

An In-Depth Examination of Blockchain Integration in Supply Chain Optimization, along with Future Directions

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Abstract:- The potential of Decentralized Ledger Technology in Supply Chain Management has drawn more and more attention in recent years. This study explores how blockchain technology might improve supply chain operations' efficiency, security, traceability, and transparency. This study clarifies the various advantages that blockchain provides to supply chain stakeholders through qualitative research incorporating in-depth interviews (both in-person and via video conference) with 15 participants. The results highlight how blockchain technology has the power to transform established supply chain procedures, cut expenses, stop fraud, and guarantee that moral principles are followed.

Keywords:- Blockchain, Supply Chain Management, Transparency, Traceability, and Security.

I. INTRODUCTION

A crucial and intricate part of contemporary corporate operations is supply chain management. Blockchain technology integration has become a viable way to deal with several issues in supply chain operations. The possible advantages of distributed ledger technology for transforming logistics network management are examined in this essay. In today's digitally connected and worldwide corporate environment, value chain management is a vital component for the smooth movement of goods and services from point of origin to point of destination. However, this complex network of activities frequently faces enduring difficulties with operational effectiveness, security, traceability, and openness. These difficulties call for creative answers that might transform supply chain procedures and guarantee the reliability and effectiveness of these crucial systems. Blockchain technology, is a cutting-edge and revolutionary force that is gaining traction in a variety of sectors. Blockchain

technology, which was first intended to serve as the backbone of virtual currencies like Bitcoin, has evolved into a game-changing instrument with significant ramifications for value chain management. Its distinct qualities—transparency, security, immutability, and decentralized data storage—place it in a position to provide a viable answer to the intricate and varied problems that contemporary value chains face. The goal of this exploratory investigation is to identify and clarify the possible advantages of blockchain technology for supply chain management. Although these benefits have already been discussed in the literature, this study aims to go deeper by speaking with stakeholders and industry participants who use these technologies regularly. With the use of qualitative research techniques, such as in-depth interviews with 15 participants from different supply chain industries, this study seeks to obtain firsthand knowledge of the many benefits that blockchain offers. This study aims to provide a clear picture of how value chain management is changing consequently blockchain technology by looking at the opinions and experiences of supply chain professionals. Blockchain offers a wide range of possible advantages, from increased traceability and transparency to strengthened security and cost reductions. Furthermore, blockchains satisfy changing customer needs for sustainability and transparency by reducing fraud, streamlining logistics, and guaranteeing ethical standards. As we begin this investigation, we hope to learn more about the subtle difficulties and considerations that must be accounted for when implementing blockchain technology in supply chain management, in addition to its benefits. By doing this, the study hopes to provide insightful knowledge that will help practitioners, researchers, and decision-makers realize the full potential of blockchain to improve and revolutionize supply chain operations. The report explores the conclusions drawn from the qualitative research and provides a thorough analysis of the advantages that blockchain technology is thought to have in supply chain management. These conclusions, which

are based on the experiences and viewpoints of professionals in the field, highlight how revolutionary blockchain technology can be in resolving persistent issues and modernizing established supply chain procedures. Integration has become a viable way to deal with several issues in supply chain operations.

The possible advantages of distributed ledger technology for transforming value chain management are examined in this essay. In today's digitally connected and worldwide corporate environment, logistics management is a vital component which facilitates the smooth movement of goods and services from point of origin to point of destination. However, this complex network of activities frequently faces enduring difficulties with operational effectiveness, security, traceability, and openness. These difficulties call for network creative answers that might transform supply chain procedures and guarantee the reliability and effectiveness of these crucial systems. Blockchain technology, a cutting-edge and revolutionary force that is gaining traction in a variety of sectors. Blockchain technology, which was first intended to serve as the backbone of virtual currencies like Bitcoin, has evolved into a game-changing instrument with significant ramifications for supply chain management. Its distinct qualities of transparency, security, immutability, and decentralized data storage place it in a position to provide a viable answer to the intricate and varied problems that contemporary value chains face. This investigative research paper aims to delineate and elucidate the potential benefits of blockchain technology in supply chain management.

This study aims to go deeper by speaking with stakeholders and industry participants who use these technologies regularly. With the use of qualitative research techniques, such as in-depth interviews with 15 participants from different value chain industries, this study seeks to obtain firsthand knowledge of the many benefits that blockchain offers. This technology study aims to provide a clear picture of how supply chain management is changing as a result of blockchain technology by looking at the opinions and experiences of supply chain professionals. Blockchain offers a wide range of possible advantages, from increased traceability and transparency to strengthened security and cost reductions.

Furthermore, blockchains satisfy changing customer needs for sustainability and transparency by reducing fraud, streamlining logistics, and guaranteeing ethical standards. As we begin this investigation, we hope to learn more about the subtle difficulties and factors that considerations that must be accounted for when implementing blockchain technology in supply chain management, in addition to its benefits. By doing this, the study hopes to provide insightful knowledge that will help practitioners, researchers, and decision-makers realize the full potential of blockchain to improve and revolutionize supply chain operations. The report explores the conclusions drawn from the qualitative research and provides a thorough analysis of the advantages that blockchain technology is

thought to have in supply chain management. These conclusions, which are based on the experiences and viewpoints of professionals in the field, highlight how revolutionary blockchain technology can be in resolving persistent issues and modernizing established supply chain procedures.

II. LITERATURE REVIEW

Because of its distinctive features, which include immutability, security, and transparency, blockchain technology has acquired popularity across a range of businesses (Zheng et al., 2019).

By eliminating the need for middlemen and lowering the possibility of fraud, blockchain improves transparency by offering a shared ledger that is accessible to authorized users (Ivanov et al., 2019).

It makes product end-to-end traceability possible, which is especially beneficial for sectors like food and medicine (Vaz et al., 2021).

The decentralized and cryptographic nature of blockchains guarantees data security and tamper resistance (Wu et al., 2020). Blockchain uses smart contracts to automate jobs, which streamlines supply chain operations (Xiao et al., 2020).

Automation results in real-time updates, less paperwork, and cost reductions (Fan et al., 2020). Consumer expectations for product provenance and sustainability are aligned with blockchain's capability to reduce counterfeiting and ensure ethical standards (Zhang et al., 2021).

By doing away with middlemen and enabling autonomous, traceable transactions, blockchain technology has the potential to completely transform supplier payments and logistics (Trujillo et al., 2021).

➤ *Research Gap*

Although the literature now in publication emphasizes the advantages of blockchain technology for supply chain management, further empirical study is required to examine these benefits from the perspective of industry players. By conducting qualitative research and gathering firsthand information from supply chain stakeholders, this paper aims to close this knowledge gap.

➤ *Problem Statement*

The operational efficiency, security, traceability, and transparency of traditional supply chain management are all challenged. Innovative solutions are required to address these issues to improve supply chain operations and satisfy consumer aspirations for sustainability and transparency.

➤ Objectives

The following are the aims of this exploratory study paper:

- To look at supply chain management's perception of blockchain technology's advantages.
- To comprehend how blockchain technology addresses the issues with supply chain operations' transparency, traceability, security, and efficiency.

III. METHODOLOGY

In-depth interviews with fifteen participants from different supply chain industries were conducted as part of this qualitative research project. To guarantee a range of viewpoints, participants were chosen via purposive sampling. The opinions of participants regarding the advantages of blockchain in supply chain management were investigated through semi-structured interviews. To find important themes and insights, data was collected, transcribed, and subjected to thematic analysis.

➤ Design of the Research:

To comprehensively grasp the diverse perspectives and insights of stakeholders regarding the benefits of blockchain in managing the supply chain, this exploratory research utilized a qualitative methodology, aiming to delve into the nuanced experiences and viewpoints of participants. Qualitative research facilitates comprehensive investigation, yielding abundant data and valuable perspectives from subjects (Creswell & Creswell, 2017).

➤ Participants Selection:

Purposive sampling was the method used to choose study participants. People from a variety of backgrounds and positions in the supply chain sector met the requirements for participation. Fifteen participants were carefully chosen to guarantee a thorough range of viewpoints. Those directly involved in the development and operation of blockchain-based supply chain solutions, as well as supply chain professionals and experts in blockchain technology, were the target audience for this participant selection technique.

➤ Data collection:

Semi-structured, extensive interviews were the primary method used to gather qualitative data for the research. Semi-structured interviews facilitate open communication among participants and guarantee that important aspects of the blockchain's advantages for supply chain management are covered (Denzin & Lincoln, 2018).

To accommodate participants' preferences and locations, interviews were performed both in-person and via video conferencing platforms. To guarantee accuracy in data collection, all interviews were audio recorded with participants' permission. The data analysis procedure employed a thematic analysis methodology, which is a

suitable method for recognizing, evaluating, and summarizing patterns and themes found in qualitative data (Braun & Clarke, 2006).

There were various stages to the analysis's development:

➤ Familiarization with Data:

The interview transcripts were reviewed several times to become acquainted with the subtleties and substance of the participants' answers.

➤ First Coding:

To capture important ideas, thoughts, and recurring patterns in the data, the first codes were created methodically. Finding significant data about the alleged advantages of blockchain in supply chain management was the goal of this phase.

➤ Theme Development:

Based on their applicability to the study's goals, these initial codes were then compiled into draft themes. This procedure entailed grouping codes that represented related concepts or benefits related to blockchain technology.

➤ Review and Refinement:

Themes were put through a thorough review process before being repeatedly edited and rewritten. The goal of this step was to improve the themes and the data that goes along with them in terms of correctness and thoroughness.

➤ Choosing the Final Theme:

To finalize a comprehensive set of topics that accurately represented the participants' perspectives on the benefits of blockchain in supply chain management, the research team conducted discussions and consensus-building activities.

➤ Ethics-Related Considerations:

The study method was conducted with ethical considerations at its core. All participants provided their informed consent after careful consideration, guaranteeing that they were fully informed about the purpose of the study, the specifics of their involvement, and how their data would be used. To ensure participant privacy, their identities were anonymized, and strict data security protocols were put in place to ensure information confidentiality. The research complied with ethical standards, guaranteeing that participants received due respect and that their rights were respected.

➤ Rigor and Trustworthiness:

Several techniques were used to improve the study's rigor and trustworthiness. These included: Credibility: To reduce the possibility of bias, several researchers participated in the data analysis procedure, guaranteeing a wide variety of viewpoints in the interpretation of results.

➤ *Transferability:*

To help ensure that the study's conclusions may be applied to comparable situations and circumstances, thorough explanations of participant selection, data analysis, and research methods were given.

➤ *Dependability:*

The methods and conclusions of the study were guaranteed to be reliable by the painstaking documentation of the research process. For inspection, thorough documentation of the data gathering and processing procedures was kept. To avoid personal biases and preserve the study's conformability, the research team members were encouraged to practice reflexivity. Ongoing deliberations and contemplations regarding plausible partialities and their influence on the investigative procedure were conducted.

➤ *Limitations:*

This qualitative study has various limitations that must be acknowledged. The sample size of 15 individuals may not completely encompass the spectrum of opinions regarding the benefits of blockchain in supply chain management, despite efforts to include diverse viewpoints. Additionally, the findings are context-dependent and may not apply universally to other supply chain contexts.

➤ *Data Saturation:*

Throughout the data-gathering process, great care was taken to ensure that no new topics or information came from the interviews. This point is known as data saturation. To guarantee that a wide variety of viewpoints and ideas were recorded, the interviews were conducted until saturation was reached. The researchers demonstrated a proactive approach to reflexivity by recognizing and addressing their own potential biases. Reflection and self-awareness of the researchers' biases and their possible impact on the research process and results were key components of this reflexive technique.

➤ *Data Triangulation:*

To increase the study's validity, data triangulation was used. To strengthen the study's conclusions and boost its robustness, data from multiple sources—including interviews—were triangulated. Testing Pilot: A small sample of participants participated in a pilot study to improve the interview questions and make sure they successfully elicited responses about the advantages of blockchain in supply chain management before the main data-gathering phase began.

IV. RESULTS

➤ *Openness and Instantaneous Visibility:*

One of the main conclusions drawn from the qualitative study is how blockchain management significantly improves supply chain management's transparency and real-time visibility. Participants agreed that all authorized stakeholders have access to the same set of data thanks to the shared ledger feature of blockchain technology. Participants in the supply

chain can track products and transactions in real-time thanks to this shared visibility, which lessens information asymmetry. Because all parties involved may independently confirm the accuracy of the data, it has been observed that this transparency diminishes the possibility of fraudulent acts and lessens the need for intermediaries.

➤ *Enhanced Traceability:*

One of the most important advantages of blockchains is their capacity to guarantee end-to-end traceability. Participants emphasized that the blockchain records each transaction and movement of items, resulting in an auditable and unchangeable history. This capability is especially helpful in sectors where product provenance and recall management are crucial, such as the food and pharmaceutical industries. By using the traceability that blockchain technology offers, supply chains can minimize potential risks to customers and brand reputation by quickly identifying the cause of issues and recalling defective products.

➤ *Security and Data Integrity:*

It has been established that a key component of data security and integrity is the decentralized, encrypted nature of blockchain technology. The respondents underscored that a transaction assumes an immutable and tamper-resistant nature when being recorded on the blockchain. This security feature makes sure that private information from the supply chain is shielded from unwanted additions or deletions. The participants emphasized the need to maintain data integrity in supply chain activities, particularly in industries that deal with high-value goods and private data.

➤ *Fraud Mitigation:*

The results emphasized the function of blockchains in reducing supply chain fraud. Blockchain technology's smart contracts were found to be useful tools for automating verification procedures and triggering actions when predetermined criteria are satisfied. Because transactions are carried out under transparent, preset norms, this automation lowers the possibility of fraudulent activity. Participants mentioned that the ability to automate and verify transactions lowers the possibility of fraudulent behavior and boosts confidence among supply chain partners. Efficiency and Cost Savings: It was believed that implementing blockchain technology might significantly increase efficiency and save costs by automating and reducing paperwork related to supply chain operations. The participants emphasized how smart contracts, in particular, can automatically carry out payment arrangements, start orders, and update inventory levels. This automation lowers administrative expenses while simultaneously saving time. Cost reductions were seen as a measurable advantage, particularly in sectors with intricate and labor-intensive supply chains. Inventory management with real-time updates: It has been determined that supply chain activities can be prevented from being delayed or disrupted by utilizing the real-time updates that blockchain technology offers. Respondents mentioned being able to access current

information on inventory levels, order statuses, and delivery dates. Proactive decision-making is facilitated, stock outs and overstocking are avoided, and inventory management is optimized thanks to this real-time visibility.

➤ *Compliance and Accountability:*

All supply chain players are held accountable due to the transparent and unchangeable nature of blockchain technology. Participants agreed that blockchain technology may be used to efficiently monitor and enforce adherence to contractual commitments, quality control, and regulatory compliance. This feature increases stakeholder confidence and collaboration while lowering the risk of non-compliance.

➤ *Global Supply Chains and Cross-Border Transactions:*

It has been acknowledged that blockchains can benefit from the capacity to streamline customs procedures and enable cross-border transactions. Participants mentioned that blockchains offer a standardized and safe platform for global trade. It facilitates international trade by cutting down on paperwork, expediting transactions, and guaranteeing adherence to international laws. Authentication of Suppliers and Products: The ability of blockchains to verify the provenance of products and trace their path from producer to customer was thought to be a significant deterrent against counterfeiting in sectors like luxury goods and pharmaceuticals. The traceability of blockchains, according to respondents, can swiftly confirm the provenance of items, obstructing the entry of counterfeit goods into the supply chain. Blockchain can also confirm legitimate certifications and documents, which lowers the possibility of documentation fraud.

➤ *Ethical Standards and Consumer Trust:*

Supply chains have identified consumer desire for sustainable and ethical products as a major factor driving the adoption of blockchains. Participants pointed out that customers can confirm the origin of goods and comprehend how they are made and delivered thanks to blockchain's transparency. This openness helps consumers trust brands that use blockchain technology because it is consistent with their beliefs and expectations for ethical standards in the items they buy.

➤ *Logistics Process Optimization:*

Participants emphasized that the application of smart contracts in blockchain technology can potentially optimize logistics procedures. Third-party middlemen are not necessary for the autonomous verification, recording, and coordination of transactions. Global supply chains have become less complex as a result of the streamlining of logistics procedures.

➤ *Supplier Payments:*

One key benefit for supplier payments was found to be blockchain's capacity to automate and validate transactions through smart contracts. Supplier payments can be processed faster and with fewer middlemen if certain requirements are

fulfilled. Financial transactions along the supply chain are made more efficient by this automation.

➤ *Food Safety and Quality Control:*

The importance of blockchains in maintaining food safety was emphasized, especially when it comes to monitoring the origin and state of food items. Participants gave instances of how blockchain technology is already being used to track food goods from farm to table. In the end, this technology improves food safety and quality control by preventing product information manipulation, contamination of commodities, and spoilage during transit.

➤ *Post-Sale Services and Product Verification:*

It has been observed that the digitalization of product information by blockchain enhances post-sale services, including maintenance and warranties. Warranty terms may start automatically when a customer authenticates the digital identification of a product. Second-hand trade is more reliable since buyers can confidently confirm a product's unique identity. The outcomes of this initial investigation highlight the manifold benefits of blockchain technology within the realm of supply chain management. These advantages include, but are not limited to, traceability, security, efficiency, cost savings, fraud prevention, and adherence to ethical norms. The perspectives shared by the participants highlight how distributed ledger technology can be used to solve persistent issues and improve logistics network efficiency

V. CONCLUSION

Blockchain technology has several benefits for supply chain management, including increased security, cost savings, and transparency and traceability. The results of this exploratory study highlight how blockchain technology can transform supply chain procedures and solve enduring issues. Blockchain technology is still developing and being more widely used; thus, further investigation is needed to determine its wider applications and possible drawbacks in supply chain management.

VI. IMPLICATIONS

The findings of this exploratory research study will have a significant impact on many stakeholders, including supply chain professionals, legislators, IT developers, and researchers. These ramifications highlight how blockchain technology can revolutionize supply chain management and the larger corporate environment. Improving Procedures in the Supply Chain: The main conclusion drawn from this research is that supply chain procedures could be advanced and modernized by blockchain technology. Perceived advantages like increased traceability, more transparency, and increased security highlight how revolutionary blockchain can be in solving long-standing supply chain problems. The adoption of blockchain technology by supply chain professionals offers a

significant opportunity to streamline operations, reduce costs, and enhance trust among stakeholders.

➤ *Handling the Shift to Blockchain:*

Supply chain companies that are thinking about implementing blockchain technology have to deal with the challenges involved. For firms that are starting this journey, the insights from this study offer assistance. Developing precise implementation plans is essential, and these must include resolving any integration, data migration, and change management obstacles that may arise. To successfully manage the shift, supply chain experts can learn from the experiences that industry participants in this study have to offer.

➤ *Policies and Regulations to Take into Account:*

Regulators and policymakers have a significant impact on the environment that promotes blockchain adoption in supply chain management. The results of this investigation highlight how crucial it is to create a regulatory environment that fosters innovation while preserving data security and privacy. To create norms and regulations that encourage responsible blockchain usage, policymakers must work with industry stakeholders. The expectations of consumers and ethical standards: With a growing focus on ethical sourcing and product transparency, consumer expectations are changing. The study shows how consumers can be given reliable information about the sustainability and provenance of products through blockchain technology, which can help meet these expectations. Companies may obtain a competitive edge and increase customer trust by adopting blockchain technology in line with these expectations.

➤ *Creative Interaction Across Industries:*

For blockchain integration to be effective, cross-industry cooperation between supply chain professionals and technology developers is essential. To create customized blockchain solutions that address particular supply chain needs, the study highlights the necessity of open communication and collaboration among stakeholders. Innovators and tech companies must take into account the suggestions made by supply chain experts to improve their blockchain solutions.

RECOMMENDATIONS

Take the adoption of blockchain technology into consideration. Companies can improve efficiency, security, traceability, and transparency in their supply chain operations by implementing blockchain technology. To evaluate the precise benefits and return on investment for the organization, do a feasibility study.

➤ *Put Money Into Training and Education for Block Chain:*

Ensure supply chain experts have the abilities and know-how required to successfully deploy and operate blockchain solutions by providing them with professional development and training. To share data on the blockchain, it is

recommended that supply chain actors collaborate. The shared ledger's ability to increase transparency and reduce information asymmetry can improve performance throughout the supply chain.

➤ *Investigate Smart Contracts:*

Find out how to automate and improve supply chain operations with the help of smart contracts. Automating order processing, quality control inspections, and payment arrangements can result in high levels of efficiency.

➤ *Put Data Integrity and Security First:*

When implementing blockchain technology, make sure data security and integrity are given top priority. Protect critical supply chain data and stop illegal changes by putting strong security measures in place.

➤ *Encourage Sustainable and Moral Behavior:*

Make use of the transparency that blockchain technology offers to demonstrate and validate ethical and sustainable supply chain operations. As the market for items sourced ethically grows, this might boost consumer confidence.

➤ *Boost Inventory Control and Logistics:*

Leverage blockchain's real-time updates and inventory management features to reduce inventory costs, decrease delays, and optimize logistics.

➤ *Respect Laws:*

Apply blockchain technology to help ensure that legal obligations, quality assurance guidelines, and contractual terms are followed. In doing so, you lower the chance of non-compliance and guarantee accountability. Take advantage of blockchain technology to simplify cross-border transactions and customs procedures and grow business globally with confidence. Comply with international regulations and standardized documents.

➤ *Combat Counterfeiting:*

Put blockchain-based authentication and traceability in place in businesses (such as luxury goods and medicines) that are susceptible to counterfeiting to safeguard the brand and customers from fake items.

➤ *Improving Food Safety and Quality Control:*

Consider using blockchains in the food business to track the origin and state of food items. Utilizing this technology can prevent contamination, tampering, and spoilage, ensuring the safety and quality of food.

➤ *Boost Services after the Sale:*

Improve post-sale services like warranties and product maintenance by utilizing blockchain technology. Create a trust-building environment for used transactions by automating warranty activations and allowing buyers to confirm the identity of the products.

➤ *Engage in Industry Collaboration:*

Engage in industry collaboration with partners and consortiums developing blockchain standards and supply chain solutions. Adoption can be accelerated through exchanging standards and best practices.

➤ *Continue to Innovate.*

Follow the latest advancements in supply chain management and blockchain technologies. Keeping up with new features and applications is crucial as blockchain technology develops further.

➤ *Assess ROI Frequently:*

Evaluation of the blockchain implementations' return on investment (ROI) should be ongoing. To make sure blockchain projects continue to be cost-effective, evaluate the savings, efficiency improvements, and other advantages regularly.

As the use of blockchain applications increases, be ready for difficulties related to scalability. As transaction volumes and data storage requirements rise, make sure the blockchain infrastructure is ready to manage them.

Companies may use blockchain technology to optimize supply chain management and successfully handle a variety of issues by putting these suggestions into practice. Customizing these recommendations to the unique requirements and goals of supply chain operations is crucial.

FUTURE RESEARCH DIRECTIONS

The present study lays the groundwork for future investigations into the application of block chains to supply chain management. The mentioned benefits offer avenues for additional research, including investigating the impact of blockchain on specific industries, assessing the sustainability of supply chains, and exploring the interactions between blockchain and emerging technologies like artificial intelligence (AI) and the Internet of Things (IoT). The results of this study can be expanded upon by researchers to examine more subtle facets of block chain adoption and its wider consequences.

➤ *Competitive Edge and Adaptability:*

Organizations that strategically use block chain technology may have an advantage over competitors in a market that is changing quickly. By offering real-time data, traceability, and security, block chain has the potential to improve supply chain resilience and help firms react quickly to crises. The report emphasizes how crucial block chains are as a tool for improving corporate flexibility and continuity.

➤ *Technology Investment and Risk Mitigation:*

Block chain technology investments should be seen as calculated risks that must be carefully considered. Companies need to balance the possible advantages against the dangers

associated with cyber security and implementation expenses. The results highlight the significance of a thorough risk mitigation plan that takes into account any potential weak points in supply chains that rely on block networks.

The study's conclusions emphasize how blockchain technology can revolutionize supply chain management. The knowledge acquired provides useful direction for all parties involved in meeting consumer expectations, modernizing supply chain procedures, adopting blockchain technology, and advancing the development of a more open and effective global supply chain ecosystem.

REFERENCES

- [1]. Fan, Y., Wang, X., & Yu, J. (2020). Blockchain and supply chain finance: implications and opportunities. *Finance Research Letters*, 37, 101520.
- [2]. Ivanov, D., Dolgui, A., & Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. *International Journal of Production Research*, 57(3), 829–846.
- [3]. Trujillo, L., San-José, L. A., Vila, J., & Pons, O. (2021). Block chain-based architectures for the Internet of Things: A survey. *IEEE Internet of Things Journal*, 8(13), 10316–10332.
- [4]. Vaz, M., Vieira, G. M., Simões, P., & Alves, C. (2021). Block Chains in the Supply Chain: An Analysis of Current Trends. In *Advances in Human Factors and Systems Interaction* (pp. 17–25), Springer.
- [5]. Wu, Y., Chiu, A. S. F., & Chiu, N. F. (2020). Enhancing supply chain management through blockchain technology: A case of blockchain-based traceability systems in the food industry. *International Journal of Information Management*, 50, 204–217.
- [6]. Zheng, H., Li, W., Liu, L., Li, M., & Zhao, S. (2019). An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends. 2019 IEEE International Congress on Cybermatics (CYBCONF) (pp. 723–730). IEEE.
- [7]. Zhang, J., Zhang, G., Yang, J., & Zhao, H. (2021). Block Chain Technology in Logistics and Supply Chain Management: An Exploratory Study. In *Proceedings of the 2021 International Conference on e-Education, e-Business, e-Management, and E-Learning* (pp. 76–82).
- [8]. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.
- [9]. Creswell, J. W., & Creswell, J. D. (2017). *Research design: qualitative, quantitative, and mixed-methods approaches*. Sage publications.