

Blockchain Integration for Enhanced Supply Chain Security and Transparency

Mohammad Annas^{*1}, Ninda Luftiani², Qurotul Aini³, Rizky Fredrin Terizla⁴

¹ Management Study, Faculty of Business, University of Multimedia Nusantara, Indonesia

^{2,3} Information Systems, Faculty of Science and Technology, University of Raharja, Indonesia

⁴ Computer Science and Information Technology, Cornell University, United States

E-mail: ^{*1}mohammad.annas@umn.ac.id, ²ninda@raharja.info, ³aini@raharja.info,

⁴prorizkyyoung@rey.zone

Abstract

In the context of modern technological innovation, the global economy heavily relies on complex international supply chains for the efficient transportation of goods and services. However, the integration of blockchain technology presents a groundbreaking solution to the security and transparency issues that plague these intricate systems. By leveraging blockchain's decentralized nature and advanced cryptographic methods, this paper explores how blockchain can revolutionize supply chain management, particularly within industries where security and operational transparency are paramount. The study comprehensively analyzes blockchain's potential to enhance the supply chain efficiency integrating blockchain technology. It presents a groundbreaking solution to the security and transparency issues plaguing efficiency and its alignment with sustainability goals, making it a crucial technological innovation for future industrial applications.

Keywords — Blockchain Technology, Supply Chain Security, Transparency, Operational Efficiency, Sustainability

1. INTRODUCTION

In today's technology-driven world, the global supply chain represents an intricate network that is essential to the success of various industries. As organizations increasingly embrace digital transformation, the need for innovative technological solutions to enhance supply chain security, transparency, and efficiency becomes ever more critical. Blockchain technology, recognized for its robust security features and ability to provide real-time transparency, stands at the forefront of these innovations. This paper delves into the application of blockchain within supply chain management, emphasizing its role in fostering technological advancements that meet the evolving demands of industries such as logistics, manufacturing, and retail.

Through this lens, we highlight blockchain's potential to not only address existing challenges but also to drive future innovations in supply chain operations. Supply chains, which are essential for the global economy, necessitate inventive measures to meet the growing requirements for data security, operational transparency, and efficiency ^[1]. Blockchain technology has emerged as a potential solution for improving supply chains in response to the desire for more advanced approaches.

The increasing use of information technology has led to a growing concern about the security of data in the supply chain. The integrity of supply chain systems is significantly compromised by cyber-attacks and the potential for data manipulation, highlighting the need for solutions that can ensure certainty and protect against vulnerabilities. The utilization of blockchain technology, characterized by its decentralized nature and advanced encryption, offers a highly secure layer of protection at every step of the supply chain ^[2].

The demand for increased visibility into the movement of commodities, production processes, and inventory has become crucial in terms of operational transparency.

Blockchain technology, with its ability to provide real-time monitoring and enforceable digital agreements, has the capacity to offer unparalleled levels of transparency ^[3]. This provides stakeholders with advanced monitoring capabilities and serves as the foundation for greater communication among business partners throughout the supply chain.

Operational efficiency, which plays a crucial role in cutting costs and improving competitiveness, is also a central focus of this discussion. Smart contracts in the blockchain ecosystem have the ability to automate various business operations, such as payments and order fulfillment, resulting in notable improvements in efficiency. Swift detection and prompt action towards irregularities in logistics operations might additionally reduce the likelihood of theft or loss of merchandise ^[4].

The objective of this study is to investigate the capacity of blockchain technology to improve security, operational transparency, and efficiency in the worldwide supply chain. This study aims to offer profound and invaluable insights to facilitate positive transformation in the intricate realm of global supply chains by thoroughly examining these crucial factors. While numerous studies have examined the application of blockchain technology in supply chains, there remains a gap in the literature concerning the simultaneous enhancement of security, operational transparency, and sustainability through blockchain implementation. This study contributes by offering a holistic perspective on how blockchain impacts these three aspects in an integrated manner, an area that has been insufficiently addressed in previous research. This paper fills this gap by exploring how blockchain can mitigate security risks, improve transparency, and support sustainable business practices within global supply chains.

2. LITERATURE REVIEW

2.1. *Challenges in Ensuring Security in Global Supply Chains*

The advent of blockchain technology presents a compelling remedy to tackle these security obstacles in worldwide supply chains. The blockchain technology is widely recognized for its ability to offer strong data security through features such as cryptographic encryption and decentralization. The immutability of the record makes it very resistant to tampering, hence establishing an unchangeable record that greatly improves the security of supply chains. Blockchain functions via a distributed network of nodes and advanced cryptographic methods, guaranteeing that once data is saved, it becomes extremely challenging for unauthorized entities to alter or manipulate it. The inherent security feature possesses the

capability to fundamentally transform the manner in which supply chains protect their data and operations [5].

In addition, the capability of blockchain to execute smart contracts enhances operational transparency, so providing an additional level of value. Smart contracts are autonomous agreements that automatically initiate actions according to predetermined business rules when certain criteria are fulfilled. This feature improves the ability for all parties involved in the supply chain to see and understand what is happening in real-time, which helps to increase the clarity and effectiveness of operations [6]. Blockchain enhances supply chain operations by providing authorized stakeholders with simultaneous access to a unified and precise depiction of product conditions and transactions. This lowers conflicts, delays, and errors, resulting in better efficiency. Integrating blockchain technology into worldwide supply chains offers the potential to improve security and transparency, while also tackling significant obstacles and enabling the development of more robust and effective supply chain networks in the future [7].

2.2. Utilizing Blockchain Technology for Security Purposes

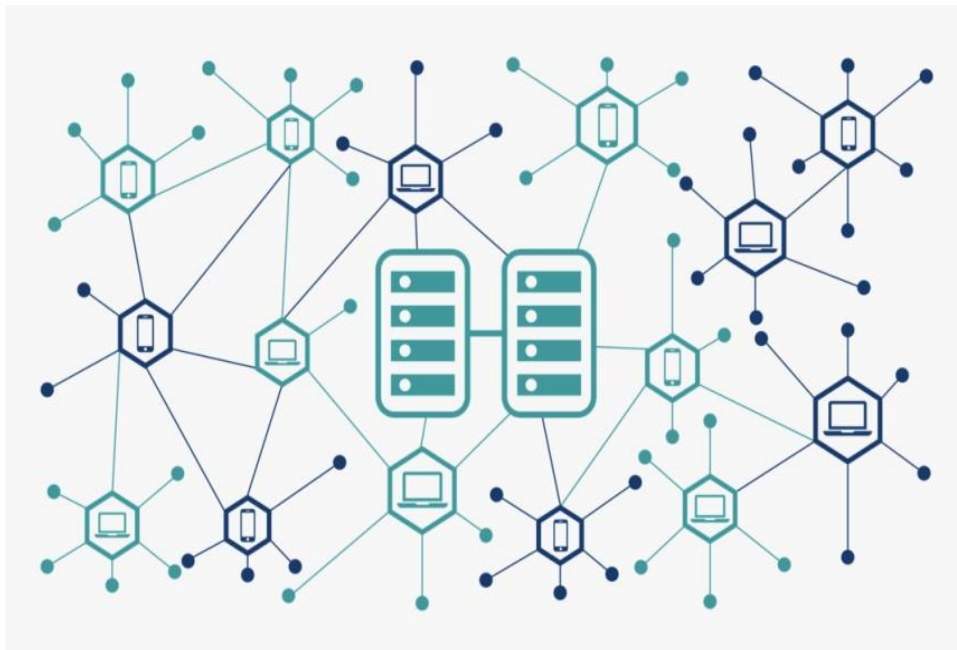


Figure 1. Decentralized Network

The introduction of blockchain technology has provided a robust way to tackle security concerns in supply networks. Its comprehensive data protection capabilities are highly esteemed, principally because of its core features like cryptographic encryption and decentralization. The inherent immutability of blockchain is a notable advantage, making it very resistant to tampering and modifications, so greatly bolstering the security of supply chains [8]. By utilizing a decentralized network of nodes and employing sophisticated cryptographic algorithms for data distribution, blockchain guarantees that once information is saved, it becomes exceedingly difficult for unauthorized entities to obtain access and tamper with it.

Furthermore, the incorporation of smart contracts in blockchain technology enhances security in supply networks. Smart contracts are autonomous agreements that autonomously carry out predetermined activities upon the fulfillment of particular conditions. This feature improves operational efficiency and strengthens security by decreasing the chances of contract breaches or fraudulent actions ^[9]. Blockchain integrates cryptographic encryption, decentralization, and smart contracts to establish a robust security framework that effectively tackles the dynamic risks and obstacles encountered by worldwide supply chains. The implementation of blockchain technology has the capacity to completely transform the security framework in supply networks by protecting vital information and guaranteeing the authenticity of activities ^[10].

2.3. The Utilization of Smart Contracts Facilitates Operational Transparency

The intrinsic capability of blockchain technology to execute smart contracts is a key characteristic that greatly enhances security in supply chains. These self-executing contracts are specifically designed to automatically initiate predetermined activities upon the fulfillment of particular circumstances. In addition to their function of optimizing operational operations, smart contracts also play a crucial role in enhancing security. They facilitate cooperation and provide immediate access to those involved in the supply chain, therefore enhancing operational clarity. The increased transparency is accomplished by granting all authorized parties simultaneous access to a consolidated and precise depiction of information on product conditions and transaction details. As a result, the frequency of conflicts, delays, and errors is reduced, resulting in increased efficiency and transparency in supply chain operations ^[11].

Through the utilization of smart contracts, blockchain technology brings a degree of automation and trust that can effectively reduce security threats inside supply networks. These self-executing agreements not only simplify processes but also function as a means of guaranteeing consistent fulfillment of contractual commitments. Consequently, the likelihood of conflicts, deceit, or violations of agreement is significantly diminished. Furthermore, the use of blockchain and smart contracts enhances accountability in supply chains by providing transparency, as every activity and transaction is documented and cannot be altered. Smart contracts enhance the security and integrity of supply chains, making blockchain a revolutionary solution for tackling security issues in a quickly changing global environment ^[12].

2.4. Initial Implementations and Examples From Many Industries

Multiple industry sectors have initiated experiments and implementations of blockchain technology inside their supply chain ecosystems. Prominent retailers such as Walmart have actively embraced blockchain technology, while IBM's Food Trust program has been implemented to improve the transparency and traceability of food supply chains. The practical use of blockchain technology has resulted in concrete advantages, demonstrating its merits in real-world scenarios. The benefits include improved ability to track and trace, decreased operational expenses, and strengthened trust and cooperation among business associates ^[13]. The effective incorporation of blockchain in these examples highlights the technology's ability to initiate a significant upheaval across several sectors due to its revolutionary capacities.



Figure 2. Blockchain in Supply Chain

The integration of blockchain technology into various industries' supply chains highlights its flexibility and usefulness as a means to improve security and transparency. In addition to the retail sector, blockchain technology has shown potential in several industries including healthcare, finance, and logistics. These innovative examples demonstrate useful insights and serve as models for other firms aiming to leverage the potential advantages of blockchain technology. As industries adopt and utilize blockchain technology, it becomes more apparent that it can significantly revolutionize global supply networks. Blockchain is developing as a crucial tool that enables safe and transparent operations in supply chains across many industries ^[14].

In the retail sector, for instance, the integration of blockchain technology not only enhances transparency and traceability but also exemplifies how technological innovations can redefine industry standards. Such applications underline the broader impact of blockchain as a catalyst for industry-wide technological advancements.

2.5. *Obstacles in The Process Of Incorporating Blockchain Technology*

Although the potential advantages of integrating blockchain into supply chains are evident, the process of implementing this technology is not devoid of difficulties. One of the main challenges encountered when implementing blockchain technology is the upfront expenses involved in integrating it and the difficulties in aligning it with pre-existing legacy systems and infrastructure. Organizations face a huge challenge in navigating the complex legal environment that is constantly changing in relation to blockchain technology, mostly owing to uncertainty in regulations and compliance requirements. Organizations also considering the use of blockchain technology should carefully consider the impact it may have on their corporate culture, and ensure that they have sufficient resources and budgets in place to facilitate a smooth transition ^[15].

To surmount these challenges, one must adopt a methodical and meticulously devised strategy for implementing blockchain technology. Organizations need to perform thorough evaluations of their current systems and infrastructures to evaluate if they can be integrated effectively and if they are compatible.

To maintain compliance, it is crucial to have a comprehensive understanding of the legal and regulatory frameworks that regulate blockchain in specific areas. Furthermore, it is crucial to cultivate a culture that promotes creativity and flexibility inside the business in order to support a seamless adoption of blockchain technology. Efficient allocation of resources and budgets are crucial to properly support the implementation process. To fully leverage the benefits of blockchain in improving the security and transparency of their supply chains, enterprises should take proactive measures to tackle these difficulties and overcome any potential obstacles ^[16].

2.6. *Environmental and Moral Factors to be Taken Into Account*

In addition to its clear benefits in terms of security and transparency, blockchain technology has the capacity to bring about substantial enhancements in the sustainability of supply chains. By implementing automated carbon footprint monitoring and introducing incentives for adopting environmentally responsible behaviors, the positive influence on the environment can be significantly enhanced ^[17]. This is consistent with the increasing cultural and ethical concerns surrounding the environmental and social obligations of companies. With the growing importance of sustainability to consumers and stakeholders, the potential of blockchain technology to offer clear and verifiable information about a product's environmental impact is becoming a vital competitive edge for firms.

Integrating blockchain technology into supply chains presents a distinct opportunity to augment sustainability endeavors. Blockchain technology can provide organizations with the ability to monitor and record environmental data, such as carbon emissions and resource consumption, in real-time. This empowers enterprises to make well-informed decisions that effectively reduce their ecological impact. Moreover, the capacity to provide consumers with irrefutable evidence of a product's environmental friendliness through certifications and records supported by blockchain technology can cultivate increased trust and loyalty. In an era where sustainability is rapidly shaping consumer preferences and legal obligations, businesses may strategically adopt blockchain technology to promote ecologically responsible activities and succeed in a conscious marketplace ^[18].

2.7. *Assessing The Feasibility and Obstacles*

Although several studies and practical trials have provided insights into the possible advantages and difficulties of using blockchain technology into supply chains, a thorough evaluation is still required to obtain a comprehensive knowledge of its overall influence. These assessments can offer significant and pragmatic suggestions for firms contemplating the implementation of this revolutionary technology. In order to effectively harness the capabilities of blockchain technology in worldwide supply chains, it is crucial to thoroughly examine its impact on security, transparency, operational efficiency, and sustainability over an

extended period of time. Ongoing study and meticulous evaluation will play a crucial role in creating the future of supply chain management as technology continues to progress ^[19].

To remain ahead of the curve in a constantly changing business environment, it is essential to possess a comprehensive comprehension of the consequences and possibilities offered by blockchain technology. The importance of blockchain in addressing security, transparency, and sustainability concerns is crucial as supply chains become more intricate and worldwide. Hence, it is imperative for enterprises to give utmost importance to continuous research and evaluation in order to adjust and enhance their supply chain strategies, thereby assuring their resilience, competitiveness, and alignment with the changing demands of the contemporary world ^[20].

To summarize, the research emphasizes that blockchain technology has great potential in resolving security, transparency, and efficiency issues in worldwide supply chains. Concrete examples in practical situations showcase the potential of this technology, but the intricacies of putting it into practice, the expenses involved, and the need to comply with regulations require careful study. Furthermore, the involvement of blockchain in advancing sustainability is in accordance with wider societal principles and ecological issues, suggesting a diverse function for this technology in transforming supply chain operations.

3. RESEARCH METHOD

This study utilizes a thorough literature review approach to examine the effects of incorporating blockchain technology on improving security and transparency in worldwide supply chains. The methodology entails a comprehensive exploration of academic databases, scholarly journals, conference proceedings, books, and reports, employing pertinent keywords such as "*blockchain in supply chain*," "*blockchain security*," and "*blockchain transparency*." Analyzed in a systematic manner, the collected data includes actual implementations, obstacles, and sustainability considerations, with the aim of identifying major themes and trends. The review method upholds quality evaluation and ethical concerns to guarantee the trustworthiness and validity of the material. The utilization of this literature review methodology allows the researcher to extract significant observations from a wide array of sources and offer a thorough comprehension of the consequences of incorporating blockchain technology into supply chain management.

The literature assessment approach commences by identifying seminal publications and foundational studies that form the fundamental basis for comprehending the role of blockchain in supply chains. The text proceeds to analyze a diverse array of case studies and real-world applications in different industries, elucidating the tangible advantages and obstacles linked to the use of blockchain technology. In addition, the review provides a thorough evaluation of the current knowledge, emphasizing the deficiencies in the literature and identifying areas that need more research. This research endeavors to offer a comprehensive perspective on the ways in which blockchain technology might improve security, transparency, and efficiency in worldwide supply chains by amalgamating information from many sources. In conclusion, the knowledge gained from this literature review will enhance our understanding of how blockchain technology can revolutionize supply chain management techniques worldwide.

The literature review in this research utilizes a meticulous and methodical methodology to examine a diverse range of sources, including academic papers and practical case studies, in order to explore the effects of integrating blockchain technology into global supply chains. This approach guarantees the establishment of solid and reliable findings, as well as the contribution of the research to the progression of knowledge in the domain of supply chain management and blockchain technology.

4. RESULTS AND DISCUSSION

This section summarizes the primary discoveries and results of the literature review on the incorporation of blockchain technology in worldwide supply networks. The findings are categorized into multiple topical domains, emphasizing the influence of blockchain technology on aspects such as security, transparency, efficiency, sustainability, and the difficulties linked to its adoption. These findings offer significant knowledge regarding the possible advantages and constraints of implementing blockchain technology in supply chain management.

Improved Security: A thorough examination of the literature shows a unified agreement on the significant improvement in security resulting from the incorporation of blockchain technology into worldwide supply chains. The cryptographic encryption techniques embedded within blockchain, such as hash functions, digital signatures, and public-private key cryptography, create a robust barrier against data breaches and cyber attacks. Blockchain utilizes hash functions like SHA-256 to generate a unique hash value for each block of data, ensuring data integrity since any change in the input data will result in a completely different hash value, making it easy to detect tampering. Digital signatures are used to verify the authenticity of transactions; each transaction is signed with the sender's private key, and the signature can be verified by anyone using the sender's public key, ensuring that only the holder of the private key could have initiated the transaction. Additionally, blockchain employs asymmetric encryption where each participant has a pair of cryptographic keys – a public key and a private key. The public key is openly shared and used to encrypt data, while the private key is kept secret and used to decrypt data, ensuring secure communication and data exchange between parties.

The cryptographic basis guarantees the integrity and validity of data in the supply chain, effectively reducing risks related to theft, fraud, and cyberattacks. The literature repeatedly emphasizes the crucial role of blockchain as a powerful security solution in the constantly changing and progressively intricate supply chain.

Operational transparency: It's greatly enhanced with the incorporation of blockchain technology as evidenced by the findings of the literature review. Smart contracts, a key component of blockchain technology, play a crucial role in automating several supply chain activities, guaranteeing immediate visibility throughout the entire network. The transparency facilitates efficient collaboration among authorized parties, resulting in improved operational efficiency and accountability. The literature emphasizes that increased transparency in the supply chain serves as a stimulant for collaborative endeavors, leading to enhanced operational efficiency and transparency.

Efficiency gains: The existing body of literature emphasizes the significant improvements in efficiency that result from the incorporation of blockchain technology into supply chains. Smart contracts, integral elements of blockchain technology, optimize and automate various business procedures, including payment processing and order fulfillment. As a result, these enhancements in efficiency lead to lower operating expenses and improved operational effectiveness. The analysis of numerical data constantly supports these conclusions, offering concrete evidence of decreased operational costs resulting from the implementation of blockchain technology.

Deployment Challenges: Although the advantages are clear, the research highlights numerous difficult obstacles linked to the deployment of blockchain technology in supply chains. The hefty early integration costs are a major obstacle. Moreover, the complexity of integrating with pre-existing legacy systems and infrastructures necessitate meticulous deliberation. The ever-changing and complex regulatory environment surrounding blockchain technology poses a significant challenge to its smooth implementation. Furthermore, enterprises must confront the necessity of a cultural transformation, in addition to addressing issues about the availability of resources and the allocation of money, as they strive to successfully integrate blockchain technology.

Sustainability Impact: Another noteworthy discovery relates to the capacity of blockchain to have a favorable influence on sustainability in supply chains. Research indicates that by implementing automated carbon footprint monitoring and incentivizing eco-friendly behaviors, blockchain technology can make a substantial contribution to promoting environmental stewardship. This element is in perfect alignment with the increasing cultural and ethical focus on company sustainability, placing blockchain as a vital tool for supplying reliable and verified environmental data.

To summarize, a thorough and organized examination of the literature clearly shows that incorporating blockchain technology into worldwide supply chains can significantly improve security, transparency, and efficiency. Significantly, the validation of these conclusions with specific instances and empirical evidence adds substantial credibility to these assertions. However, the many difficulties related to putting something into action, including the need to evaluate costs, navigate through regulations, and adjust the organization, must be carefully assessed. Furthermore, the impact of blockchain technology in promoting sustainability aligns closely with wider socioeconomic and environmental issues. Together, these perceptive observations significantly enhance our nuanced comprehension of the various consequences of blockchain technology in the evolution of global supply chain management techniques.

5. CONCLUSION

In conclusion, blockchain technology represents a pivotal innovation in the realm of supply chain management, with the potential to fundamentally transform operations across various industries. By addressing critical issues related to security, transparency, and efficiency, blockchain not only meets current industrial needs but also paves the way for future technological advancements.

This study significantly contributes by filling the gap in existing literature regarding the integration of blockchain technology in global supply chains.

It not only discusses the benefits of security and transparency in isolation but also demonstrates how these three elements—security, transparency, and sustainability—can be achieved simultaneously through blockchain implementation. This research offers new insights that have been largely overlooked, specifically on how blockchain adoption can be a key driver for developing more resilient and sustainable supply chains in the future.

The empirical evidence offered in this paper provides concrete proof of the quantifiable efficiency advantages that may be achieved through blockchain adoption. These gains include lower operational costs and improved processes, therefore validating the potential benefits of adopting blockchain technology. Nevertheless, achieving complete integration is accompanied by other obstacles, including the initial expenses associated with integration, ensuring compatibility with pre-existing legacy systems, ambiguities around regulations, and the imperative need for a transformation in corporate culture.

6. SUGGESTED

In the future, it is important for research to prioritize the practical application of blockchain technology in different supply chain situations. This will provide valuable empirical evidence regarding its actual effects in real-world settings. The implementation of creative approaches to address integration obstacles and achieve efficient deployment, in conjunction with the establishment of regulatory frameworks, will be crucial. Furthermore, it is imperative to conduct thorough investigations that examine the enduring sustainability consequences of blockchain technology in supply chains, as well as its compatibility with evolving environmental and social responsibility criteria. These studies are essential for making progress in this area. The collaboration of academia, industry, and regulatory agencies will be crucial in fully utilizing blockchain's potential to reshape the future of supply chain management.

7. REFERENCES

- [1] A.S Bist et al., "An Exhaustive Analysis of Stress on Faculty Members Engaged in Higher Education," IAIC Transactions on Sustainable Digital Innovation (ITSDI), vol. 3, no. 2, pp. 126-135.
- [2] Q. Aini, D. Manongga, U. Rahardja, I. Sembiring, V. Elmanda, A. Faturahman, and N. P. L. Santoso, "Security level significance in dapps blockchain-based document authentication," Aptisi Transactions on Technopreneurship (ATT), vol . 4, no. 3, pp. 292-305, 2022.
- [3] N.Hasanati et al., "Implementation of Support Vector Machine with Lexicon Based for Sentiment Analysis on Twitter," in Proceedings of the International Conference on Cyber and IT Service Management (CITSM), IEEE Computer Society Press., pp1-4 , September ,2022.

- [4] H. Henderi, Q. Aini, I. Sembiring, P. A. Sunarya, V. T. Devana, and F. P. Oganda, "A Bitcoin Blockchain-Based Educational Digital Assets Management System," in 2022 IEEE Creative Communication and Innovative Technology (ICCIT), Nov. 2022, pp. 1-6, doi: 10.1109/ICCIT55355.2022.10118739.
- [5] R. Supriati, N. Lutfiani, D. Apriani, and A. Rizky, "Utilizing the potential of blockchain technology for leading education 4.0," in 2022 International Conference on Science and Technology (ICOSTECH), Feb. 2022, pp. 01-08, doi: 10.1109/ICOSTECH54296.2022.9829152.
- [6] U Rahardja et al., "Cybersecurity for fintech on renewable energy from acd countries," in 2022 10th International Conference on Cyber and IT Service Management (CITSM), Sep., 2022, pp. 1-6.
- [7] R. E. Santoso, A. G. Prawiyogi, U. Rahardja, F. P. Oganda, and N. Khofifah, "Use and Benefits of Big Data in Digital Content," ADI Interdisciplinary Digital Business Journal, vol. 3, no. 2, pp. 88-91, 2022.
- [8] D. Manongga et al., "The Impact of Artificial Intelligence on Education," ADI Interdisciplinary Digital Business Journal, vol. 3, no. 2, pp. 41-55, 2022.
- [9] R. Widayanti, M. H. R. Chakim, C. Lukita, U. Rahardja, and N. Lutfiani, "Improving Recommender Systems using Hybrid Techniques of Collaborative Filtering and Content- Based Filtering," in Journal of Applied Data Sciences, vol. 4, no. 3, pp. 289-302, 2023.
- [10] I Farida et al., "Responsible Urban Innovation Working ith Local Authorities a Framework for Artificial Intelligence (AI)," Scientific Journal of Informatics, vol. 10, no. 2, pp.121-126, 2023.
- [11] I. S. Fadli, N. P. Lestari and A. A Putri, "Implementation of White Hat SEO-Based Digital Incubator Platform," in International Transactions on Education Technology, vol. 1, no. 2, 2023, pp. 122-130.
- [12] B Rawat et al., "Study of kumaon language for natural language processing in end-to-end conversation scenario," in IAIC Transactions on Sustainable Digital Innovation (ITSDI), vol. 3, no. 2, Jun., 2022, pp. 143-149.
- [13] U. Rahardja, "Social Media Analysis as a Marketing Strategy in Online Marketing Business," Startuppreneur Business Digital (SABDA Journal), vol. 1, no. 2, pp. 176-182, 2022.
- [14] S. Kosasi, S. Millah, and N. P. L. Santoso, "Management in Concepts and Principles of Education Management using Cloud Computing," in MENTARI Journal: Management, Education and Information Technology, vol. 1, no. 1, 2022, pp. 38-45.
- [15] U. Rahardja, "Application of Blockchain Technology in E-Portfolio Based Cooperative Education," Technomedia Journal, vol. 7, no. February 3, pp. 354-363, 2023.
- [16] N. Lutfiani, S. Wijono, U. Rahardja, A. Iriani, and E. A. Nabila, "Artificial Intelligence Based on Recommendation System for Startup Matchmaking Platform," in 2022 IEEE Creative Communication and Innovative Technology (ICCIT), Nov. 2022, pp. 1-5, doi: 10.1109/ICCIT55355.2022.10118708.
- [17] N. Lutfiani et al., "A bibliometric study: Recommendation based on artificial intelligence for ilearning education," Aptisi Transactions on Technopreneurship (ATT), vol. 5, no. 2, pp. 109- 117, 2023.

- [18] D. Amiruddin, G. P. Cesna, R. Supriati, N. Lutfiani, and T. Nurtino, "Startuppreneur Multiproduct: Visionary iLearning on Digital Business," in 2022 IEEE Creative Communication and Innovative Technology (ICCIT), Nov. 2022, pp. 1-7, doi: 10.1109/ICCIT55355.2022.10118739.
- [19] B Rawat et al., "Ai based drones for security concerns in smart cities," in APTISI Transactions on Management (ATM), vol. 7, no. 2, Mar.-Apr., 2023, pp. 125-130.
- [20] Fazri et al., "Implementing Artificial Intelligence to Reduce Marine Ecosystem Pollution," in IAIC Transactions on Sustainable Digital Innovation (ITSDI), vol. 4, no. 2, Sep., 2023, pp.101-108.