $)	Operating Cash Flow(MILLION US $)	Total Assets(MILLION US $)	Earnings Quality (OCF / Net Income
2	IBM	USA	INFORMATION TECHNOLOGY AND CONSULTING	BEFORE	2007	10 418	16 094	120 431	1,544826262
3				BEFORE	2008	12 334	18 812	109 524	1,525214853
4				BEFORE	2009	13 425	20 773	109 022	1,547337058
5				BEFORE	2010	14 833	19 549	113 452	1,317939729
6				BEFORE	2011	16 389	23 643	180 782	1,442613948
7				BEFORE	2012	15 699	24 255	193 406	1,545002866
8				BEFORE	2013	16 999	25 591	203 105	1,505441497
9				BEFORE	2014	16 022	23 257	204 751	1,451566596
10				BEFORE	2015	16 363	28 564	203 490	1,745645664
11				ADOPTED	2016	14 694	27 552	199 581	1,875051041
12				AFTER	2017	13 643	31 673	198 825	2,321556842
13				AFTER	2018	9 862	28 337	204 522	2,873352261
14				AFTER	2019	6 670	27 753	219 295	4,160869565
15				AFTER	2020	14 881	25 255	236 495	1,697130569
16				AFTER	2021	13 510	36 074	252 496	2,670170244
17				AFTER	2022	13 673	24 181	244 860	1,768521904
18				AFTER	2023	11 680	28 841	243 197	2,469263699
19				AFTER	2024	15 511	35 726	252 399	2,303268648

Accruals Ratio (Measure of Earnings Managem	Earnings-Cash Gap(Net Income–OCF)	EARNINGS GAP RATIO
-0,047130722	-5 676	-35,27
-0,05914685	-6 478	-34,44
-0,067399241	-7 348	-35,37
-0,04156824	-4 716	-24,12
-0,040125676	-7 254	-30,68
-0,044238545	-8 556	-35,28
-0,042303242	-8 592	-33,57
-0,035335603	-7 235	-31,11
-0,05995872	-12 201	-42,71
-0,06442497	-12 858	-46,67
-0,090682761	-18 030	-56,93
-0,09033258	-18 475	-65,20
-0,096139903	-21 083	-75,97
-0,043865621	-10 374	-41,08
-0,089363792	-22 564	-62,55
-0,042914318	-10 508	-43,46
-0,070564193	-17 161	-70,97
-0,080091443	-20 215	-56,58

APPENDIX N°2 : FUJITSU excel output.

	COMPANY	COUNTRY	SECTOR	PERIOD(ADOPTION)	YEAR	Net Income(MILLION US $)	Operating Cash Flow(MILLION US $)	Total Assets(MILLION US $)	Earnings Quality (OCF / Net Income)
2	Fujitsu	Japan	technology	before	2011	644,570	2989,74	35 382	0,215593998
3				before	2012	542,370	3048,12	37 408	0,177935908
4				before	2013	-882,240	859,22	36 894	-1,026791741
5				before	2014	486,100	1755,32	30 795	0,276929563
6				before	2015	1319,600	2549,35	29 767	0,517622139
7				before	2016	720,133	2100,66	26 778	0,342812082
8				before	2017	822,948	2328,08	29 681	0,353488156
9				addopted	2018	1524,060	1803,74	28 094	0,844946736
10				after	2019	941,058	894,74	27 944	1,051762292
11				after	2020	1472,386	3194,82	29 324	0,460866653
12				after	2021	1905,380	2894,70	29 988	0,658230105
13				after	2022	1592,347	2210,29	29 653	0,720425121
14				after	2023	1592,347	1630,44	24 165	0,976639363
15				after	2024	1755,898	2133,63	24 252	0,822964673

Accruals Ratio (Measure of Earnings Management)	Earnings-Cash Gap(Net Income–OCF)	EARNINGS GAP RATIO
-0,066281443	-2 345,170	-78,44060019
-0,066984335	-2 505,750	-82,2064092
-0,047201713	-1741,460	-202,6791741
-0,041215132	-1269,220	-72,30704373
-0,041312527	-1229,750	-93,19111852
-0,051554672	-1380,531	-191,7050045
-0,050710219	-1505,130	-182,8949095
-0,009954973	-279,675	-18,35065549
0,001657386	-1722,434	-183,0316516
-0,05873803	-1722,434	-116,9825032
-0,032990596	-989,322	-51,92255613
-0,020839072	-617,941	-38,8069309
-0,001576164	-38,088	-2,391940953
-0,015575087	-377,727	-21,51189875

APPENDIX N°3 : SIEMENS excel output.

	A	B	C	D	E	F	G	H	I
1	COMPANY	COUNTRY	SECTOR	PERIOD(ADOPTION)	YEAR	Net Income ((in millions of l)	Operating Cash Flow(in millions of l)	Total Assets(in millions of l)	Earnings Quality (OCF / Net Income)
2	Siemens	Germany	industrial manufacturing and digital technology	before	2011	6 321	8 056	104 243	1,27
3				before	2012	4 590	6 996	108 282	1,52
4				before	2013	4 409	7 126	101 936	1,62
5				before	2014	5 507	7 230	104 879	1,31
6				before	2015	7 380	6 881	120 348	0,93
7				before	2016	5 584	7 668	125 717	1,37
8				ADOPTED	2017	6 179	7 225	133 804	1,17
9				after	2018	6 120	8 415	138 915	1,38
10				after	2019	5 648	8 482	150 248	1,50
11				after	2020	4 200	8 178	123 897	1,95
12				after	2021	10 236	15 216	101 265	1,49
13				after	2022	4 392	10 322	151 502	2,35
14				after	2023	8 529	12 281	103 884	1,44
15					2024	8 992	11 814	99 188	1,31

J	K	L
Accruals Ratio	Earnings-Cash Gap(Net Income–OCF)	EARNINGS GAP RATIO
-0,016643803	-1 735	-21,5367428
-0,02221976	-2 406	-34,39108062
-0,026653979	-2 717	-38,12798204
-0,016428456	-1 723	-23,83125864
0,004146309	499	7,251852928
-0,016576915	-2 084	-27,17788211
-0,007817405	-1 046	-14,47750865
-0,016520894	-2 295	-27,27272727
-0,018862148	-2 834	-33,41193115
-0,032107315	-3 978	-48,64269993
-0,0491779	-4 980	-32,72870662
-0,039141397	-5 930	-57,45010657
-0,036117208	-3 752	-30,55125804
-0,028451022	-2 822	-23,88691383

APPENDIX N°4 : IBM SPSS output.

Test T IBM company

BEFORE

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
NETI	9	14720,22	2214,229	738,076
OCF	9	22282,00	3827,324	1275,775
ASSETS	9	159773,67	44970,087	14990,029
EARNINGQ	9	1,513954274777778	,114190104386950	,038063368128983
EM	9	-,048578537666667	,010906982591718	,003635660863906
ECG	9	-7561,78	2140,345	713,448
EGR	9	-33,6167	4,96283	1,65428

Test sur échantillon unique

	Valeur de test = 0				
					Intervalle de confiance de la différence à 95 %
	T	df	Sig. (bilatérale)	Différence moyenne	Inférieur
NETI	19,944	8	,000	14720,222	13018,21
OCF	17,465	8	,000	22282,000	19340,06
ASSETS	10,659	8	,000	159773,667	125206,60
EARNINGQ	39,775	8	,000	1,513954274777778	1,426179990472735
EM	-13,362	8	,000	-,048578537666667	-,056962386653015
ECG	-10,599	8	,000	-7561,778	-9206,99
EGR	-20,321	8	,000	-33,61667	-37,4314

Test sur échantillon unique

	Valeur de test = 0
	Intervalle de confiance de la différence à 95 %
	Supérieur
NETI	16422,23
OCF	25223,94
ASSETS	194340,74
EARNINGQ	1,601728559082820
EM	-,040194688680318
ECG	-5916,56
EGR	-29,8019

Tailles d'effet pour échantillon unique

	Standardisation[a]		95% Intervalle de confiance

			Estimation des points	Inférieur	Supérieur
NETI	d de Cohen	2214,229	6,648	3,394	9,901
	Correction de Hedges	2452,887	6,001	3,064	8,938
OCF	d de Cohen	3827,324	5,822	2,952	8,686
	Correction de Hedges	4239,847	5,255	2,665	7,841
ASSETS	d de Cohen	44970,087	3,553	1,717	5,368
	Correction de Hedges	49817,127	3,207	1,550	4,846
EARNINGQ	d de Cohen	,114190104386950	13,258	6,882	19,658
	Correction de Hedges	,126497931409970	11,968	6,212	17,746
EM	d de Cohen	,010906982591718	-4,454	-6,681	-2,213
	Correction de Hedges	,012082577060281	-4,021	-6,031	-1,998
ECG	d de Cohen	2140,345	-3,533	-5,340	-1,706
	Correction de Hedges	2371,039	-3,189	-4,820	-1,540
EGR	d de Cohen	4,96283	-6,774	-10,086	-3,461
	Correction de Hedges	5,49774	-6,115	-9,105	-3,124

a. Dénominateur utilisé pour estimer les tailles d'effet.

Le d de Cohen utilise l'écart type échantillon.

La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

Test T

ADOPTED

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
ADOPNETI	1[a]	14694,00	.	.

ADOPOCF	1[a]	27552,00	.	.
ADOPASSETS	1[a]	199581,00	.	.
ADOPEARNINGQ	1[a]	1,875051041000000	.	.
ADOPEM	1[a]	-,064424970000000	.	.
ADOPECG	1[a]	-12858,00	.	.
ADOPEGR	1[a]	-46,6700	.	.

a. t ne peut pas être calculé, car la somme des pondérations d'observations est inférieure ou égale à 1.

Test T

AFTER

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
AFTERNETI	8	12428,75	2928,127	1035,249
AFTEROCF	8	29730,00	4430,897	1566,559
AFTERASSETS	8	231511,13	21254,542	7514,615
AFTEREARNINGQ	8	2,533016716500000	,771757376751321	,272857437265800
AFTEREM	8	-,075494326375000	,021303037589147	,007531761169579
AFTERECG	8	-17301,25	4575,581	1617,712
AFTEREGR	8	-59,0925	12,27655	4,34041

Test sur échantillon unique

	Valeur de test = 0				
	T	Df	Sig. (bilatérale)	Différence moyenne	Intervalle de confiance de la différence à 95 %

					Inférieur
AFTERNETI	12,006	7	,000	12428,750	9980,77
AFTEROCF	18,978	7	,000	29730,000	26025,68
AFTERASSETS	30,808	7	,000	231511,125	213741,88
AFTEREARNINGQ	9,283	7	,000	2,533016716500000	1,887811403113833
AFTEREM	-10,023	7	,000	-,075494326375000	-,093304111493791
AFTERECG	-10,695	7	,000	-17301,250	-21126,53
AFTEREGR	-13,614	7	,000	-59,09250	-69,3559

Test sur échantillon unique

	Valeur de test = 0
	Intervalle de confiance de la différence à 95 %
	Supérieur
AFTERNETI	14876,73
AFTEROCF	33434,32
AFTERASSETS	249280,37
AFTEREARNINGQ	3,178222029886167
AFTEREM	-,057684541256209
AFTERECG	-13475,97
AFTEREGR	-48,8291

Tailles d'effet pour échantillon unique

		95% Intervalle de confiance
Standardisation[a]	Estimation des points	Inférieur

AFTERNETI	d de Cohen	2928,127	4,245	1,961
	Correction de Hedges	3296,687	3,770	1,742
AFTEROCF	d de Cohen	4430,897	6,710	3,216
	Correction de Hedges	4988,609	5,960	2,857
AFTERASSETS	d de Cohen	21254,542	10,892	5,302
	Correction de Hedges	23929,827	9,675	4,709
AFTEREARNINGQ	d de Cohen	,771757376751321	3,282	1,455
	Correction de Hedges	,868897602208331	2,915	1,292
AFTEREM	d de Cohen	,021303037589147	-3,544	-5,474
	Correction de Hedges	,023984426762309	-3,148	-4,862
AFTERECG	d de Cohen	4575,581	-3,781	-5,826
	Correction de Hedges	5151,504	-3,358	-5,175
AFTEREGR	d de Cohen	12,27655	-4,813	-7,365
	Correction de Hedges	13,82178	-4,275	-6,542

Tailles d'effet pour échantillon unique

		95% Intervalle de confiance[a]
		Supérieur
AFTERNETI	d de Cohen	6,516
	Correction de Hedges	5,787
AFTEROCF	d de Cohen	10,209
	Correction de Hedges	9,068
AFTERASSETS	d de Cohen	16,512
	Correction de Hedges	14,666
AFTEREARNINGQ	d de Cohen	5,087
	Correction de Hedges	4,518

AFTEREM	d de Cohen	-1,594
	Correction de Hedges	-1,416
AFTERECG	d de Cohen	-1,719
	Correction de Hedges	-1,527
AFTEREGR	d de Cohen	-2,254
	Correction de Hedges	-2,002

a. Dénominateur utilisé pour estimer les tailles d'effet.

Le d de Cohen utilise l'écart type échantillon.

La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

APPENDIX N°2 : FUJITSU SPSS output.

Test T

BEFORE

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
NETincom	7	521,8401	677,45262	256,05302
OCF	7	2232,9271	761,48507	287,81430
TA	7	32386,43	4136,740	1563,541
EARNINGQ	7	,1225127	,51872751	,19606057
AR	7	-,052177142857143	,010674782924078	,004034688702387
ECG	7	-1711,00157	518,505916	195,976815
EGR	7	-129,060442857142870	59,871135541479330	22,629162193399253

Test sur échantillon unique

	Valeur de test = 0				
					Intervalle de confiance de la différence à 95 %
	T	df	Sig. (bilatérale)	Différence moyenne	Inférieur
NETincom	2,038	6	,088	521,84014	-104,6990
OCF	7,758	6	,000	2232,92714	1528,6709
TA	20,714	6	,000	32386,429	28560,58
EARNINGQ	,625	6	,555	,12251271	-,3572302
AR	-12,932	6	,000	-,052177142857143	-,062049670458694
ECG	-8,731	6	,000	-1711,001571	-2190,53956
EGR	-5,703	6	,001	-129,060442857142870	-184,432008009650840

Test sur échantillon unique

	Valeur de test = 0
	Intervalle de confiance de la différence à 95 %
	Supérieur
NETincom	1148,3793
OCF	2937,1834
TA	36212,27
EARNINGQ	,6022556
AR	-,042304615255592
ECG	-1231,46358
EGR	-73,688877704634920

Tailles d'effet pour échantillon unique

		Standardisation[a]	Estimation des points	95% Intervalle de confiance	
				Inférieur	Supérieur
NETincom	d de Cohen	677,45262	,770	-,107	1,602
	Correction de Hedges	779,91228	,669	-,093	1,391
OCF	d de Cohen	761,48507	2,932	1,143	4,694
	Correction de Hedges	876,65401	2,547	,993	4,077
TA	d de Cohen	4136,740	7,829	3,480	12,205
	Correction de Hedges	4762,391	6,800	3,023	10,601
EARNINGQ	d de Cohen	,51872751	,236	-,525	,979
	Correction de Hedges	,59718118	,205	-,456	,850
AR	d de Cohen	,010674782924078	-4,888	-7,673	-2,102
	Correction de Hedges	,012289264276208	-4,246	-6,665	-1,826
ECG	d de Cohen	518,505916	-3,300	-5,249	-1,329
	Correction de Hedges	596,926071	-2,866	-4,560	-1,154
EGR	d de Cohen	59,871135541479330	-2,156	-3,535	-,736
	Correction de Hedges	68,926198539015060	-1,872	-3,071	-,639

a. Dénominateur utilisé pour estimer les tailles d'effet.

Le d de Cohen utilise l'écart type échantillon.

La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

NEW FILE.

DATASET NAME Jeu_de_données1 WINDOW=FRONT.

SAVE OUTFILE='C:\Users\Dell\Desktop\ISRAA\fujitsu adopted.sav'

/COMPRESSED.

T-TEST

Test T

ADOPTED

Avertissements

La table de tests d'échantillon unique n'est pas générée.
La table Tailles d'effet pour échantillon unique n'est pas générée.

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
adoptNETincom	1[a]	1524,06	.	.
adoptOCF	1[a]	1803,74000000000	.	.
adoptTOTALassets	1[a]	28094,00	.	.
adoptEARNINGQ	1[a]	,844946736000000	.	.
adoptAR	1[a]	-,0099549730000	.	.
adoptECG	1[a]	-279,675000000000000	.	.
adoptEGR	1[a]	-18,350655490000000	.	.

a. t ne peut pas être calculé, car la somme des pondérations d'observations est inférieure ou égale à 1.

Test T

AFTER

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
afterNETincom	6	1543,23600	331,311108	135,257193

afterOCF	6	2159,770000	836,0834082	341,3296221
afterTOTALASSETS	6	27554,33333333	2683,418764686	1095,501123282
afterEARNINGQ	6	,781814701	,2165969314	,0884253270
AfterAR	6	-,021343594	,0223039148	,0091055351
afterECG	6	-911,313000000	700,7300047271	286,0718265066
afterEGR	6	-69,10791358883	68,118253220492	27,809160426650

Test sur échantillon unique

	Valeur de test = 0				
					Intervalle de confiance de la différence à 95 %
	T	df	Sig. (bilatérale)	Différence moyenne	Inférieur
afterNETincom	11,410	5	,000	1543,236000	1195,54632
afterOCF	6,328	5	,001	2159,7700000	1282,354274
afterTOTALASSETS	25,152	5	,000	27554,333333333	24738,25804493
afterEARNINGQ	8,842	5	,000	,7818147012	,554510162
AfterAR	-2,344	5	,066	-,0213435938	-,044750117
afterECG	-3,186	5	,024	-911,3130000000	-1646,684040899
afterEGR	-2,485	5	,055	-69,107913588833	-140,59363624528

Test sur échantillon unique

	Valeur de test = 0
	Intervalle de confiance de la différence à 95 %
	Supérieur
AfterNETincom	1890,92568
AfterOCF	3037,185726

AfterTOTALASSETS	30370,40862174
AfterEARNINGQ	1,009119240
AfterAR	,002062929
AfterECG	-175,941959101
AfterEGR	2,37780906762

Tailles d'effet pour échantillon unique

		Standardisation[a]	Estimation des points	95% Intervalle de confiance Inférieur
afterNETincom	d de Cohen	331,311108	4,658	1,764
	Correction de Hedges	394,066758	3,916	1,483
afterOCF	d de Cohen	836,0834082	2,583	,823
	Correction de Hedges	994,4510478	2,172	,692
afterTOTALASSETS	d de Cohen	2683,418764686	10,268	4,124
	Correction de Hedges	3191,701421208	8,633	3,467
afterEARNINGQ	d de Cohen	,2165969314	3,610	1,300
	Correction de Hedges	,2576238725	3,035	1,093
AfterAR	d de Cohen	,0223039148	-,957	-1,914
	Correction de Hedges	,0265286349	-,805	-1,609
afterECG	d de Cohen	700,7300047271	-1,301	-2,390
	Correction de Hedges	833,4595335636	-1,093	-2,009
afterEGR	d de Cohen	68,118253220492	-1,015	-1,992
	Correction de Hedges	81,020945547254	-,853	-1,674

Tailles d'effet pour échantillon unique

		95% Intervalle de confiance[a]
		Supérieur
AfterNETincom	d de Cohen	7,560
	Correction de Hedges	6,356
AfterOCF	d de Cohen	4,309
	Correction de Hedges	3,623
AfterTOTALASSETS	d de Cohen	16,495
	Correction de Hedges	13,868
AfterEARNINGQ	d de Cohen	5,907
	Correction de Hedges	4,966
AfterAR	d de Cohen	,059
	Correction de Hedges	,049
AfterECG	d de Cohen	-,152
	Correction de Hedges	-,127
AfterEGR	d de Cohen	,022
	Correction de Hedges	,018

a. Dénominateur utilisé pour estimer les tailles d'effet.

Le d de Cohen utilise l'écart type échantillon.

La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

APPENDIX N°5 : SIEMENES SPSS output.

Test T

BEFORE

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
NETincome	6	5631,83	1107,217	452,019
OCF	6	7326,17	448,554	183,122
TASSETS	6	110900,83	9763,027	3985,739
EARNINGQ	6	1,33667	,238970	,097559
AR	6	-,015729434000000	,010569371800778	,004314927968944
ECG	6	-1694,33	1141,696	466,095
EGR	6	-22,9688488803	16,08768568193	6,56777017717

Test sur échantillon unique

	Valeur de test = 0				
					Intervalle de confiance de la différence à 95 %
	T	df	Sig. (bilatérale)	Différence moyenne	Inférieur
NETincome	12,459	5	,000	5631,833	4469,88
OCF	40,007	5	,000	7326,167	6855,44
TASSETS	27,824	5	,000	110900,833	100655,16
EARNINGQ	13,701	5	,000	1,336667	1,08588
AR	-3,645	5	,015	-,015729434000000	-,026821309458956
ECG	-3,635	5	,015	-1694,333	-2892,47
EGR	-3,497	5	,017	-22,96884888033	-39,8518395983

Test sur échantillon unique

	Valeur de test = 0
	Intervalle de confiance de la différence à 95 %
	Supérieur
NETincome	6793,79
OCF	7796,90
TASSETS	121146,50
EARNINGQ	1,58745
AR	-,004637558541044
ECG	-496,20
EGR	-6,0858581624

Tailles d'effet pour échantillon unique

		Standardisation[a]	Estimation des points	95% Intervalle de confiance	
				Inférieur	Supérieur
NETincome	d de Cohen	1107,217	5,086	1,949	8,238
	Correction de Hedges	1316,942	4,276	1,639	6,926
OCF	d de Cohen	448,554	16,333	6,620	26,194
	Correction de Hedges	533,518	13,732	5,566	22,022
TASSETS	d de Cohen	9763,027	11,359	4,575	18,238
	Correction de Hedges	11612,301	9,550	3,846	15,334
EARNINGQ	d de Cohen	,238970	5,593	2,167	9,042
	Correction de Hedges	,284235	4,703	1,822	7,602
AR	d de Cohen	,010569371800778	-1,488	-2,660	-,259
	Correction de Hedges	,012571380748235	-1,251	-2,236	-,218
ECG	d de Cohen	1141,696	-1,484	-2,654	-,257

	Correction de Hedges	1357,951	-1,248	-2,231	-,216
EGR	d de Cohen	16,08768568193	-1,428	-2,572	-,225
	Correction de Hedges	19,13495199881	-1,200	-2,163	-,189

a. Dénominateur utilisé pour estimer les tailles d'effet.

Le d de Cohen utilise l'écart type échantillon.

La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

```
NEW FILE.
DATASET NAME Jeu_de_données1 WINDOW=FRONT.

SAVE OUTFILE='C:\Users\Dell\Desktop\ISRAA\SIMENS ADOPTED.sav'
  /COMPRESSED.
T-TEST
  /TESTVAL=0
  /MISSING=ANALYSIS
  /VARIABLES=ADOPNETincome ADOPOCF ADOPTASSETS ADOPEARNINGQ ADOPAR ADOPECG ADOPEGR
  /ES DISPLAY(TRUE)
  /CRITERIA=CI(.95)
```

Test T

ADOPTED

Avertissements

La table de tests d'échantillon unique n'est pas générée.
La table Tailles d'effet pour échantillon unique n'est pas générée.

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
ADOPNETincome	1[a]	6179,00	.	.

ADOPOCF	1[a]	7225,00	.	.
ADOPTASSETS	1[a]	133804,00	.	.
ADOPEARNINGQ	1[a]	1,17000	.	.
ADOPAR	1[a]	-,007817405000000	.	.
ADOPECG	1[a]	-1046,00	.	.
ADOPEGR	1[a]	-14,4775086500	.	.

a. t ne peut pas être calculé, car la somme des pondérations d'observations est inférieure ou égale à 1.

DATASET ACTIVATE Jeu_de_données0.

DATASET CLOSE Jeu_de_données1.

NEW FILE.

DATASET NAME Jeu_de_données2 WINDOW=FRONT.

Test T

AFTER

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
AFTERNETincome	7	6873,86	2377,330	898,546
AFTEROCF	7	10672,57	2606,839	985,293
AFTERTASSETS	7	124128,43	23111,465	8735,313
AFTEREARNINGQ	7	1,63	,378	,143
AFTERAR	7	-,03	,011	,004
AFTERECG	7	-3798,71	1298,585	490,819
AFTEREGR	7	-36,28	12,175	4,602

Test sur échantillon unique

	Valeur de test = 0				
					Intervalle de confiance de la différence à 95 %
	T	df	Sig. (bilatérale)	Différence moyenne	Inférieur
AFTERNETincome	7,650	6	,000	6873,857	4675,19
AFTEROCF	10,832	6	,000	10672,571	8261,65
AFTERTASSETS	14,210	6	,000	124128,429	102753,89
AFTEREARNINGQ	11,412	6	,000	1,631	1,28
AFTERAR	-7,278	6	,000	-,031	-,04
AFTERECG	-7,740	6	,000	-3798,714	-4999,71
AFTEREGR	-7,884	6	,000	-36,278	-47,54

Test sur échantillon unique

	Valeur de test = 0
	Intervalle de confiance de la différence à 95 %
	Supérieur
AFTERNETincome	9072,52
AFTEROCF	13083,50
AFTERTASSETS	145502,97
AFTEREARNINGQ	1,98
AFTERAR	-,02
AFTERECG	-2597,72
AFTEREGR	-25,02

Tailles d'effet pour échantillon unique

		Standardisation[a]	Estimation des points	95% Intervalle de confiance Inférieur
AFTERNETincome	d de Cohen	2377,330	2,891	1,122
	Correction de Hedges	2736,883	2,512	,975
AFTEROCF	d de Cohen	2606,839	4,094	1,720
	Correction de Hedges	3001,104	3,556	1,494
AFTERTASSETS	d de Cohen	23111,465	5,371	2,331
	Correction de Hedges	26606,902	4,665	2,025
AFTEREARNINGQ	d de Cohen	,378	4,313	1,826
	Correction de Hedges	,435	3,747	1,586
AFTERAR	d de Cohen	,011	-2,751	-4,421
	Correction de Hedges	,013	-2,389	-3,840
AFTERECG	d de Cohen	1298,585	-2,925	-4,683
	Correction de Hedges	1494,987	-2,541	-4,068
AFTEREGR	d de Cohen	12,175	-2,980	-4,765
	Correction de Hedges	14,016	-2,588	-4,139

Tailles d'effet pour échantillon unique

		95% Intervalle de confiance[a] Supérieur
AFTERNETincome	d de Cohen	4,632
	Correction de Hedges	4,024
AFTEROCF	d de Cohen	6,458
	Correction de Hedges	5,609
AFTERTASSETS	d de Cohen	8,415

	Correction de Hedges	7,309
AFTEREARNINGQ	d de Cohen	6,793
	Correction de Hedges	5,901
AFTERAR	d de Cohen	-1,050
	Correction de Hedges	-,912
AFTERECG	d de Cohen	-1,140
	Correction de Hedges	-,990
AFTEREGR	d de Cohen	-1,167
	Correction de Hedges	-1,014

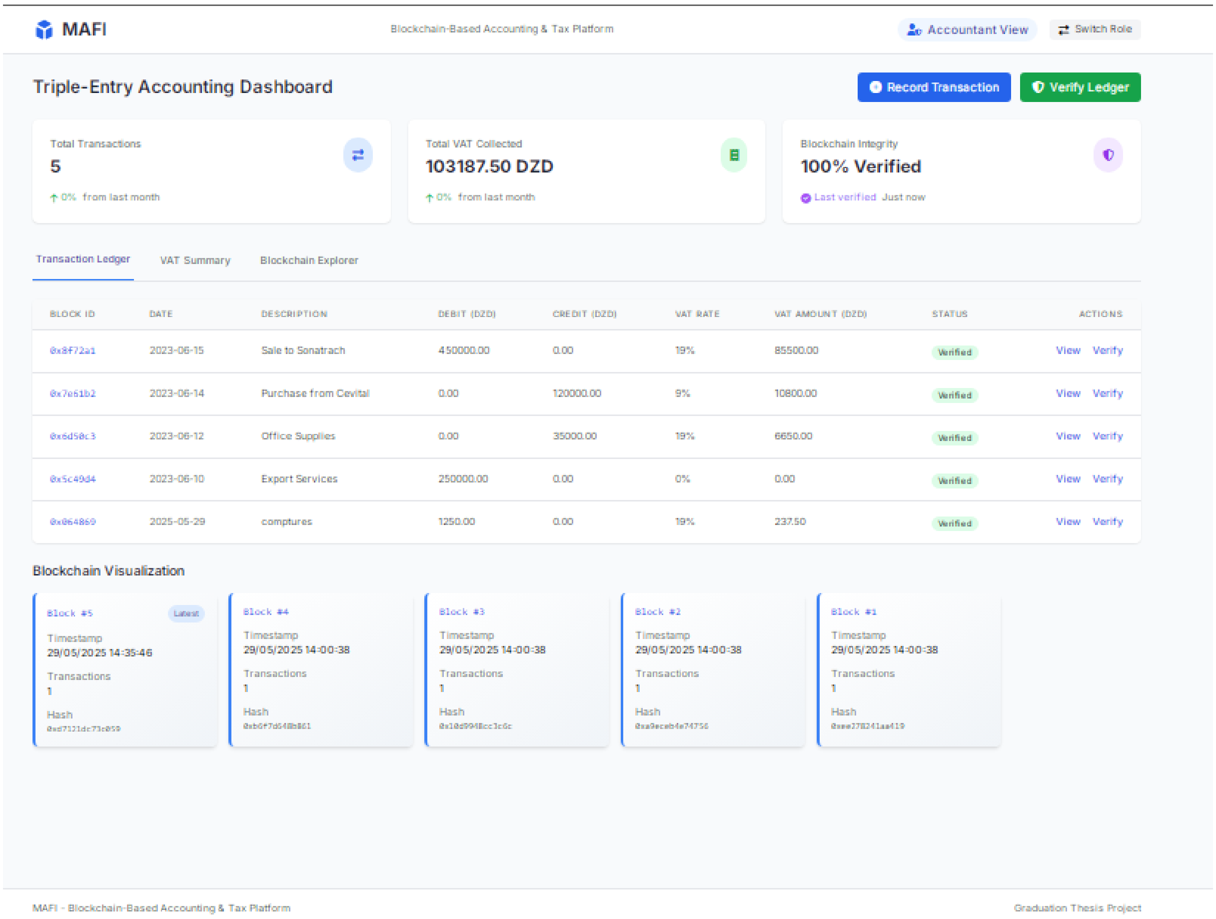
a. Dénominateur utilisé pour estimer les tailles d'effet.

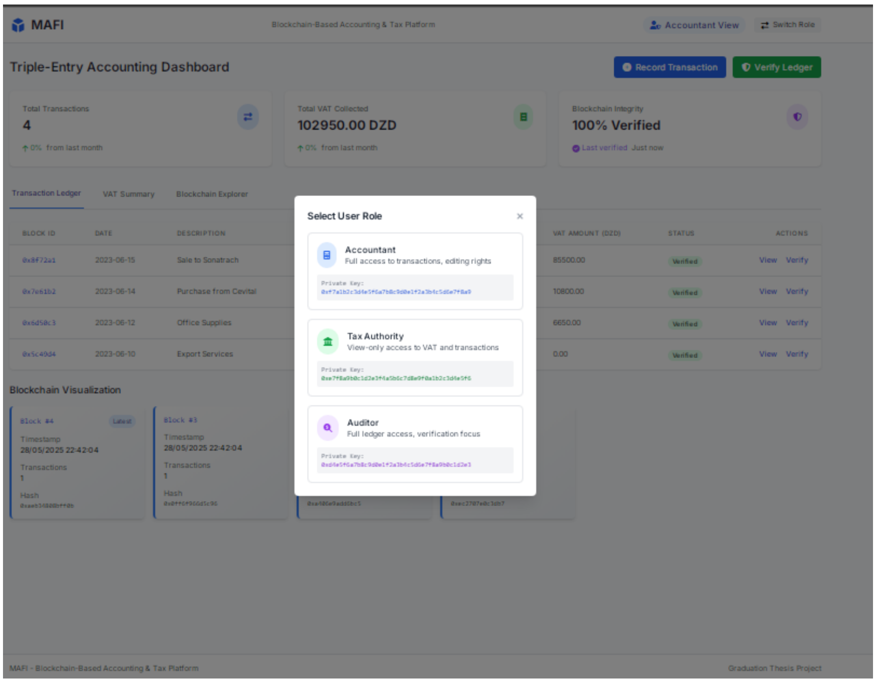
Le d de Cohen utilise l'écart type échantillon.

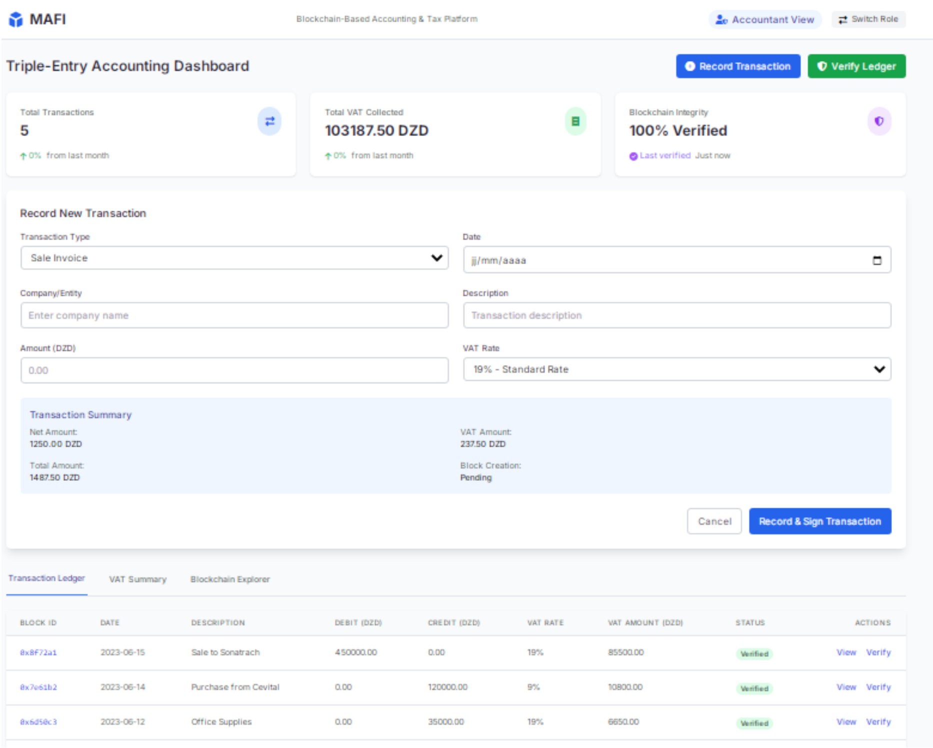
La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

APPENDIX N°6: Proof of concept screenshots

(https://mafibc.netlify.app/)


MAFI
Blockchain-Based Accounting & Tax Platform
Accountant View
Switch Role
Triple-Entry Accounting Dashboard
Record Transaction
Verify Ledger
Total Transactions
5
0% from last month
Total VAT Collected
103187.50 DZD
0% from last month
Blockchain Integrity
100% Verified
Last verified Just now
Transaction Ledger
VAT Summary
Blockchain Explorer
BLOCK ID
DATE
DESCRIPTION
DEBIT (DZD)
CREDIT (DZD)
VAT RATE
VAT AMOUNT (DZD)
STATUS
ACTIONS
2023-06-15
Sale to Sonatrach
450000.00
0.00
19%
85500.00
Verified
View
Verify
2023-06-14
Purchase from Cevital
0.00
120000.00
9%
10800.00
2023-06-12
Office Supplies
0.00
35000.00
19%
6650.00
2023-06-10
Export Services
250000.00
0.00
0%
0.00
2025-05-29
comptures
1250.00
0.00
19%
237.50
Blockchain Visualization
Block #5
Latest
Timestamp
29/05/2025 14:35:46
Transactions
1
Hash
Block #4
29/05/2025 14:00:38
Block #3
Block #2
Block #1
MAFI - Blockchain-Based Accounting & Tax Platform
Graduation Thesis Project


MAFI
Triple-Entry Accounting Dashboard
Record Transaction
Verify Ledger
Total Transactions
4
Total VAT Collected
102950.00 DZD
Blockchain Integrity
100% Verified
Select User Role
Accountant
Full access to transactions, editing rights
Private Key:
Tax Authority
View-only access to VAT and transactions
Auditor
Full ledger access, verification focus
Blockchain Visualization


MAFI
Blockchain-Based Accounting & Tax Platform
Accountant View
Switch Role
Triple-Entry Accounting Dashboard
Record Transaction
Verify Ledger
Total Transactions
5
0% from last month
Total VAT Collected
103187.50 DZD
0% from last month
Blockchain Integrity
100% Verified
Last verified Just now
Record New Transaction
Transaction Type
Sale Invoice
Date
jj/mm/aaaa
Company/Entity
Enter company name
Description
Transaction description
Amount (DZD)
0.00
VAT Rate
19% - Standard Rate
Transaction Summary
Net Amount:
1250.00 DZD
VAT Amount:
237.50 DZD
Total Amount:
1487.50 DZD
Block Creation:
Pending
Cancel
Record & Sign Transaction
Transaction Ledger
VAT Summary
Blockchain Explorer
BLOCK ID
DATE
DESCRIPTION
DEBIT (DZD)
CREDIT (DZD)
VAT RATE
VAT AMOUNT (DZD)
STATUS
ACTIONS
2023-06-15
Sale to Sonatrach
450000.00
0.00
19%
85500.00
Verified
View Verify
2023-06-14
Purchase from Cevital
0.00
120000.00
9%
10800.00
Verified
View Verify
2023-06-12
Office Supplies
0.00
35000.00
19%
6650.00
Verified
View Verify