جـــامـــعـــة الـــشـــرق الأوســـط
MIDDLE EAST UNIVERSITY
Amman - Jordan

The Impact of Blockchain on the Digitalizing Courier System of Supply Chain in Jordan

أثر سلاسل الكتل على رقمنة نظام البريد السريع لسلسلة التوريد في الأردن

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Thesis Submitted as Partial Fulfillment of the Requirements for Master's Degree in Business Administration.

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Dedication

I extend my deepest gratitude to my **mother** and to the memory of my **father**, whose love and guidance have been with me in all my endeavors. They have been the ultimate role models.

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Mustafa Yousef Jaber

Table of Contents

Subject **Page**

Chapter Three: Study Methodology (Methods and Procedure)

Chapter Four: Data Analysis

List of Tables

List of Models

List of Figures

List of Appendices

The Impact of Blockchain on the Digitalizing Courier System of Supply Chain in Jordan

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Abstract

Purpose: This study explores the impact of the collective blockchain sub-variables (Decentralization, distributed ledger, cryptography, immutability, and smart contract) on the digitalization of the courier system in logistics firms in Jordan, focusing on digitalization dimensions such as real-time tracking, digital documentation, automated operations, transparency, and cybersecurity.

Design/Methodology/Approach: A quantitative, descriptive, and cause-effect study design was utilized. Data were collected through questionnaires from 130 managers, supervisors, and operators in 35 Jordanian logistics and courier firms out of 200 companies operating in Jordan. The data collection tool was validated and checked for reliability. Next, descriptive and correlation analyses were run, and finally, multiple regression analyses were used to find the impact.

Findings: The results indicate that blockchain significantly impacts the courier system's digitalization, with the most significant impact on automated operations, followed by transparency and digital documentation. However, real-time tracking and cybersecurity showed no significant impact from blockchain implementation. Additionally, Jordanian logistics and courier firms are highly implementing blockchain technology and digitalizing their courier systems. A strong correlation exists between collective blockchain sub-variables and the dimensions of the digitalized courier system.

Practical and Managerial Implications: Integrating blockchain into the digitalization of courier systems is essential. Firms should embrace blockchain technology in their vision, mission, and strategies to enhance their digitalization processes.

Social Implications: Firms are encouraged to adopt corporate social responsibility practices, beginning with automated operations, digital documentation, and enhanced transparency throughout the courier process.

Limitations/Recommendations: This study is cross-sectional and limited to Jordanian logistics and courier firms. It recommends future research, conducting longitudinal studies, and including larger groups to validate the current model and measurement instruments. Similar studies in other Arab countries are recommended to assess the generalizability of the results.

Originality/Value: This study is among the few that examine the impact of blockchain technology on the digitalization of the courier system within the Jordanian logistics industry.

Keywords: Blockchain, Digitalizing, Courier, Logistics, Automated, Documentation, Transparency, Real-Time Tracking, Cybersecurity.

أثر تقنية سلاسل الكتل على رقمنة نظام البريد السريع لسلسلة التوريد في الأردن

اعداد:مصطفى يوسف جابر

اشراف: الاستاذ. الدكتور: عبد العزيز أحمد الشرباتي

الملخص

الغرض: تستكشف هذه الدراسة تأثير المتغيرات الفرعية الجماعية لسلسلة الكتل (اللامركزية، والسجل الموزع، والتشفير، والثبات، والعقد الذكي) على رقمنة نظام البريد السريع في شركات الخدمات اللوجستية في الاردن، مع التركيز على أبعاد الرقمنة مثل التتبع في الوقت الفعلي، والتوثيق الرقمي، والعمليات الآلية، والشفافية، والأمن السيبراني.

التصميم/المنهجية/المنهج: تم استخدام تصميم دراسة كمية ووصفية وسببية. تم جمع البيانات من خلال استبيانات من 130 مديرًا ومشرفًا ومشغلًا في 35 شركة لوجستية وبريد سريع أردنية من أصل 200 شركة تعمل في الأردن. تم التحقق من صحة أداة جمع البيانات والتحقق من موثوقيتها. بعد ذلك، تم إجراء تحليلات وصفية وارتباطية، وأخيرًا، تم استخدام تحليلات الانحدار المتعددة للعثور على التأثير.

النتائج: تشير النتائج إلى أن تقنية البلوك تشين تؤثر بشكل كبير على رقمنة نظام البريد السريع، مع التأثير الأكبر على العمليات الآلية، تليها الشفافية والتوثيق الرقمي. ومع ذلك، لم يظهر التتبع في الوقت الفعلي والأمن السيبراني أي تأثير كبير من تنفيذ تقنية البلوك تشين. بالإضافة إلى ذلك، تنفذ شركات الخدمات اللوجستية والبريد السريع الأردنية تقنية البلوك تشين بشكل كبير ورقمنة أنظمة البريد السريع الخاصة بها. يوجد ارتباط قوي بين المتغيرات الفرعية الجماعية لتقنية البلوك تشين وأبعاد نظام البريد السريع الرقمي.

الآثار العملية والإدارية: يعد دمج تقنية البلوك تشين في رقمنة أنظمة التوصيل أمرًا ضروريًا. يجب على الشركات تبني تقنية البلوك تشين في رؤيتها ورسالتها واستراتيجياتها لتعزيز عمليات الرقمنة الخاصة بها.

الآثار الاجتماعية: توصي هذه الدراسة الشركات بالنظر في المسؤولية الاجتماعية للشركات فيما يتعلق بأنشطة البريد السريع، بدءًا من أتمتة العملية، والتوثيق الرقمي وتقليل استخدام الأوراق، والشفافية طوال العملية.

القيود/التوصيات: هذه الدراسة مقطعية وتقتصر على شركات الخدمات اللوجستية والبريد السريع الأردنية. وتوصي بإجراء أبحاث مستقبلية، وإجراء دراسات طولية، وإشراك مجموعات أكبر للتحقق من صحة النموذج الحالي وأدوات القياس. كما يوصى بإجراء دراسات مماثلة في دول عربية أخرى لتقييم إمكانية تعميم النتائج.

الأصالة/القيمة: تُعد هذه الدراسة من الدراسات القليلة التي تبحث في تأثير تقنية البلوك تشين على رقمنة نظام التوصيل داخل قطاع الخدمات اللوجستية الأردني.

الكلمات المفتاحية: سلسلة الكتل، رقمنة البريد السريع، الخدمات اللوجستية، الآلي، التوثيق، الشفافية، التتبع في الوقت الحقيقي، الأمن السيبراني.

Chapter One
Study Background and Significance

1.1 Background

The logistics sector faces heightened competition in today's technologically driven era, where information and communication technologies (ICTs) enable innovation and integration. E-commerce platforms propel cross-border transactions, increasing reliance on courier services for rapid deliveries.

This global shift necessitates efficient, transparent, and reliable supply chains. However, current courier logistics rely on centralized systems, leading to linear information and goods flow. Manual record-keeping, fragmented data storage, outdated software, and limited traceability hinder real-time visibility and optimal route planning. Additionally, reliance on intermediaries for validation and documentation increases costs and exposes vulnerabilities due to a lack of transparency.

Blockchain technology, with its decentralized, transparent, and immutable nature, offers a transformative solution for the courier industry. It is potential to enhance traceability, streamline operations, save time, and strengthen security holds immense promise for reshaping traditional logistics frameworks.

According to Ducret (2014), and Ruvoletto (2023), the courier sector confronts mounting demands for enhanced efficiency and transparency. Conventional logistics, reliant on manual records and fragmented data, struggle to meet these escalating customer expectations, prompting a need for substantial improvement. Erceg & Damoska (2019) pointed out that the rise of e-commerce has transformed logistics, fostering a competitive environment where innovation is vital. Utilizing Information and Communications Technology (ICT) is pivotal for companies to provide efficient, cost-effective services, elevating customer satisfaction and granting a substantial competitive edge in the logistics sector. Attaran & Gunasekaran (2019) pointed out that blockchain technology is a game changer in industries as it boosts automation. It also uses smart contracts and self-executing agreements within the blockchain to automate business tasks, and make resource management better. Litke et. al. (2019) pointed out the reliance on intermediaries for validation and documentation, which leads to increased operational costs and potential vulnerabilities in the supply chain. Zhou et. al. (2024) pointed out that reliance on intermediaries for validation and documentation adds to operational costs and exposes the supply chain to potential vulnerabilities. According to Garg (2020), Blockchain technology offers a secure, decentralized, and transparent way to handle and exchange data. Raja & Muthuswamy (2022) pointed out that It uses distributed ledger technology to follow products and assets across supply chains, giving instant visibility, saving time, and ensuring traceability. Furthermore, Visalli & Soldano (2022) pointed out that smart contracts automate processes and enforce agreements, making operations smoother and cutting down expenses. Bodemer (2023) added that Blockchain technology's decentralized, transparent, and immutable nature signifies its potential as a transformative innovation poised to revolutionize the courier industry, showcasing its pivotal role in reshaping the sector's operations. According to Alacam & Sencer (2021), blockchain's potential to revolutionize logistics by favoring decentralized, collaborative models marks a significant departure from traditional hierarchical structures. This technology's innate capabilities have ignited substantial enthusiasm within the courier industry. Khan & Al-Amin (2022) pointed out that blockchain technology can modernize industries by shifting them from old-fashioned paper-based systems to transparent, secure, and efficient digital setups. Madhwal et. al (2022) pointed out that, in fast deliveries within supply chains, blockchain shows promise in digitalizing the final steps, improving transparency, traceability, and satisfying customers.

1.2 Study Purpose and Objectives:

The purpose of this study is to explore the impact of blockchain technology on the digitization of courier supply chains, through the following objectives, which revolve around five main objectives:

1. To evaluate the usage level of blockchain within courier supply chains.
2. To evaluate the level of digitalization within courier supply chains.
3. To measure the relationship between Blockchain and digitalization within courier supply chains.
4. To explore the impact of blockchain on digitalization within courier supply chains.

1.3 Study Significance and Importance:

The importance of this study lies in the fact that it was one of the few studies conducted in Jordan, or it might be the first study conducted in Jordan on this topic and conducted a comprehensive examination of the transformative potential of blockchain technology within the courier supply chain. It is also one of the few studies in the Arab world that discussed the impact of Blockchain on the digitization of courier supply chains. And provide strategic insights on leveraging blockchain technology to digitalize. By exploring the multi-faceted roles of blockchain, the study intends to provide actionable recommendations to revolutionize courier logistics.

Therefore, the value of this study arises from the following practical considerations:

1. The study directly explores the real-world application of blockchain technology within courier supply chains, it provides practical insights that can be implemented by courier and logistics companies, and other industries.
2. The study provides actionable recommendations for the adoption and implementation of blockchain technology in courier supply chains. These insights can guide decision-makers in this and other industries to strategize and effectively implement technological advancements.
3. The study contributes to the regional understanding and application of blockchain technology in the Arab world.

The value of this study arises from the following academic considerations:

1. The study filled a significant knowledge gap by exploring the potential of digitalization by adopting blockchain technology within courier supply chains.
2. The study explored the features of blockchain technology and provided theoretical insights into its potential for digitalization within the courier logistics framework.

1.4 Study Problem Statement:

In interviews conducted with managers of delivery and logistics firms for a separate research project. Managers highlighted major issues in the supply chain, mainly concerning traceability. These problems include limited visibility, communication breakdowns, potential errors in data processing, and evolving security threats. To improve transparency, managers have tried real-time tracking updates and proof of delivery, but reliance on paperwork and outdated data remains, hindering effectiveness in today's industry.

To address these challenges, based on previous studies and the researcher's experience, blockchain was proposed for digitalizing the courier system in the supply chain. Blockchain's decentralized ledger system enhances traceability (Merkaš et. al., 2020), (Hackius, 2022) prevents fraud (Rathore, 2019), and improves record-keeping (Yaga et. al.,2018) from origin to delivery. Additionally, smart contracts within the blockchain can increase efficiency and transparency (Saberi et. al., 2018) and (Ugochukwu et. al.,2022).

Kanike (2023) pointed out challenges in the courier supply chain problems with tracking visibility, communication disruptions, human errors, and security threats, these issues hinder tracking shipments, updates, and issue resolutions. Moreover, Kramarz (2023) highlighted that repeated delivery attempts due to outdated data showcase the shortcomings of traditional courier operations in achieving full traceability. The study conducted by Raj et. al. (2024) raised the same issues and said that traditional courier operations encounter difficulties with real-time package visibility, challenges involving limited visibility, communication problems, errors, and security threats impede effective tracking, in addition to practitioner company Faster-capital (2024) published that real-time tracking updates and proof of delivery documents were suggested to improve visibility, provide evidence of successful deliveries, and reduce disputes. However, Gurzhii et.al. (2022) recommended that more research is needed to understand blockchain's potential and resolve any remaining challenges, and future studies should examine how blockchain can be used in various sectors, like manufacturers, logistics providers, and retailers, in another study conducted by Noor et.al. (2022) supported the idea that Blockchain technology, with decentralization, transparent, and unchangeable nature, provides a promising solution to revolutionize courier operations, and Lam (2023) pointed out that blockchain's decentralized feature enables simultaneous data access and updates, ensuring real-time package tracking. Moreover, Fedchun et. al. (2020) mentioned that secure record-keeping protects tracking information, while strong encryption fights security risks. on the other hand, Nahayo & Al-Azawi (2023) highlighted how integrating digital blockchain technology into traditional courier operations holds promise in addressing traceability challenges. Furthermore, Zhu (2023) noted that Blockchain's transparency and immutability tackle limited visibility. Its decentralized, secure communication minimizes disruptions. Automated record-keeping cuts human errors, while robust encryption combats security threats. Clearly, Chadha et. al (2022) declared that Blockchain technology could revolutionize the courier industry. Its decentralized structure provides a secure hub for supply chain participants, ensuring real-time tracking, transparent transactions, and less paperwork and unnecessary visits. Additionally, blockchain helps minimize human errors and security risks. However, Petersson & Baur (2018) recommended that the use of blockchain in courier services is new, requiring further research to grasp its advantages and obstacles fully.

Therefore, this study explored how blockchain can impact Digitalizing the courier supply chain.

Study Questions

The current study is devoted to answering the following main questions:

1. What is the level of using Blockchain within the Courier System?
2. What is the level of digitalization within the Courier System?
3. Is there a relationship between Blockchain and Digitalizing Courier System?
4. Is there an impact of collective Blockchain sub-variables on Digitalizing the Courier System’s dimensions?

The first and second questions were answered by descriptive statistics, the third question by using a correlation test, and the fourth question was answered by the following hypothesis.

1.5 Study Hypothesis:

Main Hypothesis:

H_{01}: There is no impact of the collective blockchain sub-variables on the Digitalizing Courier System dimensions of the supply chain, at ($\alpha \leq 0.05$).

Based on blockchain effects the main hypothesis can be divided into the following sub-hypotheses:

$H_{01.1}$: There is no impact of the collective blockchain sub-variables on Real-time Tracking within the Digitalizing Courier System of the supply chain, ($\alpha \leq 0.05$).

$H_{01.2}$: There is no impact of the collective blockchain sub-variables on Digital Documentation within the Digitalizing Courier System of the supply chain, at ($\alpha \leq 0.05$).

$H_{01.3}$: There is no impact of the collective blockchain sub-variables on Automated Operations within the Digitalizing Courier System of the supply chain, at ($\alpha \leq 0.05$).

$H_{01.4}$: There is no impact of the collective blockchain sub-variables on Transparency within the Digitalizing Courier System of the supply chain, at ($\alpha \leq 0.05$).

$H_{01.5}$: There is no impact of the collective blockchain sub-variables on Cybersecurity within the Digitalizing Courier System of the supply chain, at ($\alpha \leq 0.05$).

Study Model

Based on the problem statement and the problem questions, the following model has been developed to study the effect of the blockchain on Digitalizing courier and logistics companies, as shown in the model (Figure 0.1), and the studies that illustrated the blockchain sub-variables and the dimensions of digitalization, and addressed the impact of blockchain on one or more of the dimensions of digitization.

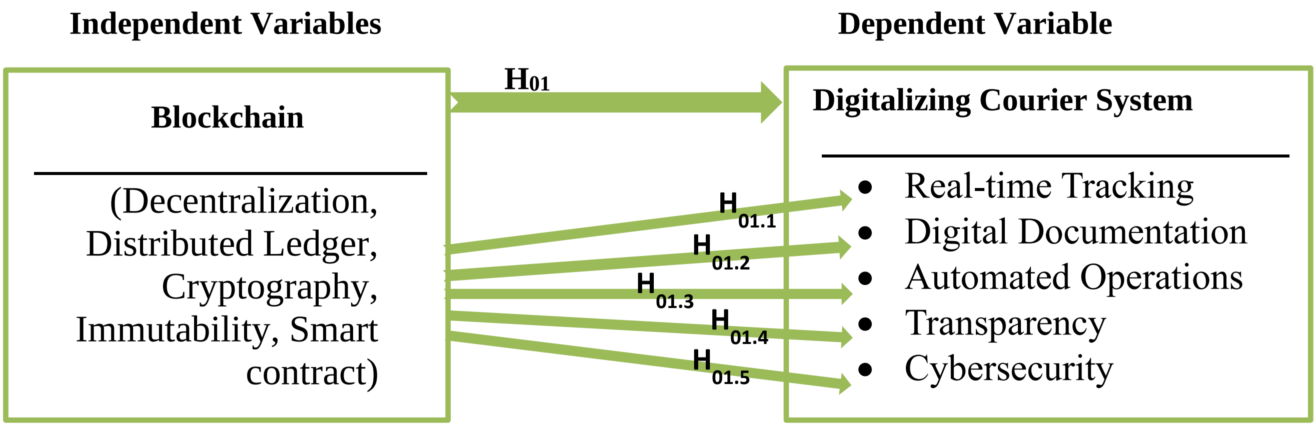


Figure (1.1): Study Model

Sources: This model was developed based on the following previous studies:

Independent variable: (Mondol, 2021; Sarfraz et.al. 2022; Anand,& Seetharaman, 2022; Chabani, & Chabani, 2022; Al Zaqeba et.al. 2022).

Dependent variable: (Lee et.al. 2022; Alexey et.al. 2019; Khan, 2021; Bhardwajet. al., 2021; Ghobakhloo & Iranmanesh, 2020).

1.6 Operational Definitions of Terms

Blockchain: The blockchain is a decentralized technology, originating from the concepts of Satoshi Nakamoto, that acts as a distributed ledger, using cryptography to maintain the integrity and immutability of data, forms an interconnected chain of blocks, to secure transactions, and enables the execution of trustless smart contracts without intermediaries. It is measured by the following five embedded elements: decentralization, distributed ledgers, cryptographic immutability, and smart contracts.

Decentralization: Decentralization in blockchain means data distribution without a single authority controlling it, enhancing reliability. It enables distribution systems with various authorities and enhances data exchange. It involves splitting data across networks, each node holds a copy, allowing direct access without central authorization, and distributing ledgers among peers for specialized applications like data validation. It is measured by the five questions that are listed in the questionnaire.

Distributed Ledger: A distributed ledger is a secure database shared among many people or locations managed by multiple nodes using peer-to-peer technology, enabling collective monitoring of transaction legitimacy. It ensures data storage and retrieval across the network without a single point of failure, It is a digital record synced across a network with data shared directly; it uses cryptography techniques that ensure tamper-resistant ledger entries, facilitating verifiable network behavior tracking**.** It is measured by the five questions that are listed in the questionnaire.

Cryptography: Cryptography is the science of hiding information using keys to encrypt and decrypt, ensuring confidentiality, integrity, authenticity, and non-repudiation. it is one of the data security strategies to protect digital information and prevent unauthorized access to computers, databases, and websites, It verifies the ownership and authenticity of digital assets. It is measured by the five questions that are listed in the questionnaire.

Immutability: Immutability in blockchain means once data is accepted, it cannot be altered, ensuring verified, unalterable records; while consensus from blockchain users is required for changes, preventing fraud as records are digitally signed and time-stamped for permanence, maintaining accuracy and integrity, that prevent tampering or deletion, and supporting error prevention, security, and efficient sharing. It is measured by the five questions that are listed in the questionnaire.

Smart Contract: A smart contract is a self-executing computer program on a blockchain, that validates and automatically executes predefined conditions without intermediaries, entails digital commitments for digital transactions, reduces manual interventions, automates due diligence processes, and automates legal contracts operating without external trusted authorities. It is measured by the six questions that are listed in the questionnaire.

Digitalization: Digitization refers to taking analog information and encoding it into zeros and ones so that computers can store, process, and transmit this information by applying information technology to enhance the performance of logistics operations, through an interactive web-based computerized platform accessible over the Internet, which can improve Case management and information access flow, which has features such as interconnection, automation, machine learning, use of real-time data while changing the structure of document exchange and delivery, accelerating the process of delivery and payment for carrier services, and increasing the efficiency of the main processes of logistics services. It is measured by the following five dimensions: Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity.

Real-time tracking: Real-time tracking means live monitoring, the identification of current location details for products, real-time status updates, unexpected events detection, and minimizing potential disruptions and damage. It is measured by the five questions that are listed in the questionnaire**.**

Digital Documentation: Digital documentation means documents, that are analog material text, are converted to digital form by using a broad suite of hardware and software to preserve original information digital archiving, is to ensure long-term access to digital documents. It is measured by the four questions that are listed in the questionnaire.

Automated Operations: Automated operation is defined as shifting work processes or equipment from manual to automated control, and computerization, a significant aspect of modern automation, and the allocation of tasks performed by machines reducing human errors, allocating computing resources, and allocating IT. It is measured by the five questions that are listed in the questionnaire.

Transparency: Transparency refers to the quality of information and openness to sharing information among parties, it is the practice of disclosing detailed and accurate information about operations and products, key concepts such as visibility, meeting the regulations, and procedures that will be used, and providing fairness in resolving disputes. It is measured by the four questions that are listed in the questionnaire.

Cybersecurity Measures: Cybersecurity refers to the methods and practices that have been developed to ensure the confidentiality of electronic information, the integrity of digital data, its availability, and its protection against security breaches and malicious attacks, as well as its protection during its transmission and storage. It is measured by the five questions that are listed in the questionnaire.

1.7 Study Limitations and Delimitations:

Limitations:

Human Limitation: This study was conducted on managers, supervisors, and operators of logistics and courier companies located in Jordan only.

Place Limitation: The study was carried out in Jordan.

Time Limitation: This study was carried out in 2024.

Study Delimitation:

This study explores how Blockchain impacts the digitalization of the courier system. However, its findings might not be broadly applicable beyond the courier and logistics industry in Jordan. Although the study covered significant aspects of blockchain in courier digitization, there are additional dimensions that remain unexplored.

Chapter Two

Theoretical and Conceptual Framework and Literature Review

2.1 Introduction:

This chapter includes definitions and components of blockchain and Digitalizing couriers, the relationship between blockchain and Digitalizing couriers, and previous models and previous studies. Finally, it summarizes what differentiates this study from previous studies.

Theoretical and Conceptual Framework:

2.2 Definitions and Components of Independent Variable (Blockchain):

Despite the various terms used to describe blockchain, there is a consensus among practitioners, researchers, and scholars regarding its definition.

Tribis et.al. (2018) stated that blockchain is a decentralized technology created by Satoshi Nakamoto. Meanwhile, Saberi et.al. (2018) defined blockchain as a distributed database that records all digital events between participants in a decentralized manner. It has its origins in distributed ledger technology. While Sarmah (2018) pointed out that It is a digital ledger in a peer-to-peer network. Then, Viriyasitavat & Hoonsopon, (2019) mentioned that blockchain is a technology that maintains unchangeable data integrity by recording transactions across linked nodes in a peer-to-peer network to ensure immutability. After that, Singh et.al. (2020) stipulated the definition of the Blockchain that is a platform for building trustless, self-executing applications (smart contracts) without relying on middlemen. Until, Moosavi et.al. (2021) indicated that blockchain is a distributed database of transactions, ledgers, and digital occurrences. Then, Mohit et. al. (2022) said that blockchain In the supply chain could increase trust, improve traceability, and eliminate the middleman. Hence, Zhu (2023) illustrated blockchain as an expanding chain of connected blocks, each holding data, timestamps, and references to previous blocks through cryptographic hashes. It creates a secure, sequential ledger of transactions, resistant to unauthorized changes.

In summary, the blockchain is a decentralized technology, originating from the concepts of Satoshi Nakamoto, that acts as a distributed ledger, using cryptography to maintain the integrity and immutability of data, and forms an interconnected chain of blocks, to secure transactions, improve traceability, and enable the execution of trustless smart contracts without intermediaries.

2.3 Blockchain Elements:

It has been noted that the studies and literature that have dealt with blockchains and their embedded elements are limited. Therefore, this study examined the main embedded elements of blockchains described by scholars and researchers.

Puthal et.al. (2018) listed the characteristics of blockchain decentralization, immutability, distributed digital ledger, and cryptography. Then, Politou et. al. (2019) pointed out that Immutability, or irreversibility, is a fundamental blockchain property. Moreover, Cong, & He (2019) described two sub-variables decentralization and Smart contracts. Meanwhile, Voulgaris et. al. (2019) illustrated that the functionality of the smart contract is one of the basic elements that determine the operation of the blockchain. After that, Manu et.al. (2020) mentioned that the basic hashing mechanism is the key factor in cryptographic algorithms, and for blockchain, it is a key component for building blocks. Until Zarrin et. al. (2021) listed three sub-variables of the blockchain, Distributed ledger, immutability storage, and smart contract. While, Aggarwal & Kumar. (2021) indicated that blockchain architecture consists of various components like smart contracts and distributed ledgers. Clearly, Habib et.al. (2022) declared Ten sub-variables of blockchain were included, three of which were considered in this study decentralization, immutability, and cryptography.

In this study, the proposed blockchain components are Decentralization; Distributed ledger; Cryptography; Immutability; and Smart contracts.

Decentralization: Garza et. al. (2015) described Decentralization as a close feature of blockchains, as it provides a large amount of redundancy necessary for the way massive data is distributed without being controlled by a single entity. Delivery time frames range from seconds to days, depending on the level of decentralization. Then, Zhu (2018) said decentralization means removing intermediaries. Furthermore, Gochhayat et. al. (2020) pointed out that Decentralization refers to distributed systems where various authorities control different components, and no single authority is entirely trusted. It relates to system control, with increased decentralization enhancing resistance against censorship and tampering. Meanwhile, Vergne (2020) mentioned that decentralization refers to the broad dispersion of the ability to exchange data and information within communication systems. While, Shubina et.al. (2020) defined decentralization as splitting and storing information across a network rather than a central server, ensuring no single entity controls all data, this concept has gained importance, notably in digital contact tracing during the global COVID-19 pandemic. Until, Taloba et. al. (2021) illustrated that Decentralization, in blockchain means that each node has its copy of the data in its local machine and has direct access to its owners without the need for any central authorization. Likewise, Cedeno et.al. (2022) indicated that decentralization involves distributing the entire ledger among network peers, it's utilized in a specialized application for sharing and validating geospatial data points.

In summary, Decentralization in blockchain means data distribution without a single authority controlling it, enhancing reliability. It enables distribution systems with various authorities and enhances data exchange. It involves splitting data across networks, Each node holds a copy, allowing direct access without central authorization, and distributes ledgers among peers for specialized applications like data validation.

Distributed Ledger: Deshpande et.al. (2017) pointed out that a distributed ledger in blockchain is a database shared among many people or locations, where each person has the same copy. It is a digital record of transactions or agreements, synced across a network so everyone can see the information at the same time. Then, El Ioini & Pahl, (2018) illustrated that distributed Ledger allows users who do not necessarily trust each other to interact without the need of a trusted third party. After that, Chowdhury et. al. (2019) defined a distributed ledger as it is a chain of blocks with strict rules, ensuring data storage and retrieval across the network without a single failure point. Yzquierdo (2020) mentioned that a distributed ledger is the method used to maintain ledger records, employing Peer-to-Peer (P2P) technology where computers directly share data without relying on a central server. Meanwhile, Xue et. al. (2020) pointed out that a distributed ledger involves transaction accounting by multiple nodes across various locations. Each node maintains a complete record, enabling them to monitor transaction legality collectively and provide joint testimony for it. Charalampidis & Fragkiadakis (2020) clarified that the distributed ledger is a combination of three components of a peer-to-peer network, distributed data storage, and cryptographic techniques to ensure the validity of ledger entries that enable network behavior to be tracked in a verifiable and tamper-resistant manner. Moreover, den Heuvel et.al. (2021) highlighted that a distributed ledger stores data in interconnected blocks using hash pointers. DLT emphasizes distributing data and transactions among participants and comparing transaction outcomes within the network.

In summary, a distributed ledger is a secure chain of blocks managed by multiple nodes using peer-to-peer technology, enabling collective monitoring of transaction legitimacy. It ensures data storage and retrieval across the network without a single point of failure. It is a digital record synced across a network with data shared directly; it uses cryptography techniques that ensure tamper-resistant ledger entries, facilitating verifiable network behavior tracking.

Cryptography: Paira & Chandra (2016) Cryptography means hiding information, covering writing using asymmetric keys for encryption and decryption, which are a private secret key for decryption and a shared public key for encryption to provide confidentiality, integrity, authenticity, and non-repudiation. Then, Gençoğlu (2019) mentioned that Cryptography is the science of hiding important information from unauthorized access. Meanwhile, Zhai et. al. (2019) pointed out that cryptography technology is mainly used to protect user privacy and transaction information and ensure data consistency. After that, Buop (2020) pointed out that cryptography refers to protecting information and communication through mathematical techniques, transforming messages to be tough to decode, and ensuring stored data protection and integrity. While Fedchun et. al. (2020) illustrated that Cryptography is utilized to verify digital asset ownership and authenticity, while consensus algorithms validate transactions for inclusion in the ledger and maintain the historical integrity of the ledger. Until, Choudhary & Husain (2023) defined Cryptography refers to the method of hiding the content of messages, and it is one of the data security strategies to protect digital information and prevent unauthorized access to computers, databases, and websites.

In Summary, Cryptography is the science of hiding information using keys to encrypt and decrypt, ensuring confidentiality, integrity, authenticity, and non-repudiation. it is one of the data security strategies to protect digital information and prevent unauthorized access to computers, databases, and websites, It verifies the ownership and authenticity of digital assets.

Immutability: Hofmann et.al. (2017) pointed out that Immutability refers to once data is accepted by the blockchain network, it cannot be altered or tampered with, the idea of immutability also extends to the regulations and functions of blockchain apps. Then, Savelyev (2018) defined immutability as the extreme difficulty of changing records, requiring consensus from the majority of blockchain users to make any changes. After that, Rathore (2019) illustrated that Immutability means that there is no possibility of tampering or change. Verified records that are added to the blockchain are digitally signed and time-stamped to create a permanent and immutable record without losing its accuracy, which ensures data integrity and prevents fraudulent activities. Furthermore, Bazel et.al. (2021) mentioned that Immutability refers to the ability of a blockchain ledger to remain unaltered or changed, so tinkering with any data is unfeasible. Meanwhile, Cirone (2021) indicated that Immutability is a fundamental principle in blockchain, that involves recording data in a way that essentially prevents its deletion or alteration. While Bakhshi & Ghita (2021) defined immutability refers to the once a record is added to the blockchain, it cannot fraud with or be deleted. However, Zhao (2023) said that Immutability as an object's unchangeable state after creation, advocated by API and programming language designers for bug prevention, security, simple state handling, and efficient and secure sharing.

In Summary, Immutability in blockchain means once data is accepted, it cannot be altered, ensuring verified, unalterable records; while consensus from blockchain users is required for changes, preventing fraud as records are digitally signed and time-stamped for permanence, maintaining accuracy and integrity, that prevent tampering or deletion, and supporting error prevention, security, and efficient sharing.

Smart Contract: Mohanta et. al (2018) defined a smart contract as a computer program consisting of a set of rules that runs on a blockchain, is validated by multiple parties, and is executed automatically based on pre-defined conditions, eliminating the need for an intermediary. Then, Zain et. al (2019) mentioned that a smart contract entails digital commitments and protocols guiding parties in fulfilling these commitments. Its optimal function lies in digital transactions. Meanwhile, Luciano (2019) illustrated the smart contract as a self-executing code that satisfies agreed-upon terms and conditions usually specified in existing contracts so that all permitted transactions are executed if pre-defined conditions are met and written as software code. While, Chang et. al. (2019) pointed out that a smart contract is one of the most important elements in blockchain design and application, as it can reduce manual interventions and automate SCM flows, improving the efficiency of SCM services. Furthermore, Roumpos (2020) mentioned that smart contract technology automates due diligence, contract drafting, approval, and submission processes. However, Hu et.al. (2020) indicated that a smart contract as an executable code designed for reliable software production. It emphasizes correctness, aiming to generate legally sound and error-free software. Combining software engineering theory, formal methods, and computational law, it seeks to reduce contract development errors, enhance development efficiency, and standardize the contract creation process. Moreover, Muneeb et. al (2021) defined Smart contracts are self-executing contracts deployed on the blockchain and include agreement terms between two or more entities. However, Zou et.al. (2021) said that a smart contract is the automation of legal contracts as a program running on a blockchain, a smart contract can be correctly executed by a network of mutually distrusting nodes without the need for an external trusted authority.

In Summary, A smart contract is a self-executing computer program on a blockchain, that validates and automatically executes predefined conditions without intermediaries, entails digital commitments for digital transactions, reduces manual interventions, automates due diligence processes, and automates legal contracts operating without external trusted authorities.

2.4 Definitions and Components of the Dependent Variable (Digitalizing system):

Digitalizing: Merriam-Webster (2024) defined that digitalizing linguistically is subject to digitalization. Lai et.al. (2010) defined the Digitization of logistics refers to the application of Information technology to enhance the performance of logistics operations. Thereafter, Gray & Rumpe, (2015) mentioned that digitalization means merging various technologies into all facets of daily life that can be digitized. It involves using digital technologies to alter business models, generating fresh revenue streams and avenues for creating value. Essentially, it is the shift toward a digital business. Then, Parviainen et. al. (2017) pointed out that the term digitization means the steps or operation of Digitalizing, the conversion of analog data into digital format. After that, Bloomberg (2018) illustrated that digitization essentially refers to taking analog information and encoding it into zeroes and ones so that computers can store, process, and transmit such information. Furthermore, Haddud & Khare (2020) pointed out that digitalizing supply chains encompasses the adoption of advanced and smart technological capabilities to make supply chains more connected, collaborative, and efficient. Meanwhile, Sullivan et. al. (2020) pointed out that digitization is what allows passing ships to be tracked and located in real-time. Then, Kim et. al (2021) mentioned that digitization refers to Digitalizing a company's diverse business activities, encompassing the entire planning, producing, and distributing of products, activities, and services. Alareeni (2021) pointed out that Digitization simplifies business processes and work systems, facilitates effective and flexible control and management, and has the advantages of empowering employee decision-making, decentralizing management, and enjoying better cooperation and transparency. Furthermore, Thetu (2021) mentioned that a courier management system is an interactive, web-based computerized platform accessible over the Internet, which has the potential to improve case management flow and access to information. However, Herold et. al (2021) pointed out that, digitalization is assuming a major role in the supply chain sector, characterized by features such as interconnection, automation, machine learning, and the use of real-time data. It enhances the ability to collect and analyze huge sets of data, enhance visibility, and integrate information across physical networks, thus facilitating rapid delivery alternatives. Then, Hackius (2022) defined Courier service that is a logistics service that delivers documents or packages weighing up to 31.5 kg or door to door. Moreover, Calderon & Ribeiro (2023) illustrated that digitalization pertains to the adaptability between digital technologies and the social and institutional activities that transform these technologies into infrastructural factors, subsequently influencing both society and the economy. Meanwhile, Baimukhanbetova et. al. (2023) mentioned that digitization refers to increasing the efficiency of the main processes of logistics services, which require electronic documents, changing the structure of document exchange and delivery, and accelerating the process of delivery and payment for carrier services. While Al-Rbeawi (2023) defined Digitization refers to the use of technology to comprehensively manage the sectors and add more value to business operations, as it helps in developing measurement technology, and real-time processing based on automated operation detection. However, Goswami et. al. (2023) pointed out that Sustainable digitalization refers to the use of digital technology in a way that promotes sustainable development, which is strongly linked to cybersecurity, to promote the responsible and safe use of digital technology

In summary, Digitization refers to taking analog information and encoding it into zeros and ones so that computers can store, process, and transmit this information by applying information technology to enhance the performance of logistics operations, through an interactive web-based computerized platform accessible over the Internet, which can improve Case management and information access flow, which has features such as interconnection, automation, machine learning, use of real-time data while changing the structure of document exchange and delivery, accelerating the process of delivery and payment for carrier services, and increasing the efficiency of the main processes of logistics services.

2.5 Digitalizing System components:

It has been noted that the studies and literature that have dealt with digitalizing systems and their embedded elements are limited. Therefore, this study examined the main embedded elements of the digitalizing system described by scholars and researchers.

Magyar (2007) pointed out that Digital components may contain data necessary for the structure of the digital document components, which are the logical and physical objects needed to reconstruct and display the conceptual object through a word processing application, producing graphics, tables, hyperlinks, and XML output, which allows the application to integrate many components. Then, Schumacher et. al. (2016) mentioned that Nowadays it requires digital elements to operate without human intervention and any type of digitalization requires elements to handle and display information automatically. After that, González et. al. (2020) illustrated that the experts pointed out that technology and innovation become essential elements for providing information in real-time and providing new services from data flow and digitization of processes, distinguishing between those elements that give innovation value and which will include this process in ports, and transparency in the process and data. While giving importance to cybersecurity. Meanwhile, Bhattacharjee (2020) highlighted that information transparency is one of the components of digitization in the fourth industry, as information transparency provides information systems with the ability to create a virtual copy of the actual factory and enrich digital factory models with sensor data, this requires aggregating raw sensor data into higher-value contextual information. Furthermore, Kostetskyi (2021) mentioned that the connection between digitalization and transparency is intimate, as advancements in digital technologies enhance openness, accountability, and transparency. Moreover, Shabdin & Yaacob (2023) illustrated that cybersecurity is one of the essential components of digitalization. Meanwhile, Saeed et. al. (2023) clarified in their conclusion that Cybersecurity is an essential component of digital transformation as it helps prevent interruptions due to malicious activities or unauthorized access by attackers aiming at sensitive information alteration, destruction, or extortion from users. Thereafter, Benga & Elhamma (2024) declared that automation is one of the components of digitization, as automation simplifies tasks, reduces errors, and enhances productivity. However, Benga & Elhamma (2024) said that the essential components of digitalization are Connecting physical devices to the internet for real-time monitoring, predictive maintenance, and process automation across industries.

In summary, the main components and elements of digitalization are cybersecurity, digital documents, transparency, automation, and real-time monitoring.

Real-Time Tracking: Shamsuzzoha (2011) pointed out that real-time tracking includes comprehensive material tracking and traceability, providing information about the origin, processing history, and distribution of products after delivery, and enables unexpected events to be detected and responded to promptly, minimizing potential disruptions or damage. Again, Shamsuzzoha (2011) noted that real-time tracking involves traceability including continuous product location identification of shipments and recording parts, processes, and materials used in production, identified by lot or serial number. Then, Thomas (2014) illustrated that Real-time implies the speed of the instantaneous present, watching it live, and real-time tracking means, reaching back into the past. After that, Singla (2018) mentioned that Real-time tracking means live monitoring while the vehicle is in motion. Meanwhile, Vatn (2018) pointed out that a real-time model is also referred to as an online model, where relevant data is collected and processed into relevant information in real-time. Moreover, Zhao et.al. (2019) said that a Real-time tracking system shows uninterrupted presence indices at work which is highly correlated with value-adding time. However, Morcos et. al. (2022) highlighted that real-time tracking means the continuous monitoring of the applicator's pose in space. Zhu (2022) defined Real-time tracking as constantly watching and updating where something is or how it is doing with very little delay. Furthermore, Lam (2023) pointed out that real-time tracking, facilitated by blockchain solutions, establishes secure and transparent connections between production stations. It enables constant monitoring and accurate real-time status updates of all manufacturing stations through reliable data. Hence, Herbe (2024) illustrated that real-time tracking refers to the identification and administration of current location details for products or delivery items. However, Shah et. al. (2024) mentioned that real-time tracking assists firms in production in making decisions in advance, acting quickly, and increasing flexibility. Firms can improve processes, find disruption, and deal with issues quickly with the help of real-time tracking.

In Summary, Real-time tracking means live monitoring, the identification of current location details for products, real-time status updates, unexpected events detection, and minimizing potential disruptions and damage.

Digital Documentation: Styliadis (2007) pointed out that digital documentation serves as an integration platform for the entire digital documentation process, streamlining modeling efforts compared to traditional analog methods that rely on manual processes. After a while, Goswami & Deka (2017) mentioned that digital documentation means documents, that are analog material text, are converted to digital form, for preservation Digital preservation, or digital archiving, is to ensure long-term access to digital documents. Then, Fortenberry (2019) defined Digital documentation as a broad suite of hardware and software that captures and quantifies building information in digital form. After that, Zhang et.al. (2020) illustrated that Digital documentation is crucial for preserving original information and includes aspects like digital technology, quality, and graphic editing, with key steps including scanning, indexing, quality checking, and archiving of digital documentary information. However, Szyjewski (2023) mentioned that digital documentation is any form of information that is stored and processed in a digital form. Furthermore, Mutiah (2024) highlighted that digital documentation refers to utilizing technologies like computers, mobile devices, and cloud-based systems for the storage, organization, and dissemination of information.

In summary, digital documentation means documents, that are analog material text, are converted to digital form by using a broad suite of hardware and software to preserve original information digital archiving, is to ensure long-term access to digital documents.

Automated Operation: Thurman, et.al. (1999) pointed out that Automated operations are designed to take over tasks traditionally performed by human controllers, performing activities similarly to how these controllers currently operate. After a while, Sinz (2019) illustrated that automation refers to the allocation of tasks performed by machines. Then, Simmler & Frischknecht (2020) mentioned that automated operations typically involve machines performing tasks or portions of tasks that were previously carried out by humans. However, Li et. al (2021) illustrated that automated operation is essentially the use of automated means to manage IT resources, perform operations, and control status, Aiming at the high-security requirements of information equipment operation, and the problem of operation efficiency. Meanwhile, Kormann, et.al. (2021) highlighted that automated operation involves using machines, computers, or robots to perform physical tasks or computational commands. Moreover, Kœhler (2022) declared that automating operations conserves human time by using machines instead. In various fields, automation can improve task feasibility, productivity, and quality. There after, Gerovitch (2003) defined automated operation as shifting work processes or equipment from manual to automated control, computerization, a significant aspect of modern automation, often serves as the primary means for this transformation, aiming to minimize human involvement in processing tasks, thereby reducing human errors. While Baranwal et. al. (2023) noted that automated operation in blockchain refers to the use of smart contracts to automatically allocate computing resources based on predetermined rules. This can help to improve the efficiency and security of resource allocation, as well as to reduce the need for human intervention.

In summary, Automated operation is defined as shifting work processes or equipment from manual to automated control, and computerization, a significant aspect of modern automation, and the allocation of tasks performed by machines reducing human errors, allocating computing resources, and allocating IT resources.

Transparency: Armstrong (2005) pointed out that Transparency means the public has open and dependable access to timely information regarding decisions. After a while, Turilli & Floridi, (2009) illustrated that Transparency refers to the possibility of accessing information, intentions, or behaviors that have been intentionally revealed through a process of disclosure. Hence, Ebinger & Omondi (2020) pointed out that transparency means openness to sharing information among parties, within supply chains with stakeholders, and building trust and responsibility. While, Das (2020) mentioned that transparency refers to the degree to which a user can see how an algorithm makes decisions, providing fairness in resolving disputes. Then, Hossiep et. al. (2021) defined transparency as the quality of the information in any context and can be adapted to a variety of settings. Meanwhile, Montecchi et. al. (2021) mentioned that Supply chain transparency is the practice of disclosing detailed and accurate information about operations and products, key concepts such as visibility, traceability, disclosure, and openness are often used as near-synonyms of supply chain transparency. While Grimmelikhuijsen et. al. (2021) highlighted that process transparency refers to the events that occur during the decision-making process. This information can be disclosed in advance, in real-time, or retrospectively. Ex-ante transparency can be enhanced by specifying the steps, regulations, and procedures that will be used. However, Hellani et.al. (2021) pointed out that Transparency refers to the disclosure of information to trading partners, shareholders, customers, consumers, and regulatory bodies.

In Summary, transparency refers to the quality of information and openness to sharing information among parties, it is the practice of disclosing detailed and accurate information about operations and products, key concepts such as visibility, meeting the regulations, and procedures that will be used, and providing fairness in resolving disputes.

Cybersecurity Measures: Carataş et. al. (2019) defined Cybersecurity measures as it entails proactive and reactive actions ensuring the confidentiality, integrity, availability, authenticity, and non-repudiation of electronic information across public and private digital resources and services within cyberspace. Then, Nadikattu (2020) pointed out that Cybersecurity measures are safeguarding computers, networks, data, and servers from unauthorized access, specifically targeting security breaches aimed at maliciously obtaining information for purposes like espionage or causing embarrassment. Meanwhile, Möller (2020) illustrated that Cybersecurity refers to the methods and practices developed to safeguard data within information systems during storage, transmission, or use. While, Fuster & Jasmontaite (2020) defined Cybersecurity, as the protection of networks and information systems against cyber-attacks, technical failures, human mistakes, or natural disasters. However, Snyder et.al. (2020) mentioned that Cybersecurity measures aim to secure cyber systems by ensuring confidentiality, integrity, and availability through predominantly defensive actions. After that, Kavak. et.al., (2021) highlighted Cybersecurity measures encompass a set of tools, policies, concepts, and safeguards aimed at safeguarding the cyber environment, including an organization's assets and users, by managing risks and employing various technologies, practices, and guidelines. Hence, Mitrovic et. al. (2023) pointed out that cybersecurity refers to the practice of protecting computer systems, networks, devices, and digital data from unauthorized access, attacks, damage, or theft, to ensure the confidentiality, integrity, and availability of digital resources while minimizing the risks associated with potential cyber incidents.

In summary, Cybersecurity refers to the methods and practices that have been developed to ensure the confidentiality of electronic information, the integrity of digital data, its availability, and its protection against security breaches and malicious attacks, as well as its protection during its transmission and storage.

2.6 Relationships between Blockchain and Digitalizing Courier:

Many researchers studied the relationships between blockchain technology and supply chain including the logistics and courier system.

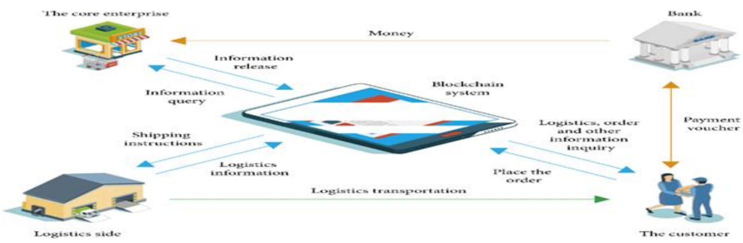
Previous studies have been reviewed to find the correlation between variables, but few studies are related to this topic, the researcher combined independent variables from several studies that indicate a possible effect on dependent variables. ROMARE (2017) studied Forming the Future Digitalized Supply Chain through the Use of Blockchain Technology: An Exploratory Study of Blockchain's Effect on the Supply Chain. the study pointed out that One of the most promising technologies for digitalization is blockchain. The same study by ROMARE (2017) mentioned that delivery companies have shown packages some real-time tracking, however, this is only a part of the product's journey in the supply chain. Then, Tijan et.al. (2019) studied Blockchain technology implementation in logistics, the study showed that blockchain technology can effectively contribute to tracking digital assets, and the creation of a digital "token", Blockchain can help digitally. After that, Bakshi (2020) studied the impact of blockchain to digitalize international trade, and the study included the Impact on Transportation and Logistics Companies. Meanwhile, Merkaš et. al (2020) studied The Significance of Blockchain Technology in the Digital Transformation of Logistics and Transportation. Moreover, Koleshnia & Zhaldak (2021) studied digital technologies in Logistics, the study included the blockchain for tracking deliveries and quality of deliveries used by TradeLens. While

Bekrar et. al. (2021) studied Digitalizing the Closing-of-the-Loop for Supply Chains: A Transportation and Blockchain Perspective. Furthermore, Hackius (2022) studied Blockchain adoption in supply chain management and logistics. Meanwhile, Winkler (2022) studied Blockchain-Based Digitalization of Logistics Processes—Innovation, Applications, and Best Practices. However, Zhu (2022) studied Research on real-time tracking algorithms of e-commerce logistics information based on blockchain technology, the study pointed out that blockchain is one of the digital technologies that is becoming more and more obvious. While Da Silva et. al. (2022) conducted a Study of Blockchain Applications in the Logistics Industry, the study included that the shipping information will be digital which increases the quality of delivery and decreases the amount of waste. In addition to Ugochukwu et. al. (2022) studied Blockchain-Based IoT-Enabled Systems for Secure and Efficient Logistics Management in the Era of IR 4.0, this study Reviewed smart logistics, blockchain, and IoT in logistics; the study shows the importance of integrating Blockchain and IoT in logistics. Meanwhile, Vaghani et. al. (2022) studied Blockchain: Research and Applications, in this study, the study pointed out that Smart logistics ensures intelligence, logistics automation, real-time analysis of supply chain data, synchronization of the logistics process, and cost transparency. Hence, Zhang et. al. (2023) studied the impacts of blockchain-based digital transition on cold supply chains with a third-party logistics service provider. Moreover, Abdelhamid et. al (2023) studied a survey on blockchain for intelligent governmental applications, this study mentioned that Blockchain makes it easier to find the owners of original digital documents in a digital courier service CargoX. Then, Tiwari et. al (2023) studied blockchain and third-party logistics for global supply chain operations: stakeholders' perspectives and decision roadmap. This study pointed out that blockchain technology-enabled 3PL logistics chains have increased transparency and visibility while ensuring high levels of trust and information sharing. While Su & Yu (2024) studied a bibliometric analysis of blockchain development in industrial digital transformation using Cite Space, the study summarized the importance of blockchain in enabling digital transformation, and its application to digital transformation in the field of supply chains, including logistics.

In summary, there is a scarcity of literature that has addressed the impact of blockchain on courier system digitalization in particular. However, most of the previous relationships were made for the impact of blockchain on the digitalizing supply chain, logistics systems, and other systems. This study aims to conceptualize the impact of blockchain technology on the digitalizing courier system of the supply chain and the digital benefits that can be obtained. The visualization of the digital courier system was extracted based on the summarization of previous relationships.

2.7 Previous Models:

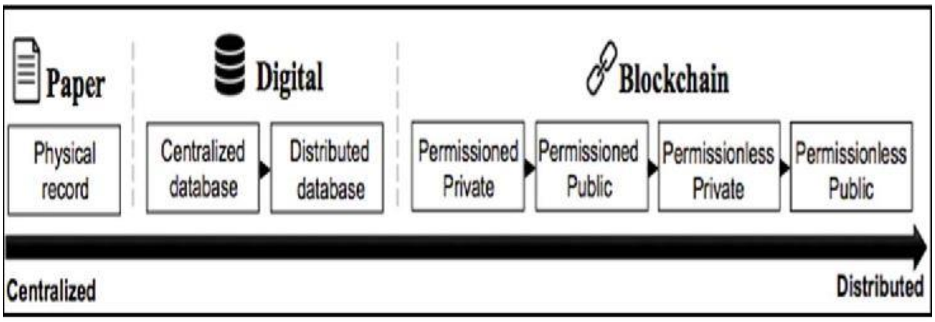
After reviewing the relevant literature, it was found that the definition and classification of each sub-variable was not standardized. Moreover, measurement methods and models have not been standardized either. Limited literature has discussed and studied blockchain technology, as well as its subvariants and components. The following section briefly discusses some of the literature and models that have studied sub-variables of blockchain technology and their relationship to one or more of the digitalizing courier systems.



Model (2.1): Zhu (2022)

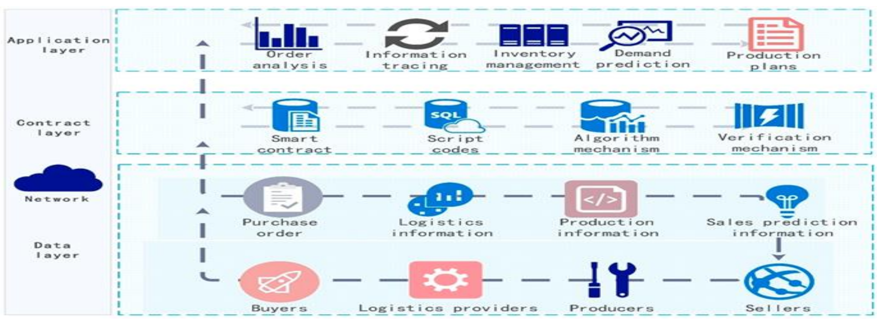
Model (2.1) developed by Zhu (2022) showed the external operating system model of the blockchain logistics system that is divided into an ordering system, logistics transportation system, and supply chain financing system according to a certain type of information sent.

Model (2.2) was developed by Benbunan & Castellanos (2018) shows the features of blockchain applications, whether they are public or private, and these two factors affect the degree of decentralization: permissioned private, permissioned public, permissionless private, and permissionless public blockchain. It also shows that the permissioned private blockchain is the closest to the traditional distributed database system.



Model (2.2): Benbunan and Castellanos (2018)

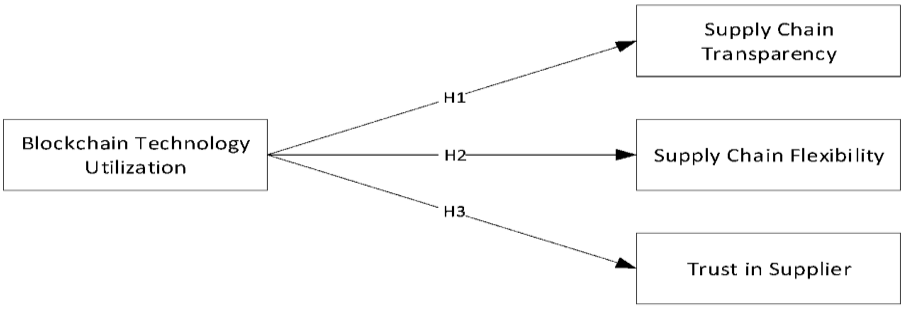
Model (2.3) was developed by Xiaet. al. (2023) to show the integration of the application layer, contract layer, and data layer information of the supply chain. Each block in the blockchain contains the information of all previous blocks.



Model (2.3): Xiaet. al. (2023) Model

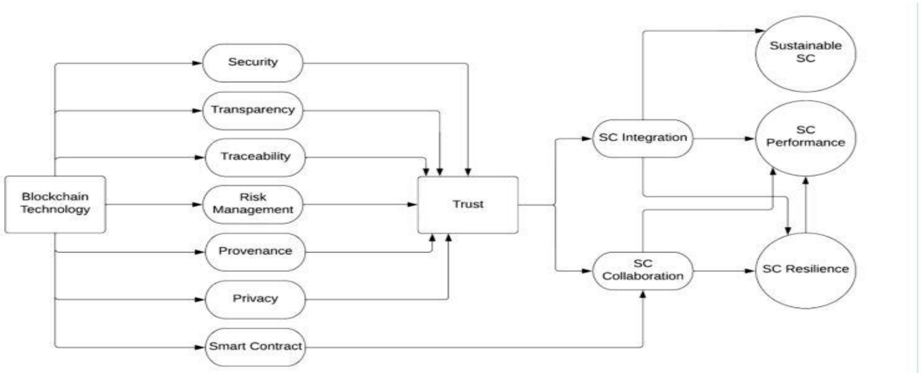
Newly added blocks will automatically identify previous contracts and start the contracting process. Then, the relevant steps will be performed automatically, enabling intelligent information collaboration to be managed at a higher level. The first layer is the data layer. The data layer determines how the data in each node is linked and organized to verify the information and encrypt the data. The second layer is the contract layer. The contract layer contains multiple scripts and algorithms required for more complex blockchain and smart contract operations. The third layer is the application layer, which encapsulates application scenarios for supply chains. It is an intermediary for interactions between participants in supply chains and information platforms as well as a vector of direct information exchange between users, Supply chain participants keep a record of logistics, information flows, and fund flows via the application layer.

Model (2.4) was developed by Meidute-Kavaliauskieneet. al. (2021) to show the impact of the use of blockchain technology on supply chain transparency, supply chain flexibility, and trust in suppliers, which are among the key requirements for a more efficient supply chain process, will be affected by new information technologies. The study believes that these dynamics will increase the level of cooperation and integration in supply chains. Furthermore, blockchain technology allows for better tracking and reporting, and transparency in logistics services, leading to improved delivery timelines. Blockchain is great for logistics when it comes to tracking a vehicle's location because it reduces costs and increases efficiency.



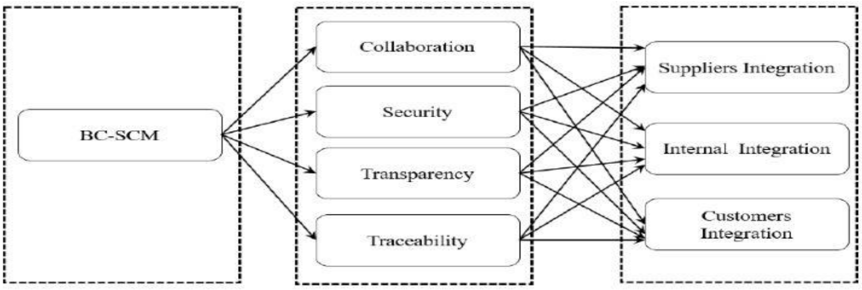
Model (2.4): Meidute Kavaliauskiene, et.al. (2021) Model

Model (2.5) was developed by Manzoor et. al. (2022) model shows the impact of the discussed blockchain features on the integration of the supply chain, from enhancing security, transparency/visibility, traceability, risk management, provenance, privacy, immutability, security, transparency, smart contracts, collaboration, and driving drivers for the sustainability of the supply chain.



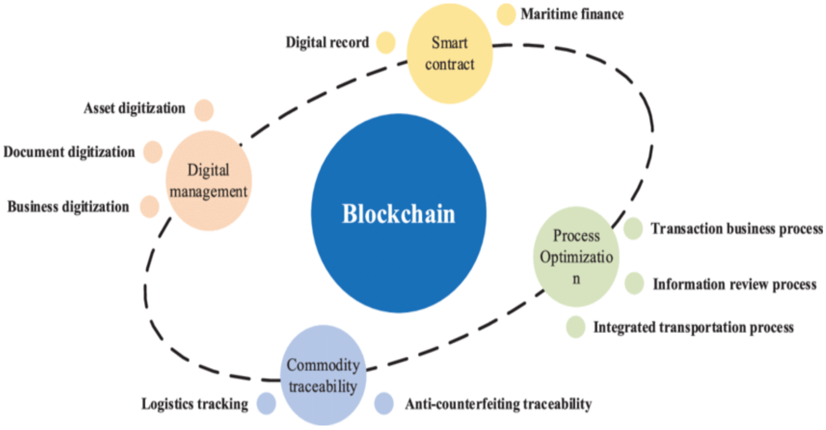
Model (2.5): Manzoor, et. al (2022) Model

Model (2.6) developed by Mubarik & Mubarak (2020) shows that a blockchain-based supply chain management system. It can enhance complex supply chain operations through better integration, collaboration, and coordination between all these stakeholders in order to enhance transparency, traceability, security, and trust.



Model (2.6): Mubarik, and Mubarak (2020) Model

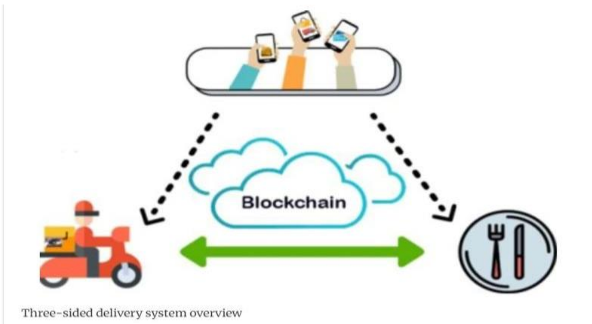
Model (2.7) developed by Liu et. al. (2023) shows that ledger technology has made a huge contribution to cargo transportation, ship design, construction, and tracking the whole life cycle of ships.



Model (2.7): Liu et. al. (2023)

Through the practical application of the blockchain in the shipping field, the study can intuitively find that the industry uses the characteristics of blockchain technology to ensure the openness and transparency of platform information, realize the coordinated operation of nodes, and improve the digital level and operational efficiency of shipping to establish an intelligent, green, and ecologically integrated shipping blockchain network. Optimize processes and paperless bills of lading. There are many types of documents created by moving services, such as bills of lading, commercial invoices, and insurance certificates. Traditional paper documents (labor, paper, and printing) will produce waste in terms of cost management of the existing paper office. Some companies have achieved record digitization by transforming logistics and supply chain information systems.

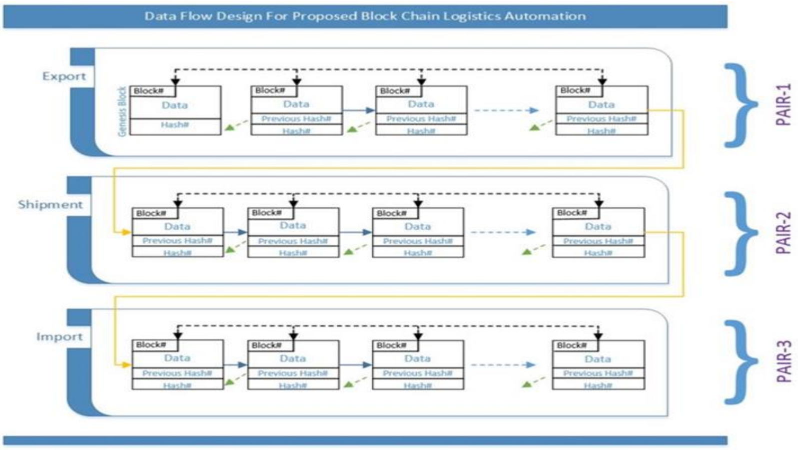
Model (2.8) was developed by Tokkozhina et. al. (2023) showing a Three-sided delivery system, a decentralized food delivery blockchain network, where the centralized



Model (2.8): Tokkozhina et. al. (2023)

New wireless protocols, known as low-power wide-area networks, provide high coverage capabilities while allowing high energy efficiency; enabling users to review drivers' real-time locations throughout the whole journey.

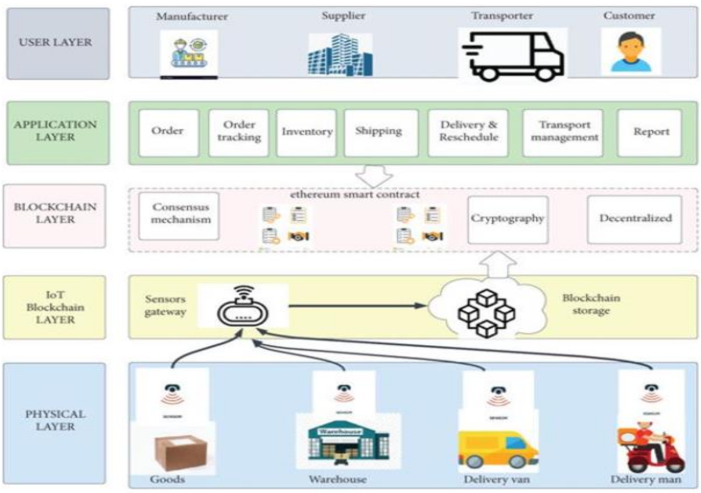
Model (2.9) was developed by Mughal & Brohi (2019) to show the flow of the shipping process to automate logistics operations that rely on cryptocurrency and follow the rules of the blockchain. It also shows the flow of delivery of materials from source to destination with data encryption at each station and the hash number changed. Shipping blocks are linked to shipping departments that help the delivery items reach the destination.



Model (2.9): Mughal & Brohi (2019)

The first block of the shipping section will only receive data from the last block in the exporting section. The shipping blocks have no concerns about the previous block and cannot make any changes, they are only linked to the previous hash numbers. All transactions will be executed automatically and the data will be saved in the distributed ledger, which means that only authorized users can view the logs of all blocks, and others can only access those blocks in which they work or are responsible for monitoring.

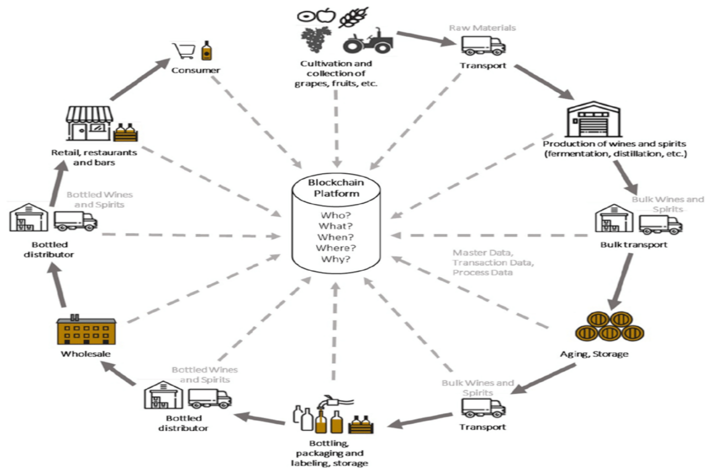
Model (2.10) developed by Ugochukwu et. al (2022) shows the integration of a smart contract with Blockchain and IoT for a secure transaction between logistics stakeholders through 5 layers (User layer, Application layer, Blockchain layer, Network layer, and Physical layer). User Layer: This layer consists of all the legitimate members of logistics management stakeholders including manufacturer, supplier, carrier, and customers. Legitimate members sign contracts and submit their logistics orders through terminal devices (such as smartphones or desktop computers). This layer provides various applications such as parcel tracking, order dispatch, warehouse management, inventory management, order tracking, and vehicle routing. It provides the service to the user. Blockchain Layer: This layer provides a peer-to-peer distributed network for communication and transactions between logistics stakeholders. The Ethereum smart contract is dedicated to security, the privacy of information, and secure payment. IoT/Blockchain Layer:



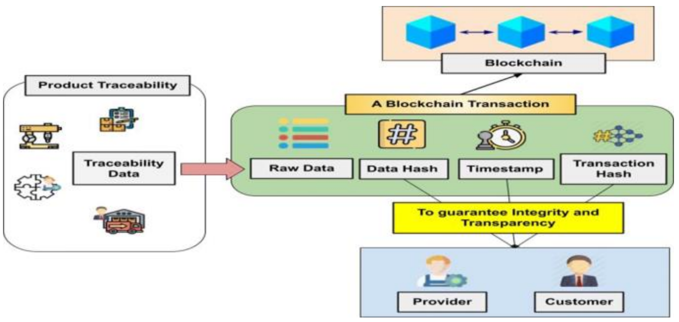
Model (2.10): Ugochukwu et. al (2022)

The network layer provides communication channels between sensors and the Blockchain. The collected data will be transferred from the physical layer to the Blockchain layer using these communication channels, such as 4G/5G and ZigBee networks. Physical layer: This is the lowest layer in BFSELMS; It collects data using sensors (RFID, GPS sensors, and scanners) installed on goods, delivery vehicles, and warehouses through a sensor. These devices are responsible for sending various logistics-related data to the data node that will be stored regularly. In Blockchain Store. The customers sign contracts and submit their logistics orders through terminal devices (such as smartphones or desktop computers).

Model (2.11) developed by Gayialis et. al. (2021) shows the platform that records all important events from production to final distribution of the product to consumers. The platform will be able to record all product supply chain events regardless of their origin and the possible heterogeneity of the entities that will transmit the events. All required codes will be recorded on the latest labels that cannot be reused, counterfeited, or copied. The blockchain database will contain data shared between collaborating entities (such as producers, distributors, and sellers) and data about transactions, validation of the product's authenticity, origin, and possible loss of product quality.



Model (2.11): Gayialis et. al. (2021)



Model (2.12): Mullet et. al (2023)

Model (2.12) was developed by Mullet et. al (2023) to show a blockchain-based system for product traceability in Industry 4.0, where sensitive traceability data is secured using cryptographic hashing techniques. This allows relevant parties to verify the integrity of the data without compromising confidentiality.

Model (2.13) developed by ROMARE (2017) shows that technology is the key to high digital transformation, and that blockchain technology represents a promising solution. Application areas are embodying the potential of blockchain through digitization. It shows that digitalization can improve collaboration, communication, engagement, and trust along the supply chain. These are the driving factors behind digital transformation, and blockchain is a technology connected to these drivers, making blockchain suitable for digitalization technology. When these drivers are improved, more information and knowledge can be obtained, and a more efficient supply chain can take shape.

Model (2.13): ROMARE (2017)

Through three areas of use identified by ROMARE where blockchain technology will contribute through digitization, the first is transactions - embedding banking services in blockchain will increase efficiency, reduce costs, and bridge the information gap about the flow of products, and the second is traceability - Blockchain technology allows companies to forecast and plan better, leading to more efficient production, and thirdly, transparency – Blockchain technology allows manufacturing companies to be able to improve products, efficiency and sustainability and use it as a competitive advantage.

2.8 Previous Studies

Niels & Mortiz (2017) study titled "**Blockchain in Logistics and Supply Chain: Trick or treat?**" The study conducted an online survey and asked logistics professionals for their opinions on use case exemplars, barriers, facilitators, and the general prospects of Blockchain in logistics and supply chain management. The study offered valuable insights into Blockchain adoption within logistics and supply chain management. The study identified a positive reception toward Blockchain's potential impact on the industry among the four participants. The study delves into the current state of Blockchain in logistics and supply chain management. The findings highlight the anticipated substantial influence of Blockchain in the logistics industry, positioning it as a potential solution. However, it is crucial for the logistics sector to swiftly engage with Blockchain technology. It is advisable to assess the potential value addition this technology could offer to its service portfolio before competitors capitalize on its overall hype.

Deshpande et. al. (2017) study titled "**Distributed Ledger Technologies/Blockchain: Challenges, opportunities and the Prospects for Standards**" The study was conducted by collecting data from different sources, including literature reviews, interviews, and workshops, that were synthesized to produce the final report. The study highlights substantial opportunities and challenges within distributed ledger/blockchain technology. The study emphasizes the need to comprehend current realities, factors driving change, and affected sectors amid the rapid changes and uncertainties in this domain. The analysis underscores the potential for standards to support technology adoption, acting as facilitators for the development, adoption, and market growth of Blockchain/DLT. Furthermore, DLT/Blockchain can streamline supply chain processes by eliminating the need for active intermediary data synchronization and concurrency control, leading to enhanced efficiency gains. Notably, certain sectors like financial services and supply chain management have devoted more resources to proof of concept studies in this technology than others.

Hofmann et. al. (2017) study titled "**The immutability concept of blockchains and benefits of early Standardization**" The study argued the benefits of early standardization of the blockchain based on the literature and the analysis of the central blockchain immutability characteristic. The study proposed a framework that aims to understand the dimensions and limits of blockchain immutability. The resulting framework is proposed as a good practice standard for implementing blockchain systems. Building on these efforts, the study supports initiatives to better exploit the full potential of blockchain technology through standardization. Blockchain technology and the concept of blockchain immutability are discussed. The benefits of early standardization of blockchain technology are discussed based on the literature and analysis of the immutability property of centralized blockchain. The study concluded that Blockchain technology has the potential to become a cornerstone of the digital revolution by enabling decentralized collaboration in networks. The development of early standards and good practices can provide essential support for technological development and market acceptance. One of the basic characteristics of the network is trust in the recorded data transactions as well as in the rules of the decentralized network. For this purpose, a classification is provided to support maintenance and updates, specifying the immutability property of the system. When the decentralization and coordination potential of blockchain technology can be successfully exploited, applications can be realized in many fields such as the manufacturing sector, financial services sector, health sector, e-government, or Internet of Things, and lead to a wave of economic and social changes. To support this development, standardization has been recognized as an important topic.

Saberi et. al. (2018) study titled "**Blockchain Technology and its Relationships to Sustainable Supply Chain Management**" The study critically examined Blockchain technology as a digital technology and smart contracts with potential applications for the supply chain management. This is driven by increasing pressure from governments, communities, and consumers to achieve sustainability goals. This prompts further investigation into how blockchain technology can address and aid supply chain sustainability. Part of this critical examination is how blockchain, a potentially disruptive technology early in its development, can overcome many potential obstacles. Four categories of barriers to blockchain adoption are presented: Interorganizational, technical, and external barriers. True business and supply chain transformation led by blockchain is still in progress and its early stages; Blockchain technology has the potential to improve efficiency through the use of smart contracts. Regulations, contracts, and policies, which can delay supply chain and logistics activities, can be implemented automatically via smart contracts. Blockchain technology is also a new paradigm for computing and information flow with wide-ranging implications for future development in supply chain management and logistics.

Yaga et. al. (2018) study titled "**Blockchain Technology Overview**" The document layout a high-level overview of blockchain technology to help readers understand how blockchain works. Exploration extends beyond transactions to cover smart contracts. The study highlights how blockchain assures secure transactions, independent of central oversight. It relies on cryptographic hash and asymmetric key pairs for transaction security, maintaining an unchangeable transaction log that mandates recalculating subsequent blocks with any alteration. While rooted in established cryptographic principles, blockchain transforms traditional network, encryption, and record-keeping methods. Its widespread adoption introduces challenges in altering recorded data, persisting indefinitely despite errors. To manage this permanence, blockchain-based applications use subsequent blocks and transaction modifications, facilitating changes to business data while retaining a comprehensive history of alterations. For instance, within a blockchain-enabled supply chain, a transaction can modify digital asset attributes like shipment location.

Tijan et. al. (2019) study titled "**Blockchain Technology Implementation in Logistics**" The study provided a comprehensive review of the current and rising trends of blockchain technology usage in logistics and supply chain management. Investigated decentralized data storage represented by blockchain technology and its potential for development in the field of sustainable logistics and supply chain management. Although the benefits of blockchain technology have been widely researched in the financial sector, major challenges in logistics, such as order delays, goods damage, errors, and multiple data entries can also be minimized by introducing blockchain technology. This paper has provided a comprehensive review of current and rising trends in the use of blockchain technology in logistics and supply chain management.

Zhai et. al. (2019) study titled "**Research on the Application of Cryptography on the Blockchain**" The study outlines the infrastructure of blockchain. The study delineates the blockchain infrastructure, comprising layers like data, network, consensus, contract, and application. The study introduces key cryptographic principles—hash functions, asymmetric cryptosystems, and digital signatures—assessing their application across various blockchain layers. The research demonstrates cryptography's pervasive role within the blockchain system, detailing its primary applications and analyzing existing issues. It simplifies blockchain technology by delineating its infrastructure and highlights how encryption tech has advanced it. The study scrutinizes security challenges in blockchain, stressing that digital encryption remains the core technology. It underscores the pivotal role of cryptographic research in blockchain development and anticipates future research trajectories in this technology.

Bakshi (2020) study titled; "**Impact of Blockchain to Digitalize International Trade**" The study relies on data collected from secondary sources that contain journal articles, published papers, and books on blockchain and digitalizing international trade. The study presents some trade-related applications and analyzes the importance of this technology for international trade. The study pointed out that Blockchain technology could change various areas of international digital trade, finance, transportation, logistics, and intellectual property. The transparent, decentralized, and immutable nature of Blockchain has sparked the interest of private organizations and governments to investigate the effectiveness of Blockchain in intensifying efficiency, as well as the impact of Blockchain on transportation and logistics companies, as international shipments are handled by different companies along the way. Sharing all relevant shipping information with authorized partners in real-time on a secure blockchain that ensures that no added data has been tampered with can dramatically improve coordination, speed up operations, and reduce costs. One of the main benefits that Blockchain technology offers when it comes to transportation and logistics is the possibility of enhancing cooperation between the various companies involved. These potential benefits are leading an increasing number of companies in this sector to develop blockchain applications, and are also opening up new opportunities to move closer to paperless commerce.

Merkaš et. al. (2020) study titled "**The Significance of Blockchain Technology in Digital Transformation of Logistics and Transportation**". The study provides a comprehensive overview of current blockchain initiatives and use cases. The purpose is to identify the role of blockchain technology in achieving logistics goals, by pointing out the importance of blockchain technology in the digital transformation of logistics and transportation services. Implementing blockchain technology combined with IoT elements in logistics and transportation contributes to improved business processes, supply chain traceability, transparency, and significant financial savings. The study used a theory-building approach from multiple case studies. The study provides a comprehensive overview of current blockchain initiatives and use cases. The results of this research indicated that blockchain technology contributes to achieving logistics goals.

Valle and Oliver (2020) study titled "**Blockchain Enablers for Supply Chains: How to Boost Implementation in Industry**". The study conducted a qualitative analysis using ethnographic methods and expert interviews. This study made solid contributions to the understanding of blockchain innovation and provided some key features and guidelines on how to promote blockchain implementation in the industry. As exploratory research, this paper presented a theoretical analysis based on 18 expert interviews. The total interviewees consist of academics, business representatives, and institutions who have technological knowledge relevant to blockchain management and innovation. The study found that in terms of supply chains, blockchain-based mobility, and blockchain-based logistics are two sectors of empowerment where blockchain may have a greater impact on society.

Koleshnia & Zhaldak (2021) study titled "**Digital technologies in logistics**”. The study's methodology is analysis and synthesis for preliminary analysis with the formulation of problems, the definition of goals, and the system approach for the definition of structural connections between elements of digital technology in logistics. This study highlighted an attempt to explain the concept of digital logistics, which in most scientific papers is not considered a separate concept, but rather a set of technologies that allows the digitalization of logistics services. The main goal of the study is to review the main technologies that allow talking about the digital transformation and digitization of logistics services, and the study pointed out that one of the most common technologies used, including in the field of logistics, to form reliable and transparent supply chains is blockchain technology. study explained that the blockchain is an information package that contains all the previous information and some new information, and the entire chain is a database distributed among many participants, operating without central management and no intermediary, and the advantage of this technology is that the information stored in the chain cannot be changed or modified. Delete it. All the stages that take place, for example, the shipment when moving from supplier to customer in international logistics, are recorded using blockchain. Errors and discrepancies in documents are tracked instantly, making it possible to determine who is responsible for losses or expenses.

Bekrar et. al. (2021) study titled "**Digitalizing the Closing-of-the-Loop for Supply Chains: A Transportation and Blockchain Perspective**". The study methodology is based on a thematic review and synthesis of the literature based on the general framework of the three topics Reverse logistics activities, mechanisms, inputs, and outputs. the study proposed a review of empirical research and concerns regarding the relationship between transportation, RL, and Blockchain as a digital technology. The potential benefits of blockchain technology in various aspects of reverse logistics and transportation activities were presented. This integration and applications have been evaluated using different capability aspects of blockchain technology, in particular as an immutable and reliable ledger, a tracking service, a utility for smart contracts, as market support, and as a token and incentivizer. The study included in the study potential research directions and managerial implications across the nexus of blockchain, transportation, and reverse logistics.

Park & Li (2021) study titled "**Blockchain Technology's Impact on Supply Chain Sustainability**". The study focused on new supply chain management based on blockchain technology and its sustainable performance in the areas of environmental protection, social justice, and governance efficiency. Using a systematic literature review and two case studies, the researcher evaluated whether sustainability indicators could be improved indirectly along blockchain-based supply chains. The study showed that blockchain technology has the potential to improve supply chain sustainability performance, and expected the popularity of blockchain technology to rise in supply chain management. Moreover, the blockchain system can monitor the system based on an immutable recording system. There are many potential positive improvements to sustainability through blockchain-based systems in logistics.

Esmat et. al. (2021) study titled "**A novel decentralized platform for peer-to-peer energy trading market with blockchain technology**" devised a pioneering decentralized Peer 2 Peer (P2P) energy trading platform aimed at resolving multiple challenges. Their focus encompassed designing a decentralized P2P market to balance economic efficiency and information privacy. Addressing the proliferation of storage devices, the study sought new P2P market designs considering intertemporal dependencies. The study emphasized the practical implementation of blockchain technology to facilitate secure, intermediary-free, and efficient P2P trading. Their platform comprises two primary layers: the market and blockchain. The market layer includes a parallel, short-term pool structured auction cleared through decentralized Ant Colony Optimization, ensuring efficient market solutions while safeguarding players' privacy. The blockchain layer provides high automation, security, and swift real-time settlements through smart contracts. The researchers conducted simulations using real-world data to assess the platform's functionality, encompassing energy trading, market clearing, smart contract operations, and blockchain-based settlements.

Hackius (2022) study titled "**Blockchain Adoption in Supply Chain Management and Logistics**." The study is an explorative, qualitative Grounded Theory approach that was chosen to investigate how companies approach Blockchain in supply chain and logistics, it investigated a theoretical study, examining how Blockchain can be adopted into blockchain and logistics practices. Blockchain solutions can become a tool that allows companies to enhance efficiency by aligning supply chain and logistics partners around the world. To provide a range of value-added services, for example, providing identities, certificates, or anti-counterfeiting solutions. Blockchain technology can also benefit society. For example, recycling companies can get better information about the materials in discarded products, as Blockchain solutions can be designed and operated without the influence of large service providers or the need for a trusted third party. All participants can always verify all transactions themselves and can therefore be assured of the immutability of history. Practitioners with initial insights into Blockchain can expect widespread benefits for logistics companies and along the entire supply chain. At the company leadership level, the adoption of Blockchain solutions is considered a possibility. A centralized setup in Blockchain allows all participants to participate in transactions and set up the vision in accordance with their needs. According to experts, this transparency creates the trust that companies need in order to conduct deals. For example, the expected efficiency is increased visibility and transparency at the supply chain level through track and trace.

Overall, this will provide an improved data basis for corrective actions and process improvement. Furthermore, data stored on Blockchain also provides an audit basis and a documentation trail for products or parts. Since tamper-proof and accountability are requirements for audit trails, experts expect this to be one of the first use cases. The potential for audit rollback may have to go beyond a company's scope, making a decentralized system ideal. A few experts have found that Blockchain technology can be a solution to this problem. Using Blockchain, infrastructure solutions also holds the potential to reduce the possible risk of loss by sharing transactions among many participants. Data cannot be tampered with and can be recovered from the network. The availability of historical data is useful for tracking business operations, and some experts are outsourcing this via Blockchain technology.

Winkler (2022) study titled "**Blockchain Technologies in Logistics and Supply Chain Management: A Bibliometric Review**". The study is designed to present the results of a comprehensive bibliometric review that analytically and objectively identifies the field's intellectual structure, basic research, and most influential scholars. The researcher used a knowledge domain visualization technique to generate insights that go beyond other review studies on blockchain research in logistics and supply chain management. The analysis began by selecting a total of 628 research papers published during the period 2016–2020. The results of the bibliometric analysis showed that the number of blockchain papers has increased rapidly since 2017. It was shown that the most productive researchers are from the United States of America, China, and India. The most important academic institutions contributing to the literature were also identified. Based on network analyses, the researcher found that the literature mainly focuses on the visualization of blockchain and its potential for supply chain citation. This study has enriched the existing literature on blockchain technology, providing a snapshot of the current state of research, and examines the body of knowledge of blockchain research in the field of logistics and supply chain management (SCM) with the help of evidence-based scientific measurement methods.

Zhu (2022) study titled "**Research on real-time tracking algorithm of e-commerce logistics information based on blockchain technology**". The study proposed a research method for the real-time tracking algorithm of e-commerce logistics information based on blockchain technology. The background of the application of blockchain technology in real-time tracking algorithms for e-commerce logistics information is first described. Also, blockchain technology, real-time tracking algorithms for logistics information, encryption technology, blockchain consensus algorithm, blockchain application scenarios, and other related technologies are analyzed in detail. Then, a blockchain model was created for real-time tracking of e-commerce logistics information, and it was found that data is stored on-chain only when more than 51% of the nodes in the distributed system confirm that the data is valid. Otherwise, data on the chain cannot be affected. Finally, the model description and hypothesis of real-time tracking of e-commerce logistics information based on blockchain technology are verified to provide a guarantee for improving real-time tracking of e-commerce logistics information.

Da Silva et. al. (2022) study titled "**Study of Blockchain Application in the Logistics Industry**" proposed the application of blockchain technology in the logistics industry. explored the role of blockchain in reducing or avoiding the main problems in the logistics field delivery delays, loss of documents, unknown sources of products, and errors, among other things through its application. Blockchain technology emerged and was distinguished by its qualities related to privacy, security, and authenticity. Thus, the aim of this work, exploratory and illustrative, was to evaluate the level of knowledge about the tool, the difficulties in the logistics sector, and the advantages of supply chain management. This was done by applying models and a questionnaire aimed at determining the level of knowledge about blockchain among logistics professionals and its adoption in the organizations in which work. This work aims to conduct a bibliographic study on the benefits of applying blockchain technology. A survey was conducted with a sample of 40 participants. The results obtained revealed that only 42.5% of the participants had the necessary knowledge regarding this technology because it is modern in the logistical field. 87.5% agreed that blockchain technology will solve some problems in the logistics field.

Ugochukwu et. al. (2022) study titled "**Blockchain-Based IoT-Enabled System for Secure and Efficient Logistics Management in the Era of IR 4.0**". the study highlighted the technology that enables smart logistics and reviews smart logistics, blockchain, and the Internet of Things in logistics; Showcases the importance of integrating Blockchain and IoT in logistics. The study proposed a framework of a Blockchain-based, IoT-enabled system for secure and efficient logistics management where logistics data can be captured using IoT sensors, also designed and described the sequence diagram for secure communication between logistics stakeholders through a smart contract. In conclusion, Blockchain can provide security for logistics data and enhance operational efficiency with its key features.

Vaghani et. al. (2022) study titled "**Security and QoS issues in blockchain-enabled next-generation smart logistic networks: A tutorial**". The study conducted a literature review and employed use cases, the study showed that the blockchain-enabled smart logistics market is expected to grow to US$1,620 billion at a compound annual growth rate of 62.4%. Intelligent logistics ensures intelligence infrastructure, logistics automation, real-time analysis to synchronize supply chain data of logistics process, cost transparency, uninterrupted tracking of shipments all the way to the transportation route, etc. The study highlighted motivating examples to demonstrate the necessity of integrating 6G and blockchain technology into smart logistics networks. Next, the study proposed a high-level intelligent logistics framework supporting 6G and blockchain technology. The main substantive issues of this framework have been presented mainly from the context of security and resource management. In this paper, recent developments in blockchain technology for next-generation intelligent logistics networks are analyzed. The paper also studied why 6G but not 5G is compatible with the smart grid.

Zhang et. al. (2023) study titled "**Impacts of blockchain-based digital transition on cold supply chains with a third-party logistics service provider**". The study was organized by providing a literature review and highlighting the study's contribution to the existing literature, After that, the basic model with and without blockchain was presented, and then the equilibrium results were compared, as was the impact of blockchain on the cold supply chain as well as its members' performances. and the study extended the basic model. Finally, the study concluded and summarized. The study reviewed the impacts of blockchain-based digital transformation in the cold supply chain with a manufacturer, retailer, and third-party logistics provider. The study established a cold supply chain comprised of an upstream manufacturer, a downstream retailer, and a 3PL. The manufacturer produces the goods, which the retailer resells to the end market. The retailer pays for the 3PL logistics services through transportation fees.

The study presented the administrative implications of adopting blockchain in terms of increasing the level of custody service if the 3PL company imposes low transportation fees. It also leads to urging the manufacturer to increase the wholesale price, which does not prompt the retailer to reduce the order quantity, but instead sets a higher price. Finally, simply relying on the market mechanism may not enable the cold supply chain to make the optimal decision; Therefore, government intervention or external coordination mechanism should be introduced to push cold supply chain members to reach a consensus on blockchain-based digital transformation. The study presented that a third-party logistics service provider is able to provide storage, transportation, distribution, and other logistical operations services in a relatively professional manner. Blockchain technology is an emerging tracking technology characterized by decentralization, cryptographic protection, openness, and transparency.

Abdelhamid et. al (2023) study titled "**A survey on blockchain for intelligent governmental applications**" highlighted several recent studies of use cases in the public sector for decentralized information infrastructure. Since the use of blockchain has not yet been widely adopted in government or industrial settings, this study conducted a systematic literature evaluation of 29 academic studies investigating software engineering problems in blockchain technology for government applications. The papers were initially analyzed inductively in order to clarify and identify issues that have been repeatedly highlighted in the academic literature. Furthermore, the theoretical framework was discussed by drawing on models used in traditional software development, which is then followed by deductive analysis to draw blockchain use cases and future trends associated with the challenges. The researcher also pointed out that blockchain technology has the potential to enable new models of public service delivery and engagement by generating data consistency across the ecosystem of institutions and actors that transcend traditional public organizational boundaries.

Tiwari et. al. (2023) study titled "**Blockchain and third-party logistics for global supply chain operations: Stakeholders' perspectives and decision Roadmap**" Examined the literature and identified the challenges associated with third-party logistics and how blockchain can be used for third-party logistics. Conducted interviews with four innovation/project managers at well-established logistics companies to uncover the state of blockchain adoption in third-party logistics and the challenges hindering the adoption of this technology. The study then proposed a framework with a roadmap for decision-making to implement the BCT. Third-party logistics services have proven to be critical in assisting many supply chain agents with distribution tasks so that third-party logistics can focus on their core competencies in product development and manufacturing, and inefficiencies have necessitated digital transformation in many companies. This digitization enhances information exchange and supply chain visibility, which improves supply chain performance; However, digitization may create challenges regarding cybersecurity and data quality. Blockchain technology can help, with features such as being highly secure and distributed.

Singh et. al. (2023) study titled "**Barriers of Blockchain Technology for Supply Chain Transparency and Sustainability in the Construction Industry: Pythagorean FAHP Method Application**". The study employed a three-phase approach, a comprehensive literature review, data collected from 17 experts representing academia and industry, and in the last phase, the collected data was analyzed using the Pythagorean fuzzy analytical hierarchical process (AHP) methodology. The study emphasized the "security environment" as a primary hurdle in blockchain adoption for construction companies. The study aimed to offer a comprehensive understanding of these challenges to industry stakeholders, aiding in the development of effective strategies and policies to overcome these barriers. The study emphasized the importance of accounting for uncertainty in decision-making for technology adoption beyond the construction sector. Additionally, the research contributed a new multi-criteria decision-making analysis for blockchain adoption in supply chains, aligning with previous findings on barriers hindering the effective implementation of blockchain in sustainable supply chain management within construction. These obstacles encompass difficulties in tracking product components, processes, sustainability, supply chain environmental information, interoperability, security, and the use of cryptocurrency smart contracts. Moreover, the study highlighted additional barriers related to participant engagement, situational information, sustainability participation conditions, partner involvement, operational scope, social supply chain information, reliability assurance, and complexities. The growing focus on environmental information management in supply chains has led to various technological strategies like blockchain, smart contracts, and digital tools to address these challenges.

Su & Yu (2024) study titled "**A bibliometric analysis of blockchain development in industrial digital transformation using CiteSpace**" analyzed the origin and development of blockchain, summarized its features in detail, and systematically summarized the importance of blockchain in enabling digital transformation. The data for the analysis is based on information from research published from 2015 to 2023 in the core set of the Web of Science database. The study pointed out the advantages of blockchain in security, privacy, and the ability to create smart contracts and consensus mechanisms and has been applied to digital transformation in areas such as financial transactions, supply chains, and IoT management. This paper also discussed high-level applications of blockchain technology in cutting-edge fields such as smart grids, e-healthcare, the Internet of Vehicles, and machine learning. The paper draws conclusions and implications from the findings and argues that to accelerate the digital transformation of industry, it is necessary to commit to blockchain technological innovation and expand its scope of application. Regulatory agencies and industry associations must also strengthen their supervision and cooperation to ensure the safe and effective promotion of sustainable development in the digital economy.

2.9 Expected Contributions of the Current Study as Compared with Previous Studies:

1. This research marks a pioneering examination of blockchain technology's impacts on digitalizing the last mile of the supply chain (courier services), It is one of the few studies that took the route of digitalizing the courier system, setting it apart from previous studies that mainly focused on broader supply chain management applications of blockchain.
2. This localized approach aims to capture nuances that might differ from global trends. The study takes a holistic approach, encompassing various dimensions such as real-time tracking, digital documentation, automated processes, transparency, and cybersecurity measures in the context of blockchain integration, providing a comprehensive view of potential effects.
3. Using a hypothesis-driven analysis, the study investigates the impact of blockchain on specific facets of digitalization within courier supply chains, aiming to furnish empirical evidence and statistical insights. By segmenting key variables and establishing a robust theoretical foundation, this research defines and interconnects essential concepts, thereby constructing a comprehensive analytical framework.

Chapter Three
Study Methodology (Methods and Procedure)

3.1 Introduction:

This chapter includes study design, population and sampling, data collection methods, data collection analysis, study tool, and validity and reliability test. In addition to the respondent demographic description

3.2 Study Design:

The current study is a quantitative, descriptive, and cause/effect study. This research aims to study the impact of collective blockchain sub-variables (decentralization, distributed ledgers, encryption, immutability, and smart contracts), on the elements of digitization real-time tracking, digital documentation, automated processes, transparency, and cybersecurity measures in the courier services industry in Jordan. This study began with a literature review and expert interviews. Then, a panel of judges was used to improve the measurement tool, i.e., the questionnaire. Afterward, develop a questionnaire that is used to collect data. The collected data was scanned and coded on SPSS. Then after checking normality, validity, and reliability, descriptive analysis was carried out, and correlation among variables was checked. Finally, the impact was tested by multiple regressions.

3.3 Study Population, Sample, and Unit of Analysis:

Population and sample: The study population is courier and logistics service firms, the number of which reaches 200 firms operating in Jordan which are responsible for every step in delivering parcels and goods in Jordan. The sample is selected from the population using a convenience sampling method.

Unit of Analysis: 35 firms responded to the questionnaire, the survey analysis unit consists of 130 survey participants (38) managers, (46) supervisors, and (46) operators in the courier industry that is operating in Jordan, who are responsible for every step in the process of delivering parcels and goods in Jordan.

Data Sources: For fulfilling the purposes of the study, the data was collected from two sources: secondary and primary data, as follows:

Secondary data Secondary data is collected from different sources, such as journals, working papers, research, theses, studies, and the worldwide Web.

Primary data to actualize this study, primary data was collected from managers, supervisors, and operators working in the courier companies, through a questionnaire, which was built and developed for this purpose.

Study Instrument (Tool)

The questionnaire was developed based on previous studies, which addresses questions related to the definition of independent variables, dependent variables, and demographic data. The questionnaire was refereed by eight specialist academics holding PhDs or above and three practice firms, as shown in Appendix (1).

The Questionnaire: To actualize this study, the questionnaire was used as the main tool, which contains three parts, as follows:

The first part contains the:

Demographic dimensions related to gender, age, experience, education, position, and division.

The second part includes both independent and dependent variables, as follows:

Independent Variable (Blockchain): embedding decentralization, distributed ledger, cryptography, immutability, and smart contract**.**

Dependent Variable (Digitalizing): Contains the following dimensions: Real-time tracking, digital documentation, automated processes, transparency, and cybersecurity measures**.** Five items were used to measure each dimension.

All sub-variables were measured by suitable questions rated by five Likert scales to measure courier services workers' perception, ranging from value 1(strongly unimplemented) to value 5 (strongly implemented) used all over the questionnaire.

Data Collection Method

Hundred thirty (130) questionnaires were collected out of 170 questionnaires distributed to managers, supervisors, and operators which is 76.5% of questionnaires returned. Data was collected from 35 companies working in the Jordan market, from February to April 2024. All collected questionnaires were complete, suitable, and coded against SPSS 20.

Validity Test: The tool`s validity was confirmed using three methods: content, face, and construct. The content validity was confirmed by collecting data from multiple literature resources, such as books, journals, working papers, research, theses, dissertations, studies, the worldwide Web (WWW), and courier and logistics companies. Moreover, the face validity was confirmed through the board of referees, which judged the questionnaire (see Appendix 1). Finally, construct validity was confirmed by principal component factor analysis with Kaiser Meyer Olkin (KMO).

3.4 Construct Validity (Factor Analysis)

The construct validity was confirmed using Principal Component Factor Analysis with Kaiser Meyer Olkin (KMO). The data explanation and conformity were examined using Principal Factor Analysis. Factor loading more than 0.50 is good and accepted if it exceeds 0.40

(Hair, et. al. 2014). However, Kaiser Meyer Olkin (KMO) is used to measure sampling adequacy, harmony, and inter-correlations, KMO values between 0.615 and 0.811 indicate that a high sampling is adequacy, and is accepted if it exceeds 0.6.

Another indicator is Bartlett's of Sphericity used for the determination of suitability of data and correlation, where if the significant value of data is less than 0.05 at a 95% confidence level, that indicates a useful factor analysis. Variance percentage shows the explanation power of factors (Cerny & Kaiser, 1977).

3.5 Decentralization

Table (3.1) shows that the loading factor of decentralization scored between 0.451 and 0.769. Therefore, construct validity is assumed. KMO has rated 61.6%, which indicates good adequacy, and the Chi2 is 129.051, which indicates the model's fitness. Moreover, the variance percentage is 66.003, so it can explain 66.00% of the variation. Finally, the significance of Bartlett's sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (3.1): Principal Component Analysis Decentralization

Item	F1	KMO	Chi^2	Var. %	Sig.
The company applies information storage within its network	.729	.616	129.051	66.003	0.000
The company implements multiple control authorities on data.	.769				
The company enhances direct access to information.	.671				
The company maintains data validation.	.451				
The company uses a dispersed data exchange system.	.711				

3.6 Distributed Ledger

Table (3.2): Principal Component Analysis Distributed Ledger

Item	F1	KMO	Chi^2	Var. %	Sig.
The company enhances Joint monitoring legality along Peer to Peer within its network.	.775	.811	222.154	57.725	0.000
The company performs transaction synchronization.	.636				
The company implements tamper-proof records.	.640				
The company empowers data sharing.	.876				
The company uses multiple points of failure along its network.	.481				

Table (3.2) shows that the loading factor of Distributed Ledger items scored between 0.481 and 0.867. Therefore, the construct validity is assumed. KMO has rated 81.1%, which indicates good adequacy, and the Chi2 is 222.154, which indicates the fitness of the model. Moreover, the variance percentage is 57.725, so it can explain 57.73% of the variation. Finally, the significance of Bartlett's sphericity is less than 0.05, which indicates the factor analysis is useful.

3.7 Cryptography

Table (3.3) shows that the loading factor of Cryptography items scored between 0.547 and 0.854. Therefore, construct validity is assumed. KMO is rated 73.3%, which indicates good adequacy, and the Chi2 is 162.646, which indicates the model's fitness. Moreover, the variance percentage is 49.851, so it can explain 49.85% of the variation. Finally, the significance of Bartlett's sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (3.3): Principal Component Analysis Cryptography

Item	F1	KMO	Chi^2	Var. %	Sig.
The company improves information security by encoding data.	.854	.733	162.646	49.851	0.000
The company prevents unauthorized access using encryption techniques.	.808				
The company maintains data integrity.	.553				
The company verifies the transactions' authenticity.	.547				
The company achieves non-repudiation.	.711				

3.8 Immutability

Table (3.4) shows that the loading factor of Immutability items scored between 0.538 and 0.732. Therefore, construct validity is assumed. KMO is rated 61.5%, which indicates good adequacy, and the Chi2 is 57.619, which indicates the model's fitness.

Table (3.4): Principal Component Analysis Immutability

Item	F1	KMO	Chi^2	Var.%	Sig.
The company enhances verified data recording.	.550	.615	57.619	58.530	0.000
The company maintains unalterable records.	.538				
The company supports modifying consensus data.	.732				
The company enhances anti-fraud.	.594				
The company achieves efficient sharing.	.591				

Moreover, the variance percentage is 58.530, so it can explain 58.53% of the variation. Finally, the significance of Bartlett's sphericity is less than 0.05, which indicates the factor analysis is useful.

3.9 Smart contract

Table (3.5) shows that the loading factor of Smart contract items scored between 0.508 and 0.686. Therefore, the construct validity is assumed. KMO is rated 63.3%, which indicates good adequacy, and the Chi2 is 125.903, which indicates the model's fitness. Moreover, the variance percentage is 59.932, so it can explain 59.93% of the variation. Finally, the significance of Bartlett's sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (3.5): Principal Component Analysis Smart contract

Item	F1	KMO	Chi^2	Var.%	Sig.
The company uses self-executing contracts.	.508	.633	125.903	59.932	0.000
The company performs predefined conditions.	.512				
The company achieves automatic due diligence.	.654				
The company achieves digital transactions.	.686				
The company reduces manual interventions.	.615				
The company shortens the intermediaries.	561				

3.10 Real-Time tracking

Table (3.6) shows that the loading factor of real-time tracking items scored between 0.572 and 0.858. Therefore, the construct validity is assumed. KMO is rated 73.1%, which indicates good adequacy, and the Chi2 is 194.416, which indicates the model's fitness. Moreover, the variance percentage is 53.565, so it can explain 53.57% of the variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates factor analysis is useful.

Table (3.6): Principal Component Analysis Real-Time tracking

Item	F1	KMO	Chi^2	Var.%	Sig.
The company implements live monitoring.	.572	.731	194.416	53.565	0.000
The company maximizes continuous status updates.	.668				
The company improves unexpected event detection.	.740				
The company minimizes delivery potential damages.	.858				
The company reduces delivery potential disruptions.	.788				

3.11 Digital Documentation

Table (3.7): Principal Component Analysis Digital documentation

Item	F1	KMO	Chi^2	Var.%	Sig.
The company enhances long-term access to digital documents.	.683	.663	60.307	46.340	0.000
The company uses documentation devices.	.799				
The company empowers digital information archiving.	.782				
The company emphasizes preserving original information.	.369				

Table (3.7) shows that the loading factor of digital documentation items scored between 0.369 and 0.799, according to (Costello & Osborne, 2005) such loadings can be acceptable in exploratory research when they add meaningful content to the factor. 0.369 is very close to 0.4 and could be rounded to 0.4. Therefore, the construct validity is assumed. KMO has rated 66.3%, which indicates good adequacy, and the Chi2 is 60.307, which indicates the model's fitness. Moreover, the variance percentage is 46.340, so it can explain 46.34% of the variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates factor analysis is useful.

3.12 Automated Operation

Table (3.8) shows that the loading factor of automated operation items scored between 0.395 and 0.859, according to (Costello & Osborne, 2005) such loadings can be acceptable in exploratory research when they add meaningful content to the factor. 0.395 is very close to 0.4 and could be rounded to 0.4. Therefore, the construct validity is assumed. KMO has rated 67.6%, which indicates good adequacy, and the Chi2 is 170.668, which indicates the model's fitness. Moreover, the variance percentage is 68.842, so it can explain 68.84% of the variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates factor analysis is useful.

Table (3.8): Principal Component Analysis Automated Operation

Item	F1	KMO	Chi^2	Var.%	Sig.
The company conducts computerization for processes.	.395	.676	170.668	68.842	0.000
The company improves the machines' task allocation.	.823				
The company reduces human errors.	.420				
The company optimizes computing resource allocation.	.859				
The company uses information technology resources.	.814				

3.13 Transparency

Table (3.9): Principal Component Analysis Transparency

Item	F1	KMO	Chi^2	Var.%	Sig.
The company enhances information quality.	.680	.699	88.037	52.137	0.000
The company improves visibility throughout the chain.	.625				
The company empowers openness to shipment information.	.768				
The company performs dispute resolution.	.803				

Table (3.9) shows that the loading factor of Transparency items scored between 0.625 and 0.803. Therefore, construct validity is assumed. KMO is rated 69.9%, which indicates good adequacy, and the Chi2 is 88.037, which indicates the model's fitness. Moreover, the variance percentage is 52.137, so it can explain 52.14% of the variation. Finally, the significance of Bartlett's sphericity is less than 0.05, which indicates the factor analysis is useful.

3.14 Cybersecurity

Table (3.10) shows that the loading factor of Cybersecurity items scored between 0.593 and 0.737. Therefore, the construct validity is assumed. KMO is rated 67.5%, which indicates good adequacy, and the Chi2 is 74.315, which indicates the model's fitness. Moreover, the variance percentage is 40.704, so it can explain 40.70% of the variation. Finally, the significance of Bartlett's sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (3.10): Principal Component Analysis Cybersecurity

Item	F1	KMO	Chi^2	Var.%	Sig.
The company enhances data confidentiality.	.593	.675	74.315	40.704	0.000
The company ensures digital integrity.	.622				
The company improves information availability.	.604				
The company implements security breach protection.	.623				
The company enhances safe data transmission. Cybersecurity	.737				

3.15 Reliability Test

Table (3.11): Reliability Test for all Variables

Variable	Sub-Variables	Cronbach's Alpha
Blockchain	**5 Sub-Variables**	
Decentralization	5	0.700
Distributed Ledger	5	0.813
Cryptography	5	0.745
Immutability	5	0.564
Smart Contract	6	0.616
Digitalizing Courier	**5 Dimensions**	
Real-Time Tracking	5	0.779
Digital Documentation	4	0.609
Automated Operations	5	0.727
Transparency	4	0.685
Cybersecurity	5	0.633

The data reliability is examined through Cronbach’s alpha, the reliable tools have a Cronbach’s alpha above 0.70 and are accepted if it exceeds 0.60 (Hairet. al. 2014). Table (3.11) shows that the reliability coefficient for blockchain sub-variables ranges between 0.564 and 0.813, according to (Nunnally & Bernstein,1994) Cronbach’s alpha values around 0.60 can be acceptable in early-stage research. 0.564 is very close to 0.6 and could be rounded to 0.6, supporting the inclusion of this sub-variable. For Digitizing Courier system dimensions are between 0.609 and 0.779.

The demographic analysis presented in the below sections is based on the characteristics of the valid respondent i.e. frequency and percentage of participants such as gender, age, Experience, education, Position, and division.

Gender: Table (3.12) shows that the majority of respondents are males, where 111 (85.4%), and only 19(14.6%) are females. This is justified since the female proportion is low within the scope of tested divisions.

Table (3.12): Respondents Gender

Gender	Frequency	Percent %
Male	111	85.4
Female	19	14.6
Total	**130**	**100**

Age: Table (3.13) shows that the majority of respondents ages are between (30-40 years) 112 (86.2%) out of the total sample and this matches with the study scope, then those ages between (40-50 years) 10 (7.7%), after that the respondents younger than 30 years 8 (6.2%).

Table (3.13): Respondents Age

Age	Frequency	Percent %
Less 30	8	6.15
Bet 30-40	112	86.15
Bet 40-50	10	7.70
Total	**130**	**100**

Experience: Table (3.14) shows that the majority of respondents have experienced between (10-20 years) 82 (63.1%), then respondents experienced between (20-30 years) 25 (19.2%), followed by those with experience less than 10 years 23 (17.7%).

Table (3.14): Respondents Experience

Experience	Frequency	Percent %
Less 10	23	17.7
Bet 10-20	82	63.1
Bet 20-30	25	19.2
Total	**130**	**100**

Education

Table (3.15): Respondents Education

Education	Frequency	Percent %
Master	8	6.2
Bachelor	104	80
Diploma	18	13.8
Total	**130**	**100**

Table (3.15) shows that the majority of respondents hold a high educational level and this came from the nature of the logistics industry. Where the majority 104 (80%) have a bachelor's degree, after that 18 (13.8%) have a Diploma degree, finally, 8 (6.2%) have a Master degree.

Position: Table (3.16) shows that the majority of respondents are operators 46 (35.4%) and supervisors 46 (35.4%) out of the total respondents, 38 (29.2%) are managers.

Table (3.16): Respondents Position

Position	Frequency	Percent %
Manager	38	29.2
Operator	46	35.4
Supervisor	46	35.4
Total	**130**	**100**

Division: Table (3.17) shows that the majority of respondents are working in supply chain division 56 (43.1%) and this is because the scope of this study is logistics activities, then those working in operations division 49 (37.7%), after IT 25 (19.2%).

Table (3.17): Respondents Division

Division	Frequency	Percent %
IT	25	19.2
Operation	49	37.7
SupplyChain	56	43.1
Total	**130**	**100**

Chapter Four
Data Analysis

4.1 Introduction

This chapter includes descriptive statistical analysis data of respondents' perceptions, and a bivariate Pearson correlation matrix to test the relationships between the blockchain sub-variables with each other, and the dimensions of digitalizing courier system with each other; And between the blockchain variable and the sub-variables with dimensions of digitalizing courier system. Finally, multiple regressions to verify the hypothesis: the impact of blockchain on the digitalizing courier system.

4.2 Descriptive Statistical Analysis:

The mean, standard deviation, t-value, ranking, and implementation level are used to describe the respondents' perceptions and the degree of implementation of each variable, dimension, and item.

The implementation level is divided into three categories based on thefollowing formula:

$$\frac{5-1}{3} = 1.33$$

Therefore, implementation is considered high if it is within the range of 3.67–5.00, medium if it is between 2.34 and 3.66, and low implementation is between 1.00 and 2.33.

4.3 Independent Variable (Blockchain)

Table (4.1) shows that the means of the Blockchain sub-variables range from 4.25 to 4.45, with a standard deviation between 0.384 and 0.510. This indicates that respondents agree on the high implementation of Blockchain sub-variables, which is supported by a high t-value compared to the T-tabulated.

Table (4.1): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Blockchain.

No.		Mean	Std. D.	t	Sig.	Rank	Impl.
1	Decentralization	4.35	0.407	37.73	0.000	2	High
2	Distributed Ledger	4.33	0.507	29.94	0.000	3	High
3	Cryptography	4.45	0.510	32.35	0.000	1	High
4	Immutability	4.33	0.391	38.58	0.000	4	High
5	Smart contract	4.25	0.384	36.99	0.000	5	High
	Blockchain	**4.34**	**0.369**	**41.22**	**0.000**		**High**

T-tabulated=1.960

Moreover, Cryptography has rated the highest implementation, then the average mean is 4.34 with a standard deviation of 0.369, indicating that the respondents are highly aware of and concerned about the Blockchain, where the t-value is 41.22>T-tabulated = 1.960.

4.4 Decentralization

Table (4.2) shows that the means of Decentralization items range from 4.05 to 4.52 with a standard deviation between 0.587 and 0.810. This indicates that respondents agree on the high implementation of Decentralization, this is supported by a high t-value compared to the T-tabulated value for items from 1 to 5. The average mean is 4.35 with a standard deviation of 0.407, indicating that the respondents are highly aware and concerned about Decentralization, where the t-value is 37.73>T-tabulated = 1.960.

Table (4.2): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Decentralization

No.		Mean	Std. D.	t	Sig	Rank	Impl.
1	The company applies information storage within its network.	4.42	0.746	21.76	0.000	2	High
2	The company implements multiple control authorities on data.	4.22	0.810	17.23	0.000	4	High
3	The company enhances direct access to information.	4.32	0.650	23.22	0.000	3	High
4	The company maintains data validation.	4.52	0.587	29.43	0.000	1	High
5	The company uses a dispersed data exchange system.	4.05	0.781	15.39	0.000	5	High
	Decentralization	**4.35**	**0.407**	**37.73**	**0.000**		**High**

T-tabulated=1.960

4.5 Distributed Ledger

Table (4.3): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Distributed Ledger

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company enhances Joint monitoring legality along Peer to Peer within its network.	4.21	0.744	18.51	0.000	4	High
2	The company performs transaction synchronization.	4.60	0.537	33.97	0.000	1	High
3	The company implements tamper-proof records.	4.39	0.742	21.40	0.000	2	High
4	The company empowers data sharing.	4.12	0.774	16.43	0.000	5	High
5	The company uses multiple points of failure along its network.	4.35	0.814	18.86	0.000	3	High
	Distributed Ledger	**4.33**	**0.507**	**29.94**	**0.000**		**High**

T-tabulated=1.960

Table (4.3) shows that the means of Distributed Ledger items range from 4.12 to 4.60 with a standard deviation between 0.507 and 0.814. This indicates that respondents agree on the high implementation of Distributed Ledger items, this is supported by a high t-value compared to Ttabulated. The average mean is 4.33 with a standard deviation of 0.507, indicating that the respondents are highly aware and concerned about the Distributed Ledger, where the t-value is 29.94>T-tabulated = 1.960.

4.6 Cryptography

Table (4.4) shows that the means of Cryptography items range from 4.09 to 4.76 with a standard deviation between 0.460 and 0.950. This indicates that respondents agree on the high implementation of Cryptography items; this is supported by a high t-value compared to T- tabulated. The average mean is 4.45 with a standard deviation of 0.510, which indicates that the respondents are highly aware and concerned about Cryptography, where the t-value is 32.35>T-tabulated = 1.960.

Table (4.4): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Cryptography

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company improves information security by encoding data.	4.29	0.950	15.42	0.000	4	High
2	The company prevents unauthorized access using encryption techniques.	4.09	0.902	13.81	0.000	5	High
3	The company maintains data integrity.	4.76	0.479	41.92	0.000	1	High
4	The company verifies the transactions' authenticity.	4.70	0.460	42.13	0.000	2	High
5	The company achieves non-repudiation.	4.40	0.689	23.18	0.000	3	High
	Cryptography	**4.45**	**0.510**	**32.35**	**0.000**		**High**

T-tabulated=1.960

4.7 Immutability

Table (4.5): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Immutability

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company enhances verified data recording.	4.61	0.564	32.52	0.000	2	High
2	The company maintains unalterable records.	4.26	0.654	22.01	0.000	4	High
3	The company supports modifying consensus data.	3.88	0.760	13.08	0.000	5	High
4	The company enhances anti-fraud.	4.64	0.557	33.55	0.000	1	High
5	The company achieves efficient sharing.	4.27	0.680	21.30	0.000	3	High
	Immutability	**4.33**	**0.391**	**38.58**	**0.000**		**High**

T-tabulated=1.960

4.8 Smart Contract

Table (4.6) shows that the means of Smart Contract items range from 3.97 to 4.50 with a standard deviation between 0.568 and 7.97. This indicates that respondents agree on the high implementation of Smart Contract items; this is supported by a high t-value compared to T-tabulated. The average mean is 4.25 with a standard deviation of 0.384, indicating that the respondents are highly aware of and concerned about Smart Contracts, where the t-value is 36.99>T- tabulated = 1.960.

Table (4.6): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Smart Contract

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company uses self-executing contracts.	3.97	0.797	13.87	0.000	6	High
2	The company performs predefined conditions.	4.50	0.574	29.80	0.000	1	High
3	The company achieves automatic due diligence.	4.192	0.672	20.24	0.000	4	High
4	The company achieves digital transactions.	4.185	0.568	23.79	0.000	5	High
5	The company reduces manual interventions.	4.27	0.620	23.34	0.000	3	High
6	The company shortens the intermediaries.	4.37	0.684	22.84	0.000	2	High
	Smart Contract	**4.25**	**0.384**	**36.99**	**0.000**		**High**

T-tabulated=1.960

4.9 Dependent variable (Digitalizing Courier System)

Table (4.7) shows that the means of Digitalizing Courier System items range from 4.25 to 4.57 with a standard deviation between 0.315 and 0.492.

Table (4.7): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Digitalizing Courier System

No.		Mean	Std. D.	t	Sig.	Rank	Impl.
1	Real-time Tracking	4.49	0.370	45.85	0.000	3	High
2	Digital Documentation	4.55	0.343	51.68	0.000	2	High
3	Automated Operations	4.25	0.492	28.93	0.000	5	High
4	Transparency	4.44	0.348	47.14	0.000	4	High
5	Cybersecurity	4.57	0.315	56.91	0.000	1	High
	Digitalizing Courier System	**4.46**	**0.285**	**58.43**	**0.000**		High

T-tabulated=1.960

This indicates that respondents agree on the high implementation of Digitalizing Courier System items; this is supported by a high t-value compared to T-tabulated. The average mean is 4.46 with a standard deviation of 0.285, which indicates that the respondents are highly aware and concerned about the Digitalizing Courier System, The t-value is 58.43>T-tabulated = 1.960.

4.10 Real-Time Tracking

Table (4.8): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Real-Time Tracking

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company implements live monitoring.	4.62	0.502	36.85	0.000	1	High
2	The company maximizes continuous status updates.	4.58	0.526	34.16	0.000	2	High
3	The company improves unexpected event detection.	4.30	0.606	24.48	0.000	5	High
4	The company minimizes delivery potential damages.	4.45	0.572	28.97	0.000	4	High
5	The company reduces delivery potential disruptions.	4.48	0.531	31.69	0.000	3	High
	Real-Time Tracking	**4.49**	**0.370**	**45.85**	**0.000**		**High**

T-tabulated=1.960

Table (4.8) shows that the means of Real-Time Tracking items range from 4.30 to 4.62, with a standard deviation between 0.502 and 0.606. This indicates that respondents agree on the high implementation of Real-Time Tracking items; this is supported by a high t-value compared to T-tabulated. The average mean is 4.49 with a standard deviation of 0.370, indicating that the respondents are highly aware and concerned about Real-Time Tracking, where the t-value is 45.85>T-tabulated = 1.960.

4.11 Digital Documentation

Table (4.9) shows that the means of Digital Documentation items range from 4.24 to 4.90 with a standard deviation between 0.301 and 0.735.

Table (4.9): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Digital Documentation

No.		Mean	Std. D.	t	Sig.	Rank	Impl
1	The company enhances long-term access to digital documents.	4.546	0.624	28.25	0.000	3	High
2	The company uses documentation devices.	4.24	0.735	19.22	0.000	4	High
3	The company empowers digital information archiving.	4.554	0.571	31.00	0.000	2	High
4	The company emphasizes preserving original information.	4.90	0.301	71.93	0.000	1	High
	Digital Documentation	**4.55**	**0.343**	**51.68**	**0.000**		**High**

T-tabulated=1.960

This indicates that respondents agree on the high implementation of Digital Documentation items; this is supported by a high t-value compared to T-tabulated. The average mean is 4.55 with a standard deviation of 0.343, indicating that the respondents are highly aware and concerned about Digital Documentation, where the t-value is 51.68>T-tabulated = 1.960.

4.12 Automated Operation

Table (4.10) shows that the means of Automated Operation items range from 3.93 to 4.39, with a standard deviation between 0.488 and 0.823. This indicates that respondents agree on the high implementation of Automated Operation items; this is supported by a high t-value compared to T-tabulated. The average mean is 4.25 with a standard deviation of 0.492, which indicates that the respondents are highly aware and concerned about Automated Operation, where the t-value is 28.93>T-tabulated = 1.960.

Table (4.10): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Automated Operation

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company conducts computerization for processes.	4.39	0.488	32.33	0.000	3	High
2	The company improves the machines' task allocation.	3.93	0.809	13.12	0.000	5	High
3	The company reduces human errors.	4.39	0.576	27.42	0.000	1	High
4	The company optimizes computing resource allocation.	4.21	0.823	16.73	0.000	4	High
5	The company uses information technology resources.	4.33	0.791	19.18	0.000	3	High
	Automated Operation	**4.25**	**0.492**	**28.93**	**0.000**		**High**

T-tabulated=1.960

4.13 Transparency

Table (4.11): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Transparency

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company enhances information quality.	4.60	0.492	37.09	0.000	1	High
2	The company improves visibility throughout the chain.	4.25	0.575	24.87	0.000	3	High
3	The company empowers openness to shipment information.	4.24	0.691	20.43	0.000	4	High
4	The company performs dispute resolution.	4.50	0.532	32.15	0.000	2	High
	Transparency	**4.44**	**0.348**	**47.14**	**0.000**		**High**

T-tabulated=1.960

Table (4.11) shows that the means of Transparency items range from 4.24 to 4.60, with a standard deviation between 0.492 and 0.691. This indicates that respondents agree on the high implementation of Transparency items; this is supported by a high t-value compared to T-tabulated. The average mean is 4.44 with a standard deviation of 0.348, which indicates that the respondents are highly aware of and concerned about Transparency, the t-value is 47.14>T-tabulated = 1.960.

4.14 Cybersecurity

Table (4.12) shows that the means of Cybersecurity items range from 4.37 to 4.69 with a standard deviation between 0.463 and 0.573. This indicates that respondents agree on the High implementation of Cybersecurity items; this is supported by a high t-value compared to T- tabulated. The average mean is 4.57 with a standard deviation of 0.315, indicating that the respondents were highly aware and concerned about Cybersecurity, where the t-value is 56.91>T-tabulated = 1.960.

Table (4.12): Mean, Standard Deviation, t-value, Ranking, and Implementation Level of Cybersecurity

No.		Mean	Std. D.	t	Sig	Rank	Impl
1	The company enhances data confidentiality.	4.69	0.463	41.65	0.000	1	High
2	The company ensures digital integrity.	4.56	0.528	33.70	0.000	3	High
3	The company improves information availability.	4.37	0.573	27.27	0.000	5	High
4	The company implements security breach protection.	4.58	0.511	35.16	0.000	2	High
5	The company enhances safe data transmission.	4.55	0.544	32.59	0.000	4	High
	Cybersecurity	**4.57**	**0.315**	**56.91**	**0.000**		**High**

T-tabulated=1.960

4.15 Relationship between Independent and Dependent Variables

Table (4.13): Relationship between Independent and Dependent Variables

No.		1	2	3	4	5	6	7	8	9	10	11	12
1	Decentralization												
2	Distributed Ledger	.718**											
3	Cryptography	.591**	.705**										
4	Immutability	.517**	.695**	.641**									
5	Smart Contract	.485**	.623**	.593**	.575**								
6	**BlochChain**	.794**	.908**	.862**	.816**	.774**							
7	Real-Time Tracking	.431**	.450**	.379**	.524**	.469**	.533**						
8	Digital Documentation	.388**	.484**	.482**	.445**	.501**	.552**	.317**					
9	Automated Operation	.665**	.651**	.517**	.477**	.570**	.690**	.517**	.442**				
10	Transparency	.396**	.507**	.446**	.623**	.531**	.593**	.602**	.311**	.434**			
11	Cybersecurity	.448**	.579**	.549**	.522**	.389**	.602**	.549**	.411**	.569**	.567**		
12	**Digitizing Courier System**	.631**	.710**	.624**	.677**	.655**	.789**	.783**	.643**	.818**	.750**	.798**	1

****. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).**

The Bivariate Pearson Correlation Test was employed to analyze the relationships between various sets of variables, as detailed in Table (4.13). The results indicate that the correlations among the Blockchain sub-variables are quite strong, with Pearson correlation coefficients ranging from 0.575 to 0.718. This suggests a strong positive correlation, implying that as one sub-variable increases, the others also tend to increase. Additionally, the Digitalizing Courier System dimensions exhibit strong correlations, with coefficients ranging from 0.317 to 0.567. Although these correlations are slightly lower, they still represent a strong positive relationship, indicating a consistent connection among these dimensions. Finally, the relationship between the independent and dependent variables is very strong, with a Pearson correlation coefficient of 0.789.

4.16 Hypothesis Testing

After confirming validity, reliability, and the correlation between independent and dependent variables, the following tests should be carried out to ensure the validity of regression analysis. (Sekaran, 2003):

Normality: Figure (4.1) shows that the shape follows the normal distribution, in such case the model does not violate this assumption.

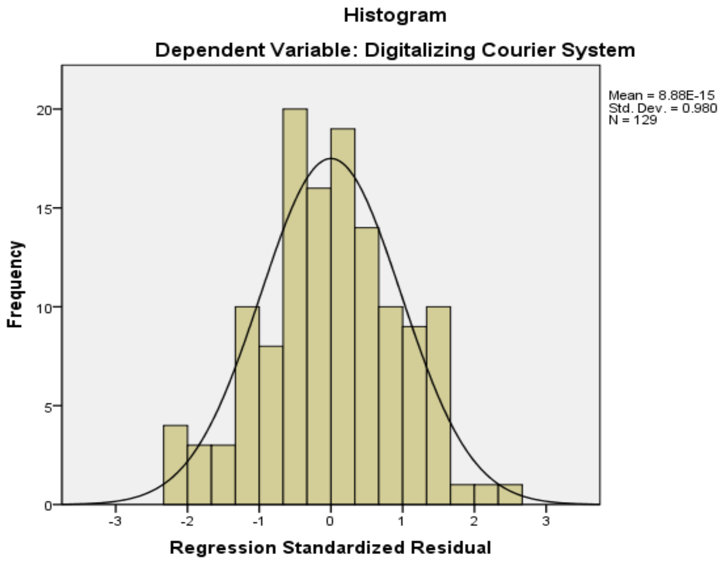


Figure (4.1): Normality Test

Linearity test: figure (4.2) shows that there is a linear relationship between independent and dependent variables. In such a case, the model does not violate this assumption.

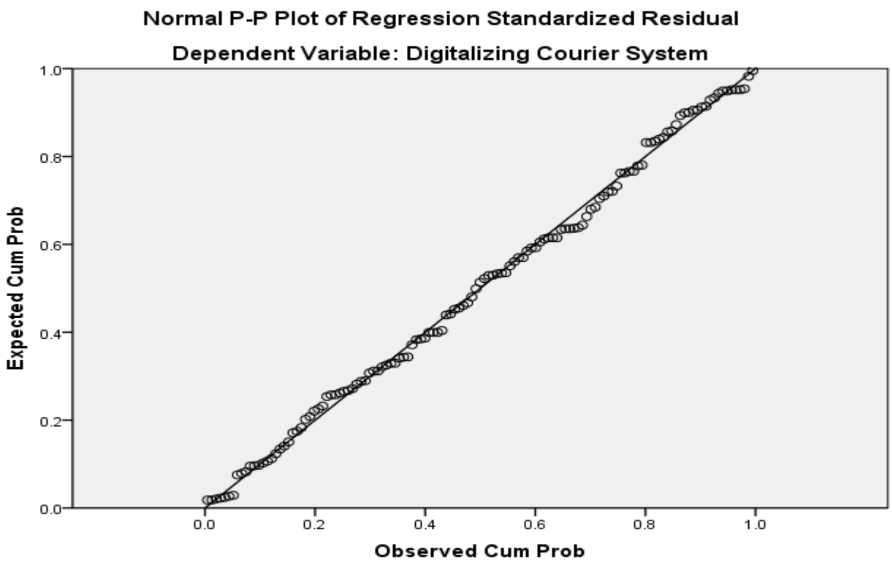


Figure (4.2): Linearity Test

Equal variance (homoscedasticity): figure (4.3) shows that the errors are scattered around the mean, therefore there is no relation between errors and predicted values, in such case, the model does not violate this assumption.

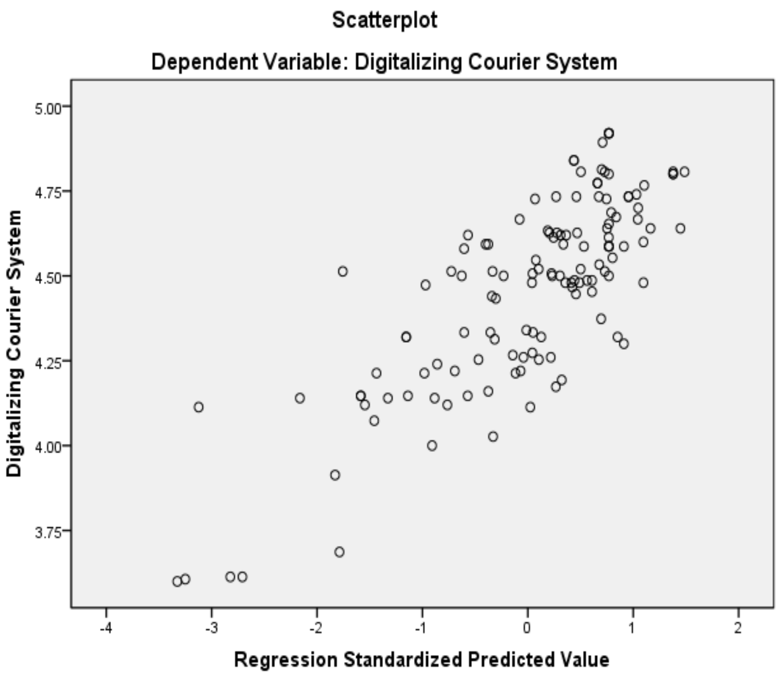


Figure (4.3): Linearity Test

Table (4.14) shows Multi-Collinearity: the VIF (Variance Inflation Factor) value is less than 10, and tolerance is more than 10%, in such case the Collinearity model does not violate this assumption.

Table (4.14): Durbin-Watson value and Variance Inflation Factor

Sub Variable	Collinearity Statistics	
	Tolerance	VIF
Decentralization	0.470	2.129
Distributed Ledger	0.292	3.427
Cryptography	0.426	2.347
Immutability	0.455	2.197
Smart Contract	0.545	1.834

Dependent Variable: Digitalizing Courier System

4.17 Main Hypothesis

H01: There is no impact of the collective blockchain sub-variables on the Digitalizing Courier System dimensions of the supply chain, at ($\alpha \leq 0.05$).

Table (4.15) shows that when regressing the five sub-variables of the Blockchain against the total of the Digitaqlizing Courier System, the model shows that the Blockchain can explain 64% of the variation of the Digitalizing Courier System where (R2=0.64, F=43.779, and Sig.=0.000). Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted, which states that there is an impact of the collective blockchain sub-variables on the Digitalizing Courier System dimensions of the supply chain, at ($\leq$0.05)

Table (4.15): Multiple Regressions of Blockchain Sub- variables on Digitalizing Courier System

Model	R	R Square	Adjusted R Square	F	Sig.
1	.800[a]	0.64	0.626	43.779	0.000a

a. Predictors: (Constant), Smart, Decentralization, Immutability, Cryptography, Distributed. b. Dependent Variable: Digitizing Courier System

Based on the components of blockchain, table (4.16) shows the impact of each sub-variable of Blockchain on the Digitalizing Courier System, three of them impacted the Digitalizing courier System, and the highest impact was for Smart Contracts with 26.4% of the total impact on the Digitalizing Courier System, and followed by Immutability with an impact of 26.0% on Digitalizing Courier System, then Decentralization rated 21.2%

of the total impact on the Digitalizing Courier System. The Distributed Ledger with 17.3% of the total impact on the Digitalizing Courier System and Cryptography with 5.4% of the total impact on the Digitalizing Courier System do not significantly affect the Digitalizing Courier System.

Table (4.16): Multiple Regressions of Blockchain Sub-variables on Digitalizing Courier System (ANOVA)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.619	0.213		7.608	0.000
	Decentralization	0.147	0.055	0.212	2.688	0.008
	Distributed Ledger	0.097	0.056	0.173	1.732	0.086
	Cryptography	0.03	0.046	0.054	0.649	0.517
	Immutability	0.189	0.058	0.26	3.246	0.002
	Smart contract	0.195	0.054	0.264	3.61	0.000

a. Dependent Variable: Digitalizing Courier System, T-tabulated=1.960

Blockchain elements do not affect the Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity), at α≤0.05.

Table (4.17) shows that when regressing the Blockchain against the Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity), the model shows that the Blockchain can explain 64.8% of the variation of Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity), where (R2=0.648, F=45.225, Sig.=0.000). Therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted, which states that There is an impact of the blockchain on Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity), at α≤0.05.

Table (4.17): Multiple Regressions of Blockchain on Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity).

Model	R	R Square	Adjusted R Square	F	Sig.
1	.805[a]	0.648	0.633	45.225	0.000

a. Predictors: (Constant), Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity, b. Dependent Variable: Blockchain.

Based on the dimensions of Digitalizing Courier System, table (4.18) shows the impact of Blockchain on Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity), where three of them impacted Blockchain, the highest impact was for Automated Operation with 38.7% of the total impact, Transparency with an impact of 27.0%, and Digital Documentation with an impact of 24.5% on Digitalizing Courier System. While Real-Time Tracking and Cybersecurity do not significantly impact the Blockchain.

Table (4.18): Multiple Regressions of Blockchain on Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity) (ANOVA).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.119	0.35		-0.34	0.740
	Real-time Tracking	0.032	0.073	0.032	0.435	0.660
	Digital Documentation	0.264	0.066	0.245	4.015	0.000
	Automated Operations	0.291	0.053	0.387	5.509	0.000
	Transparency	0.287	0.076	0.27	3.767	0.000
	Cybersecurity	0.133	0.087	0.114	1.527	0.130

a. Predictors: (Constant), Rea-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity, b. Dependent Variable: Blockchain. T-tabulated=1.960

H01.1: There is no impact of the collective blockchain sub-variables on Real-time Tracking within the Digitalizing Courier System of the supply chain, (α≤0.05). The null hypothesis with 3.2% of total impact, and Significant value =0.666 is accepted.

H01.2: There is no impact of the collective blockchain sub-variables on Digital Documentation within the Digitalizing Courier System of the supply chain, at (α≤0.05). The null hypothesis with 24.5% of the total impact, and a significant value=0.000, The null hypothesis is rejected and the alternative hypothesis is accepted, which states that there is an impact of the collective blockchain on Digital Documentation within the Digitalizing Courier System of the supply chain, at (α≤0.05).

H01.3: There is no impact of the collective blockchain sub-variables on Automated Operations within the Digitalizing Courier System of the supply chain, at (α≤0.05). The null hypothesis with 38.7% of the total impact, and the significant value=0.000 is rejected and the alternative hypothesis is accepted, which states There is an impact of the collective blockchain sub-variables on Automated Operations within the Digitalizing courier system of the supply chain, at (α≤0.05).

H01.4: There is no impact of the collective blockchain sub-variables on Transparency within the Digitalizing Courier System of the supply chain, at (α≤0.05). The null hypothesis with 27% of the total impact, and the significant value=0.000 is rejected and the alternative hypothesis is accepted, which states There is the impact of the collective blockchain sub-variables on Transparency within the Digitalizing Courier System supply chain, at (α≤0.05).

H01.5: There is no impact of the collective blockchain sub-variables on Cybersecurity within the Digitalizing Courier System of the supply chain, at (α≤0.05). The null hypothesis with 11.4% of the total impact, and the significant value=0.130 is accepted.

Chapter Five
Results' Discussion, Conclusion, and Recommendations

5.1 Results' Discussion:

The results of this study indicated a high implementation rate of blockchain sub-variables in the digitalization of the courier system within the supply chain industry. Cryptography has the highest implementation rate, followed by decentralization, distributed ledger, immutability, and smart contracts.

Furthermore, the findings revealed that among the dimensions of courier system digitalization, cybersecurity is the most highly implemented, followed by digital documentation, real-time tracking, transparency, and automated operations.

The study demonstrated strong relationships among the blockchain sub-variables, among the dimensions of digitalizing courier systems, and between blockchain and the digitalizing courier system. However, what is considered high implementation in some industries may not be satisfactory to others, as some firms aim to achieve Six Sigma standards, with only 3.4 defects per million.

Table (5.1) summarizes the impact matrix among the collective blockchain sub-variables on the dimensions of the Digitalizing Courier System (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity) via ANOVA analysis, the results are as follows:

Table (5.1): Summarizes the impact matrix of the Blockchain on Digitalizing Courier System dimensions (Real-Time Tracking, Digital Documentation, Automated Operation, Transparency, and Cybersecurity) via ANOVA analysis, the results are as follows:

	Digitalizing Courier System	Real-Time Tracking	Digital Documentation	Automated Operation	Transparency	Cybersecurity
Blockchain	X	-	X	X	X	-

+: Significant Impact

1. The significant impact of the total Blockchain on the courier system digitalization is supported by previous studies as Hofmann et. al. (2017) concluded that blockchain technology has the potential to become a cornerstone of the digital revolution by enabling decentralized collaboration in networks. A fundamental characteristic of such networks is trust in recorded data transactions and the rules of the decentralized network. To support maintenance and updates, the study provides a classification that specifies the system's immutability property, and the study conducted by Deshpande et. al. (2017) and Bakshi (2020) showed that Blockchain can streamline supply chain processes by eliminating the need for active intermediary data synchronization and concurrency control, leading to enhanced efficiency gains and can facilitate the supply chain by providing a high level of transparency and better product traceability.
2. The significant impact of Blockchain for most of the Digitalizing Courier System dimensions except Real-Time Tracking, and Cybersecurity. Despite, Zhu (2022) suggests that a blockchain model is created for real-time tracking of e-commerce logistics information, it turns out that data will be stored on-chain only when more than 51% of the nodes in the distributed system confirm that the data is valid, also Tokkozhina et. al. (2023) pointed out that all players can access real-time information at every stage of the process, and restaurants can also choose a specific carrier to deliver the order.

As well as Tiwari et. al (2023) pointed out that Blockchain technology (BCT) can help, with features such as being highly secure and distributed, which is against the results of this study. Meanwhile, the results of this study were in line with Liu et. al. (2023) study which indicated that a blockchain-based operating platform can achieve the digital conversion of paper documents and create a stable and shared network to enhance blockchain data management, and data monitoring, and reduce risks. Also, this study's results support Xiaet. al. (2023) pointed out that blockchain improves supply chain management by enhancing automation, transparency, and efficiency. and this study's results support Meidute Kavaliauskieneet. al. (2021) confirmed that blockchain technology would increase logistics supply chain transparency. Furthermore, the results of this study were consistent with the study conducted by Hackius (2022) which concluded that blockchain technology presents significant opportunities for improving supply chain and logistics operations by enhancing efficiency, transparency, trust, and data integrity.

3. The researcher reviewed feedback from participants regarding the significant impact of collective blockchain sub-variables on the dimensions of digitization in the courier system, specifically automated operations, transparency, and digital documentation. However, the results indicated no impact on real-time tracking and cybersecurity, contrary to Zhang et. al. (2023), which highlighted blockchain's capabilities in decentralized tracking, cryptographic protection, openness, and transparency. Participants explained that despite blockchain's capabilities, firms do not rely solely on it for cybersecurity. They also employ other systems such as Intrusion Prevention Systems (IPS), Sandboxing, Content Disarm and Reconstruction (CDR), firewalls, and antivirus software. Participants provided

feedback on why this study found no impact of collective blockchain sub-variables on real-time tracking, contrary to Zhu's (2022) study, which highlighted blockchain's potential in enhancing real-time tracking of e-commerce logistics. Participants noted that real-time tracking relies on radio frequency identification (RFID) technology, and their focus was not on noting the real-time tracking of information using blockchain.

4. The significant impact of Blockchain sub-variables on the Digitalizing Courier System except for Distributed Ledger and Cryptography (despite it has a high implementation rate). This study focused on the impact of collective blockchain sub-variables on the dimensions of digitizing the courier system. The researcher measured the level of implementation without elaborating and discussing the results. It should be noted that high implementation in one industry may not be satisfactory in another, as firms strive to reach Six Sigma standards, with only 3.4 defects per million.

5.1 Conclusion

This study is dedicated to answering the study's main question: Is there an impact of collective blockchain sub-variables on digitalizing Courier System’s dimensions? The study methodically collected data through a carefully designed questionnaire, which went through testing for validity and reliability. To examine the hypotheses, statistical methods, including correlation and multiple regression analyses, were employed.

The results of this study show the high implementation of blockchain sub-variables within the logistics industry. Among these sub-variables, cryptography emerged as the highest implementation, followed sequentially by decentralization, distributed ledger, immutability, and smart contracts. Furthermore, the study revealed substantial implementation of the various dimensions of the digitalizing courier system.

Cybersecurity was the highest implementation dimension, followed by digital documentation, real-time tracking, transparency, and automated operations. Nevertheless, it is crucial to recognize that the high level of implementation observed in some industries might fall short of the strict held by others, especially those aiming for Six Sigma quality, characterized by a target of only 3.4 defects per million opportunities.

The correlations among the blockchain sub-variables were notably robust, while the digitalizing courier system dimensions also exhibited strong, albeit slightly weaker, correlations. This signifies a consistent and positive interrelationship among these dimensions, confirming a deep connection between the independent variables (blockchain sub-variables) and the dependent variables (digitalizing courier system dimensions).

The study concluded that blockchain has a significant and transformative impact on the digitalizing courier systems within Jordan's logistics industry. Automated operations dimension was the highest impacted by the Blockchain, followed by the transparency dimension and digital documentation dimension. Conversely, the real-time tracking dimension and cybersecurity dimension did not demonstrate that have been impacted by collective Blockchain sub-variables. Participants illustrated that, despite blockchain's capabilities, firms do not rely solely on blockchain for cybersecurity, firms also rely on a suite of other cybersecurity measures, including Intrusion Prevention Systems (IPS), sandboxing, Content Disarm and Reconstruction (CDR), firewalls, and antivirus software. Additionally, participants highlighted that real-time tracking relies on Radio Frequency Identification (RFID) technology, rather than blockchain, and their focus was not on noting the real-time tracking of information using blockchain.

This study offers a comprehensive exploration of the diverse impacts of blockchain technology on the digitalization of courier systems in Jordan's supply chain sector. It highlights the relationship between technological advancement and its real-world implementation in an increasingly digital environment.

5.2 Recommendations

Recommendations for the Logistics Industry in Jordan

- The study recommends that logistics firms operating in Jordan integrate the Blockchain for Digitalizing Courier System within their strategic plans and practices.
- The study recommends that other industries take advantage of the Blockchain capabilities in their systems.
- Decision-makers in the Jordanian Government; and the Ministry of Digital Economy And Entrepreneurship to consider Blockchain technology as part of the strategic plan 2024-2028 for digital transformation to provide digital government services

Recommendations for Future Research:

- Since this study is carried out on managers, supervisors, and operators who are working in the Jordanian logistics Industry, the study recommends including the customers.
- It recommends conducting such a study on the same industry in other countries, especially, Arab Countries because they have similar social and cultural lifestyles.
- It recommends repeating this study after a suitable time to check industry development. Longitudinal study.
- It recommends re-examining real-time tracking and cybersecurity on a larger group.
- It recommends that logistics firms in Jordan have to reevaluate the Distributed Ledger, and Cryptography and its impact on their Digitalizing Courier System.
- Extending the analyses to other countries represents future research opportunities, which can be done by further testing with larger samples within the same industry, and including other countries will help mitigate the issue of generalizing conclusions on other firms and countries.

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Appendices

Appendix (1): Panel of Referees Committee:

No.	Name	Rank	Major	Organization
1	Ahmed Ali Saleh	Professor	Business Administration	Middle East University
2	Ali Mohammad Al-Adaileh	Professor	Management - Organizational Behavior and Human Resources Management	Middle East University
3	Azzam Abu Moghli	Professor	Management	Middle East University
5	Ahmad A M Ghandour	Professor	Information Science	Middle East University
6	Hussam Yassin	Associate Professor	Information Systems/ E-commerce	Middle East University
7	Luai Jraisat	Professor	Logistics & Supply Chain Management/ Operations Management/ (Digital) Marketing	Arab Open University
8	Naser Assaf	Associate Professor	Business Administration-Management	Al Zarqa University
9	Salam Hamdan	Assistant Professor	Computer Science	Al Zaytoonah University
10	A specialized company did not agree to reveal its name	Practice company	Shipping, logistics, and transportation solutions	Implement Blockchain
11	A specialized company did not agree to reveal its name	Practice company	Shipping, logistics, and transportation solutions	Implement Blockchain
12	A specialized company did not agree to reveal its name	Practice company	Shipping, logistics, and transportation solutions	Implement Blockchain

جـــامـعــة الـــشرق الأوسـط
MIDDLE EAST UNIVERSITY
Amman - Jordan

Appendix (2): Letter and Questionnaire of Respondents

Dear Participant,

The researcher is currently conducting a scientific study intended to identify the:

"**The Impact of Blockchain on the Digitalizing Courier System of Supply Chain in Jordan**".

The purpose of this study is to obtain a master's degree in business administration. Your assistance in answering the study questionnaire means a lot to us and will add value to this study. It will be used only for academic purposes and will not be used outside the scope of this scientific research.

I would appreciate very much your kind assistance in answering the attached questions.

عزيزي المشارك،

يقوم الباحث حالياً بإجراء دراسة علمية تهدف إلى التعرف على:

"أثر تقنية سلاسل الكتل على رقمنة نظام البريد السريع لسلسلة التوريد في الأردن".

والغرض من هذه الدراسة هو الحصول على درجة الماجستير في إدارة الأعمال. مساعدتكم في الإجابة على استبيان الدراسة تعني لنا الكثير وستضيف قيمة لدراستنا. سيتم استخدامه للأغراض الأكاديمية فقط ولن يتم استخدامه خارج نطاق هذا البحث العلمي.

وسأكون ممتنًا جدًا لمساعدتكم الكريمة في الإجابة على الأسئلة المرفقة.

Thank you very much in anticipation.

Researcher: Mustafa Yousef Jaber

Supervised by: Prof. Dr. Abdel-Aziz Ahmad Sharabati

Part (1): Demographic Information

المعلومات الديموغرافية

Gender(الجنس) : ☐ Male ذكر ☐ Female انثى

Age (العمر): ☐ Less than equal 30 (اقل او يساوي 30) ☐ Between 30-40(بين 30-40) ☐ Between 41-50(بين 40-50) ☐ More than equal 50(اكبر او يساوي 50)

Experience (سنوات الخبرة): ☒Less than equal to 10(اقل او يساوي 10) ☐ Between 11-20 (بين 11-20) ☐Between21-30 (بين 21-30) ☐More than equal to 30(اكبر او يساوي 30) .

Education(التحصيل العلمي) : ☐ Diploma(دبلوم) ☐ Bachelor(بكالوريوس) ☐ Master (ماجستير).

Position (الموقع الوظيفي) ☐ Operator(مشغل) ☐ Supervisor(مشرف) ☐ Manager (مدير)

Division(القسم): ☐Operation(العمليات) ☐ Quality(الجودة) ☐ Supply Chain(سلسلة التوريد) ☐Information Technology(تكنولوجيا المعلومات) ☐ Accounting & Finance(المالية و المحاسبة)

Part two: The following 55 that tap into your perception of the actual implementation of these items in your organization. Where, [1 = strongly unimplemented (لم يتم تنفيذها بقوة), 2 = unimplemented(غير منفذة) , 3 = normal(طبيعي) , 4 = implemented(منفذة), 5 = strongly implementedمنفذة بقوة)

No.	Question	strongly unimplemented لم يتم تنفيذها بقوة	unimplemented غير منفذة	normal طبيعي	implemented مُنفّذ	Strongly Implemented تم التنفيذ بقوة
Part (2): Blockchain (سلاسل الكتل)						
1	**Decentralization (اللامركزية)**					
	The company applies information storage within its network. تستخدم الشركة تخزين المعلومات داخل شبكتها	1	2	3	4	5
	The company implements multiple control authorities on data. تطبق الشركة سلطات رقابية متعددة على البيانات	1	2	3	4	5
	The company enhances direct access to information. تعمل الشركة على تعزيز الوصول المباشر إلى المعلومات	1	2	3	4	5
	The company maintains data validation. تحافظ الشركة على التحقق من صحة البيانات	1	2	3	4	5
	The company uses a dispersed data exchange system. تستخدم الشركة نظام تبادل البيانات المتفرقة	1	2	3	4	5
2	**Distributed Ledger (دفتر الأستاذ الموزع)**					
	The company enhances Joint monitoring legality along Perr to Peer within its network. تعمل الشركة على تعزيزشرعية المراقبة المشتركةعلى طول شبكة نظير الى نظير داخل شبكتها	1	2	3	4	5
	The company performs transaction synchronization. تقوم الشركة بمزامنة المعاملات	1	2	3	4	5
	The company implements temper-proof records. تقوم الشركة بتنفيذ سجلات مقاومة للتلاعب	1	2	3	4	5
	The company empowers data sharing. تعمل الشركة على تمكين تبادل البيانات	1	2	3	4	5
	The company uses multiple points of failure along its network. تستخدم الشركة نقاط فشل متعددة على طول شبكتها	1	2	3	4	5
3	**Cryptography (التشفير)**					
	The company improves information security by encoding data. تعمل الشركة على تحسين أمن المعلومات عن طريق تشفير البيانات	1	2	3	4	5
	The company prevents unauthorized access using encryption techniques. تمنع الشركة الوصول غير المصرح به باستخدام تقنية التشفير	1	2	3	4	5
	The company maintains data integrity. تحافظ الشركة على سلامة البيانات	1	2	3	4	5

No.	Question	strongly unimplemented لم يتم تنفيذها بقوة	unimplemented غير منفذة	normal طبيعي	implemented منفّذ	Strongly Implemented تم التنفيذ بقوة
	The company verifies the transactions' authenticity. تقوم الشركة بالتحقق من صحة المعاملات	1	2	3	4	5
	The company achieves non-repudiation. تحقق الشركة عدم التنصل	1	2	3	4	5
4	**Immutability (الثبات)**					
	The company enhances verified data recording. تعمل الشركة على تحسين تسجيل البيانات التي تم التحقق منها	1	2	3	4	5
	The company maintains unalterable records. تحتفظ الشركة بسجلات غير قابلة للتغيير	1	2	3	4	5
	The company supports modifying consensus data. تدعم الشركة تعديل بيانات الإجماع	1	2	3	4	5
	The company enhances anti-fraud. تعمل الشركة على تعزيز مكافحة الاحتيال	1	2	3	4	5
	The company achieves efficient sharing. تحقق الشركة المشاركة الفعالة	1	2	3	4	5
5	**Smart contract (العقد الذكي)**					
	The company uses self-executing contracts. تستخدم الشركة العقود ذاتية التنفيذ	1	2	3	4	5
	The company performs predefined conditions. تقوم الشركة بتنفيذ الشروط المحددة مسبقا	1	2	3	4	5
	The company achieves automatic due diligence. تحقق الشركة العناية الواجبة التلقائية	1	2	3	4	5
	The company achieves digital transactions. تقوم الشركة بإنجاز المعاملات الرقمية	1	2	3	4	5
	The company reduces manual interventions. تقلل الشركة من التدخلات اليدوية	1	2	3	4	5
	The company shortens the intermediaries. الشركة تختصر الوسطاء	1	2	3	4	5
Part (3): Digitalizing Courier System (رقمنة نظام البريد السريع)						
6	**Real-time Tracking (تتبع في الوقت الحقيقي)**					
	The company implements live monitoring. تقوم الشركة بتنفيذ المراقبة الحية	1	2	3	4	5
	The company maximizes continuous status updates. تقوم الشركة بتعظيم تحديثات الحالة المستمرة	1	2	3	4	5

No.	Question	strongly unimplemented لم يتم تنفيذها بقوة	unimplemented غير منفذة	normal طبيعي	implemented منفذ	Strongly Implemented تم التنفيذ بقوة
	The company improves unexpected event detection. تعمل الشركة على تحسين الكشف عن الأحداث غير المتوقعة	1	2	3	4	5
	The company minimizes delivery potential damages. تقلل الشركة من الأضرار المحتملة للتسليم	1	2	3	4	5
	The company reduces delivery potential disruptions. تقلل الشركة من الاضطرابات المحتملة في التسليم	1	2	3	4	5
7	**Digital Documentation (التوثيق الرقمي)**					
	The company enhances long-term access to digital documents. تعمل الشركة على تعزيز الوصول على المدى الطويل إلى المستندات الرقمية	1	2	3	4	5
	The company uses documentation devices. تستخدم الشركة أجهزة التوثيق	1	2	3	4	5
	The company empowers digital information archiving. تعمل الشركة على تمكين أرشفة المعلومات الرقمية					
	The company emphasizes preserving original information. تؤكد الشركة على الحفاظ على المعلومات الأصلية					
8	**Automated Operations (العمليات الآلية)**					
	The company conducts computerization for processes. تقوم الشركة بإجراء حوسبة العمليات	1	2	3	4	5
	The company improves the machines' task allocation. تعمل الشركة على تحسين توزيع مهام الآلات	1	2	3	4	5
	The company reduces human errors. تقلل الشركة من الأخطاء البشرية	1	2	3	4	5
	The company optimizes computing resource allocation. تعمل الشركة على تحسين تخصيص موارد الحوسبة	1	2	3	4	5
	The company uses information technology resources. تستخدم الشركة موارد تكنولوجيا المعلومات	1	2	3	4	5
9	**Transparency (الشفافية)**					
	The company enhances information quality. تعمل الشركة على تحسين جودة المعلومات	1	2	3	4	5
	The company improves visibility throughout the chain.	1	2	3	4	5

No.	Question	strongly unimplemented لم يتم تنفيذها بقوة	unimplemented غير منفذة	normal طبيعي	implemented منفّذ	Strongly Implemented تم التنفيذ بقوة
	تعمل الشركة على تحسين الرؤية في جميع أنحاء السلسلة					
	The company empowers openness to shipment information. تتيح الشركة الانفتاح على معلومات الشحن	1	2	3	4	5
	The company performs dispute resolution. تقوم الشركة بتسوية المنازعات	1	2	3	4	5
10	**Cybersecurity (الأمن الإلكتروني)**					
	The company enhances data confidentiality. تعمل الشركة على تعزيز سرية البيانات	1	2	3	4	5
	The company ensures digital integrity. تضمن الشركة السلامة الرقمية	1	2	3	4	5
	The company improves information availability. تعمل الشركة على تحسين توافر المعلومات	1	2	3	4	5
	The company implements security breach protection. تقوم الشركة بتنفيذ الحماية من الاختراقات الأمنية	1	2	3	4	5
	The company enhances safe data transmission. تعمل الشركة على تعزيز النقل الآمن للبيانات	1	2	3	4	5