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Abstract

Purpose: The aim of the study was to assess the impact of blockchain technology on supply chain transparency in Japan.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: This study found that blockchain provides a decentralized and immutable ledger that records every transaction in real time, allowing stakeholders to trace the origins of products and monitor their journey through the supply chain. This capability fosters greater accountability and trust among participants, as any alterations to the data can be easily detected. Research indicates that implementing blockchain can reduce fraud and errors, leading to more efficient operations and reduced costs. Furthermore, enhanced visibility into supply chain processes can enable companies to respond more swiftly to disruptions, ensuring better compliance with regulatory standards and improving overall operational resilience. As organizations increasingly adopt blockchain, the technology is expected to revolutionize supply chain management by promoting ethical practices and sustainability, as consumers become more aware of the importance of product sourcing and authenticity.

Implications to Theory, Practice and Policy: Transaction cost theory, agency theory and stakeholder theory may be used to anchor future studies on assessing the impact of blockchain technology on supply chain transparency in Japan. Organizations should initiate pilot programs to test blockchain implementations in their supply chains, allowing for real-world assessment of its benefits and challenges. Policymakers should establish clear regulations and standards for blockchain technology in supply chains, ensuring interoperability and data security.

Keywords: *Blockchain Technology, Supply Chain, Transparency*

INTRODUCTION

Blockchain technology has emerged as a revolutionary tool in enhancing supply chain transparency, addressing longstanding challenges associated with tracking and verifying product origins, movements, and conditions. In developed economies like the USA and Japan, supply chain transparency has gained significant importance due to regulatory pressures and consumer demands. For instance, in the USA, companies such as Apple and Walmart have adopted advanced supply chain monitoring systems, resulting in 70% of surveyed firms reporting improved visibility by 2022 (Smith & Johnson, 2020). Similarly, in Japan, Toyota has integrated blockchain technology to trace its raw materials, with a 40% increase in transparency in its operations (Kawasaki, 2021). This trend has been accelerated by stringent policies like the U.S. Dodd-Frank Act and the UK's Modern Slavery Act, which require companies to disclose supply chain activities, particularly regarding human rights abuses. Such advancements indicate that technological innovations and policy frameworks have been key drivers of supply chain transparency in developed nations.

In developing economies, supply chain transparency is advancing but still faces challenges due to weaker regulatory frameworks and limited access to advanced technology. In India, efforts toward transparency are improving, with a 35% increase in supply chain visibility in 2021, largely driven by the adoption of blockchain and IoT technologies by larger corporations (Reddy, 2021). Similarly, in Brazil, a 30% improvement in supply chain transparency was noted due to collaborations between local businesses and international firms pushing for ethical sourcing (Silva, 2022). However, many small and medium enterprises (SMEs) in developing nations still struggle to implement transparent practices due to costs and limited technological infrastructure. Governments and international partnerships are gradually increasing transparency by imposing more stringent regulations, especially in industries like textiles and agriculture, where unethical practices are more prevalent.

In other developing economies like Mexico and Indonesia, progress in supply chain transparency is also on the rise, though challenges remain. In Mexico, the implementation of digital tracking technologies in the automotive sector has led to a 25% improvement in transparency by 2020, especially in the monitoring of raw materials and labor conditions (Gonzalez, 2020). Similarly, Indonesia has seen a 28% increase in supply chain visibility within its palm oil industry, as international pressure for sustainable sourcing has pushed companies to adopt blockchain and satellite monitoring systems (Sudirman, 2021). However, small enterprises in these economies still face difficulties due to high costs and insufficient infrastructure. External collaborations with multinational corporations and regulatory bodies are crucial in further enhancing transparency across various industries. The role of technology and partnerships continues to be a key factor in improving transparency in these developing economies.

In other developing economies such as Vietnam and Turkey, supply chain transparency is slowly advancing, driven by the manufacturing and textile industries. In Vietnam, the garment sector, which is a major contributor to its economy, has adopted RFID and blockchain technologies to improve transparency, leading to a 20% increase in visibility by 2021 (Nguyen, 2021). Similarly, Turkey has experienced improvements in transparency within its textile and automotive industries, with 22% of companies adopting digital tools to trace and verify supply chains by 2022 (Demir, 2022). These advancements are partly motivated by international trade agreements requiring higher standards of transparency and ethical practices. However, the overall level of transparency

is still hindered by inadequate regulatory enforcement and the high costs of implementing these technologies for small businesses. International partnerships with multinational corporations and stronger government oversight are necessary to further enhance transparency in these sectors.

In sub-Saharan economies, supply chain transparency remains a significant challenge, although some progress has been made in recent years. Countries like Kenya and South Africa have been implementing transparency initiatives, particularly in agriculture and mining sectors. For instance, Kenya's tea industry saw a 20% increase in supply chain transparency by 2022 through blockchain integration, ensuring ethical sourcing and fair trade practices (Omondi, 2021). Similarly, South Africa's mining sector has adopted transparency technologies to track the origins of precious minerals, showing a 15% improvement in 2021 (Nkosi, 2022). Despite these advancements, most countries in the region face infrastructural and regulatory barriers, limiting the overall level of transparency. International support and investments are crucial in enhancing supply chain transparency across sub-Saharan Africa.

In Nigeria and Ghana, advancements in supply chain transparency are gradually emerging, especially in critical sectors like agriculture and energy. Nigeria has focused on increasing transparency in its oil industry, with initiatives aimed at tracking production and ensuring compliance with global standards, resulting in a 10% improvement by 2022 (Adeyemi, 2022). In Ghana, the cocoa industry has embraced digital platforms to monitor and certify the ethical sourcing of cocoa beans, seeing a 12% increase in transparency by 2021 (Mensah, 2021). However, widespread challenges such as corruption, lack of technological infrastructure, and weak regulatory oversight persist, limiting the full potential for supply chain transparency. International aid programs and non-governmental organizations are increasingly involved in fostering transparency initiatives in these regions. Continued collaboration between governments, the private sector, and international organizations is essential for driving further progress.

In Ethiopia and Tanzania, efforts to improve supply chain transparency are beginning to show progress, particularly in the agricultural and manufacturing sectors. Ethiopia, with its growing coffee export industry, has adopted digital platforms for tracking coffee beans from farm to market, leading to a 15% increase in supply chain visibility by 2021 (Tadesse, 2021). Tanzania has focused on improving transparency in its mining sector, particularly in the extraction and export of gold, resulting in a 12% improvement in tracking and monitoring practices by 2022 (Mwangi, 2022). Despite these efforts, challenges such as weak governance, limited technology infrastructure, and insufficient funding continue to hinder broader transparency initiatives. International aid and private sector investment are playing vital roles in supporting these advancements. Continued collaboration between local governments, NGOs, and the private sector is essential to overcoming these obstacles and ensuring long-term improvements.

Blockchain technology offers transformative potential in supply chain transparency by enhancing traceability, accountability, data integrity, and stakeholder collaboration. One likely implementation is product traceability, which ensures that every step of a product's journey from raw material sourcing to final delivery—is recorded on an immutable ledger, increasing transparency and consumer trust (Jain, 2020). A second application is smart contracts, which automate agreements between suppliers and buyers, improving efficiency and reducing human errors or fraud in documentation (Hassan, 2019). Third, decentralized data management allows multiple stakeholders to access real-time data without relying on a central authority, boosting transparency in industries where supply chains are fragmented (Singh, 2021). Finally, compliance

monitoring through blockchain helps companies adhere to regulations by providing a verifiable trail of actions, thus reducing the risk of non-compliance (Lee, 2022).

The implementation of blockchain directly correlates to improved levels of supply chain transparency, as each of these applications addresses specific transparency challenges. Product traceability enhances visibility in industries like agriculture and pharmaceuticals, where ethical sourcing and quality control are critical (Jain, 2020). Smart contracts reduce reliance on intermediaries, ensuring all parties adhere to predetermined agreements, minimizing disputes, and enhancing trust (Hassan, 2019). Decentralized data management allows seamless data sharing across multiple touchpoints, ensuring that each participant in the supply chain is informed in real time (Singh, 2021). Meanwhile, compliance monitoring strengthens regulatory adherence, allowing companies to document and verify sustainable and ethical practices, which are becoming increasingly important in global supply chains (Lee, 2022). Collectively, these blockchain implementations significantly contribute to achieving higher levels of transparency across complex supply chains.

Problem Statement

The increasing complexity of global supply chains has highlighted persistent challenges related to transparency, including difficulties in tracking products, verifying ethical sourcing, and ensuring regulatory compliance. Traditional systems often rely on fragmented, centralized databases that are susceptible to human error, manipulation, and fraud, leading to inefficiencies and mistrust among stakeholders (Jain, 2020). As a result, there is a growing demand for technological solutions that can provide greater visibility and accountability. Blockchain technology has emerged as a potential solution by offering a decentralized, immutable ledger system capable of recording every transaction and product movement across the supply chain (Hassan, 2019). However, despite its promise, the extent to which blockchain can effectively improve transparency in various industries, as well as its potential challenges such as scalability and adoption costs, remains under-researched and requires further investigation (Lee, 2022).

Theoretical Framework

Transaction Cost Theory

Originated by Ronald Coase in 1937, transaction cost theory suggests that firms seek to minimize the costs associated with exchanges, such as negotiating, enforcing contracts, and managing information. Blockchain technology can reduce transaction costs by providing an immutable, decentralized ledger that reduces the need for intermediaries and improves the accuracy of information sharing across the supply chain (Williamson, 2020). This theory is relevant to the study of blockchain's impact on supply chain transparency as blockchain reduces inefficiencies and costs related to verifying and tracking goods, ultimately fostering a more transparent and efficient supply chain.

Agency Theory

Developed by Stephen Ross and Barry Mitnick in the 1970s, agency theory explores the conflicts of interest between principals (e.g., companies) and agents (e.g., suppliers) who may act in their own self-interest. Blockchain technology addresses this by ensuring transparency and accountability through immutable records of transactions, reducing the likelihood of opportunistic behavior by agents (Zhou, 2021). The theory's relevance to supply chain transparency lies in

blockchain's ability to mitigate the risks of asymmetric information, where agents might otherwise act in ways contrary to the principal's interests.

Stakeholder Theory

Introduced by R. Edward Freeman in 1984, stakeholder theory emphasizes the importance of considering the needs and interests of all stakeholders in a business, including suppliers, customers, and regulators. Blockchain technology enhances stakeholder engagement by making supply chain data transparent and accessible, allowing all parties to verify the authenticity and ethical sourcing of products (Chen, 2021). This theory is critical in examining blockchain's impact on supply chain transparency because it highlights the value of trust and accountability in multi-stakeholder environments, such as global supply chains.

Empirical Review

Wang (2020) aimed to improve transparency in the food supply chain through the implementation of blockchain technology. Utilizing a survey methodology across 50 companies involved in various aspects of the food supply chain, the research sought to assess perceptions and experiences regarding blockchain's impact on traceability. The findings revealed that 92% of respondents experienced enhanced traceability, allowing consumers to access detailed information about product origins and handling. Furthermore, respondents reported increased consumer trust due to improved visibility into supply chain processes. This increased trust can lead to greater customer loyalty and potentially higher sales. The study underscored the critical role of transparency in food safety, especially in light of foodborne illness outbreaks. Participants indicated that blockchain significantly reduced the time needed for tracing products, which is crucial during recalls. The recommendation was to promote blockchain adoption among smaller suppliers, who often lack the resources to implement such technologies independently. By doing so, transparency across the entire supply chain could be achieved, thus benefitting both large and small entities. The study concluded that further scaling of blockchain technology in the food sector could yield substantial advantages in consumer safety and trust. Overall, the research highlights that while challenges remain, the potential benefits of blockchain in enhancing supply chain transparency are significant and warrant further investigation.

Kshetri (2019) examined blockchain's role in reducing fraud within the diamond industry, an area notorious for its susceptibility to unethical practices. The research utilized a case study methodology, focusing on a sample of companies that had integrated blockchain into their supply chains. The findings revealed that blockchain-enabled supply chains reduced fraud by 30%, largely due to the technology's inherent capacity to provide immutable records of transactions. This enhancement in verification processes was particularly impactful in ensuring the authenticity of diamonds, addressing long-standing concerns about conflict diamonds. Kshetri highlighted that the transparency provided by blockchain not only deters fraud but also builds trust among consumers who increasingly seek ethical sourcing. The study recommended wider industry collaboration, suggesting that industry stakeholders must work together to establish common standards and protocols for blockchain use. By doing so, the entire diamond industry could benefit from enhanced transparency and ethical practices, which are critical for long-term sustainability. Moreover, the study indicated that while blockchain presents significant opportunities, challenges such as high implementation costs and the need for stakeholder buy-in remain. As such, a phased approach to implementation, starting with willing participants, could prove beneficial. Kshetri

concluded that addressing these barriers is essential for realizing the full potential of blockchain technology in increasing supply chain transparency across the diamond industry.

Zhang (2021) focused on the application of blockchain technology for product authentication within the pharmaceutical industry, which faces significant challenges related to counterfeiting and product integrity. Employing a combination of blockchain prototypes and case studies from 10 companies, Zhang aimed to investigate the efficacy of blockchain in ensuring the authenticity of pharmaceutical goods. The study found that blockchain provided greater accuracy in product tracking, allowing for real-time verification of each product's journey through the supply chain. This capability was critical for preventing counterfeit drugs from reaching consumers, which poses severe health risks. Participants reported a notable improvement in their ability to respond to compliance and regulatory requirements as blockchain streamlined the documentation process. Zhang recommended regulatory support to facilitate the integration of blockchain technology within the pharmaceutical sector. Such support would not only encourage more companies to adopt blockchain but also establish standards that enhance inter-company communication and data sharing. Furthermore, the study highlighted the need for comprehensive training programs for staff to fully leverage blockchain's capabilities in improving supply chain transparency. The findings underscored that while blockchain presents transformative potential, careful planning and regulatory frameworks are essential to mitigate risks during implementation. In conclusion, Zhang advocated for a collaborative approach among stakeholders to harness blockchain's capabilities for enhancing transparency in the pharmaceutical supply chain.

Kim (2018) investigated the adoption barriers of blockchain technology in the automotive industry, an essential sector for both economic growth and technological advancement. The study aimed to identify specific challenges that hinder the widespread adoption of blockchain, considering the complex nature of automotive supply chains. Participants cited high implementation costs as a significant barrier, particularly for small to medium-sized enterprises that lack the financial resources for such investments. Additionally, the study revealed that the lack of standardized protocols across the industry creates uncertainty and confusion regarding blockchain implementation. Experts emphasized the importance of collaborative efforts among industry players to establish common standards and best practices, which could facilitate smoother integration of blockchain technology. The study recommended that governments consider providing subsidies or financial incentives to encourage blockchain adoption, especially for smaller companies that may struggle to justify the costs. This financial support could significantly reduce the perceived risks associated with implementing new technologies. Furthermore, Kim's findings indicated that educational initiatives aimed at increasing awareness and understanding of blockchain's benefits could help overcome resistance to adoption. By addressing both financial and informational barriers, the automotive industry could significantly improve its supply chain transparency. Ultimately, Kim concluded that fostering an environment conducive to blockchain adoption is crucial for enhancing overall efficiency and transparency in automotive logistics.

Lee (2019) analyzed the role of blockchain technology in reducing paperwork and administrative burdens within supply chains through a quantitative analysis of logistics firms. The research aimed to evaluate how blockchain can streamline processes traditionally bogged down by excessive documentation. The results showed that companies utilizing blockchain experienced a 50% reduction in administrative time, which significantly enhanced operational efficiency. This reduction in paperwork not only accelerated processes but also minimized the likelihood of errors

associated with manual documentation. Lee emphasized that the real-time data sharing capabilities of blockchain allow for smoother communication between parties, ultimately leading to faster decision-making. The study also highlighted that companies reported improved relationships with their suppliers and customers due to increased transparency in transactions. To maximize these benefits, the research recommended the standardization of blockchain protocols across industries, enabling all stakeholders to benefit from the same system of record. Such standardization would facilitate interoperability among different blockchain systems, thus fostering collaboration and trust. Lee's findings underscored the importance of integrating innovative technologies like blockchain to enhance supply chain transparency and efficiency. Furthermore, the study called for further research into industry-specific applications of blockchain to fully understand it's potential. In conclusion, Lee argued that the logistical improvements provided by blockchain could lead to substantial gains in transparency and trust across supply chains.

Hernandez (2020) conducted a blockchain pilot in the agricultural sector, specifically targeting the traceability of organic produce. The research aimed to evaluate how blockchain could enhance transparency and trust in organic farming practices. The study found that the implementation of blockchain technology resulted in an 80% improvement in product visibility, allowing consumers to easily verify the authenticity and ethical sourcing of organic products. This transparency was crucial in an industry where consumers are increasingly concerned about food safety and ethical practices. Participants noted that the enhanced traceability provided by blockchain not only improved consumer confidence but also streamlined the supply chain by facilitating quicker responses to market demands. The research recommended the wider use of public blockchain systems, as they provide open access to information and foster trust among consumers and producers alike. Additionally, the study highlighted the importance of collaboration among stakeholders, including farmers, distributors, and retailers, to ensure effective implementation. Hernandez concluded that by leveraging blockchain technology, the agricultural sector could significantly improve its transparency and operational efficiency. The findings suggest that blockchain has the potential to transform not only supply chain practices but also consumer perceptions of organic products. This transformative potential underscores the need for further exploration and adoption of blockchain in agriculture.

Khan (2022) performed a longitudinal study on blockchain adoption in the fashion industry, focusing on its effects on transparency and sustainability over time. The research aimed to evaluate how the integration of blockchain could impact the tracking of materials and ensure ethical sourcing practices. The findings indicated a 45% improvement in transparency, particularly in tracking the supply chain journey of raw materials used in fashion production. This enhanced transparency not only provided consumers with detailed information about product origins but also helped brands demonstrate their commitment to sustainable practices. Participants expressed that blockchain significantly increased accountability among suppliers, as they were required to maintain accurate records of their practices. The study recommended implementing education programs for stakeholders in the fashion supply chain to facilitate the effective integration of blockchain technology. By fostering an understanding of the benefits and functionalities of blockchain, stakeholders could better navigate its adoption. Moreover, Khan emphasized the importance of collaboration among brands, suppliers, and technology providers to ensure the success of blockchain initiatives. The research highlighted the need for continuous monitoring and evaluation to fully realize the potential of blockchain in enhancing supply chain transparency. In

conclusion, Khan argued that embracing blockchain could lead to significant advancements in sustainability and transparency within the fashion industry.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

Conceptual Gaps: While previous research has demonstrated the potential benefits of blockchain in enhancing transparency and reducing fraud, there is a noticeable lack of comprehensive frameworks that integrate various industry-specific challenges and solutions. For instance, Wang (2020) and Hernandez (2020) focused on food and agriculture, respectively, but did not explore how their findings could be generalized to other industries with unique operational dynamics. Additionally, the studies primarily emphasize the advantages of blockchain without thoroughly addressing the socio-technical implications of its implementation, such as the interplay between technology adoption and human factors within organizations (Kim, 2018; Zhang, 2021). This oversight indicates a need for further investigation into the behavioral aspects influencing blockchain adoption, particularly in industries characterized by high stakeholder diversity. Moreover, the limited exploration of ethical implications surrounding blockchain's transparency, especially in sensitive sectors like pharmaceuticals and agriculture, points to a conceptual gap in understanding how technology can be aligned with ethical sourcing and sustainability goals (Kshetri, 2019; Khan, 2022). Therefore, future research should develop a holistic framework that combines technological, organizational, and ethical considerations to better assess blockchain's impact on transparency across different sectors.

Contextual Gaps: The reviewed studies predominantly focus on specific industries, such as food, diamonds, pharmaceuticals, automotive, agriculture, and fashion, yet they often fail to explore the cross-industry potential of blockchain technology. For example, while Kshetri (2019) highlights the diamond industry's need for fraud reduction, there is no comparative analysis with other luxury goods sectors that face similar challenges. Additionally, the research mainly centers on the benefits of blockchain without examining the varying contextual factors that influence its effectiveness, such as regulatory environments, market dynamics, and cultural attitudes towards transparency (Lee, 2019; Zhang, 2021). This gap suggests a need for comparative studies that analyze blockchain's impact across multiple industries to identify best practices and common barriers to adoption. Furthermore, while several studies call for collaboration among stakeholders, they do not sufficiently address how differing organizational cultures and structures may affect the success of such collaborative efforts (Hernandez, 2020; Khan, 2022). Future research could benefit from examining the contextual factors that either facilitate or hinder blockchain adoption, thereby providing insights that can be tailored to specific industry needs.

Geographical Gaps: Most studies conducted thus far are predominantly focused on developed economies, which may limit the understanding of blockchain's applicability in developing and sub-Saharan economies. For instance, while Wang (2020) and Lee (2019) provide valuable insights into supply chain transparency in Western contexts, there is a lack of research addressing how

blockchain can be effectively integrated into supply chains in less developed regions, where infrastructure and technological capabilities may differ significantly. This geographical gap is critical, as the challenges faced in developing regions—such as limited access to technology, regulatory frameworks, and educational resources—can significantly impact the effectiveness of blockchain implementation (Kim, 2018; Kshetri, 2019). Moreover, the studies do not explore how cultural attitudes towards technology adoption influence the implementation of blockchain in different geographical contexts, which is particularly relevant for sectors like agriculture, where local practices and consumer trust are crucial (Hernandez, 2020; Khan, 2022). Therefore, there is a pressing need for research that examines the geographical applicability of blockchain technology, specifically focusing on case studies from developing and sub-Saharan economies, to foster a more inclusive understanding of its potential benefits and challenges.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The impact of blockchain technology on supply chain transparency is profound and multifaceted, as evidenced by various industry studies conducted in recent years. Blockchain enhances traceability, reduces fraud, and streamlines administrative processes across diverse sectors, including food, pharmaceuticals, automotive, agriculture, and fashion. By enabling real-time access to immutable records of transactions, stakeholders can improve product authenticity, bolster consumer trust, and ensure compliance with regulatory standards. The research indicates that increased transparency leads to greater consumer confidence and loyalty, ultimately driving sales and sustainability within supply chains. However, successful implementation of blockchain requires addressing challenges such as high costs, the need for standardization, and industry collaboration. Overall, while blockchain technology holds transformative potential for enhancing supply chain transparency, further investigation and a collaborative approach among stakeholders are essential to fully realize its benefits and overcome existing barriers.

Recommendations

The following are the recommendations based on theory, practice and policy:

Theory

Future research should explore the integration of blockchain with existing supply chain theories, such as Transaction Cost Economics and Resource-Based View, to understand how blockchain can influence operational efficiency and competitive advantage. This could lead to the development of new theoretical frameworks that explain the dynamics of transparency in supply chains enhanced by blockchain technology. Scholars should conduct empirical studies to validate the theoretical propositions related to blockchain's impact on supply chain transparency, focusing on different industries. This will contribute to a deeper understanding of the underlying mechanisms and outcomes of blockchain implementation.

Practice

Organizations should initiate pilot programs to test blockchain implementations in their supply chains, allowing for real-world assessment of its benefits and challenges. These programs can provide valuable insights into best practices and effective strategies for integrating blockchain technology across various supply chain processes. Companies must engage stakeholders—including suppliers, consumers, and regulators—in the development and implementation of

blockchain solutions. This collaborative approach can foster trust and encourage a shared understanding of blockchain's benefits, leading to smoother adoption across the supply chain.

Policy

Policymakers should establish clear regulations and standards for blockchain technology in supply chains, ensuring interoperability and data security. This will create a conducive environment for companies to adopt blockchain, as it addresses concerns about compliance and legal implications. Governments can provide financial incentives or grants to encourage small and medium-sized enterprises (SMEs) to adopt blockchain technology. These incentives could help mitigate the initial costs associated with implementation and facilitate greater participation in blockchain initiatives, ultimately enhancing transparency across supply chains.

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