REPUBLIC OF TÜRKİYE
ALTINBAŞ UNIVERSITY
Institute of Graduate Studies
Electrical and Computer Engineering

SECURE BANKING AND INTERNATIONAL TRADE DIGITIZATION USING BLOCKCHAIN: AN ARCHITECTURE

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Doctor of Philosophy

Supervisor

Prof. Dr. Osman Nuri UÇAN

İstanbul, 2024

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2024

The dissertation titled SECURE BANKING AND INTERNATIONAL TRADE DIGITIZATION USING BLOCKCHAIN: AN ARCHITECTURE prepared by MOHAMMED SABAH HAMEED ALSALIM AND submitted on 11/12/2024 has been **accepted unanimously** for the degree of PhD in Electrical and Computer Engineering.

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Mohammed Sabah Hameed ALSALIM

Signature

DEDICATION

I devote and pledge this research work to my supervisor who is salient for guiding me through whole research work as well as my family for always assisting me in my hard time.

PREFACE

First and foremost, I would like to thank my supervisor Prof. Dr. Osman Nuri UÇAN for guiding and helping me along the way in writing this dissertation. Discussing my progress, problems, and ideas with my supervisor Prof. Dr. Osman Nuri UÇAN a couple of times every week helped me tremendously in understanding the logic behind the research. It made me better realize the technical need for this research work.

ABSTRACT

SECURE BANKING AND INTERNATIONAL TRADE DIGITIZATION USING BLOCKCHAIN: AN ARCHITECTURE

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Date: 12/2024

Pages: 81

This Thesis aims to assess the existing challenges associated with letter of credit and bank transfers concerning the importation of foreign goods. It proposes a solution leveraging blockchain technology, integrating the security features of smart contracts and anti-money laundering measures to address the limitations of conventional banking practices. Through decentralization, the thesis suggests that certain drawbacks can be circumvented, paving the way for an autonomous, rapid, and secure international trade in foreign goods.

The proposed architecture outlined in this paper is designed to enhance the security and efficiency of the international trading system by leveraging blockchain technology. Building upon a prior study that conducted a comparative analysis and feasibility study to identify and validate potential prospects, the research emphasizes the numerous issues inherent in traditional trade processes. These issues include challenges with intermediaries, information latency, and trust, all of which collectively impede the overall efficiency of the trade process.

Recognizing the transformative potential of blockchain technology in revolutionizing business processes across industries and enterprise borders, this study contributes to the development of a high-level architecture design. This design incorporates blockchain and smart-contract-based processes, and the thesis goes beyond theoretical considerations by presenting a practical implementation. The study underscores the need for a shift towards blockchain technology to address the shortcomings of traditional trade practices.

To validate the proposed solution, the implementation involves the creation of smart contracts on the Polygon blockchain. The results of the implementation showcase that secure trading can indeed take place with the integration of blockchain technology. This research not only identifies the theoretical possibilities of blockchain in enhancing international trade but also provides tangible evidence through its practical implementation on a specific blockchain platform.

Keywords: Letter of Credit, Foreign Trade, Blockchain, Smart Contract, Distributed Ledger Technology.

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ABBREVIATIONS

LoC	:	Letter Of Credit
AML	:	Anti-Money Laundering
PoW	:	Proof Of Work
PoS	:	Proof Of Stake
PoA	:	Proof Of Authority
DPoS	:	Delegated Proof of Stake
PoI	:	Proof Of Importance
ATM	:	Automated Teller Machines
TBML	:	Banking Trade-Based Money Laundering
MR	:	Mate's Receipt
BoL	:	Bill Of Lading
TSC	:	Trading Smart Contract
LoCSC	:	Letter of Credit Smart Contracts
LSC	:	Logistics Smart Contracts

1. INTRODUCTION

1.1 BACKGROUND

The Internet has significantly transformed several facets of individuals' daily life for the better during the past few decades [1]. Nevertheless, the exchange of value over the Internet has not been as productive [2]. This is the point where advancements in blockchain technology become extremely crucial. Blockchain is a decentralised network that runs on a peer-to-peer basis. It enables secure and unchangeable storage and transfer of assets. It is primarily a decentralised digital record that enables users to store and trade data among themselves via a network of peers [3]. Every member in the network maintains and verifies their own version of the ledger, which they construct in chronological order by adding authorised transactions to blocks. Due to the decentralised nature of the blockchain and the inclusion of data from previous blocks in each block, tampering with it is highly challenging, if not quite impossible [4]. Decentralisation enhances security and transparency by ensuring that records are kept on several nodes. Blockchain is a secure and unchangeable digital database that efficiently and transparently records transactions [5].

Although first developed for bitcoin, blockchain technology has the potential to revolutionise other industries, including contract and document management, inventory control, billing, and payment processing. In the financial services industry, blockchain is a very effective instrument that may enhance programmable and automated process controls, facilitate instant information exchange, and ensure the integrity of data [6].

Upon seeing the potential of blockchain technology, prominent firms in the financial services sector, notably the Big Four, launched several projects. For instance, Deloitte launched Rubix, an innovative software platform based on blockchain technology that allows customers to develop their own smart contracts and blockchains. Furthermore, Deloitte has successfully conducted a blockchain audit, wherein they assessed a licensed blockchain program using well accepted auditing methods [7]. Libra, the distributed ledger business established by Ernst & Young, operates on blockchain technology and is currently in operation [8]. Microsoft and KPMG want to address challenges associated with the use of blockchain technology in the healthcare, government, and finance sectors by offering digital ledger services [9]. PwC's De Novo platform offers dynamic strategic advice services based on the assessment of more than a thousand blockchain companies and new market participants. Each of these initiatives showcases the transformative impact of blockchain technology on the banking and finance sector. The significance of blockchain technology has increased in contemporary times as a result of technological advancements and the active participation of large corporations [10].

1.2 MOTIVATION

Technological improvements and changing regulatory environments are leading to swift and significant changes in the financial industry, despite its reputation for being slow-moving and closely controlled [11]. PwC predicts that the banking sector will see significant disruption in the coming decade due to rapid technological advancements and regulatory changes. In order to maintain pace with global trends, banks must demonstrate their ability to swiftly adapt to emerging technologies that are reshaping the way businesses function [12]. Certain occupations within the financial industry, such as brokers, might become obsolete due to the transformative capabilities of blockchain technology. However, it is well recognised that this technological transition has the capacity to provide new job prospects [13]. Contrary to the widespread worry that blockchain technology would make banks obsolete, this thesis contends that financial institutions have more to gain than to lose from the technology.

In order to facilitate the implementation of various blockchain applications, it is imperative for the financial industry to collaborate and establish uniform standards. Developing uniform standards for implementing this technology in the highly competitive financial industry would be a significant challenge [15]. Asserts that, notwithstanding obstacles, blockchain technology has the potential to transform the financial industry [16].

The thesis asserts that the effects of blockchain technology will reach well beyond the bitcoin ecosystem. The financial industry is now in the nascent stages of blockchain technology's development, which hinders the ability to accurately forecast its exact capabilities and timeline for widespread adoption. However, blockchain technology holds great potential for causing significant changes to the existing financial system. By eliminating superfluous and expensive intermediaries in financial processes, such as foreign currency transfers and securities trading, financial organisations can potentially decrease costs and enhance efficiency. Furthermore, the utilisation of blockchain-based operations not only decreases risk but also minimises the amount of capital required [17]. The openness and dependability of blockchain technology have increased people's confidence in the banking industry [18]. It is important to note that while certain services may be more appropriate for blockchains, not all valuable information is suitable for them. However, the thesis suggests that banks and other financial organisations should prioritise automating securities trading and foreign payments using blockchain technology due to its established history of success in these domains [19].

1.3 PROBLEM STATEMENT

The current mechanisms governing letter of credit (LoC) and bank transfer processes in foreign trade face significant challenges that impede the smooth and efficient flow of international transactions. Trust issues, concerns about document integrity, and the inherent inefficiencies resulting from the involvement of numerous intermediaries contribute to a range of problems. These issues manifest as high operational costs, suboptimal user experiences, and regulatory hurdles that hinder the fluidity of global trade.

a. Trust Issues: The traditional LoC and bank transfer processes are plagued by trust-related challenges among the involved parties—sellers, buyers, and banks. Instances of fraudulent transactions, exploitation through fake documents, and the misuse of foreign currency pose substantial threats to the integrity of international trade transactions. Establishing and maintaining trust in the current system is a persistent challenge.

b. Document Integrity Concerns: The reliance on physical and digital documents within the current framework introduces vulnerabilities. Instances of fake documents, discrepancies in verification, and manipulation of essential transactional records can compromise the authenticity and reliability of international trade documentation. These challenges contribute to delays, disputes, and increased costs in the trade process.

c. Inefficiencies and Multiple Intermediaries: The involvement of numerous intermediaries, including banks, in the LoC and bank transfer processes leads to operational inefficiencies. Delays in processing, complex workflows, and a lack of transparency result in poor user experiences for businesses engaged in international trade. Additionally, the multiplicity of intermediaries increases the overall cost of transactions and hampers the competitiveness of businesses.

d. High Costs and Regulatory Hurdles: The traditional foreign trade processes, particularly in LoC and bank transfers, entail substantial costs for both buyers and sellers. These costs stem from the need for extensive documentation, verification processes, and the intermediaries' fees. Moreover, compliance with stringent regulations, such as anti-money laundering (AML) requirements, poses additional challenges and contributes to the overall complexity of international transactions.

1.4 PROPOSED SOLUTION

The paper proposes a solution that leverages blockchain technology, smart contracts, and anti-money laundering measures to address the identified challenges comprehensively. Blockchain, with its decentralized and immutable ledger, provides a secure platform to enhance transparency, eliminate the risk of fraud, and streamline the foreign trade process. Smart contracts automate and enforce contractual agreements, reducing the need for intermediaries, while AML measures enhance the security of transactions.

Objectives of the Proposed Solution:

a. Security Enhancement: Implement blockchain technology to establish a secure and tamper-proof environment for international trade transactions, mitigating trust issues and ensuring the integrity of documents.

b. Operational Efficiency: Utilize smart contracts to automate and streamline the LoC and bank transfer processes, reducing the involvement of multiple intermediaries and minimizing delays in transaction processing.

c. Cost Reduction: Eliminate unnecessary intermediaries and streamline processes to reduce operational costs associated with foreign trade, enhancing the competitiveness of businesses.

d. User Experience Improvement: Enhance the overall user experience for businesses engaged in international trade by simplifying workflows, reducing paperwork, and providing real-time transparency into transaction statuses.

e. Regulatory Compliance: Integrate anti-money laundering measures into the blockchain solution to ensure compliance with international regulations, fostering a secure and regulated environment for global transactions.

1.5 RESEARCH CONTRIBUTION

This research makes a significant contribution to the field by addressing and proposing solutions to the critical challenges inherent in the existing letter of credit (LoC) and bank transfer processes in foreign trade. The study not only identifies the multifaceted issues that impede the efficiency of international transactions but also proposes a comprehensive blockchain-based solution leveraging smart contracts and anti-money laundering measures. The key contributions of this research are outlined below:

1.5.1 Identification and Analysis of Challenges

a. The research thoroughly examines the trust issues prevailing in the traditional LoC and bank transfer processes. By delving into instances of fraudulent transactions and exploitation through fake documents, the study provides a comprehensive understanding of the trust-related challenges faced by various stakeholders in international trade.

b. Through an in-depth analysis, the research highlights the vulnerabilities associated with document integrity in the current framework. Instances of fake documents, discrepancies, and manipulation of transactional records are meticulously examined, shedding light on the issues compromising the reliability of international trade documentation.

c. The research articulates the operational inefficiencies resulting from the involvement of numerous intermediaries, particularly banks. Detailed insights into delays, complex workflows, and transparency issues underscore the impact of multiple intermediaries on user experiences and transaction costs.

d. A thorough examination of the high costs associated with traditional foreign trade processes and the challenges posed by regulatory requirements, such as anti-money laundering, contributes to a comprehensive understanding of the financial and regulatory complexities in international transactions.

1.5.2 Proposal of Blockchain-Based Solution

a. The research proposes the adoption of blockchain technology to establish a secure and tamper-proof environment for international trade transactions. The decentralized and immutable nature of blockchain addresses trust issues and ensures the integrity of documents, offering a robust solution to the identified challenges.

b. Leveraging smart contracts, the research advocates for the automation and streamlining of LoC and bank transfer processes. By reducing the involvement of multiple intermediaries and minimizing transaction processing delays, the proposed solution aims to enhance operational efficiency in foreign trade.

c. The research proposes the elimination of unnecessary intermediaries and the streamlining of processes to reduce operational costs associated with foreign trade. This contribution aligns with the broader goal of enhancing the competitiveness of businesses engaged in international transactions.

d. The implementation of smart contracts and blockchain technology is expected to improve the overall user experience for businesses engaged in international trade. Simplified workflows, reduced paperwork, and real-time transparency into transaction statuses contribute to a more user-friendly and efficient process.

e. The research emphasizes the integration of anti-money laundering measures into the proposed blockchain solution. This ensures compliance with international regulations, fostering a secure and regulated environment for global transactions and addressing the regulatory hurdles identified in the research.

1.5.3 Practical Implementation on the Polygon Blockchain

a. The research goes beyond theoretical proposals by demonstrating the feasibility and effectiveness of the blockchain-based solution through a practical implementation on the Polygon blockchain. Polygon's Layer 2 scaling solution for Ethereum provides the necessary infrastructure for secure, scalable, and cost-effective blockchain transactions.

b. The practical implementation serves as a real-world validation of the proposed solution, showcasing its applicability and effectiveness in addressing the challenges faced by the current LoC and bank transfer processes in foreign trade.

In summary, this research makes a substantial contribution to the field by not only identifying the critical challenges in international trade but also proposing and practically demonstrating a blockchain-based solution that leverages smart contracts and anti-money laundering measures. The insights provided and the proposed solution have implications for enhancing the security, efficiency, and transparency of global transactions, thereby contributing to the advancement of international trade practices.

1.6 THESIS OUTLINE

In the subsequent chapters, we provide a comprehensive account of the methodologies we utilised to successfully carry out our study. Chapter 2 explores the subject of blockchain technology in greater depth. Chapter 3 comprises comprehensive literature evaluations that are essential for formulating our research approach and solution. Chapter 4 provides a detailed explanation of the study's methodology and explores the rationale for choosing blockchain technology and financial services. The secondary sources we have gathered are analysed in Chapter 4. The subsequent chapter illustrates the executed architecture and its functioning. Chapter 6 involves the analysis of the facts, engaging in debates, and presenting new topics. Chapter 7 provides a concise summary of the study's main discoveries and proposes ideas for future investigation. This methodical methodology enhances the scholarly discourse on safe banking and blockchain commerce and guarantees a comprehensive analysis of the selected study field.

2. BLOCKCHCAIN TECHNOLOGY

2.1 BLOCKCHAIN

Blockchain technology is cutting-edge because it generates an unchangeable record of all network transactions in a well-organised, decentralised ledger. Blockchain provides a more efficient, cost-effective, and secure way to record transactions compared to old centralised techniques [20]. Bitcoin is a well-known instance of a decentralised, peer-to-peer digital money that operates on a blockchain. The fundamental concept underlying blockchain technology is to establish a decentralised ledger of all transactions by documenting them in linked blocks. Every block in the chain encompasses the whole record of transactions and is immutable once appended. This method guarantees the security and transparency of the network. The decentralisation of blockchain technology obviates the necessity for a central authority or intermediaries by granting access to records to all parties involved. The decentralised nature of this system enables direct contact amongst peers, resulting in decreased operating expenses and increased efficiency [21]. An essential characteristic of blockchain technology is its inherent immutability. Once a transaction has been recorded, it is immutable and cannot be modified. Each time an update is required, a fresh transaction is generated and transmitted via the network. Transactions are immutable and offer a robust degree of security and confidence since they undergo verification by several computers inside the network. Blockchain technology has several potential uses beyond the realm of bitcoin transactions. The immutability and decentralisation of this technology make it highly valuable in several situations, enhancing efficiency, security, and transparency [22]. Figure 2.1 illustrates how blockchain technology resolves the limitations of conventional centralised systems, enabling the development of novel and reliable procedures for record-keeping and transaction administration.

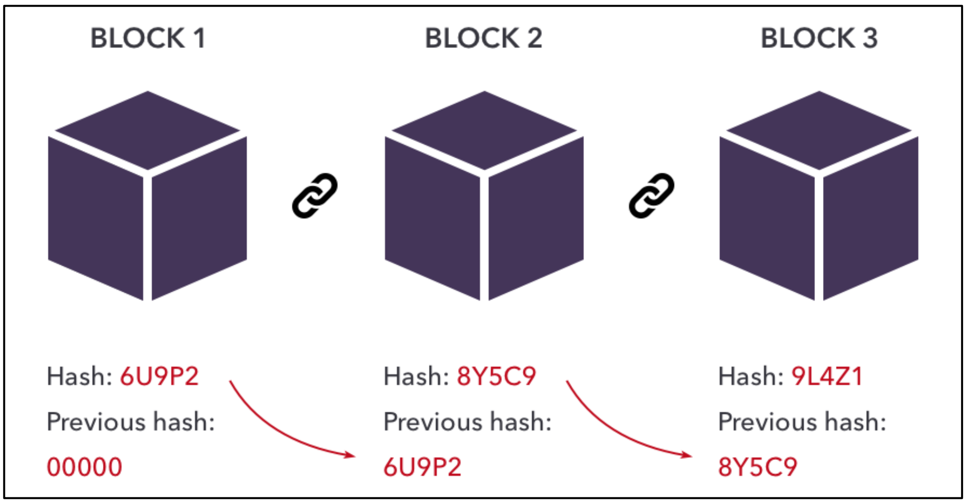

Figure 2.1: Block Structure [22].

2.2 WORKING MECHANISM

Blockchain technology is based on the abstract idea of establishing a network of interconnected blocks. The key elements of each block in this chain consist of a hashed digital signature, the hash of the previous block, and a ledger that accurately documents every legitimate transaction [23]. Every block in the chain symbolises a transaction. The chaining technique in blockchain architecture ensures immutability and high security by painstakingly linking each block to every preceding block [24]. Acquire knowledge about the regulations, the collective decision-making procedure, the interconnected network of nodes, the digital units of value, and the underlying architecture of blockchain in order to gain a comprehensive understanding of its functioning. The blockchain's node network, comprising all users or computer systems, is closely interconnected to jointly examine and verify the legitimacy of transactions. Increasing the number of linked nodes improves both network strength and security architecture. Digital currencies, often known as cryptocurrencies, are tokens that serve as representations of value and may be used to exchange for various products and services. The blockchain's structural composition is comprised of a well-organised collection of transactions, with each individual block playing a crucial role in the broader framework of the network [25]. Subsequently, every node in the network engages in a collective decision-making process called consensus to determine the accuracy of the ledger version. Nodes are essential in this process and are required to prevent problems like recurring payments and transaction manipulation [25].

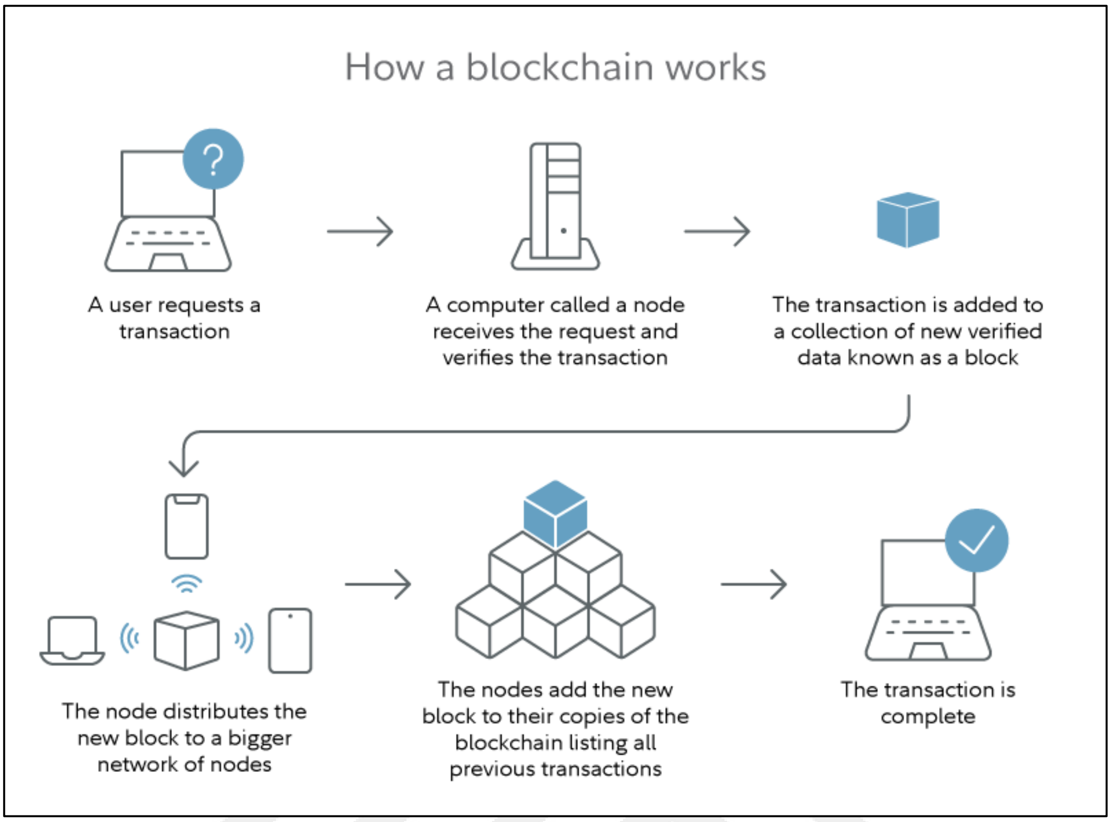

Figure 2.2: Working of Blockchain [25].

Two primary consensus mechanisms, namely proof-of-work and proof-of-stake, delineate the operational dynamics. The proof-of-work mechanism mandates nodes to resolve intricate problems to append new blocks, endowing it with a high degree of tamper resistance, as any malevolent endeavor necessitates overpowering the entire network [26]. This mechanism is prominently employed in the context of Bitcoin. Conversely, proof-of-stake operates on the premise of token ownership, where networks with elevated token holdings possess the capability to generate additional blocks [26]. Finally, the concept of rules in the realm of blockchain pertains to a set of protocols governing communication between parties, meticulously defining the attributes of ledger systems. The interplay of these interconnected concepts collectively configures the operational framework of a blockchain [26].

2.3 TYPES OF BLOCKCHAIN

It is imperative for businesses to possess a nuanced understanding of the various types of blockchain technologies before embarking on their implementation. The distinctions among these types are substantive, and businesses should carefully select the system that aligns most effectively with their unique business models [27]. Three principal categories of blockchain, each serving distinct purposes, are elucidated below.

Firstly, a public blockchain is characterized by its complete decentralization, enabling universal access for anyone possessing minimal resources. The primary objective of public blockchains is to eliminate intermediaries and facilitate peer-to-peer transactions. Examples include Bitcoin, Ethereum, and various cryptocurrencies, which are openly accessible to all participants. Transactions on public blockchains undergo verification by the network before recording, ensuring a high level of security. Although public blockchains are relatively expensive and slower compared to their private counterparts, they still outperform prevailing systems employed for record-keeping [28].

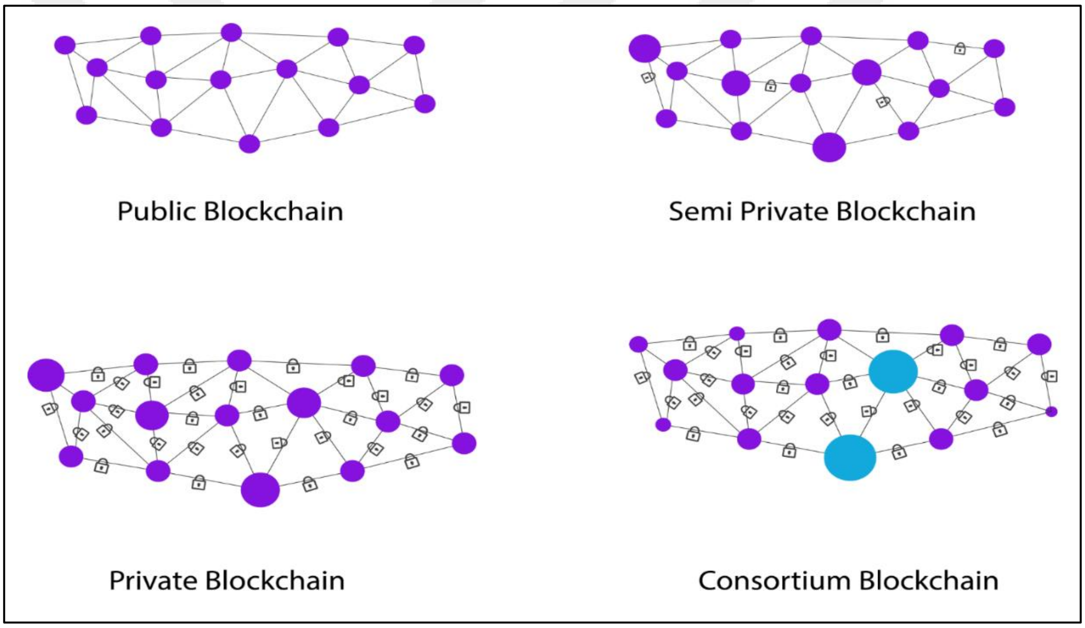

Figure 2.3: Types of Blockchain [28].

On the other hand, a private blockchain operates on a permissioned basis, requiring participants to obtain permission from a central authority to engage in specific tasks. Unlike fully decentralized systems, private blockchains are controlled by intermediaries, and each transaction undergoes verification by a designated authority before being recorded. Private blockchains are known for their speed and cost-effectiveness, making them particularly well-suited for corporate businesses and governance models. Noteworthy applications include online voting systems. A subset of private blockchains is the consortium blockchain, which shares the characteristics of private blockchains but is collectively owned by a group of entities [29].

The hybrid blockchain, as the name implies, amalgamates features of both private and public blockchains. This type provides a decentralized environment within a private network, affording businesses exceptional flexibility and control over their data. Hybrid blockchains find relevance in highly regulated industries, with XinFin serving as an exemplar. XinFin is a hybrid blockchain that combines the public Ethereum blockchain with the private Quorum blockchain. This amalgamation addresses global trade, finance, and supply chain challenges, showcasing the versatility of hybrid blockchain solutions [30]. In essence, a thorough comprehension of these blockchain variants is essential for businesses to make informed decisions in selecting the most suitable technology for their specific operational needs.

2.4 BITCOIN: THE FIRST BLOCKCHAIN

Bitcoin, a revolutionary peer-to-peer digital currency, facilitates online transactions between parties without the need for intermediaries. It emerged as a response to the perceived shortcomings of traditional fiat currencies and centralized banking systems. The underlying technology that enables the secure recording of Bitcoin transactions is the blockchain [31]. This innovative financial protocol was introduced in 2008 through a white paper authored by the pseudonymous figure Satoshi Nakamoto, titled "Bitcoin: A Peer-to-Peer Electronic Cash System.

"Functioning as the inaugural and most widely recognized cryptocurrency, Bitcoin has significantly impacted the financial landscape. With a current market capitalization of $177.81 billion as of 2020 [32], Bitcoin has garnered substantial attention for its decentralized nature and potential to revolutionize traditional payment systems. Blockchain technology serves as the backbone of Bitcoin, acting akin to an operating system with Bitcoin representing just one of its numerous applications [33]. This distributed ledger system provided by blockchain ensures the transparent and secure recording of Bitcoin transactions, overcoming the limitations of conventional financial infrastructure. Moreover, it is crucial to recognize that blockchain extends beyond Bitcoin, finding diverse applications in various industries due to its inherent characteristics of decentralization and immutability [33].

The advent of Bitcoin, coupled with blockchain technology, has opened avenues for exploring alternative financial systems and has ignited discussions about the potential transformative impact on traditional financial paradigms. The ongoing evolution of Bitcoin and blockchain technology underscores the need for a comprehensive understanding of these innovations and their broader implications for the future of finance and transactions [33].

2.4.1 The Rise and Fall of Bitcoin

Bitcoin, introduced as the first cryptocurrency in 2009, aimed to address the inefficiencies, high costs, and vulnerabilities inherent in traditional cash and banking systems. Leveraging blockchain technology, Bitcoin revolutionized the recording of transactions, offering a decentralized and secure alternative [34].

The initial two years of Bitcoin's existence saw its value virtually negligible. A pivotal shift occurred in July 2010 when the value surged from approximately $0.0008 to $0.08 per bitcoin. Over the subsequent years, Bitcoin slowly gained traction among retailers and users. However, it wasn't until 2013 that a substantial surge in price occurred. During this period, Bitcoin's value rose from $13.5 to a record high of $220 in April, experiencing a subsequent dip to $70 in the same month. The remarkable surge in price during October-November, soaring from around $100 to $1,075, marked a 975% increase. This surge was attributed to the increasing popularity of Bitcoin and the entry of Chinese miners into the market [35].

Bitcoin's history is characterized by dramatic price fluctuations. In February 2014, the largest Bitcoin exchange, Mt. Gox, filed for bankruptcy, causing a significant crash in the price to below $580. This event triggered a gradual decline, with the price falling to approximately $315 in early 2015. Subsequent years saw a gradual rise, stabilizing at around $1,000 in early 2017. However, the most significant price movements transpired in 2017, with Bitcoin reaching $5,000 in October, $10,000 in November, and a peak of $19,783 in December, reflecting an astonishing 1800% increase within a year. This bull run was followed by a market crash, with prices dropping below $7,000 and continuing until November 2018 when they fell to around $3,500. Since then, Bitcoin's price has exhibited fluctuation within the range of $5,000 to $10,000 [36]. This historical trajectory underscores the dynamic nature of Bitcoin's value, influenced by market forces, technological developments, and regulatory considerations.

2.4.2 Why is Bitcoin Highly Volatile?

The pricing dynamics of Bitcoin have exhibited pronounced volatility, particularly during the period from October 2017 to January 2018, where the volatility index reached approximately 8%. This index denotes the degree to which the price of Bitcoin could deviate, either upwards or downwards, by 8% from the average price during that timeframe. Numerous factors contribute to the fluctuating nature of Bitcoin's value in the market. A key driver is the inherent uncertainty surrounding the future valuation of Bitcoin. Given that Bitcoin essentially represents a transfer of value and the future trajectory of its worth remains uncertain, even minor news or developments can prompt significant price fluctuations. This unpredictability is further accentuated by the unregulated nature of the Bitcoin market. Lacking governance from a singular authority, Bitcoin has often been associated with illicit activities, fostering an environment of speculation and apprehension among adopters. Consequently, investors play a pivotal role in steering and influencing the market dynamics [37].

Another influential factor is the limited supply of bitcoins. In contrast to fiat currencies, Bitcoin adheres to a fixed supply cap of 21 million units. This scarcity-driven feature attracts investor interest during economic expansions or contractions, leading to heightened investment in Bitcoin. This aspect has drawn comparisons between Bitcoin and traditional commodities like gold. Moreover, concerns about security, theft, and digital vulnerabilities contribute to the market's uncertainty. The notorious example of Mt. Gox, once the largest Bitcoin exchange, serves as a testament to the anxieties surrounding the cryptocurrency market. The collapse of Mt. Gox underscored the susceptibility of the market to unforeseen events and further fueled apprehensions among users [38]. In summation, the interplay of these factors, encompassing uncertainty, market regulation, scarcity, and security concerns, collectively shapes the dynamic and often volatile nature of Bitcoin's pricing.

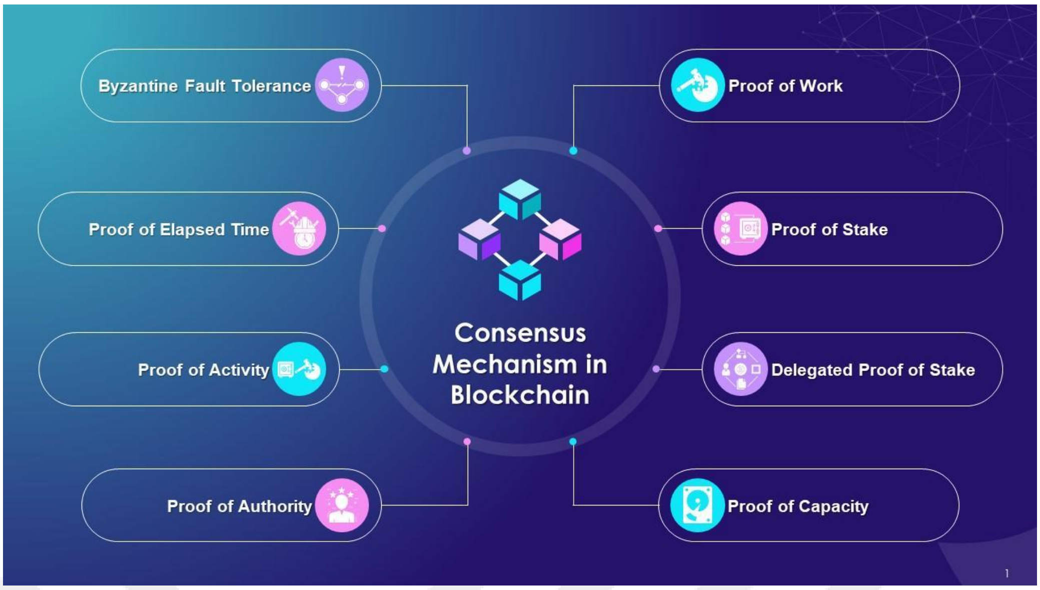

Figure 2.4: Consensus Mechanism [38].

2.5 CONSENSUS MECHANISM

A consensus mechanism in blockchain is a protocol that enables all nodes in a distributed network to agree on the state of the ledger [39]. It is crucial for maintaining the integrity and security of the network. The two most common types of consensus mechanisms are Proof of Work (PoW) and Proof of Stake (PoS), each with its own variations and alternatives.

a. Proof of Work (PoW): PoW is a decentralized consensus mechanism that requires network participants to prove that they have expended computational power to achieve consensus and prevent bad actors from overtaking the network [40]. It is used by cryptocurrencies like Bitcoin and requires miners to solve complex mathematical puzzles to validate transactions and create new blocks [40].

b. Proof of Stake (PoS): PoS is a consensus mechanism where validators are chosen based on the number of coins they hold and are willing to "stake" as collateral. It is seen as an energy-efficient alternative to PoW and is used by cryptocurrencies like Ethereum 2.0 [41].

c. Proof of Authority (PoA): Participants are chosen based on their reputation and identity [42].

d. Delegated Proof of Stake (DPoS): Token holders vote for delegates to validate transactions and create new blocks [43].

e. Proof of Importance (PoI): Considers factors such as account balance and transaction activity to determine who can create new blocks [44]. Each consensus mechanism has its own advantages and disadvantages, such as security, scalability, and energy efficiency, making it essential to choose the right one for a specific blockchain application [44].

Consensus mechanisms are fundamental to the operation of blockchain networks, and the choice of mechanism can have significant implications for security, decentralization, and energy consumption.

2.6 DO BANKS NEED BLOCKCHAIN TECHNOLOGY?

The banking industry, constituting a substantial portion of the global economy, has historically represented a cornerstone of financial intermediation. The advent of digitalization has wrought transformative changes within this sector, fundamentally altering traditional banking systems. From the elimination of the barter system to the evolution from commodity money to fiat money, the banking industry has experienced a profound shift, now marked by the prevalence of digital currency and digital payment mechanisms. Technological progress has facilitated the introduction of Automated Teller Machines (ATMs), electronic fund transfers, electronic clearing services, real-time gross settlements, online banking, debit-credit cards, and mobile banking, providing customers with an array of technologically advanced services [45].

In the current landscape, technology-driven innovations have begun to redefine the banking sector, and blockchain technology stands out as a potential game-changer. Blockchain, with its capability to record transactions in an immutable block, eliminates the need for intermediaries, promising transformative effects on the banking and finance sectors. This technology has the potential to disrupt traditional banking practices, offering a paradigm shift in the industry [46].

Over the last two decades, rapid technological advancements have permeated various industries, challenging even the well-established banking sector. Fintech, a portmanteau of

Finance and Technology, has emerged as a significant disruptor, leveraging cutting-edge technologies to provide financial services. Fintech companies specialize in areas such as payments, clearing and settlements, trading and investment, digital currencies, and other financial services. Their focus on niche services allows Fintech firms to provide innovative solutions that often outperform traditional banks in terms of speed, cost-effectiveness, reliability, and transparency. The competitive landscape has intensified, with Fintech companies gaining substantial market share, particularly in payment services where they offer faster, cheaper, and more efficient solutions compared to traditional banks [47].

Blockchain, alongside other emerging technologies like artificial intelligence, robotic process automation, and big data, is widely considered a futuristic cornerstone. Big banks, including J.P. Morgan, Bank of America, Merrill Lynch, and HSBC, have recognized the potential of blockchain technology, with several already executing transactions using blockchain and actively exploring its integration into their business models. The decentralized and immutable ledger features of blockchain hold the promise of revolutionizing record-keeping systems, not only within the banking industry but across various sectors. This technology has the potential to transform the backend operations of the banking system, leading to significant reductions in operational costs. Blockchain's advantages, including enhanced efficiency, cost reduction, transparency, and the elimination of third-party intermediaries, position it as a critical solution for current challenges faced by banks [48]. Efficiency gains are realized through the elimination of decision-making delays, allowing for automated and expedited record-keeping and management processes. Transaction and operational costs are mitigated by bypassing the need for third-party involvement and hefty broker fees. Blockchain's cryptographic foundations instill trust in third-party interactions. Furthermore, the distributed nature of blockchain ensures real-time transaction information for all parties involved, fostering transparency and accountability [49]. As the financial landscape continues to evolve, the integration of blockchain technology into the banking sector holds the potential to redefine operational paradigms and address existing challenges, offering a glimpse into the future of financial services.

3. RELATED WORK

3.1 LITERATURE REVIEW

Safe banking and global trade face several obstacles, including language hurdles, cultural differences, the management of international teams, currency translation, and inflation rates [50]. International trading entails additional risks and intricacies such as supply chain management, customs procedures, taxation, and legal regulations [50]. Letters of credit are frequently employed in global commerce to reduce these risks and guarantee seamless operations. In order to ensure accurate translation of communication and product messages into other languages, it may be necessary to hire translators and native speakers [51].Having knowledge and the ability to adapt to cultural variations is crucial for the prosperity of any global enterprise [52].Managing and leading teams that are geographically dispersed across many nations and time zones can provide significant challenges. The value of overseas transactions can be influenced by inflation and currency changes. Managing order tracking, assigning accountability for products in transit, and adhering to stipulated delivery schedules can pose greater difficulties in cross-border trade due to the intricate nature of supply networks. Therefore, it is crucial for multinational firms to closely observe religious, political, and legal developments in the countries where they operate [53]. Managing the multitude of compliance requirements and regulatory frameworks that exist in various locations is a significant obstacle for international trade. Increasing geopolitical tensions have the potential to affect trade discussions and agreements, as well as disrupt crucial energy and commodities supply networks [54].Letters of credit can mitigate these issues by offering assurance and fostering confidence among the parties engaged in commercial transactions. The seller's probability of late or nonpayment is diminished as a consequence of their endeavours [55]. Letters of credit include several parties and legal documents, which may make them intricate and need meticulous handling. When engaging in international commerce, a letter of credit provides several advantages to all parties participating. Letters of credit facilitate the establishment of new commercial partnerships between trade enterprises and overseas clients by providing a guarantee of payment. Letters of credit are versatile in accommodating the specific needs of all parties involved, making them suitable for many international trade scenarios [56]. Utilising international letters of credit services may guarantee exporters of timely payment [57]. Exporters can secure pre-shipment financing by utilising a letter of credit, which enables them to deliver their goods to customers earlier than planned while still receiving full payment. Letters of credit minimise the risks associated with foreign commercial transactions by providing assurance of payment to the seller and ensuring the agreed-upon delivery of products [58]. In addition to managing the shipping operations, they also transfer the responsibility for any loss or damage to the vendor rather than the buyer [59]. Both buyers and sellers can get advantages from utilising letters of credit as they ensure secure and hassle-free transactions [60]. Importers may enhance their credit rating and improve their chances of obtaining loans and credit in the future by utilising a letter of credit. Letters of credit facilitate international trade by providing a secure means of payment and enhancing confidence between buyers and sellers [61].Letters of credit are essential for international trade due to their ability to minimise risks, simplify procedures, and foster confidence between buyers and sellers [62]. Letters of credit (LCs) have distinct differences from normal payment methods when it comes to international business. When an exporter fulfils all the conditions specified in a Letter of Credit (LC), the importer's bank guarantees to make payment to the exporter upon delivery of the products. This is in contrast to open account transactions, where the exporter depends on the importer's commitment to pay at a later date [63]. Both the importer and the exporter derive advantages from letters of credit in international commerce transactions as they reduce the probability of non-payment or non-delivery and offer security [64]. Unlike other payment methods like open account transactions, they provide the buyer with greater control over shipping arrangements and transfer the risk from the buyer to the seller [64]. Letters of credit are versatile and may be customised to meet the specific requirements of all parties involved in various international business situations [64]. By guaranteeing prompt payment to exporters and ensuring that importers receive the commodities as stipulated, they can function as an effective financial instrument [65].Letters of credit are chosen in many international commercial transactions because they offer a high level of control, security, and risk avoidance. There are some hazards linked to the use of LCs in the realm of international commerce. For instance, exporters may not get payment if the letter of credit's conditions are not fulfilled or if the necessary documentation is not properly arranged [66]. Purchasers face the risk of getting merchandise in substandard condition or of inferior quality as the bank is obligated to remit payment to the exporter only based on the shipping documents, rather than the actual items [67]. The issuance of an LC can expose parties to fraud or forgery, as the complexity of governing rules and the reliance on shipping documents can create opportunities for fraudulent activities [68]. LCs carry foreign currency fluctuation risks, as the value of the currency in which the LC is denominated may change between the time of issuing the LC and the time of payment [69]. Banks involved in LC transactions also bear risks, including the risk of non-compliance with the LC conditions, counterfeit LCs, and the issuing bank's failure or country risk [69]. Importers should verify the authenticity of the LC with the issuing bank and ensure that it meets the agreed-upon terms and conditions [70]. Importers should ensure that all documents required by the LC follow the terms and conditions of the LC. Importers should use reputable banks with a proven track record in LC transactions to minimize the risk of fraud [71]. Importers should insure the shipment to protect against loss or damage during transit. Importers should conduct due diligence on the exporter to ensure that they are reputable and reliable. Importers can use a confirmed LC, where a second bank confirms the LC, providing an additional layer of security [72]. Importers should seek legal advice to ensure that the LC is legally binding and enforceable in the event of a dispute [73]. Some common types of fraud or forgery that can occur when using a letter of credit (LC) in international trade include; when the exporter presents fraudulent or forged documents to the bank to receive payment. When the exporter ships goods that do not meet the agreed-upon quality or quantity, or when the goods are not shipped at all [74]. When the exporter or importer misrepresents their identity, or the identity of the goods being traded. When the bank involved in the LC transaction engages in fraudulent activities, such as issuing a fraudulent LC or accepting fraudulent documents. When the exporter requests an advance fee from the importer before shipping the goods, but then fails to deliver the goods or delivers goods of inferior quality [75].

Existing research has identified several methods to tackle money laundering and fraud in international trading and banking. Trade-Based Money Laundering (TBML) involves international trade and is used to conceal the proceeds of illegal activities. Strategies to combat TBML include identifying and verifying the parties involved in the transaction, monitoring the shipment of goods, and conducting due diligence on the exporter [76].

Know Your Customer (KYC) is an essential element of anti-money laundering (AML) initiatives, mandating that financial institutions authenticate the validity and identity of their clients. Comprehensive client due diligence procedures are crucial for banks to avoid unintentionally participating in terrorist financing or money laundering [77]. Banks should adopt risk-based anti-money laundering (AML) procedures to mitigate the risks associated with money laundering and terrorist funding. It is important for banks, law enforcement, and other financial institutions to maintain regular communication in order to exchange information about suspicious activity and stay updated about each other [78]. Banks can utilise data analytics to detect trends and patterns that may suggest money laundering and subsequently respond accordingly. Technological advancements can potentially boost the number of accounts, improve reporting, and aid banks in more accurately identifying risks while minimising false positives. In order to combat money laundering effectively, banks should collaborate with international organisations and comply with global standards, such as those established by the Financial Action Task Force (FATF)[79]. This would ensure a consistent and coordinated effort in addressing this issue. The study paper suggests the implementation of a "Digital Bill (DB)" as a digital form of a bill of exchange to tackle issues of illegal activities, money laundering, and the slow acceptance of cryptocurrencies. The decentralised character, resilience to inflation, and powerful cyber security measures of the DB network provide enhanced protection against manipulation and hacking of decentralised exchanges (DEX). Additionally, it provides trust assurances, deposit protection, and real-time currency value fluctuations. The DB network aims to establish a more reliable cryptocurrency, with the goal of enhancing public confidence in the market, alleviating concerns about investment losses, and encouraging broader adoption of blockchain technology. The research [80] emphasises the positive worldwide effects, including enhanced public confidence in cryptocurrencies, less investor apprehension over financial losses, and wider implementation of blockchain technology. This essay not only addresses the issue of money laundering in impoverished countries, but also highlights the deficiencies of anti-money laundering efforts and advocates for more transparent and comprehensive laws. The research examines many real-world concerns such as insufficient oversight, economic disparity, and fraudulent activities. The problem is intensified by the fragmentation of significant establishments, hence underscoring the correlation between corruption and money laundering. Proposals for increased international collaboration and the implementation of anti-money laundering legislation are being put up as potential ways to address this widespread and detrimental issue. To enhance our defences against money laundering, we may bolster our efforts through the implementation of legislative changes, promoting transparency, establishing comprehensive beneficial ownership records, fostering international collaboration, and safeguarding whistleblowers [81]. Smart contracts provide a reliable basis for examining instances of over-and under-invoicing and transform the procedure of producing proforma invoices. The novel idea of integrating a bidding procedure into smart contracts eliminates barriers for entrepreneurs and startups, facilitating worldwide engagement. These blockchain-powered solutions signify a change in the fight against transnational money laundering (TBML) and towards a more fair global economy. Smart contracts offer several benefits, including data that cannot be changed, enhanced transparency, automated monitoring, universal accessibility, and reduced vulnerability to over- or under-invoicing. In the future, there is a possibility of experiencing reduced operating costs, improved security, increased operational efficiency, adherence to regulations, global acceptance, and better data analytics for the prevention of trade-based money laundering (TBML) and identification of anomalies [82]. The Digital Bill Ecosystem is an advanced financial system that blends the security of precious metals with blockchain technology. It provides the Digital Bill (DB) as a safe and transparent means of transaction, backed by tangible assets like as gold, silver, and platinum. The use of smart contracts and tamper-proof consensus mechanisms inside the DB ecosystem enhances efficiency, transparency, and security in many applications including as international trade, financial transactions, and voting systems. Furthermore, the DB ecosystem not only enables effortless innovation and promotes financial inclusion, but also empowers users with greater autonomy. The DB ecosystem has caused a significant shift in financial and governmental paradigms, creating a transparent and decentralised financial environment. Cryptocurrency offers stability and value preservation mechanisms that reduce volatility. The DB ecosystem has the potential to transform electoral systems globally through fair representation, the eradication of manipulation, and the promotion of transparency. The DB ecosystem possesses the capacity to streamline and safeguard global commerce, as well as impact governance and finance. Startups and company owners derive advantages from smart contracts due to their ability to enable immediate payments, optimise transactions, and eliminate intermediaries. Possible consequences of this new trading paradigm include an accelerated global economy, more economic empowerment for women, and a fairer distribution of wealth. However, enhancing the DB ecosystem need further research, cooperation, and multidisciplinary knowledge. To ensure the resilience, scalability, and responsiveness of the DB ecosystem, it is imperative to involve web architects, designers, developers, and researchers who possess knowledge in cyber security, economics, governance, and finance. This can lead to more effective resolution of potential issues [83]. The "Digital Bill (DB)" is an electronic form of a promissory note that seeks to address problems related to illegal activity, slow acceptance of cryptocurrencies, and the illegal process of making illegally obtained money appear legal. The popularity and security of this cryptocurrency ecosystem may be attributed to its unique characteristics such as the issuance of digital bills with distinct numbers, assured authenticity and traceability, decreased risk of fraud, and enhanced transparency. DB ensures the safety of all financial transactions with its rigorous cyber security procedures. In addition, it is impervious to inflation, ensuring that buyers' funds remain secure and unaffected by market volatility. Instead of depending on resource-intensive mining processes, DB focusses on regenerating private keys to improve security and protect against unauthorised access. The system integrates depository insurance, trust assurances, safe verification mechanisms, enhanced encryption, and other measures to alleviate worries around DEX hacking. Database management systems (DBs) offer real-time currency value adjustment, resulting in faster transactions, enhanced user experience, and streamlined economic activities, such as international trading. The objective of the initiative is to enhance the utilisation of blockchain technology, alleviate concerns regarding investment losses, and bolster confidence in DB [84].

Blockchain is a decentralised system of record-keeping that is accessible to the general public via a network of computers. It is transforming the financial sector by enhancing transaction transparency, eradicating human mistakes, and offering secure payment options that bypass intermediaries. Blockchain obviates the necessity of a central authority by establishing a decentralised network. Distributed ledger technology (DLT) enables all participants in a transaction to access a shared record through its constituent nodes, which are sent across a computer network [85]. Blockchain technology has the capacity to enhance transparency in global finance and commerce through the provision of up-to-date information and the reinforcement of transaction security and accessibility [86]. By eliminating intermediaries such as banks, blockchain technology has the potential to decrease transaction costs and enhance the accessibility of international trade for small and medium-sized enterprises. Blockchain technology enhances transaction transparency and security, hence reducing the probability of fraud and counterfeiting. Logistics, transportation, financing, customs administration, and inter-firm administrative operations are all components of the extensive value chain that is linked to international commerce. The implementation of blockchain technology has the potential to optimise and simplify this procedure. Smart contracts, facilitated by the blockchain, can save time and money by removing the requirement for human authentication of trade papers [88]. Blockchain technology has the potential to enhance transaction speed and accuracy while reducing the probability of errors or delays. Enhanced transparency and traceability in the supply chain can be achieved as a consequence. The trade industry has examined blockchain technology in several contexts, such as document verification, trade financing, and commercial transactions [89]. According to the research, blockchain technology has the potential to revolutionise corporate operations and there are few technological obstacles to its broad use [90]. Blockchain technology enables autonomous, rapid, and secure international commerce of products by addressing many issues associated with conventional financial systems [91]. The unchangeability, protection, and instantaneous information offered by blockchain technology are advantageous for global commerce. The utilisation of blockchain technology has the capacity to optimise trade finance transactions, facilitate cross-border operations, and provide secure transactions across national or regional borders. However, it also faces obstacles in terms of interoperability, scalability, and regulatory adoption [92]. Implementing blockchain technology has the potential to revolutionise the worldwide flow of products and services by improving interoperability between existing systems and business partners. The promise of this technology lies in its capacity to eliminate intermediaries such as banks, so increasing the accessibility of international commerce for small and medium-sized businesses, while simultaneously reducing transaction costs [94]. The implementation of blockchain technology has the capacity to streamline the authentication process of bills of lading and other trade documentation, resulting in significant time and cost savings compared to traditional manual processing methods. Enhancing the quality and efficiency of transactions can reduce the probability of mistakes or delays [95]. Blockchain technology can effectively address the issue of money laundering by offering a reliable and transparent payment method that creates an unchangeable record trail [96]. Blockchain technology facilitates the detection of suspicious activity and aids in combating money laundering by enabling all involved financial institutions to evaluate transactions and identify potential issues. Furthermore, blockchain technology can aid in the prevention of money laundering by establishing a decentralised network that guarantees the integrity of data and enables independently verifiable consensus procedures to authorise any modifications [95]. Blockchain technology has the potential to prevent money laundering by enabling decentralised monitoring of all financial activities and perhaps spotting questionable transactions [96]. When integrating blockchain technology into anti-money laundering (AML) systems, several challenges need to be overcome, including technological complexity, legal ambiguity, shortage of skilled personnel, user confidence, budgetary constraints, and lack of acceptance by other companies. Blockchain technology facilitates the monitoring and detection of fraudulent conduct by creating an immutable record of all financial transactions [98]. Businesses may address these difficulties by engaging in staff training, partnering with stakeholders to set industry standards, coordinating with authorities to ensure compliance, and doing a comprehensive cost-benefit analysis of blockchain deployment [97]. Blockchain technology's capacity to authenticate client identities can be advantageous for banks and other organisations, leading to a decrease in fraud associated with altered or counterfeit documents. Blockchain technology enables the development of self-executing contracts, which decrease the probability of fraud and disputes while automatically enforcing terms and conditions [99]. Through the analysis of vast quantities of data, blockchain technology enables firms to identify suspicious trends and possible occurrences of fraud. Financial institutions and other network players can have access to a wider range of fraud-related data sets by combining their resources and skills. Blockchain technology enables secure data sharing between parties, enhancing trust and facilitating more effective fraud prevention and detection. Utilising blockchain technology to mitigate fraud presents several obstacles. The challenges associated with the use of this technology include its intricate nature, compatibility with other systems, legal ambiguity and compliance concerns, shortage of skilled professionals, user confidence, budgetary constraints, and the lack of adoption by other firms. In order to tackle these problems, it is advisable for businesses to allocate resources towards staff training, engage in partnerships with relevant parties to develop industry benchmarks, cooperate with authorities to ensure adherence to regulations, and thoroughly evaluate the advantages and disadvantages of using blockchain technology prior to reaching a conclusion [101]. The research proposes the use of a blockchain-based solution to address the current challenges associated with international product import bank transfers and letters of credit. The approach intends to address the limitations of conventional banking operations by leveraging the security aspects of smart contracts and employing anti-money laundering technologies. The suggested technique aims to provide a decentralised, safe, and self-governing framework for international commodities commerce.

Based on a comprehensive analysis of prior studies on ensuring safe banking and preventing fraud in international commerce, we have concluded that blockchain technology is the most optimal resolution for our issue. In order to enhance the efficiency and security of international commerce networks, we will develop a system that utilises blockchain technology. In our earlier feasibility studies and comparative evaluations, we identified several drawbacks of traditional trading methods, including intermediaries, information latency, and trust-related issues. The new blockchain technology is hailed as a groundbreaking solution that has the potential to transform the way multinational organisations conduct business worldwide. In addition to providing a comprehensive architectural design for the process, we will also include specific implementation details that leverage blockchain technology and smart contracts. The results will show that blockchain technology can be used to provide safe transactions.

4. METHODOLOGY

In this section, we will provide a comprehensive explanation for our rationale in selecting a certain methodology for data gathering and examination. This qualitative research aims to explore the possible uses of blockchain technology in the financial services business..

4.1 RESEARCH STRATEGY

We plan to explore the possible uses of blockchain technology in the banking and financial sector, focussing on the viewpoint of the Big Four. To promote comprehension and reduce misunderstandings, we shall openly engage in discussions on our assumptions. Although our approach is based on a thorough examination of the current body of research, it is important to note that there is no one answer for this topic. Comprehending the intricacies of the technology and assessing its benefits and drawbacks takes precedence over formulating testable hypotheses. The framework enables the facilitation of interpretative research by fostering a reciprocal exchange between theoretical concepts and empirical evidence, so enhancing our understanding. We recognise the constraints of current theories in elucidating real-world occurrences pertaining to blockchain technology in the domains of safe banking and international trade through the utilisation of an abductive reasoning approach that amalgamates deductive and inductive reasoning. The objective of abductive reasoning is to elucidate the inexplicable phenomena by utilising existing theories and finding pertinent circumstances and components. This approach involves the analysis of theory and real facts in a cyclical fashion. In order to fulfil the objectives of our study, it is necessary to adopt a qualitative approach. This is because the implementation of blockchain technology in safe banking and international trade necessitates a comprehensive understanding that goes beyond the constraints of conventional logical and inductive reasoning.

4.2 RESEARCH DESIGN

The research aimed to get a deeper understanding of the application methods employed by organisations in the financial services industry. The study methodologies were mostly composed of qualitative approaches. Qualitative techniques are utilised in many research methodologies to gather and analyse non-numerical and non-quantified data. The primary objective of qualitative research is to explore and comprehend individuals' perspectives on a certain subject. Due to the complex nature of the topic, this strategy allows researchers greater flexibility in their interpretation and evaluation of data.

The restricted relevance of qualitative research findings is a common complaint, and case study enquiries are no different. Furthermore, due to the nascent nature of blockchain technology implementation, the coordination of quantitative research might present difficulties.

4.3 DATA COLLECTION

Due to the unique characteristics of our study technique, we had to develop a new approach for gathering data. By initiating the research planning process, we were able to more precisely establish the objectives, methods, and scope of the study. The main objectives of this early stage were to define the scope of the study and create a well designed methodology. Subsequently, a thorough literature review was conducted, encompassing all pertinent material regardless of study methodologies, publications, or geographical areas. To discover frequently cited blockchain applications, our study employed a systematic methodology to examine particular source materials. Subsequently, we presented substantiating data from scholarly sources and emphasised any deficiencies in our comprehension.

The dataset used in this study was obtained from several sources, such as books, journal articles, theoretical books, case studies, and internet resources. The investigation utilised all available data sources to investigate and assess empirical findings. The statement implies that researchers should identify deficiencies in the existing body of knowledge and develop a systematic strategy to tackle them.

4.4 DATA ANALYSIS

To ensure coherence and structure in our work, we have opted to utilise the topic analysis approach. Data analysis is the systematic examination of data to identify and communicate trends. It involves the classification and organisation of data sets while assessing different elements of a study issue. Immersion, the initial stage in the process, involves thoroughly reading the information many times, actively searching for patterns and interpretations, and actively engaging with the topic. Subsequently, the data is employed to produce preliminary codes, which emphasise the essential components or segments necessary for a comprehensive analysis of the phenomena.

Next, we go to the subsequent stage of topics in the study, which involves arranging the codes into probable themes and categorising any pertinent coded data extracts inside those themes. The validity of each topic in relation to the data set is confirmed during the process of coded data extraction, which is the subsequent stage in the analysis. By doing this, we ensure that the thematic map faithfully depicts the observed meanings over the whole data set. Subsequently, the study's participants are further modified and enhanced, and the data included within them is carefully examined to assist in the final formulation of the report.

We now have easy access to step six, which involves creating the report. The primary objective of a thematic analysis write-up, whether it is for a research project, a dissertation, or publication, is to effectively convey the intricate narrative of the data in a manner that convinces the reader of its credibility and significance.

4.5 METHODOLOGICAL REFLECTIONS

This research aimed to assess the potential ramifications of blockchain technology, specifically focussing on Swedish firms. The study's intended scope had to be narrowed due to time and money limitations, as well as a low response rate from organisations. To guarantee a satisfactory outcome for our report, we made the decision to refine the research topic so that it better aligns with the new scope. Due to the absence of any reaction or interest from organisations about our study, we made the decision to forgo collecting primary data and instead relied on existing material from research reports, study papers, and online journals related to Big Four businesses. This enabled us to improve and augment our discoveries. Therefore, we redirected our attention from studying isolated cases to including a wider range of nations in our investigation of the implementation of blockchain technology in Swedish companies.

Using secondary materials for a thesis assignment has disadvantages. Although there are potential benefits in terms of time and cost savings, it is important to acknowledge the potential presence of biassed data collected by groups and businesses driven by their own objectives. In order to reduce this risk, we implemented additional measures to validate the reliability of the data sources employed, guaranteeing their esteemed reputation within the financial services sector.

An issue with depending on secondary sources was the possibility of outdated data. During the data gathering process, we carefully examined the date of the material and assessed its relevance and applicability to the current year. Fortunately, the number of recent research papers, publications, and data on the subject of blockchain technology has made our task easier. Blockchain technology is currently a prominent topic of interest in several industries and enterprises. In addition, no revolutionary new information was discovered that may have raised concerns about the accuracy of the data.

4.6 CONCLUSION

The primary objective of this research was to investigate the potential impact of blockchain technology on the financial services sector, namely in the areas of safe banking and international trade. A more comprehensive understanding of the many applications of blockchain technology was achieved via the utilisation of a qualitative methodology. Utilising theme analysis, a reliable approach for evaluating and documenting data patterns, offered a structured framework for our findings. To verify the legitimacy and authenticity of sources, we took into account potential biases and outdated information, despite transitioning from collecting primary to secondary data.

Our research indicates that blockchain technology has both advantageous and detrimental applications in the banking and finance sector. The issues that emerged throughout the investigation highlighted the rapid pace of this business and the need for flexible approaches. While the study recognises the valuable insights it provides, it also acknowledges the constraints of qualitative research and the analysis of secondary data.

As technology continues to advance, future studies may focus specifically on certain parts of the financial industry. To get a more comprehensive comprehension of the significance of blockchain technology in ensuring safe banking and facilitating international trade, it is necessary to explore its practical applications and analyse its influence on regulatory frameworks.

This study contributes to the ongoing conversation on blockchain technology in the banking and insurance business by highlighting the importance of continuous review and adaptation to navigate the fast changing terrain of this innovative technology.

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5. PROPOSED ARCHITECTURE

The inception of a foreign trade transaction occurs when traders reach an agreement on a business order, marking the initiation of operational activities involving banks and logistics entities. The process is illustrated in Figure 5.1, highlighting the typical steps involved in foreign trade utilizing Letters of Credit (LoC). Within this intricate process, three fundamental developmental flows can be discerned, each playing a crucial role in shaping the trajectory of the trade transaction.

5.1 FLOW OF RECORDS

In the initiation of a foreign trade transaction, traders reach a consensus on a business order, marking the commencement of operations with banks and logistics entities. Figure 1 illustrates the typical steps involved in foreign trade utilizing Letters of Credit (LoC). Within this process, three fundamental developmental flows can be identified.

5.1.1 Records Management

The flow of records encompasses various types of information crucial to the foreign trade process. These records serve diverse purposes, including demonstrating ownership, detailing business operations, capturing trade and delivery orders, validating the legitimacy of trust, recording LoC agreements between negotiating and issuing banks, and documenting essential documents such as mate's receipt (MR) and bill of lading (BoL) for trading parties. Each of these components plays a vital role in ensuring transparency, accountability, and the seamless progression of the trade transaction.

a. Ownership and Business Operation Records: These documents establish the ownership and operational aspects of the traded goods, providing a comprehensive overview for all involved parties.

b. Trade and Delivery Orders: Details related to trade agreements and the subsequent delivery orders are recorded, forming a chronological account of the transaction.

c. Legitimacy of Trust Documents: Records validating the legitimacy of trust within the transaction are crucial for establishing a secure and trustworthy trading environment.

d. Letter of Credit Documentation: The negotiation and issuance of LoCs between banks are documented, outlining the financial agreements and commitments involved in the trade.

e. Mate's Receipt and Bill of Lading: Essential documents such as MR and BoL, representing the receipt of goods and their shipment, are meticulously recorded to ensure the accuracy and legitimacy of the trade.

5.2 FLOW OF FUNDS

5.2.1 Transactional Record

The flow of funds in conjunction with transactional records plays a pivotal role in determining the value and costs associated with the trade between parties. This paper specifically employs the Letter of Credit (LoC) as the chosen form of payment submitted to shareholders. In a standard LoC trade, the issuing and negotiating banks collaborate to facilitate the importer's payment to the exporter through cash transactions. This involves a meticulous financial process where funds are transferred securely and transparently, aligning with the terms specified in the LoC agreement.

5.3 FLOW OF COORDINATION

5.3.1 Operational Coordination

The flow of coordination encompasses the practical execution of the trade agreement, involving several key steps. These steps include the packaging of goods by the shipper in adherence to the agreed-upon terms, the subsequent shipping of goods to the buyer's country following necessary customs checks, and finally, the buyer's claim of the received goods. This coordination ensures that the physical aspect of the trade aligns with the predetermined terms and conditions, promoting a smooth and efficient transaction process.

a. Goods Packaging: The shipper is responsible for packaging the goods according to the terms agreed upon, ensuring the secure transportation of the products.

b. Shipping and Customs Checks: The goods are then shipped to the buyer's country, undergoing necessary customs checks to comply with international trade regulations.

c. Buyer's Claim: Upon successful delivery, the buyer claims the received goods, marking the completion of the physical aspect of the trade.

In essence, the meticulous management of the flow of records, funds, and coordination in foreign trade, as illustrated in Figure 5.1, ensures a comprehensive and well-organized process from order initiation to the successful receipt of goods. This multifaceted approach contributes to the transparency, efficiency, and reliability of international trade transactions.

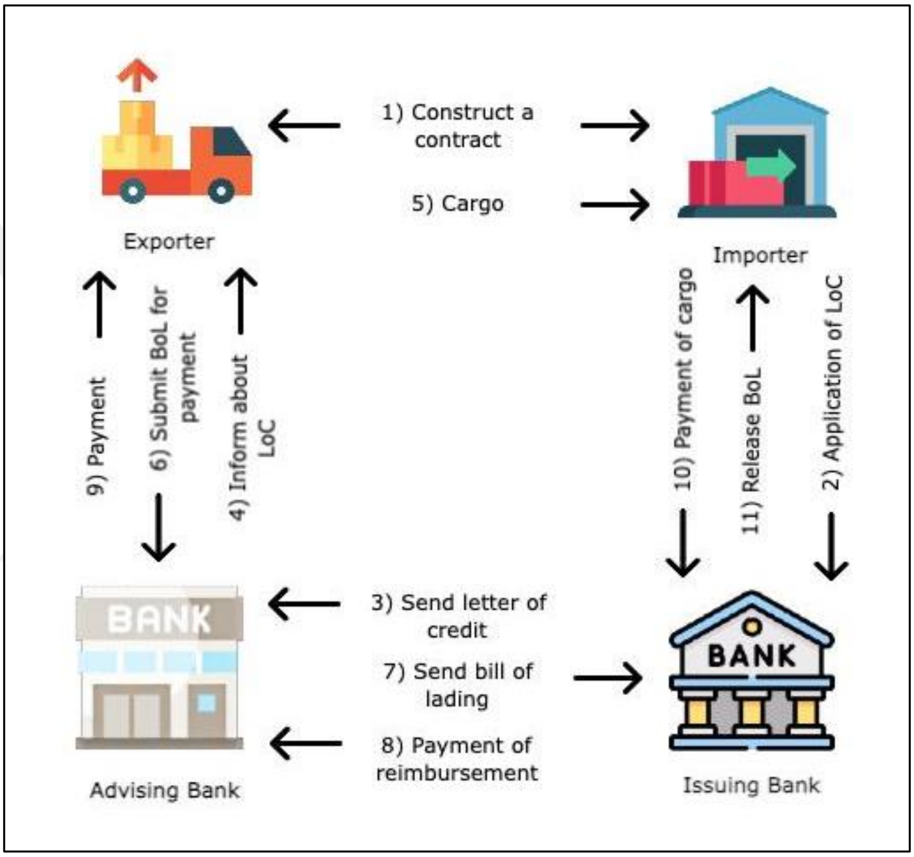

Figure 5.1: Foreign Trade Using LOC.

5.4 PROPOSED BLOCKCHAIN SMART-CONTRACTS

By harnessing the convenience of smart contracts and blockchain technology, this paper showcases the creation of a distributed ledger designed to store transactional history autonomously, triggered by specific events.

5.4.1 Trading Smart Contract (TSC): A Digital Evolution of Trade Contracts

The Trading Smart Contract (TSC) represents a transformative shift from conventional paper contracts, emerging as a digital solution that not only verifies sales in trade but also possesses a unique capability to meticulously store all pertinent information with corresponding timestamps and predefined triggering conditions.

In scenarios where disagreements may arise, TSCs prove invaluable to traders by seamlessly providing conventional documentation for negotiation purposes. Beyond dispute resolution, these contracts serve a crucial role in the real-time monitoring of updates within trade transactions. The interactive nature of TSCs extends to seamless collaboration with other intelligent contracts, specifically Letter of Credit Smart Contracts (LoCSC) and Logistics Smart Contracts (LSC).

The multifaceted functionalities of TSCs include:

a. Verification of Sales in Trade: TSCs excel in offering a digital mechanism for verifying sales in trade, streamlining the process with efficiency and transparency.

b. Information Storage with Timestamps: Leveraging blockchain technology, TSCs meticulously store relevant trade information, ensuring a secure and tamper-resistant record with precise timestamps.

c. Dispute Resolution Support: In instances of disagreements, TSCs provide traders with the necessary conventional documentation, facilitating negotiations and aiding in the resolution of disputes.

d. Real-time Transaction Monitoring: TSCs actively monitor and update stakeholders on the real-time progress of trade transactions, fostering transparency and informed decision-making.

e. Integration with LoCSC and LSC: TSCs seamlessly integrate with other smart contracts, specifically LoCSC and LSC, to enhance coordination and information flow within the entire trade ecosystem.

f. Facilitation of Payment Requests: With TSCs, traders gain the capability to request payments without the cumbersome requirement of physical Bill of Lading (BoL) documentation, streamlining and expediting the financial aspects of the trade.

g. Cargo Claiming Process: TSCs enable traders to claim their cargo without the traditional reliance on physical documentation, providing a more efficient and automated process.

Initiating a TSC involves both parties in a trade engaging in comprehensive discussions to establish the terms and conditions. Subsequently, the execution of TSCs is contingent upon validation by the opposing party, facilitated through the application of electronic signatures, ensuring the authenticity and integrity of the entire process.

5.4.2 Letter of Credit Smart Contract (LOCSC): Revolutionizing Letter of Credit Processes

The Letter of Credit Smart Contract (LoCSC) stands as a revolutionary solution designed to streamline and enhance the functions traditionally associated with paper-based letters of credit. By seamlessly facilitating the arrangement of trade conditions agreed upon by both parties, LoCSCs introduce a new era of efficiency and transparency in international trade transactions.

5.4.2.1. Key functions of locsc

a. Trade Condition Management: LoCSCs excel in managing and implementing trade conditions established through mutual agreement between involved parties. This digital framework ensures that the conditions are accurately represented and executed in the trade process.

b. Progress Status Updates: LoCSCs play a pivotal role in providing real-time updates on the current progress status of a trade transaction. This feature enhances visibility and transparency for all stakeholders involved in the process.

c. Interactions with TSCs and LSCs: LoCSCs actively interact with Trading Smart Contracts (TSCs) and Logistics Smart Contracts (LSCs), fostering seamless coordination and information exchange within the overarching trade ecosystem. This interconnectedness contributes to a holistic and automated trade environment.

d. Support for Issuing and Negotiating Banks: LoCSCs aid issuing and negotiating banks by offering a digital platform for tracking transaction processes. This function not only expedites the overall trade cycle but also ensures accuracy and reliability in financial operations.

e. Role in BoL Handling: LoCSCs take over the traditional role of handling shipping Bills of Lading (BoLs). This digital transformation mitigates the complexities associated with physical document transfer, reducing expenses and risks for all involved parties.

5.4.2.2. Initiation and triggering process

a. Importer Request: The process commences when an importer initiates a request for a letter of credit, signifying their intent to engage in a trade transaction.

b. Essential Inspection Processes: The issuing bank, responsible for LoCSC initiation, conducts essential inspection processes to validate the eligibility and authenticity of the importer's request.

c. LoCSC Initiation: Upon successful completion of inspection processes, the issuing bank initiates the Letter of Credit Smart Contract (LoCSC). This marks the formal activation of the digital framework for the trade transaction.

d. Electronic Signatures: To ensure the integrity and legitimacy of the trade transaction, electronic signatures from both the importer and the negotiating bank are required. These signatures authenticate the terms and conditions outlined in the LoCSC.

e. Official Triggering: Upon the validation of electronic signatures, the LoCSC is officially triggered, commencing the digitized letter of credit process and signaling the commencement of the associated trade transaction.

In essence, LoCSCs represent a paradigm shift in the traditional approach to letters of credit. By embracing digitalization, these smart contracts not only enhance the efficiency of trade processes but also contribute to cost reduction and risk mitigation, fostering a more secure and streamlined international trade landscape.

5.4.3 Logistics Smart Contract (LSC): Transforming Cargo Handling and Documentation

Logistics Smart Contracts (LSCs) emerge as a transformative solution, aimed at reshaping the traditional landscape of logistics documentation, including Mate's Receipts (MRs), Bills of Lading (BoLs), and packing lists. Designed to seamlessly align with the trading conditions stipulated in Trading Smart Contracts (TSCs), LSCs play a pivotal role in providing a more efficient and automated approach to cargo tracking and document handling in international trade transactions.

Key Functions of LSCs

a. Document Replacement: LSCs effectively replace conventional logistics documents, such as MRs, BoLs, and packing lists, with a secure and tamper-resistant digital framework. This transition contributes to a reduction in paperwork, minimizes errors, and enhances overall operational efficiency.

b. Alignment with TSCs: LSCs operate in tandem with Trading Smart Contracts (TSCs), ensuring seamless coordination between trade and logistics processes. This alignment facilitates real-time information exchange and updates, promoting a synchronized and transparent trade ecosystem.

c. Information Transmission: Leveraging the capabilities of blockchain technology, LSCs can transmit crucial information, current status updates, and cargo tracking details directly from the shipping database. This not only streamlines the logistics process but also provides stakeholders with accurate and up-to-date insights into the movement of goods.

d. Efficient Cargo Tracking: The primary objective of LSCs is to offer shipping companies a more efficient method of cargo tracking. By automating the tracking process and eliminating the reliance on manual documentation, LSCs contribute to a streamlined and error-free cargo handling experience.

e. Event-Activated Status Changes: The status of trade transactions undergoes changes only when predetermined events, agreed upon by involved parties and encoded in smart contracts, are activated. This event-driven approach ensures that status updates are triggered by specific milestones or conditions, adding a layer of precision to the logistics and trade coordination.

5.5 INTEGRATION WITH TRADE ECOSYSTEM

In practice, LSCs seamlessly integrate into the broader trade ecosystem, forming a cohesive network with other smart contracts, including TSCs and LoCSCs. This interconnected system ensures that logistics processes are in sync with trade conditions and financial transactions, fostering a holistic and automated approach to international trade.

By serving as a digital conduit for cargo tracking and documentation, LSCs not only modernize logistics operations but also contribute to the overarching goals of transparency, efficiency, and risk mitigation within the dynamic landscape of international trade.

In the quest to replicate traditional interactions within trade processes, a strategic integration of three smart contracts onto the blockchain is orchestrated. These smart contracts play a pivotal role in not only updating events but also triggering essential operations that streamline the intricacies of international trade. Negotiating banks, acting as vital intermediaries, establish a crucial link between exporters and importers involved in letter of credit transactions. Their responsibilities extend beyond mere financial support, encompassing the vigilant monitoring of letter of credit (LoC) operations. To address the paramount concerns of confidentiality and security, particularly emphasized by Wüst and Gervais (2018), the adoption of a consortium chain is advocated in the realm of trade. This specialized blockchain configuration enhances security measures and ensures a confidential environment conducive to the intricacies of trade transactions. Once trade contracts are meticulously arranged, the onus falls on banks to meticulously scrutinize traders' documentation. This step is imperative for the seamless transmission of credits and the facilitation of capital flow within the trade ecosystem. The intricate nature of trade transactions involves a dynamic interplay among banks, importers, exporters, and shipping companies. Shipping companies, integral players in the trade landscape, bear the responsibility of continually updating and verifying cargo status.

Additionally, they supervise essential documents pivotal for the transfer of ownership of funds. The meticulous management of these processes by shipping companies ensures the smooth flow of goods and financial assets across borders. Disagreements between parties in trade transactions often stem from the complexity inherent in these processes. In a proactive measure to prevent human errors and streamline the operational sequence across diverse systems, a trio of smart contracts adept at supporting a myriad of transactions is strategically deployed. These smart contracts are intricately linked to related systems, providing a comprehensive framework that caters to the satisfaction of all parties involved in trade. The consortium model emerges as a preferred configuration for its ability to deliver tailored transaction outputs, effectively alleviating privacy concerns. The synergistic amalgamation of consortium chains with electronic signatures further enhances the immutability of records. This not only acts as a catalyst in mitigating the burdensome aspects of conventional paperwork but also ensures a sufficient level of transparency in blockchain-based transactions.

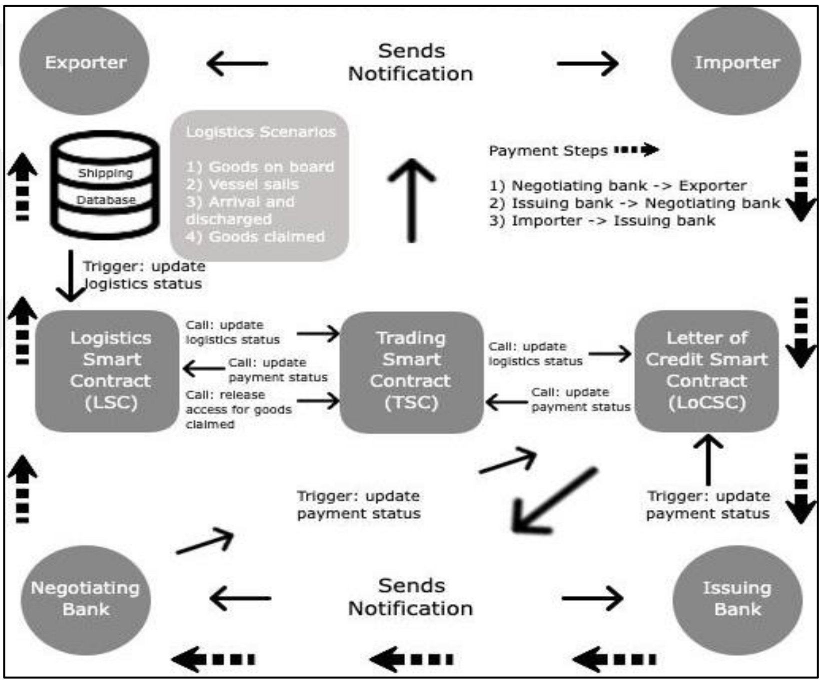

Figure 5.2: Smart Contracts to Replicate Trading.

5.6 CONSORTIUM CHAIN MEMBERSHIP REGISTRATION: FACILITATING SECURE AND CREDIBLE TRADE PARTICIPATION

The initiation of any trade endeavour within the consortium chain framework mandates traders to undergo a meticulous registration process. Prior to engaging in the overarching trading procedures, prospective traders are required to formally apply for memberships within the consortium chain. This specialized consortium chain operates under a permissioned model, boasting a selective membership that includes banks, insurance companies, shippers, and traders.

a. Membership Application Process: Traders keen on participating in this consortium-driven ecosystem must submit comprehensive membership applications. These applications serve as a crucial gateway for traders to gain access to the consortium's privileges and benefits. The administrators of the consortium, primarily constituted by consortium banks, oversee this pivotal process.

b. Essential Information Submission: The onus falls on the traders to provide a spectrum of essential information during the application process. This includes, but is not limited to, the business name, capital details, financial reports, and credit records. The exhaustive nature of the information requested ensures a robust validation and approval mechanism for traders' membership applications.

c. Administrative Validation and Approval: The submitted information undergoes a rigorous validation process orchestrated by the consortium banks, acting as the gatekeepers of the consortium chain. This audit mechanism is imperative to substantiate the credibility and authenticity of the traders seeking membership. The scrutiny is particularly stringent, considering the critical role of credit reputation and capital loans in safeguarding against potential fraudulent activities within the trading sphere.

d. Credit Evaluation for Trade Mitigation: Upon successful registration, the information provided by a trader becomes a vital reference point for ongoing credit evaluations. This continuous assessment proves instrumental in mitigating trading frictions and uncertainties associated with the respective company. By maintaining a repository of verified and up-to-date information, the consortium chain fosters an environment conducive to credible and secure trade interactions.

5.7 FACILITATING SMART CONTRACT DEVELOPMENT AND ORDER DISCUSSIONS IN TRADE

The evolution of a deal within the consortium chain unfolds as Smart Contracts are meticulously developed and discussions surrounding orders transpire. The culmination of a transaction occurs when a Trading Smart Contract (TSC) is crafted by one of the trading parties, marking a pivotal step in the trade process. Subsequent to the verification of electronic signatures, the TSC undergoes activation by the counterparty. This contract encapsulates vital trade conditions encompassing aspects such as quantity, quality, insurance, shipment details, transaction specifics, payment terms, and pricing dynamics.

5.7.1 TSC Development and Activation

a. A trading party initiates the completion of a deal by authoring a comprehensive Trading Smart Contract (TSC).

b. Electronic signature verification serves as a crucial checkpoint, ensuring the authenticity of the TSC.

c. The TSC is then triggered into action by the opposing trading party, formalizing the agreement.

5.7.2 Content Of TSC

The TSC plays a pivotal role in specifying critical trade conditions, providing clarity on quantity, quality standards, insurance coverage, shipment particulars, transaction intricacies, payment modalities, and agreed-upon pricing structures.

5.7.3 LOC Application And LOCSC Creation

a. Following the deal's confirmation, the importer proceeds to apply for a Letter of Credit (LoC) from the issuing bank.

b. Parallel to the TSC, a Letter of Credit Smart Contract (LoCSC) is formulated, mirroring the trade conditions stipulated in the TSC.

c. LoCSC undergoes activation only upon the successful verification of electronic signatures from both the importer and the negotiating bank.

5.7.4 Interlinked Smart Contracts

a. The TSC and LoCSC enter into an information exchange, facilitating the generation of a revised and synchronized version.

b. The exporter, responsible for the shipment, initiates the booking process, triggering the development of a Logistics Smart Contract (LSC) by the shipping entities.

5.7.5 LSC Components and Dependencies

The LSC's components draw essential information from the TSC, determining critical details such as the shipment date, designated export and import ports, updated TSC information, and other pertinent particulars.

This intricate web of Smart Contracts and associated discussions orchestrates a seamless and transparent progression of trade orders within the consortium chain. Each contractual element, from the foundational TSC to the interplay with LoCSC and LSC, contributes to a comprehensive and automated framework for secure and efficient trade transactions.

5.8 SEAMLESS EXECUTION OF TRADE OPERATIONS AND OPERATION DEVELOPMENT

The finalization of trade operations intricately ties into the logistics monitoring facet of foreign trade. Leveraging smart contract technology, operational intricacies are efficiently managed, and data flow adheres to the predetermined terms stipulated within the contract. This self-regulated operational framework possesses the capability to dynamically modify specific smart contract statuses and seamlessly transmit pertinent data to all involved parties. Additionally, the conclusive aspect of payments is seamlessly integrated into the interactions between the concerned parties.

5.8.1 Trade Operation Culmination

The culmination of trade operations is seamlessly intertwined with the monitoring capabilities inherent in logistics within the realm of foreign trade.

5.8.2 Smart Contract Technology Integration

a. Operational management and data flow are adeptly handled through the integration of smart contract technology.

b. The contractual terms predefined within the smart contract govern the entire operational process.

5.8.3 Self-Regulated Operations

a. The operational framework operates in a self-regulated manner, enabling dynamic modifications to specific smart contract statuses based on real-time developments.

b. This autonomy facilitates a responsive system that adapts to evolving trade scenarios and requirements.

5.8.4 Data Transmission to Stakeholders

a. Relevant data, as dictated by the operational smart contracts, is efficiently transmitted to all parties involved in the trade process.

b. This real-time data flow ensures transparency and enhances the overall efficiency of the trade operation.

5.8.5. Payment Finalization

a. Interactions between the involved parties seamlessly culminate in the finalization of payments.

b. The smart contract-driven system ensures that payments are executed in accordance with the predefined terms and conditions, fostering trust and accountability.

This advanced operational paradigm, grounded in smart contract technology, not only streamlines the execution of trade but also introduces a level of adaptability and responsiveness previously unattainable through traditional methodologies. The harmonious integration of logistics monitoring, self-regulated operations, and secure data flow propels foreign trade into an era of efficiency, transparency, and seamless financial transactions.

5.9 DEPLOYMENT AND TRIGGERING CONDITIONS OF SMART CONTRACTS

The deployment and activation of smart contracts constitute a pivotal aspect of this blockchain-based paradigm, where Ethereum serves as the underlying platform. These programmable protocols operate cohesively within the blockchain, orchestrating interactions based on predefined business processes and specific triggering events. In the realm of international trade, the inception of a business order marks the commencement of a sequence of activities involving traders, banks, and logistics service providers. The interconnected smart contracts respond to functional calls, aligning with the dynamic demands of the established trade processes.

5.9.1 Blockchain Platform Deployment

a. Smart contracts are meticulously crafted protocols and are deployed on the Ethereum blockchain platform in the context of this study.

b. Interactions among these contracts are orchestrated based on defined business processes and trigger events.

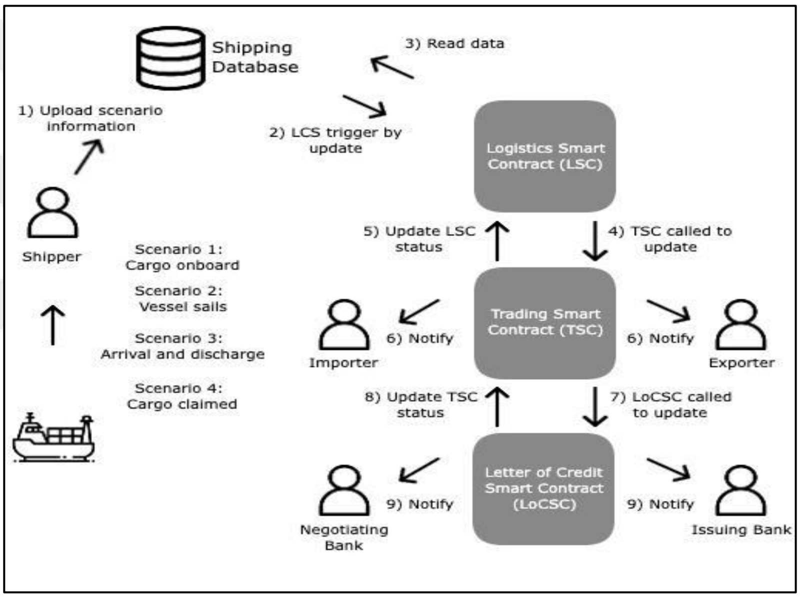

Figure 5.3: Payment Operation Between Importer and Exporter.

5.9.2 Trade Initialization

a. The initiation of an international trade commences with the establishment of a business order between traders.

b. Subsequent activities unfold in collaboration with banks and logistics service providers, setting the stage for comprehensive trade processes.

5.9.3 Functional Interaction

a. Contracts are ingeniously designed to interact functionally, dynamically responding to various operational requirements within predefined trade process flows.

b. Sales orders, coupled with contracts, grant access to trading information stored in relevant databases managed by diverse trade participants, facilitated through oracles.

5.9.4 Data Access and Transmission

a. Access to essential trading information from disparate databases is facilitated through oracles, ensuring seamless communication between smart contracts.

b. Functional codes, invoked during these interactions, carry and transmit crucial process information, steering the interactive operations among the smart contracts.

5.9.5 Real-Time Notifications

a. Smart contracts deployed within the blockchain environment possess the capability to dispatch real-time notifications regarding state and event changes.

b. These notifications are directed to pre-registered participants in the trade process, enabling them to track and monitor trade process flows dynamically.

5.9.6 Logistics-Related Scenarios

a. Four distinct logistics-related scenarios are meticulously defined to correspondingly update the shipper database based on state changes triggered by computational events.

b. State changes serve as pivotal events that prompt Logistics Smart Contracts (LSCs) to initiate subsequent procedures, including notifying other involved parties through Trading Smart Contracts (TSCs) and Letter of Credit Smart Contracts (LoCSCs), updating trade states, and more.

This comprehensive orchestration of smart contracts within the blockchain ecosystem ensures a dynamic and transparent execution of international trade processes. By providing real-time insights, notifications, and functional interactions, this blockchain-based approach fosters efficiency, accuracy, and accountability in the evolving landscape of global trade. In the intricate process of Letter of Credit (LoC) payment transactions, the exporter initiates the payment claim, prompting a sequence of meticulously orchestrated interactions with the importer. Throughout this process, the most recent payment status is diligently updated among the involved traders and banks, all authenticated through authorized digital signatures. The introduction of real-time monitoring and traceability is a key achievement facilitated by the automatic notifications triggered by smart contracts. These contracts, intricately associated with relevant trade participants, ensure that the entire payment and settlement journey is transparent and verifiable. Upon the successful completion of all financial transactions, the Trading Smart Contract (TSC) strategically invokes the Logistics Smart Contract (LSC), thereby conferring upon the importer the rightful claim to the acquired goods. This event-driven paradigm, empowered by smart contracts and underpinned by a distributed ledger, seamlessly integrates into practical trade flows. In stark contrast to centralized models, this innovative framework serves to rectify information asymmetry, streamline process hand-offs, leverage blockchain technology for enhanced process flows, and ultimately establish decentralized governance. The overarching objective is to systematically re-engineer and elevate the standards of the international trade process, ushering in efficiency, transparency, and decentralized governance as shown in Figure 5.4.

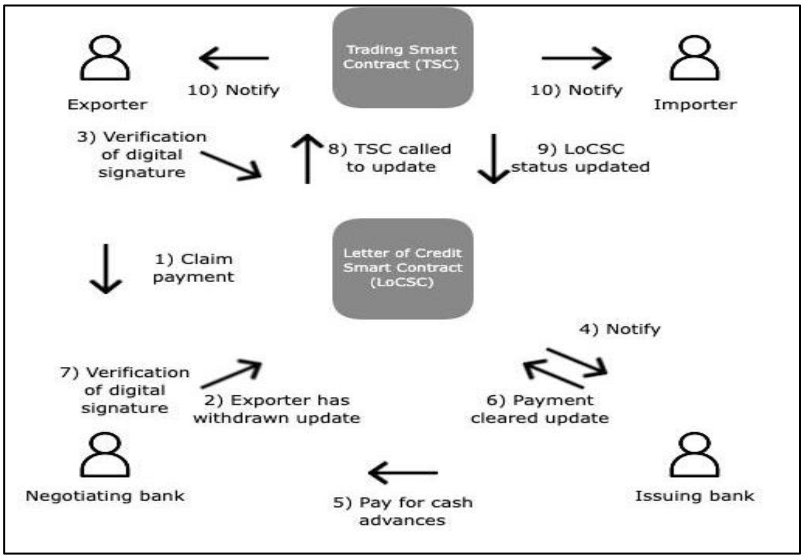

Figure 5.4: Process of the International Trade Process, Ushering in Efficiency, Transparency, and Decentralized Governance.

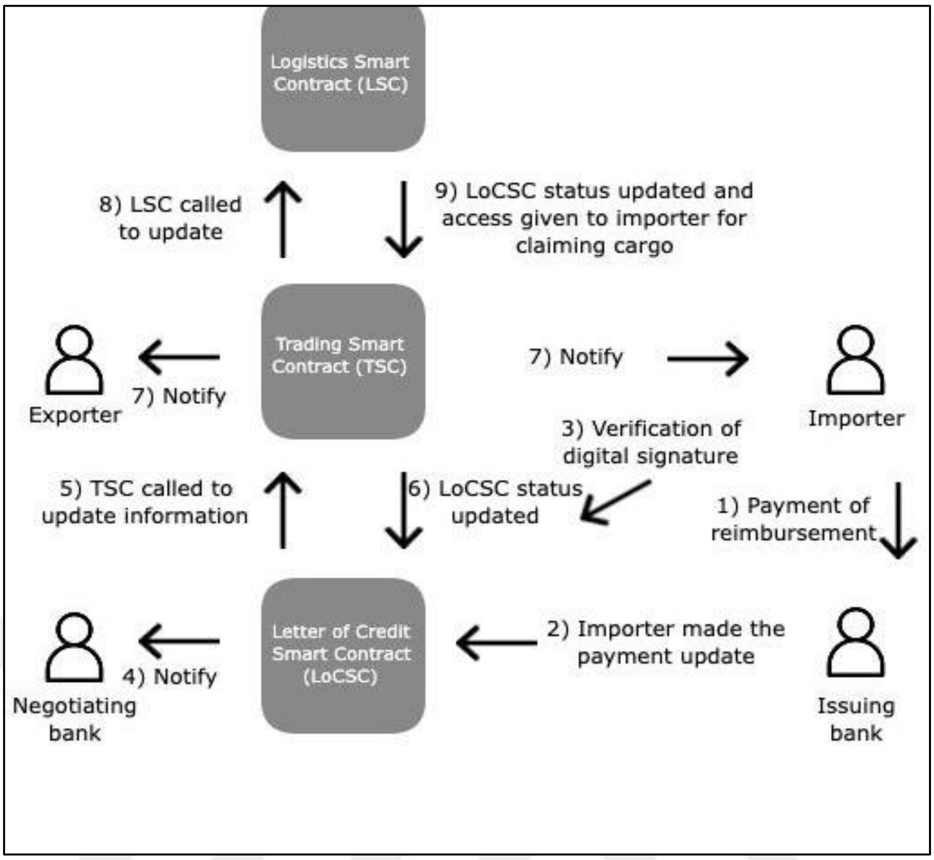

Figure 5.5: Our Proposed System is Encapsulated Within a Comprehensive Architectural Framework.

Our proposed system is encapsulated within a comprehensive architectural framework, as depicted in Figure 5.5, offering a high-level view of its intricacies. This architecture revolves around three primary components: entities, comprising importers and exporters, and banks, encompassing issuing and advising banks. The systemic structure unfolds across four distinct layers: Application layers, Smart Contracts, Consensus Protocol, and the Blockchain infrastructure. Entities and banks seamlessly interact within this system, ensuring real-time updates and comprehensive tracking of the entire trade process. Facilitating this interaction is the Application layer, an interactive and user-friendly interface accessible across diverse devices, requiring no specialized training for utilization. The second layer is anchored by Smart Contracts, the linchpin controlling the entire system's flow. Three distinct smart contracts govern this layer: Trading Smart Contracts (TSC) manage transactional paperwork functions, Logistics Smart Contracts (LSC) oversee logistics documentation and trade tracking, while Letter of Credit Smart Contracts (LOCSC) handle letter of credit responsibilities. The third layer introduces the Consensus Protocol, a set of predefined rules within the blockchain structure, orchestrating the validation and incorporation of data into the blockchain. This layer ensures the seamless execution of smart contracts by validating data based on predetermined rules. The final layer comprises the Blockchain itself, where data is cryptographically stored in sequential blocks, establishing a secure and transparent record of the entire trade process. This systematic architecture, harmonizing entities, banks, and advanced technological layers, aims to redefine and optimize the dynamics of international trade processes, fostering efficiency, transparency, and reliability. Within our system architecture, the layers seamlessly communicate, and the linchpin is the utilization of a private blockchain. This choice of a private blockchain ensures that only registered importers and exporters gain access, fostering a trusted and controlled environment. The use of a private blockchain allows for consensus through selective endorsement, wherein known users validate transactions and subsequently append them to the blockchain. Every transaction involves related entities serving as validators, ensuring the authenticity and accuracy of the data being added to the blockchain. This process establishes a secure and tamper-resistant ledger.

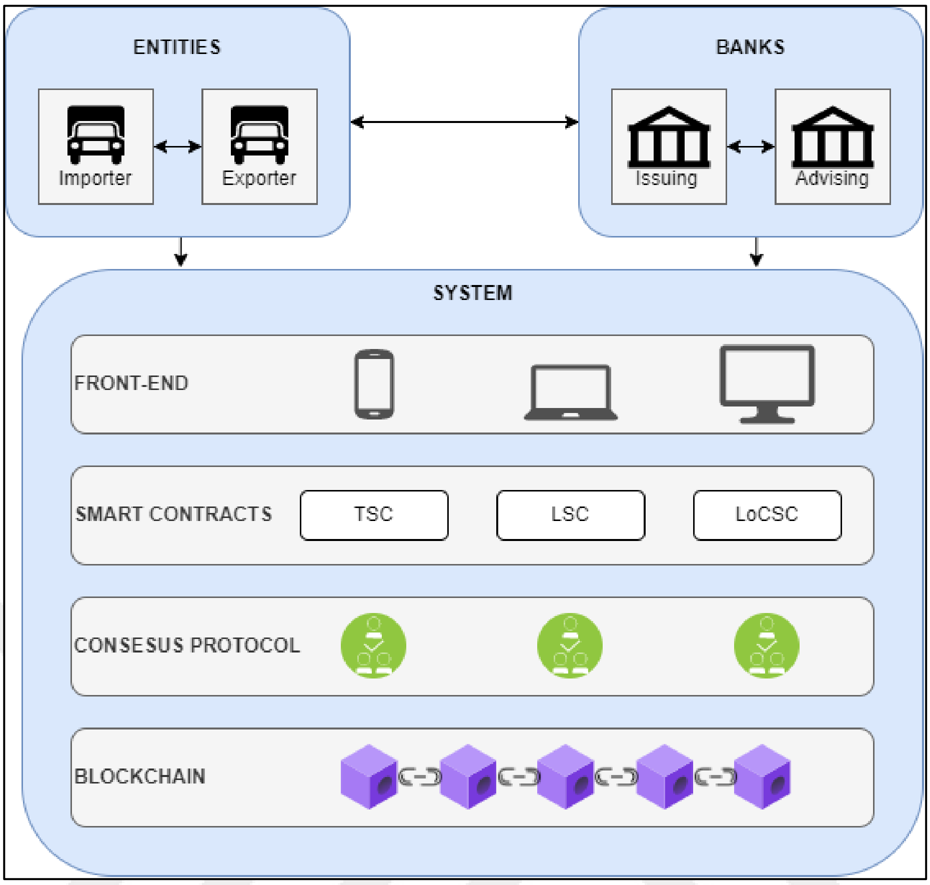

Figure 5.6: Architecture of our Proposed Work.

The workflow begins with importers and exporters reaching a mutual agreement on cargo-related terms, which are encapsulated in the letter of credit managed by the Letter of Credit Smart Contract (LoCSC). Once the LoC is created, banks review and share the agreement rules with the advising bank, subsequently informing the concerned parties about the LoC. Post-validation, the LoC details are encrypted and securely stored as a block on the blockchain. The subsequent shipment processes, such as cargo dispatch and receipt, are tracked and updated by the Logistics Smart Contract (LSC). The Bill of Lading (BoL) request is initiated by the exporter, undergoes validation through communication between both banks, and is securely stored in the blockchain. Payment transactions are securely recorded, with the Trading Smart Contract (TSC) handling the release of the Bill of Lading by the bank upon receipt of the importer's payment. Each transaction is securely stored, rendering the data immutable and traceable. No unauthorized alterations or deletions are possible, ensuring the integrity of the entire trade process.

In conclusion, this meticulously designed system, fortified by a private blockchain and smart contracts, revolutionizes international trade processes. It establishes a transparent, efficient, and secure ecosystem where trust is inherent, and data is seamlessly tracked and recorded. The layers of application, smart contracts, consensus protocol, and the blockchain itself synergistically create a robust framework that addresses the complexities and challenges of traditional trade models. This innovative system not only ensures security and transparency but also paves the way for decentralized governance, heralding a new era in international trade facilitation.

6. RESULTS AND DISCUSSION

The consensus protocol plays a crucial role in guaranteeing the verification of data before its incorporation into the blockchain, thereby ensuring the secure storage of information. Smart contracts, integral components of blockchain technology, are categorized into three main types to streamline various functionalities within a decentralized system. The first category, Trade Smart Contracts (TSC), oversees the execution of trading paperwork functions. The second category, Logistics Smart Contracts (LSC), is dedicated to the management of logistics documentation and the tracking of trade-related activities. Lastly, Letter of Credit Smart Contracts (LOCSC) takes on the responsibility of handling letter of credit obligations. This structured approach enhances the efficiency and transparency of blockchain-based systems in managing and executing diverse aspects of trade and financial transactions.

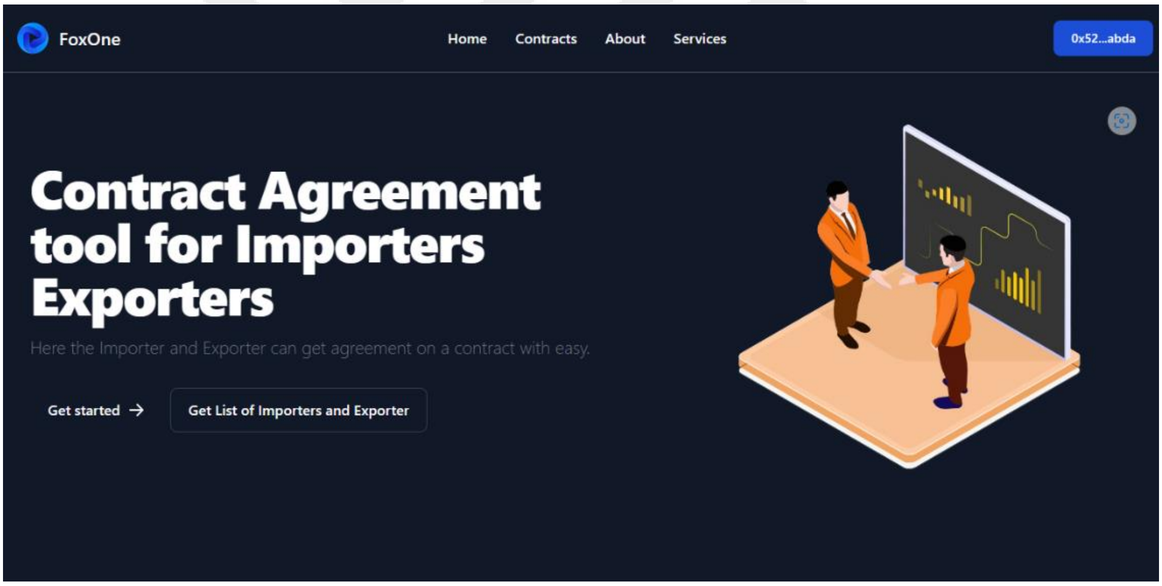

Figure 6.1: Proposed System.

The system employs a private blockchain exclusively designed for registered importers and exporters, facilitating seamless transactions and real-time tracking of goods movement. This private blockchain creates a trusted environment with selective endorsement to achieve consensus. Transactions are validated by known users who act as validators for each transaction, and additional entities related to the process can be designated as validators as needed. This approach ensures a secure and traceable record of transactions stored on the blockchain, accessible to all authorized participants.

When an importer and exporter reach an agreement regarding the cargo, pertinent details are documented in the letter of credit managed by the Letter of Credit Smart Contract (LoCSC). Subsequently, banks involved in the transaction view and share the agreement rules with each other, and the letter of credit is stored on the blockchain as encrypted data, ensuring data security.

The exporter initiates the shipment and updates the cargo status within the system, while the importer acknowledges receipt of the cargo and updates the trading status, overseen by the Logistics Smart Contract (LSC). The exporter then requests a Bill of Lading (BoL), and this request undergoes validation and is securely stored on the blockchain through communication between the banks involved. Upon successful completion of the transaction, the exporter receives payment and updates the status accordingly. Simultaneously, the importer makes the payment for the cargo, and the release of the Bill of Lading is executed by the bank, managed by the Trade Smart Contract (TSC).

Throughout this process, all transactions are securely stored and traceable on the blockchain, and the immutability of the data ensures that it cannot be altered or deleted, providing a robust and transparent foundation for the entire trade and financial transaction ecosystem.

In Figure 6.1, we present the frontend of our developed system, implemented using the Solidity programming language on the Polygon blockchain. The execution of any function within this system incurs a deduction of MATIC, the native currency of the Polygon network, from our wallet. MetaMask serves as the designated wallet for our system, holding the MATIC currency. Facilitating seamless testing on the Mumbai Testnet, our system leverages the Mumbai Faucet. This mechanism functions by dispensing test tokens, including MATIC and other ERC-20 tokens, to users upon request. These test tokens enable users to thoroughly test their decentralized applications (dApps) on the Mumbai Testnet without incurring actual gas fees or risking real currency. Additionally, the Mumbai Faucet serves as a valuable resource for developers, allowing them to validate and refine their smart contracts in the Mumbai Testnet environment by providing the necessary test tokens for testing purposes. To utilize the Mumbai Faucet, users are required to link their MetaMask wallet to the Mumbai Testnet and submit a request for test tokens. Subsequently, the allocated test tokens are transferred to the user's wallet, enabling them to initiate and conduct testing activities on the Mumbai Testnet. Notably, the Mumbai Faucet boasts a user-friendly interface, simplifying the process for both developers and users to request test tokens and engage in comprehensive testing of their dApps on the Mumbai Testnet. This user-friendly approach enhances the overall testing experience, fostering a more accessible and efficient testing environment for the development and refinement of blockchain-based applications.

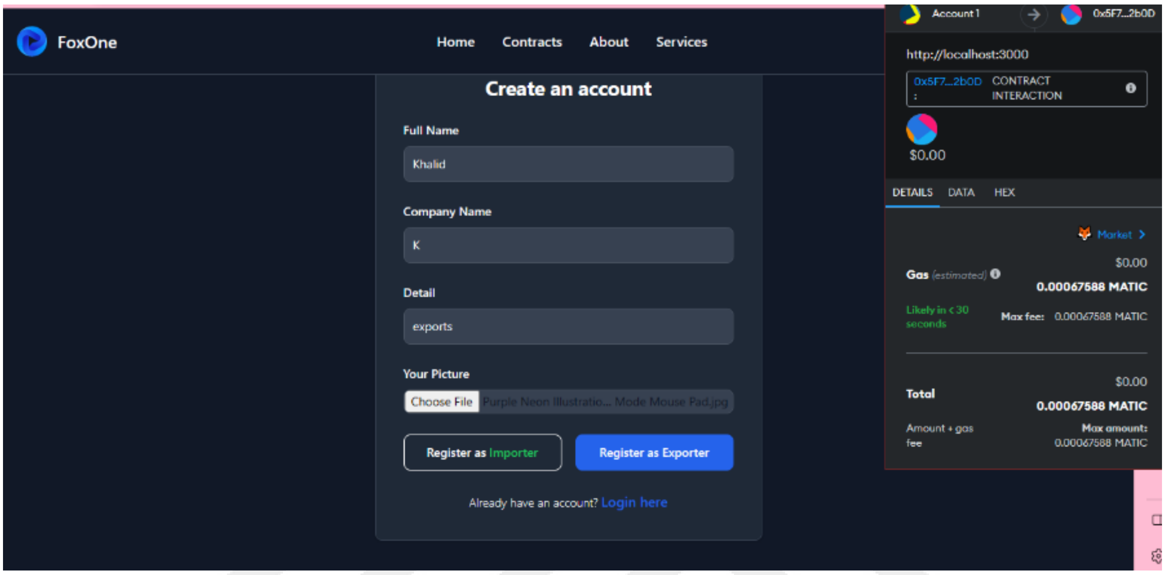

Figure 6.2: Login Screen.

Illustrated in Figure 6.2 is the login interface of our proposed system, allowing users to access the system as either an importer or an exporter. Authentication is facilitated through MetaMask, and since each MetaMask address is unique to an individual, users are spared the need to repeatedly log in or enter passwords on the website.

Upon successful login, users are presented with a list of available importers and exporters. Selection of the desired trading partner initiates the creation of a contract. As depicted in Figure 6.3, the system displays a repository of previously generated contracts. Each contract is uniquely identified by a contract ID, ensuring distinctiveness across all contracts. The system allows for the creation of multiple contracts, providing flexibility for users. However, it's crucial to note that once the contract details are added, they become immutable.

To commence the secure trading process, users select the recently created contract from the list in Figure 6.3. The system deducts a specified amount of MATIC from the user's wallet upon the successful creation of a contract. A notification confirming the successful creation of the contract is promptly displayed on the screen. This seamless and secure process streamlines the initiation of trade agreements, utilizing blockchain technology to ensure transparency, immutability, and traceability throughout the entire contract creation and trading process.

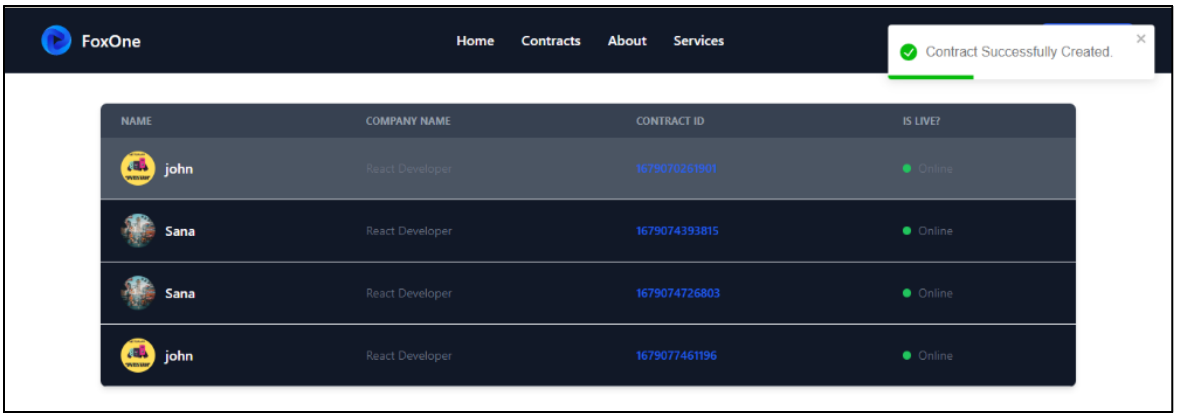

Figure 6.3: Contracts Available.

Figure 6.3 is a comprehensive depiction of the entire trading process, illustrating the sequential steps involved in facilitating a trade agreement. The initiation of this process begins as the importer sends a request for contract creation. Subsequently, the exporter reviews the contract details and affirms the agreement by signing from their perspective within the system. Upon successful signing of the contract, the trading process advances with the confirmation of the order. The importer, now in control, proceeds to create the Letter of Credit (LOC) from their viewpoint, inputting all the necessary details as depicted in Figure 10a. Importantly, a PDF document of the LOC is generated and securely stored on the blockchain with a comprehensive history. The exporter, having visibility into the LOC, acknowledges the terms and conditions and dispatches the cargo accordingly. Following the shipment, the exporter submits the Bill of Lading (BOL) through the system, contributing to the meticulous documentation of the transaction. Each step of this process is meticulously recorded, ensuring transparency, traceability, and immutability on the blockchain. This integrated approach leverages blockchain technology to streamline and secure the trading process, providing a comprehensive and tamper-proof record of each transaction. The utilization of smart contracts and distributed ledger technology enhances the efficiency and reliability of the entire trade lifecycle, from contract initiation to the successful completion of the shipment and documentation.

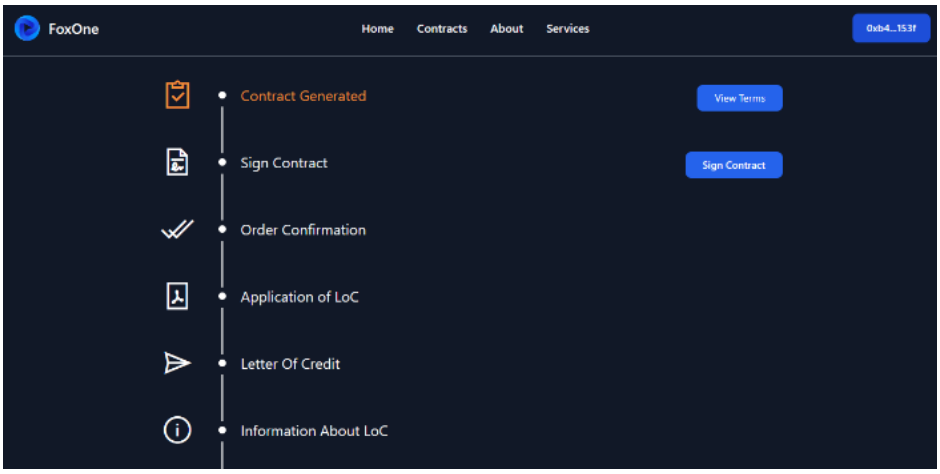

Figure 6.4: Process Our Work.

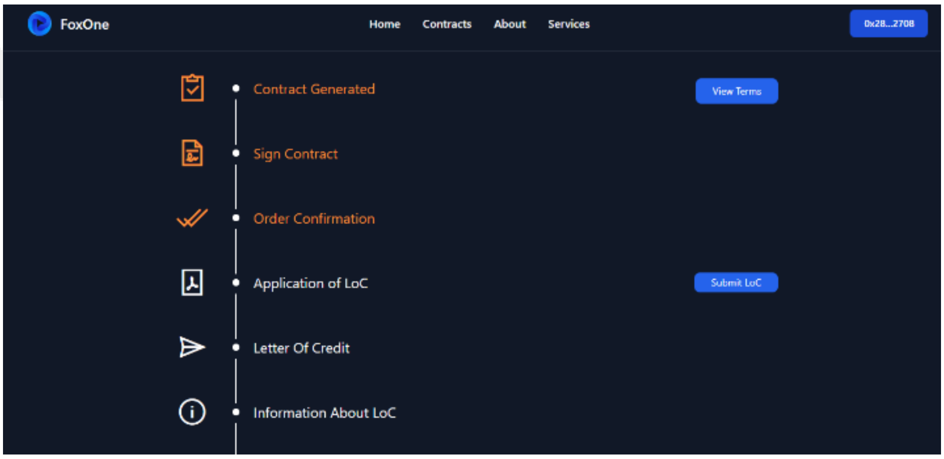

Figure 6.5: Continue Process Our Work.

Upon successful confirmation of the Bill of Lading (BOL) in Figure 6.5, the exporter is entitled to receive their payment. This pivotal step marks the culmination of the trading process. Furthermore, the system generates a PDF document encompassing all pertinent details and relevant documents, ensuring a comprehensive and secure record of the transaction. These documents are then securely stored on the blockchain, leveraging the inherent tamper-proof and transparent nature of distributed ledger technology.

The integration of blockchain technology significantly enhances the reliability of the system. The Letter of Credit (LOC) and Bill of Lading (BOL) created during the trading process are rendered tamper-proof and immutable through their storage on the blockchain. This ensures that the transaction history and associated documents can be viewed by all relevant parties, fostering trust, transparency, and accountability within the trade ecosystem. By employing blockchain, the system not only facilitates secure and efficient transactions but also establishes a robust infrastructure for documentation and record-keeping. The tamper-proof nature of blockchain ensures the integrity of critical trade documents, providing a trustworthy and transparent platform for all stakeholders involved in the trading process.

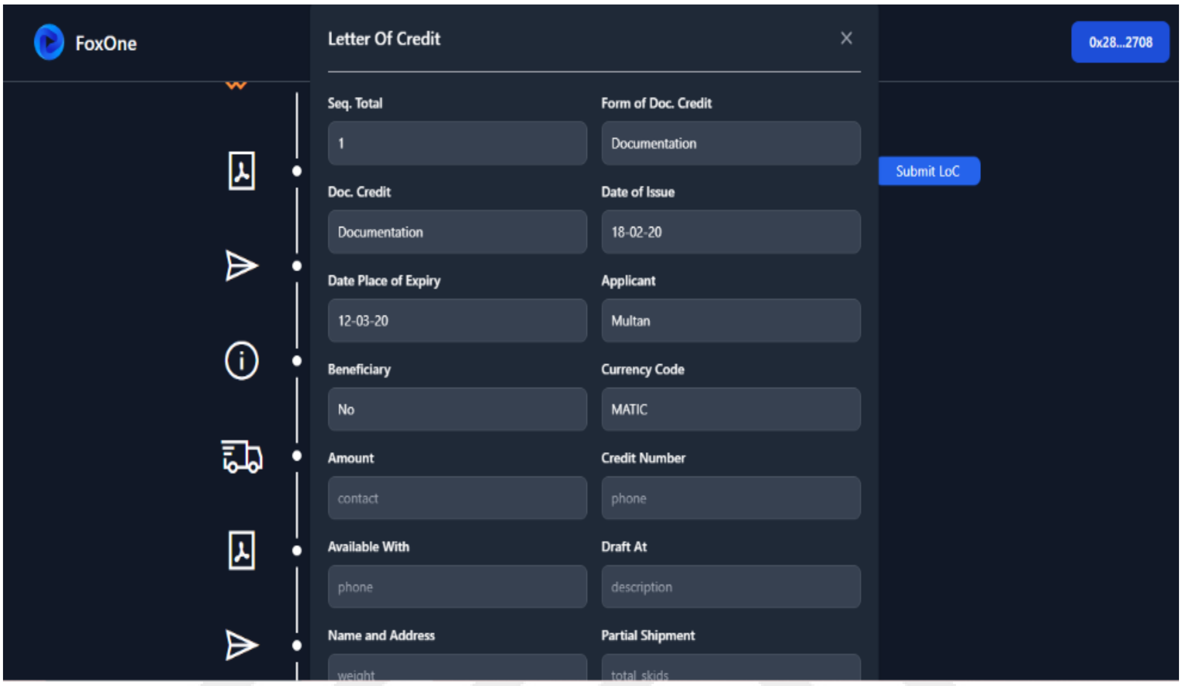

Figure 6.6: Letter of Credit.

Figure 6.7: Final Process Our Work.

This research contributes to the transformation of the traditional international trade process by introducing innovation. In the context of this study, innovation, pertains to an idea that gains acceptance or adoption by individuals or organizations. The acceptance of an innovation is influenced by five pivotal factors: relative advantage, compatibility, complexity, trialability, and observability.

Relative advantage refers to the benefits or advantages that the innovation can generate and provide. Compatibility involves the alignment between the value and user needs of the new concept with past experiences. Complexity assesses how easily the innovation can be used or understood, while trialability gauges the degree to which the innovation can be experimented with under certain conditions. Lastly, observability measures the extent to which the contribution of an innovation can be potentially observed or acknowledged by users.

In our analysis, we evaluate the value proposition of the proposed blockchain-based system against these critical factors for innovation acceptance. The results of this analysis are detailed below.

The blockchain-based system offers a significant relative advantage by enhancing the transparency, security, and efficiency of the international trade process. Its compatibility with the existing trade infrastructure is reinforced by its seamless integration with familiar tools like MetaMask and its adherence to established practices in trade agreements. Despite the sophisticated technology underpinning the system, efforts have been made to minimize complexity, ensuring ease of use and comprehension. Trialability is facilitated through features such as the Mumbai Faucet, allowing users to experiment with the system in a risk-free environment. The observability of the system's contribution is evident in the transparent and tamper-proof record-keeping on the blockchain, reinforcing trust among users.

7. CONCLUSION

7.1 CONCLUSION

In conclusion, this study presents a comprehensive and insightful exploration of the transformative potential embedded in the adoption of a blockchain-based platform to revolutionize traditional international trade processes, with a specific emphasis on optimizing Letter of Credit (LoC) transactions. The meticulous evaluation of the proposed system against critical factors influencing innovation acceptance underscores a highly promising landscape for the widespread adoption of blockchain technology within the expansive realm of global trade. The evident relative advantage offered by the blockchain-based system manifests in substantive improvements across transparency, traceability, and process automation. The strategic deployment of smart contracts within the system not only streamlines and enhances the trading process but also significantly reduces trade frictions and expedites the transmission of crucial trade documents. Crucially, the system's compatibility with traditional LoC processes is not merely retained but elevated through meticulous design grounded in Object-Oriented Analysis (OOA) and Unified Modeling Language (UML) modeling. This design framework ensures the seamless integration of blockchain technology into existing trade practices, thereby addressing the concerns and meeting the expectations of traditional LoC users.

While acknowledging the inherent complexity associated with blockchain technology, spanning cryptography, consensus algorithms, and programmable application languages, the study anticipates a gradual reduction in complexity. This aligns with the broader trend of technological evolution, as industry players become more acquainted with the benefits and intricacies of blockchain, thereby anticipating a decrease in perceived complexity.

The trialability of blockchain technology is robustly underscored by successful implementations in the international trade sector, exemplified by collaborations between major industry players such as IBM and Maersk. Tangible benefits, including cost reduction, heightened transparency, and increased efficiency observed in these trials, contribute significantly to the overall acceptability and feasibility of blockchain solutions in global trade. While observability is currently perceived as relatively low, the expectation of an increase is well-justified with the growing applications of blockchain in various domains.

As blockchain becomes more prevalent and accessible, the anticipated improvement in observability is poised to foster a better understanding of the technology among a broader audience, thereby contributing to its wider acceptance and adoption. In essence, the findings of this study underscore that blockchain technology, strategically implemented in the context of international trade, holds vast potential for transformative change. The convergence of enhanced transparency, traceability, and efficiency, coupled with compatibility with existing processes and a foreseen reduction in complexity, positions blockchain as a potent catalyst for innovation in global trade practices. The ongoing evolution of the technology, coupled with the increasing success of trials, suggests that the widespread adoption of blockchain in international trade is not merely on the horizon but is imminent, heralding a new era characterized by heightened efficiency, reduced risks, and augmented trust in cross-border transactions.

As the global business landscape continues its dynamic evolution, the integration of blockchain technology into foreign trade processes is not just advantageous but emerges as an essential and strategic imperative for businesses aiming to remain competitive, resilient, and adaptive in an increasingly interconnected and dynamic world. The paradigm shift towards blockchain-based solutions promises to reshape the foundations of international trade, providing a robust framework for efficient, secure, and transparent cross-border transactions.

7.2 FUTURE RECOMMENDATIONS

In charting the future course for research, a comprehensive set of recommendations emerges, each aimed at advancing the understanding and application of blockchain-based solutions in international trade. A pivotal suggestion involves conducting a longitudinal study to meticulously assess the sustained impact of implementing blockchain in trade over an extended period. This entails tracking the system's performance and soliciting feedback from users to gauge its influence on trade efficiency, risk mitigation, and trust establishment. Another critical avenue for exploration lies in investigating global adoption strategies, delving into the diverse approaches and potential challenges encountered by different countries and regulatory bodies. This research should scrutinize legal frameworks, address adoption barriers, and propose strategies to foster a more widespread acceptance of blockchain solutions on a global scale. Addressing scalability and interoperability challenges is imperative, examining how the proposed system can seamlessly integrate with existing trade platforms and exploring solutions to enhance its scalability. A robust analysis of cybersecurity and privacy measures is crucial, identifying vulnerabilities and recommending advanced security protocols to safeguard sensitive trade information. Regulatory compliance frameworks need to be developed, aligning the system with existing and future trade regulations, customs protocols, and financial compliance standards. In tandem, the design and implementation of user training programs are essential for facilitating seamless adoption, addressing potential resistance, and ensuring a smooth transition from traditional trade practices. Exploring integration with emerging technologies like AI, IoT, and machine learning is recommended, as is an evaluation of the environmental and sustainability impact of implementing blockchain in international trade, considering paper reduction, energy consumption, and ecological benefits. Encouraging collaborative research initiatives involving academia, industry, and governmental bodies is pivotal for a holistic understanding of blockchain's potential, while staying abreast of technological evolution ensures continuous integration of advancements in consensus algorithms, cryptographic techniques, and governance models into the proposed system. By adhering to these multifaceted recommendations, researchers can significantly contribute to refining and advancing blockchain-based solutions in international trade, fostering a resilient, efficient, and sustainable global trade ecosystem.

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