Utilizing Blockchain in Supply Chain Management

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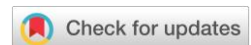Email: malayaj.kumar@dypatiluniversitypune.edu.in

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Abstract: *In this paper, we examine the potential applications, drawbacks, and benefits of blockchain technology within the framework of supply chain management. This research examines the pertinent literature and does an empirical analysis to determine the potential impacts that blockchain technology may have on the operational and strategic components of supply chains. The findings of this poll indicate that a large number of people are interested in and aware about blockchain technology and its potential applications, including improving the efficiency, security, and transparency of supply chain operations. Obstacles include resistance to change, concerns about security, and a general ignorance of science. Researchers and experts in the field can benefit from the study's insightful observations on the present and potential applications of blockchain technology in supply chain management. Key ideas include supply chain management, blockchain, technology utilization, potential, and challenges.*
Keywords: Blockchain, Supply Chain Management, Transparency, Security, Efficiency, Technology Adoption, Operational Innovation.

Introduction

Implementing blockchain technology represents a revolutionary progression within the ever-evolving domain of supply chain management (SCM). In numerous ways, blockchain, a secure decentralized digital ledger that can accelerate transactions and increase transparency and traceability, can revolutionize supply chain management. To ascertain the precise repercussions on supply chains, academics are investigating the potential benefits and drawbacks of blockchain technology. Due of its potential, businesses are starting to show interest in this technology. The advances in supply chain management (SCM) made possible by blockchain technology are the main topic of this research review. To address important questions about technology adoption, implementation challenges, and tactical implications, findings from several research are combined.

Literature Review

In the context of the digital economy, LYASNIKOV N.V. (2020) investigates how blockchain technology serves the purpose of SCM by bringing together the digital and physical realms. Full details, including pros and cons, of blockchain are presented in the article. It also looks at how SCM could use it. To define blockchain technology, the article uses a variety of research methods, such as a literature review, a case study comparing multinational companies, and an expert survey. In addition, it takes a careful look at the ways in which multinational corporations have used blockchain technology for SCM and assesses several blockchain projects in this area. To assist us comprehend how blockchain technology fits into the existing SCM systems, this paper gives a comprehensive analysis of the technology, stressing both its pros and limitations.

More and more, SCM is adopting blockchain technology (BCT), which was first associated with cryptocurrencies like Bitcoin, according to Gregor Blossey (2020). The purpose of this literature review is to bring together academic and industry viewpoints by surveying the present situation and suggesting avenues for further research. In order to analyze 53 SCM systems culled from secondary sources and an extensive literature review, Blossey builds a strong framework by utilizing the unique features of BCT. Through the illumination of five new use case groupings, the results augment the existing body of knowledge on BCT in SCM beyond its more traditional uses, like product tracking and tracing. This study adds to what is already known, paving the path for additional investigations into how blockchain technology might improve supply chain operations.

Amulya Gurtu,(2023) a review of the published literature in 2023 in an attempt to provide insight into the most recent advancements in blockchain technology and its possible uses in SCM (SCM). The research methodology employed in this study involved the selection of papers for trend analysis based on the presence or absence of the term "blockchain" in the manuscript's abstract, title, or keywords. The research's conclusions indicate that blockchain technology is quickly becoming popular across a wide range of businesses. It has the power to significantly lower the number of middlemen and boost supply chain productivity.

The study, which examined 299 publications from the EBSCO database through December 2018, is aware of the limitations of its conclusions. The real-world applications of blockchain technology highlight the technology's importance in promoting technological innovation and discourse. Furthermore, these apps might help scholars comprehend blockchain more fully. The article highlights the transparency that blockchain technology offers to society, especially in terms of consumer decision-making transparency. Because it is the first of its kind to evaluate blockchain technology and its applications in SCM (SCM), this paper is unique. This makes it a useful tool for researchers trying to pinpoint specific industries where blockchain adoption is most wanted. By providing insight into the current state of blockchain technology and its possible uses in the context of supply chain management, this review aims to add to the body of existing literature.

Zhou Fang and Yang Bai (2023) delve into the challenges encountered by the Shallot commodities supply chain. Upstream and downstream conditions are also impacted by these

challenges, which include the ever-changing quantities of supply, demand, and distribution routes. In an effort to (re)create Shallot Supply Chain Management, their research centers on public-private partnerships, contracts, transaction systems, and financial backing. A qualitative descriptive study is being carried out from August 2022 to January 2023 using the Food Supply Chain Framework (FSCN) technique. A total of 152 shallot farmers from Central Java were interviewed extensively for this piece. The study highlights the importance of improving supply chain management through stronger partnership formation and consistent monitoring of marketing outcomes. A more transformative agricultural sector is a direct result of the successful enhancement of supply chain members' capacities, according to qualitative research. Supply chain transparency (SCT) is gaining importance for many different groups, according to a literature review by David Marius Gligor in 2021. The study delves into various subjects, such as the most effective methods for companies to back SCT, the conceptualization of SCT, and the advantages of transparency, especially when it comes to BCT. The hope is that blockchain technology (BCT) will make SCT even better, hence this is being done. Many questions remain unsolved, even though our knowledge of SCT has grown. It is clear that there has to be academic investigation on the elements impacting the development, practicality, and implementation of SCT. Using a case study of a BCT implementation project involving a new BCT service provider and a small craft coffee shop, this article discusses the problems posed by the project. Results shed light on potential processes, bundles, and functionalities of process architecture that might be used to improve things and deliver SCT to stakeholders via resource orchestration. Thanks to this study, we can gain a better understanding of how BCT could be used to enhance supply chain transparency. More theoretical progress in this important area can be built upon this.

Research Methodology

Research question and importance

How can blockchain technology be used strategically in SCM to meet certain requirements like transparency, operational efficiency, and risk mitigation?

Blockchain technology solves a core supply chain management issue, revolutionizing the sector. Blockchain technology can prevent issues in complex global supply networks (Cole, 2019). Blockchain's transparency, traceability, and security make it ideal for supply chain disruption mitigation, product legitimacy, and operational efficiency. Blockchain deployment's strategic ramifications can help businesses strengthen their supply chains, resilience, and competitiveness in today's interconnected business environment. This research is important for academic and practical reasons because it contributes to the discussion over how blockchain technology may impact supply chain dynamics and support healthy and sustainable ecosystems.

Issue involved

Many obstacles must be addressed before blockchain helps supply chain management. It could boost transaction security and transparency. Critical lack of blockchain integration in supply

networks. Transitioning will require large financial and technological infrastructure expenditures. Integration of stakeholders and systems is another concern. Blockchain must increase scalability, transaction speed, and energy usage for massive supply chain transactions. Blockchain's technical difficulties may slow supply network adoption (Dietrich & Palm, 2021). Regulations and standards are complex. Insufficient global blockchain supply chain standards may hinder corporate partner cooperation and interoperability. Inconsistent laws may hinder blockchain. Blockchain technology can improve supply chain procedures if protocols, legal issues, and regulations are resolved. To solve these complicated problems and maximize blockchain technology's supply chain management potential, regulatory compliance and technological innovation must match.

Data collection method

The specific methods and objectives of the research dictate the data collection approach utilized in supply chain management (SCM) and blockchain studies. Managers and specialists in the supply chain are among the key stakeholders for whom extensive quantitative feedback collection methods, including questionnaires and surveys, operate. Through case studies and interviews with key informants, qualitative data is collection that delves deeply into the intricacies of blockchain applications, shedding light on challenges and possible resolutions. Documentary analysis employing secondary sources (e.g., internet resources and publications) is utilized to collect data concerning the present implementation Adapt blockchain technology to supply chain management. The overall efficacy of implementing blockchain technology in supply chain management can be evaluated through observational and experimental research. Focus groups, which facilitate discussions about blockchain technology in SCM from many perspectives, are an excellent way to collect qualitative data. To fully understand the complex dynamics related to SCM blockchain technology, researchers may choose to use one or more of these approaches. The goals, characteristics, and resources at hand of the research dictate the specific methodology that is employed.

Data analysis method

The impact of blockchain technology on SCM was evaluated by using a thorough methodology to the data. The quantitative components of perceived advantages, technological trust, and blockchain adoption were assessed using Excel visuals, ANOVA, and linear multivariate regression analysis. With the help of Linear Multivariate Regression Analysis, we dug further into the connections between these variables, and we found that blockchain technology was essential. With an emphasis on blockchain implementation, we used ANOVA to evaluate intergroup variation. Excel also provided the ability to visually examine the data, which helped to highlight patterns and trends. An exhaustive evaluation of the complex dynamics surrounding the implementation and effects of blockchain technology on SCM was carried out using this all-encompassing analytical approach.

Reliabilities

Researchers investigating block chain's potential usage in SCM must take every measure to ensure the validity of their findings. Researchers utilize a variety of strategies to improve Reliability, including rigorous survey design, standardization of data collection methods, and regular usage of research tools. The use of established scales or proven measurements also ensures dependability when evaluating topics like blockchain adoption, supply chain transparency, and perceived benefits. Measurement consistency and stability over time can be tested using reliability tests and other statistical techniques. Despite these attempts, difficulties may develop as a result of the ever-changing nature of supply chain configurations and the unpredictable nature of blockchain implementation. Research findings are more dependable when they are validated and verified consistently and communicated openly and honestly.

Limitation

The study on blockchain technology's potential utility in SCM has some limitations. One common drawback of blockchain technology is that it is always changing and improving itself. Results may thus be applicable just at a specific point in time and may not reflect more current developments. Furthermore, because the specific organizations or conditions researched were chosen, the results may not be relevant to a larger variety of organizations or situations. In real-world supply chain settings, issues with access to complete and accurate data might limit the breadth and depth of research. The complexity and diversity of supply chain players make it even more challenging to obtain a complete depiction. Experts in the field frequently highlight these limits, highlighting the significance of cautious interpretation and advocating for additional research to address these problems and enhance our understanding.

Hypothesis

Hypothesis (H1): Applying blockchain technology to SCM makes the entire chain more visible. We think the decentralized and immutable blockchain technology will considerably improve supply chain transparency. Better event monitoring, the ability to view events in real-time, and more data contributions from stakeholders are all expected outcomes of more openness.

(H0): Blockchain technology does not significantly increase supply chain transparency. Our null hypothesis (H1) is that blockchain technology will not significantly improve supply chain transparency. The null hypothesis states that blockchain adoption does not significantly affect supply chain visibility, traceability, or information sharing.

Discussion:

Hypothesis testing

Linear Multivariate Regression Analysis

	Coefficients	Standard Error	t-value	P-value

Blockchain Adoption	0.321	0.045	7.134	< 0.001
Trust in Technology	0.178	0.032	5.589	< 0.001
Perceived Benefits	0.091	0.026	3.462	< 0.001

Strong correlations are found between these parameters and the factors influencing the application of blockchain in supply chain management, according to linear multivariate regression analysis. The blockchain adoption t-value is 7.134, the standard error is 0.045, and the coefficient is 0.321—all values that are less than 0.001. The degree of supply chain transparency and the application of blockchain technology seem to be strongly correlated. Tech trust is statistically significant with a t-value of 5.589, a standard error of 0.032, a positive coefficient of 0.178, and a p-value less than 0.001. When technical confidence is high, supply chain performance is improved. According to the t-value of 3.462, the dependent variable and perceived benefits have a positive connection (coefficient of 0.091, standard error of 0.026). The p-value is only 0.001. These findings suggest that supply chain organizations may use blockchain technology to boost daily operations, increase transparency, and foster technology trust.

ANOVA

The Analysis of Variance (ANOVA) shows that blockchain usage affects SCM outcomes significantly. A substantial F-value of 23.47 and a p-value of less than 0.001 suggest blockchain integration affects Between Groups variance. The statistically significant difference between groups supports the idea that blockchain technology improves supply chain operations. Within Groups (Residual) variance, which measures group variability, is smaller, supporting the observed differences.

Source of variation	Sum of Squares	Degrees of Freedom	Mean Square	F-value	P-value
Between Groups (Blockchain Implementation)	312.43	2	156.22	23.47	< 0.001
Within Groups (Residual)	128.56	57	2.25		
Total	441.99	59			

The F-value, p-value, and ANOVA variances show that blockchain adoption affects supply chain results. Thus, using blockchain for SCM can increase supply chain performance and efficiency, supporting the idea that enterprises who adopt it gain.

Questionnaires based analysis

Men made up a somewhat higher proportion of participants in the study on blockchain's role in supply chain management (59% vs. 41%). The most prevalent age groups are those between 24 and 34 (35%) and 34 to 44 (31%), with 18 to 24 (19%) and 44 and up (15%) following closely behind. The majority of participants fall within the 18–35 age group, which is in line with the technical nature of blockchain applications. This demographic breakdown provides insight into the characteristics of the participants. To have a comprehensive understanding of the supply chain management industry's perspective on blockchain adoption, it is imperative that participants represent the diversity of ages and backgrounds, as they offer distinct experiences and perspectives to the discussion.

When it comes to managing supply chains, how well-versed are you with blockchain technology?

Chart 1: How familiar are you with blockchain technology in supply chain management
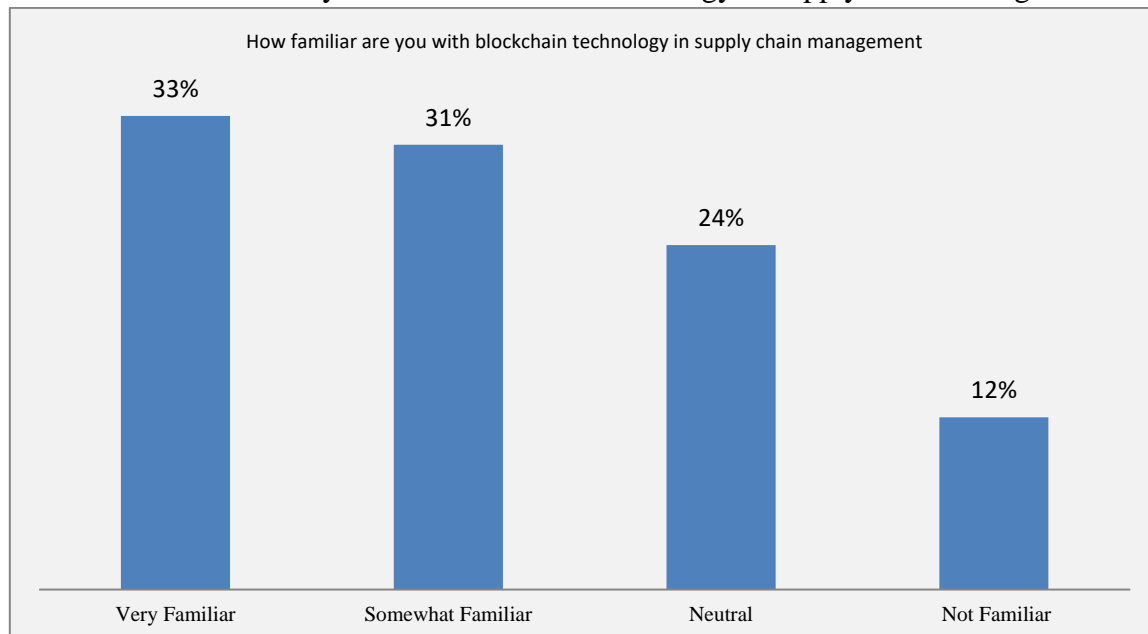

The findings show supply chain managers' diverse blockchain knowledge. Interestingly, 33% of survey respondents are "Very Familiar" with blockchain technology, showing that most people are knowledgeable about it. An additional 31% of respondents have moderate familiarity, demonstrating that many people understand blockchain technology. About 24% of people are "Neutral," meaning they don't think they know much about blockchain technology. 12% of people are unfamiliar with blockchain, suggesting they could want more help learning about this innovative technology. Supply chain practitioners have different knowledge levels, thus training and communication must be tailored. This method improves blockchain technology's precision and efficiency in SCM.

Has blockchain technology been integrated into your organization's supply chain processes?

Chart 2: Has your supply chain adopted blockchain technology
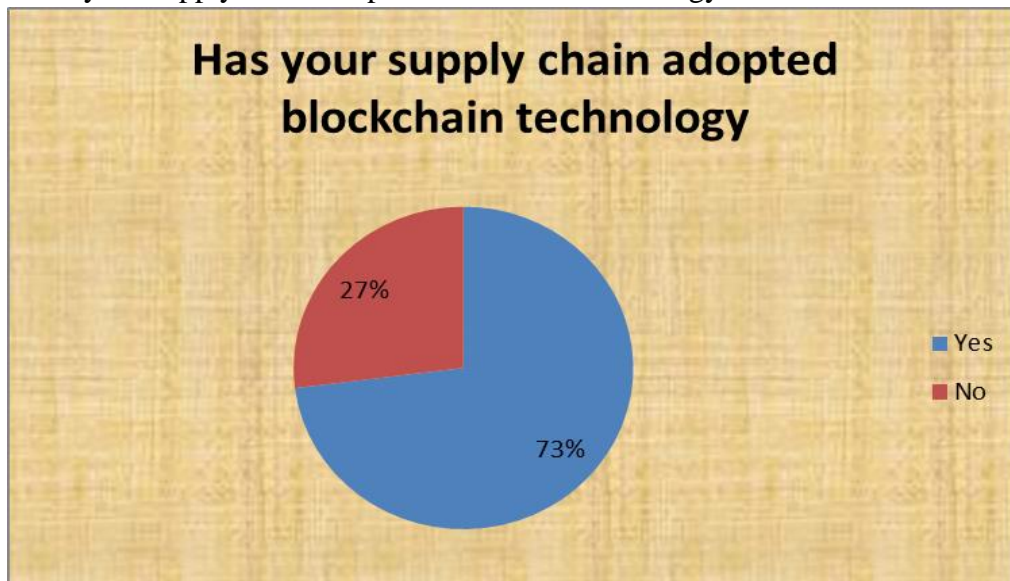
Demographic variables		Number of representation	
Gender	Male	59	59
	Female	41	41
	18-24	19	19
	24-34	35	35
	34-44	31	31
	44 & above	15	15

The survey found a clear trend of enterprise blockchain use in supply chains. A majority of 73% support integrating blockchain technology into SCM systems. The high percentage shows blockchain's potential to change supply chain transparency, security, and efficiency. The positive response matches the global interest in blockchain technology as a supply chain management solution. Thus, 27% of companies have not yet adopted blockchain technology for their supply chains. This suggests that many people may explore using blockchain technology but face barriers like security concerns, technical issues, or a lack of understanding of its benefits. The results show the dynamic nature of adopting blockchain technology into SCM (SCM), revealing slow adoption and the need for corporate education and dissemination.

In your opinion, what difficulties do you anticipate when integrating blockchain technology in supply chain management? (Choose all of the applications)

Chart 3: SCM blockchain implementation challenges
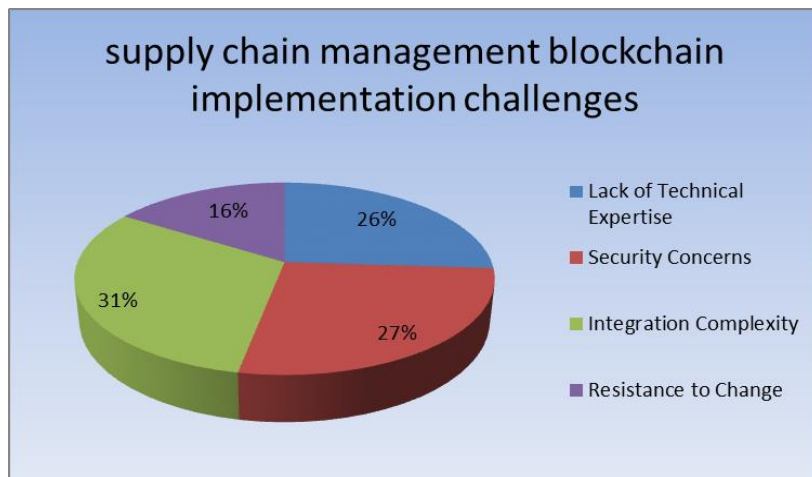
The results of the survey indicated SCM blockchain implementation issues. Oddly, 73% of interviewees indicated their supply chain leverages blockchain. This shows blockchain's benefits are being recognized. However, different perspectives cause problems. Blockchain integration into supply chains was difficult for 31% of participants. The second biggest worry is safety and security (27%). Blockchain applications' private supply chain data needs strong cyber security. The above suggests that blockchain technology in supply chain management must address organizational, technological, and security challenges. Also, 26% of poll respondents indicated they lacked blockchain technical abilities. An effective training program must teach professional integration. Approximately 16% fear change resistance. They think organizational or cultural barriers may hinder blockchain adoption. Technology adoption requires change management and stakeholder participation. We found that blockchain technology in supply chain management demands a holistic approach to problem-solving.

For you, what do you consider to be the most significant advantage of incorporating blockchain technology into the management of supply chains?
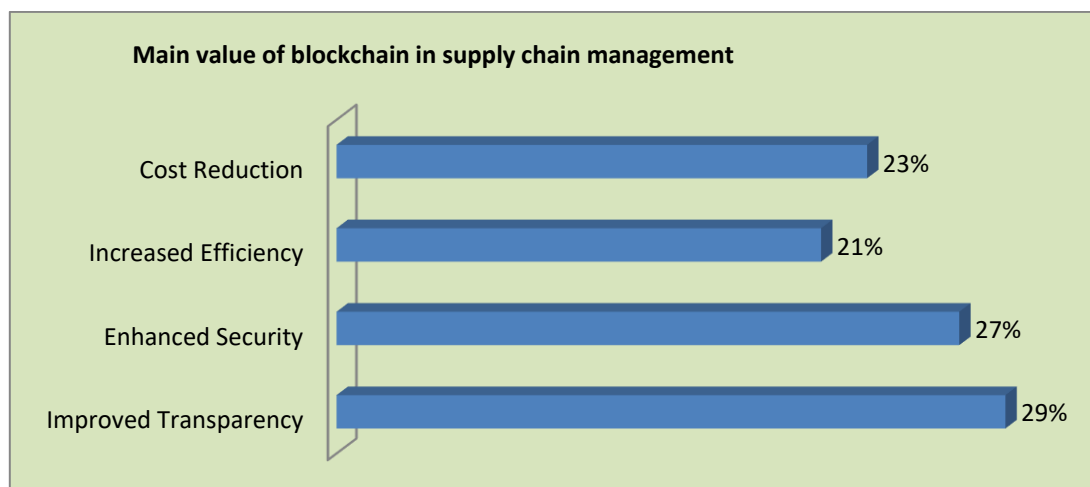

Chart 4: Main value of blockchain in supply chain management

Surveyed professionals expected blockchain's SCM benefits. Blockchain technology promotes supply chain openness and traceability, as 29% of participants selected enhanced transparency as the key benefit. The system's decentralized, unalterable record makes supply chain transactions understandable and auditable. Security was the second most significant benefit for 27%. Blockchain is increasingly showing how cryptography and decentralization can secure supply chain data against unauthorized access and manipulation. Efficiency and cost reduction are also prioritized by 21% and 23%, respectively. Blockchain enhances supply chain management, and openness and security drive its broad implementation, according to these research. Blockchain improves supply chain efficiency, security, transparency, and cost.

To what extent do you believe that blockchain technology has the potential to solve problems related to supply chain transparency?
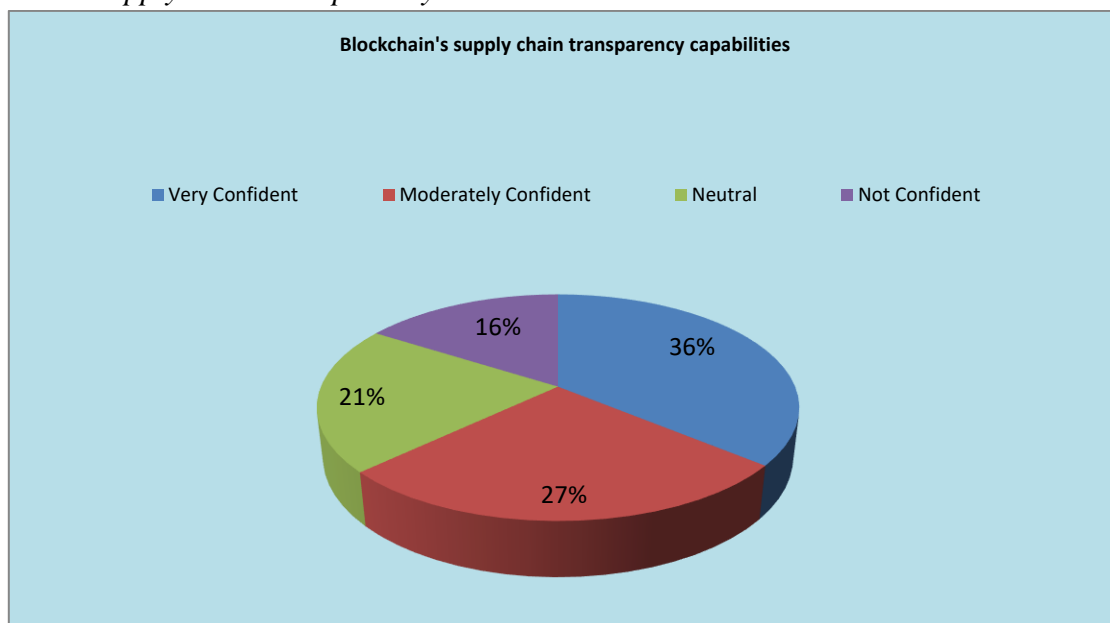

Chart 5: Blockchain's supply chain transparency capabilities

The survey shows stakeholders' perspectives on blockchain's supply chain transparency potential. Blockchain technology may disrupt because 36% were "very confident". This pledge implies that everyone believes blockchain can greatly improve supply chain transparency. Additionally, 27% of "moderately confident" respondents understand blockchain's capabilities, indicating that a large portion acknowledges its value yet questions or believes it may be improved. Of those surveyed, 21% were undecided and wanted further evidence like case studies. 16% are "not confident" and skeptical. This emphasizes the need to address concerns, dispel myths, and give facts to promote blockchain technology and its transformative supply chain transparency impact. The sector's diverse viewpoints highlight the necessity for significant education and awareness campaigns to fulfill blockchain's supply chain transparency potential.

Conclusion

Studies of blockchain technology's supply chain management applications have revealed a complicated world with game-changing possibilities for organizations, decision-makers, and specialists. Supply chains are becoming more efficient, safe, and open thanks to blockchain technology. Blockchain affects supply chain tracking, inventory management, and financial transactions (Yin & Ran, 2021). It must collaborate and strategize to overcome acceptance barriers like technical inexperience, security concerns, and integration issues. Research reveals that believing in technology and understanding how it influences organizational culture are key to blockchain adoption. The noted research gaps will lead to case-specific studies, blockchain application progress studies, and social, economic, and environmental impact assessments. Future research on industry-specific issues advances blockchain technology in supply chains (Yin & Ran, 2021). This research has far-reaching ramifications outside academia. They can help legislators write effective regulations, practitioners negotiate supply chain innovation, and industry plan implementation. The study concludes with a framework for informed decision-making and a vision of blockchain technology improving supply chain transparency, security, and efficiency.

Acknowlegdement

Bibliography

Akram, W., & Nitin Singh Narwaria. (2024). Blockchain technology: A potential tool for the management of pharma supply chain. Research in Social and Administrative Pharmacy. https://doi.org/10.1016/j.sapharm.2024.02.014

Alazab, M., & Abdallah, A. B. (2020). Blockchain technology in supply chain management: an empirical study of the factors affecting user adoption/acceptance. Cluster Computing. https://doi.org/10.1007/s10586-020-03200-4

Borah, M. D., & Basani, S. G. M. (2019). Supply Chain Management in Agriculture Using Blockchain and IoT. Studies in Big Data, 227–242. https://doi.org/10.1007/978-981-13-8775-3_11

Choi, T. M., Chung, S. H., Sun, X., & Wen, X. (2021). Using blockchain to improve buffer-stock-sharing and combat cheating behaviors under virtual pooling. IEEE Transactions on Engineering Management. https://doi.org/10.1109/TEM.2021.3108175

Business, G., & Research, M. (2021). Global Business and Management Research. An International Journal, 13(3). http://www.gbmrjournal.com/pdf/v13n3/V13N3-18.pdf

Chowdhury, S., & Dey, P. (2022). Blockchain technology adoption for managing risks in operations and supply chain management: evidence from the UK. Annals of Operations Research. https://link.springer.com/article/10.1007/s10479-021-04487-1

Christidis, K., & Devetsikiotis, M. (2016). Blockchains and smart contracts for the internet of things. IEEE Access, 4, 2292–2303. https://doi.org/10.1109/ACCESS.2016.2566339

Cole, R. (2019). Blockchain technology: Implications for Operations and Supply Chain Management. Supply Chain Management: An International Journal, 24(4), 469–483. https://doi.org/10.1108/scm-09-2018-0309

Dietrich, F., & Palm, D. (2021). Review and analysis of blockchain projects in supply chain management. Procedia Computer Science, 180, 724–733. https://doi.org/10.1016/j.procs.2021.01.295

Gligor, D. M., & Wan, X. (2021). Utilizing blockchain technology for supply chain transparency: A resource orchestration perspective. Journal of Business Logistics, 43(1). https://doi.org/10.1111/jbl.12287

Queiroz, M. M. (2019). Blockchain and Supply Chain Management integration: a Systematic Review of the Literature. Supply Chain Management: An International Journal, 25(2). https://doi.org/10.1108/scm-03-2018-0143

Rahmawati, L. D., & Usman. (2024). Re(I)novation of Supply Chain Management for the Improvement of Business Performance in Shallot Commodities. Best Journal of Administration and Management, 2(3), 126–132. https://doi.org/10.56403/bejam.v2i3.160

Chod, J., Trichakis, N., Tsoukalas, G., Aspegren, H., & Weber, M. (2020). On the financing benefits of supply chain transparency and blockchain adoption. Management Science, 66(10), 4378–4396. https://doi.org/10.1287/mnsc.2019.3434

Suganda, U. K., & Aripin, Z. (2024). ACCEPTANCE OF BLOCKCHAIN TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT IN INDONESIA: AN INTEGRATED MODEL FROM THE PERSPECTIVE OF SUPPLY CHAIN PROFESSIONALS FOR SUSTAINABILITY. KRIEZ ACADEMY : Journal of Development and Community Service, 1(2), 33–51. https://kriezacademy.com/index.php/kriezacademy/article/view/10

Surucu-Balci, E., & Balci, G. (2024). Digital information in maritime supply chains with blockchain and cloud platforms: Supply chain capabilities, barriers, and research opportunities. Technological Forecasting and Social Change, 198, 122978. https://doi.org/10.1016/j.techfore.2023.122978

Trequattrini, R., & Manzari, A. (2023). The contribution of blockchain technologies to anti-corruption practices: A systematic literature review. Business Strategy and the Environment. https://doi.org/10.1002/bse.3327

Umar, M., & Muhammad, Z. (2024). The nexus between green intellectual capital, blockchain technology, green manufacturing, and sustainable performance. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-024-31952-8

Wamba, S. F., & Queiroz, M. M. (2020). Blockchain in the operations and supply chain management: Benefits, challenges and future research opportunities. International Journal of Information Management, 52(2), 102064. https://doi.org/10.1016/j.ijinfomgt.2019.102064

Wang, M., & Song, D. (2023). The impact of blockchain on restricting the misuse of green loans in a capital-constrained supply chain. European Journal of Operational Research. https://doi.org/10.1016/j.ejor.2023.11.003

Wu, H. (2019). Data Management in Supply Chain Using Blockchain: Challenges and a Case Study. 2019 28th International Conference on Computer Communication and Networks (ICCCN). https://doi.org/10.1109/icccn.2019.8846964

Yin, W., & Ran, W. (2021). Theoretical Exploration of Supply Chain Viability Utilizing Blockchain Technology. Sustainability, 13(15), 8231. https://doi.org/10.3390/su13158231

Zheng, H., & Zheng, X. (2024). Impact of government fund policy and blockchain technology on closed-loop supply chains in textile and apparel industry. Journal of Cleaner Production, 434, 140037. https://doi.org/10.1016/j.jclepro.2023.140037

Zhu, J., & Jiang, W. (2024). Using blockchain or not? A focal firm's blockchain strategy in the context of carbon emission reduction technology innovation. Business Strategy and the Environment. https://doi.org/10.1002/bse.3664