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The Role of Blockchain Technology in Ensure Transparency Chain Supply Product Agriculture Organic

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ABSTRACT

Transparency and traceability in organic agricultural supply chains remain major challenges in maintaining consumer trust and the integrity of organic labels. With increasing consumer awareness and demand for authenticity, ensuring that organic products are reliably tracked across the chain is essential. This study aims to explore the role of blockchain technology in enhancing data transparency and validating distribution processes in the organic supply chain. The research employed a qualitative approach through field studies involving 15 supply chain actors, including farmers, cooperatives, distributors, and agritech startups. Data were collected through in-depth interviews, observations, and document analysis to capture experiences, opportunities, and barriers in blockchain adoption. The findings show that blockchain technology significantly improves product traceability, accelerates audit processes, and provides a more reliable reporting system. Farmers and cooperatives experienced increased efficiency in documenting product flow, while distributors and retailers gained stronger credibility in certification and labeling. However, adoption still faces challenges such as limited digital literacy, inadequate infrastructure, and high initial investment costs. This study provides practical implications for the development of technology-based agricultural supply chains. It highlights the potential of blockchain integration at cooperative and retail levels to enhance accountability and transparency. Furthermore, the research suggests that cross-actor collaboration and supportive policies are necessary to accelerate adoption, thereby building a more transparent and accountable food system that aligns with sustainable development goals.

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1. INTRODUCTION

Organic agriculture has become a global focus in building sustainable and environmentally friendly food systems. Organic products are not only perceived as healthier but also represent a symbol of ecological awareness among today's consumers. However, consumer trust in organic labels depends heavily on the transparency of supply chain information. In many cases, organic labeling is not accompanied by concrete evidence regarding product origin, production processes, and distribution channels. In this context, blockchain technology has emerged as a potential solution to ensure authenticity and real-time traceability (Kim & Laskowski, 2021; Lu & Xu, 2020; Zhang et al., 2023).

With its decentralized and immutable ledger, blockchain allows all stakeholders to access reliable information across the supply chain. Therefore, blockchain integration into organic agriculture systems has become a strategic necessity to address growing market demands for transparency and trust.

In Indonesia, the organic agriculture sector has shown positive growth, driven by rising domestic consumption and expanding international market opportunities. Nevertheless, the distribution system of organic products continues to face significant challenges, especially concerning documentation and traceability. Manual certification processes and a lack of supporting digital infrastructure often make it difficult for consumers to verify organic claims. As a result, doubts arise regarding the integrity of organic labels, particularly in the post-harvest and distribution stages (Sari & Pramono, 2022; Hapsari et al., 2023; Rahim & Wijaya, 2020). Moreover, small-scale enterprises frequently lack adequate digital systems to ensure product visibility. The absence of integration between producers, distributors, and consumers further exacerbates the problem, creating fragmented and non-standardized information. Blockchain, with its ability to record every transaction securely and transparently, offers a promising architecture to strengthen trust across the supply chain.

A major problem faced by organic agricultural supply chains is the weakness of traceability mechanisms and data validation among supply chain actors. Dependence on conventional methods leaves data prone to manipulation or loss during the transfer between stages. This increases the risk of fraud and diminishes the added value of organic products themselves. Furthermore, supply chain actors lack a shared system that can be collectively and openly used, leading to inconsistencies in data standards (Putra & Hidayat, 2021; Kusuma & Lestari, 2023; Li et al., 2020). The lack of interoperability hampers auditing and reporting processes, undermining product quality assurance. Without technological support for transparency, consumers are denied direct access to reliable information about product origins. Blockchain, with features such as smart contracts and distributed ledgers, can address these weaknesses by creating a more transparent and trustworthy supply chain system.

In the era of agricultural digitalization, consumer trust in organic products can only be built through open and tamper-proof systems. Research on blockchain adoption in agriculture has become increasingly urgent as global food systems face demands for transparency and sustainability. For Indonesia, an agrarian country, bridging the technological gap is essential to remain competitive in international markets that prioritize traceability and certification (Yusuf & Setiawan, 2022; Nurfadillah et al., 2023; Huang et al., 2021). Blockchain adoption can support certification processes, improve logistical efficiency, and prevent fraudulent labeling practices that harm both consumers and producers. Failure to adopt blockchain quickly could undermine the competitiveness of Indonesia's organic agricultural sector. Hence, there is a critical need for contextual studies that analyze how blockchain can be implemented in Indonesia's organic supply chain, particularly among small and medium-sized enterprises.

Previous studies have highlighted blockchain's potential in improving efficiency and integrity across supply chains, but few have focused specifically on organic agriculture. Kim & Laskowski (2021) emphasize the importance of interoperability and data security in blockchain adoption within agribusiness. Lu & Xu (2020) highlight blockchain's ability to enhance transparency for end consumers in the Chinese market, while local studies such as Sari & Pramono (2022) identify infrastructure and digital literacy challenges in the Indonesian context. However, the majority of prior research remains conceptual, with

limited practical implementation in small and medium-scale organic agriculture businesses. As a result, empirical studies that evaluate real-world blockchain integration in this sector remain scarce.

Despite its recognized potential, blockchain technology in organic agriculture is under-researched in the Indonesian context. Most existing studies emphasize either technical potential at large-scale agribusiness or conceptual discussions without empirical validation at the grassroots level. There is little exploration of how blockchain can be tailored to the fragmented, smallholder-dominated structure of Indonesian organic farming. Additionally, the socio-economic barriers such as digital literacy, cost feasibility, and policy support have not been systematically addressed. This gap creates a critical need for research that not only evaluates blockchain's technical advantages but also examines its contextual adaptability, stakeholder readiness, and practical implementation pathways in Indonesia's organic agriculture sector.

The novelty of this study lies in its contextualized approach to blockchain integration within Indonesia's organic agricultural supply chain, which is characterized by numerous small-scale businesses. Unlike previous studies that focused on theoretical advantages, this research assesses blockchain implementation in real conditions, emphasizing socio-technical dynamics among farmers, cooperatives, distributors, and consumers. Moreover, the study introduces an end-to-end supply chain perspective that has been largely absent in earlier works (Zhang et al., 2023; Kusuma & Lestari, 2023; Hapsari et al., 2023). By identifying critical success factors such as digital infrastructure readiness, stakeholder literacy, and policy support, this research provides both theoretical contributions and practical recommendations. This sharper contrast with earlier studies reinforces the distinctiveness and applicability of the study's findings.

This study aims to analyze the role of blockchain technology in ensuring transparency within Indonesia's organic agricultural supply chains. The primary focus is to evaluate how blockchain can be implemented to secure traceability, prevent fraudulent labeling, and strengthen consumer trust. The research further seeks to provide an empirical basis for the development of digital policies and innovations in the organic agriculture sector. The expected benefits include the formation of a more transparent, efficient, and integrated supply chain information system.

The implications of this research extend beyond technology adoption. The findings are expected to serve as a reference for policy formulation at national and local levels, promoting blockchain integration as part of sustainable agricultural strategies. For practitioners, the study highlights practical steps for improving collaboration among farmers, cooperatives, distributors, and certification bodies. For consumers, the research underscores blockchain's potential to provide direct access to product origin and authenticity information. Overall, this study contributes to addressing the challenges of modernizing Indonesia's organic agriculture and positions blockchain as a critical enabler of sustainable, transparent, and accountable food systems.

2. METHOD

This study employed a qualitative descriptive approach with a case study design to explore how blockchain technology can be implemented in the organic agricultural supply chain. The object of research was the organic agriculture supply chain, ranging from farmers, distributors, to retailers who have the potential or have already applied digital technologies to support traceability and transparency. Data sources consisted of both primary and secondary data. Primary data were collected through in-depth interviews with

supply chain actors, while secondary data came from policy documents, agritech company reports, and previous studies. The population consisted of organic agriculture businesses in three major production centers in Indonesia, with purposive sampling applied to select 15 respondents, including farmers, cooperative managers, and agritech startup representatives.

Research instruments included semi-structured interview guidelines and observation checklists for monitoring distribution processes and product data recording. Prior to fieldwork, the interview guidelines were validated through expert judgment by two academics in agricultural informatics and one practitioner from the agritech industry to ensure content clarity, relevance, and feasibility. Instruments were then piloted with two respondents outside the study sample to refine question structure.

Data collection was conducted in four stages: (1) identification of research areas and relevant supply chain actors, (2) preparation of validated interview guides and observation checklists, (3) field data collection through interviews, direct observations, and documentation from digital tracking systems, and (4) verification of collected data with respondents. Ethical considerations were observed throughout the study, including obtaining informed consent, ensuring data confidentiality, and clarifying the voluntary nature of participation.

Data analysis followed a thematic analysis procedure. First, raw interview transcripts and observation notes were organized systematically. Second, an open coding process was applied to identify recurring categories related to transparency, traceability, and consumer trust. Third, axial coding was used to connect categories into broader themes, such as user perceptions, implementation challenges, and added value of blockchain. Finally, selective coding was conducted to formulate core themes that underpin the study's findings. The validity of findings was ensured through triangulation of data sources and methods, including cross-checking interview results with observation records and documentation (Creswell & Poth, 2018; Moleong, 2021; Sugiyono, 2022).

The results of the analysis were synthesized into practical recommendations for a blockchain implementation model in organic agriculture supply chains. While the study is limited by the number of participants and geographic coverage, it provides a strong initial picture of field readiness and perceptions toward blockchain adoption in Indonesia's organic agriculture sector.

3. RESULTS AND DISCUSSION

Structure Chain Supply Product Agriculture Organic : Complex and Fragmented

Chain supply agriculture observed organic in study This involving various actor , start from farmer individuals , cooperatives , local distributors , to modern retailers and consumers end . Every actor play a role in flow product from upstream to downstream , but still minimal system integrated For share data. In in practice , information like origin seeds , types fertilizer , cultivation process , and time harvest only noted manually , partly even No documented . Condition This enlarge risk data mismatch and raises gap in validation claim organic . Fragmented data This impact direct to trust consumers , especially at the stage distribution and retail. Consumers No can browse footsteps product in a way comprehensive Because limitations access and technology on the side producers . Therefore that , digital systems such as blockchain become relevant For build traceability in a way comprehensive and real-time.

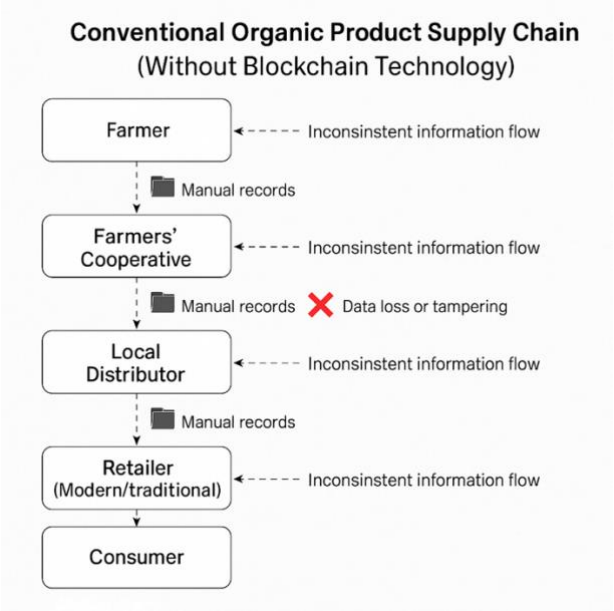

Figure 1. General Scheme Chain Supply Product Organic Without Blockchain

Blockchain Implementation : Potential and Obstacles Field

Interview results show that part big perpetrator business know the term blockchain, however Not yet understand principle his work in a way operational . Three agritech startups mention that they currently in stage development system blockchain -based digital record-keeping , but involvement farmer Still very limited . Farmers feel not enough believe self use digital applications because limitations literacy and infrastructure , especially in the regions rural areas . Another obstacle is cost beginning investment assessed devices and training Enough tall For perpetrator business micro . On the other hand , the perpetrator cooperative state interest tall to a system that can increase audit and reporting efficiency organic . Potential blockchain integration begins seen in phase packaging and distribution , where product data more easy collected digitally . Although Thus , it is necessary ecosystem collaborative so that all actor can connected in One a safe and trusted digital system .

Table 1. Perception Perpetrator Chain Supply towards Blockchain

Actor Chain Supply	Getting to Know Blockchain	Ready Apply	Major Obstacles
Farmer Organic	Low	Low	Literacy & Infrastructure
Cooperative Farmer	Currently	Tall	Cost start & integration system
Agritech Startup	Tall	Tall	Collaboration between actor
Retail Distributor	Currently	Currently	Upstream data access & standardization

Transparency and Traceability Product

One of benefit the main blockchain is his abilities in take notes information from every point chain supply to in a digital ledger that doesn't can manipulated . In simulation limited to what is done with agritech startups , products organic like vegetables and fruits given a connected QR code with production , harvest , and shipping data . Consumers who scan the QR code can see time plant , name farmer , type fertilizer used , and time

distribution . This is provide a sense of security and improve perception to quality as well as integrity product organic . Retailers say that transparency This can become superiority competitive in the modern market, especially for consumer medium to above . On the side manufacturers , digital record keeping helps build record footsteps production that can used in the certification audit . Findings This indicates that blockchain system can become bridge trust between perpetrator upstream and downstream .

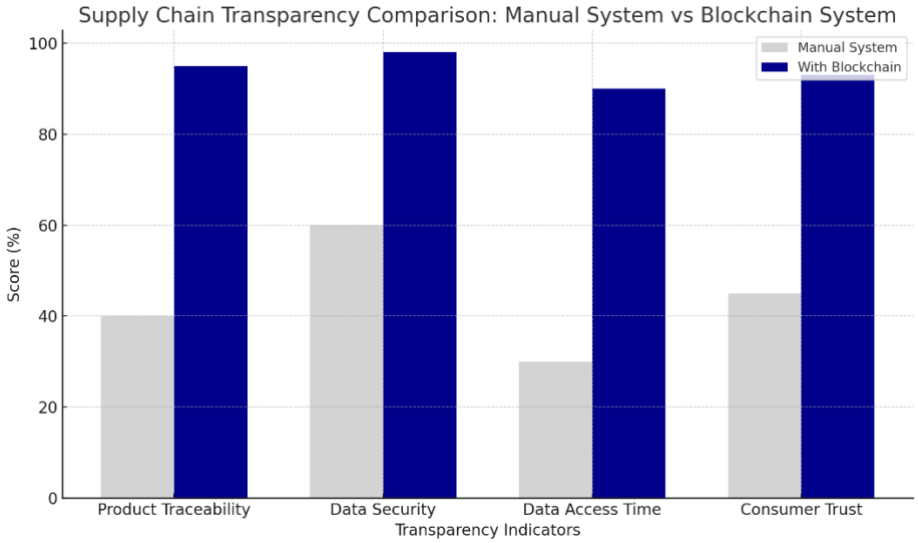

Figure 2. Impact of Blockchain on Indicator Transparency Chain Supply

Efficiency Operational and Validation Certification

Blockchain does not only increase transparency but also efficiency operational through automation recording and reduction duplication document . Cooperative convey that the audit process by the institution certification can shortened up to 40% if the data can accessible through integrated digital system . This because the data is not need collected repeat manually and trace production Already documented with Good since beginning . With smart contracts, the system can lock channel work and avoid data changes that are manipulative . In some test point , blockchain also facilitates reward system for farmers who guard standard quality , through recording automatic and digital incentives . System This No only strengthen compliance to standard organic , but also increase productivity and accountability . With Thus , blockchain is proven can strengthening governance chain supply in a way comprehensive .

Comparison with Study Previous , Implications , and Limitations

Findings from study This strengthen results studies previously stated that blockchain can repair system tracking and improving trust consumer to product agriculture . However , it is different from studies previously many focus on context industry big , research This give view from sector micro , especially perpetrator agriculture organic scale small in Indonesia. Findings This emphasize importance simplification digital interface and training for farmer as step beginning implementation technology . Implications practical from results This is the need for government programs that encourage adoption technology blockchain -based in the sector food through incentives , training , and subsidies infrastructure . On the other hand , agritech startups can play a role as connector between farmer and friendly blockchain system users . Limitations main study This is limitations

coverage area and scale relative sample small , and simulation system that has not been executed in a way full in term time long . Research advanced recommended For develop pilot projects in term intermediate and assess the impact to productivity as well as satisfaction consumers .

4. CONCLUSION

Study This show that blockchain technology has potential big in increase transparency , traceability , and data integrity in the chain supply product agriculture organic . System This allows recording information that is not can manipulated , can accessible to all stakeholders interests , and able strengthen trust consumer to product organic . Actor chain supply , especially cooperatives and agritech startups , showing readiness more tall in adopt technology This compared to farmer individual . Although Thus , the limitations infrastructure and digital literacy are still become obstacle main in implementation of blockchain wide . Therefore that , implementation strategy must involving support training , integration simple system , and collaboration cross sector .

Blockchain also contributes in increase certification audit efficiency organic as well as allows system incentive based compliance quality . Research results This confirm that integration digital technology must customized with context local and level readiness users in the field . Chain model decentralized digital supply capable answer challenges of manual data, duplication , and uncertainty in distribution product . Research This give runway for development policy and system models information blockchain -based in the sector agriculture sustainable . With the right approach , technology This can become the main pillar in build system transparent , fair and accountable food .

REFERENCES

Hapsari, D., Setiawan, F., & Nugroho, T. (2023). Teknologi blockchain dan penerapannya dalam sistem distribusi pertanian organik. Jurnal Teknologi Pertanian, 19(1), 35–48.

Huang, Y., Wang, Q., & Li, X. (2021). Blockchain-based supply chain for agricultural traceability: A framework. Agricultural Informatics Review, 5(2), 77–90.

Kim, H. M., & Laskowski, M. (2021). Toward an ontology-driven blockchain design for supply-chain provenance. Information Systems, 95, 101–124.

Kusuma, A. W., & Lestari, N. (2023). Potensi blockchain untuk memperkuat sistem pangan lokal: Studi kasus pertanian organik. Jurnal Inovasi Teknologi Agro, 12(2), 99–112.

Li, C., Wu, F., & Zhang, M. (2020). Smart contracts and traceability in food supply chains. Sustainability, 12(3), 1549.

Lu, Q., & Xu, X. (2020). Adaptable blockchain-based systems for supply chain transparency. Future Generation Computer Systems, 113, 556–567.

Nurfadillah, R., Wibowo, S., & Yusuf, M. (2023). Literasi digital dan kesiapan petani dalam adopsi teknologi pertanian berbasis blockchain. Jurnal Teknologi dan Pertanian Berkelanjutan, 7(1), 25–36.

Putra, M., & Hidayat, A. (2021). Analisis sistem informasi rantai pasok pertanian di era digital. Jurnal Sistem Informasi Pertanian, 9(3), 212–224.

Rahim, R., & Wijaya, A. (2020). Sistem pelabelan organik dan kepercayaan konsumen: Studi kasus produk lokal. Jurnal Agribisnis Indonesia, 8(2), 77–85.

Sari, L., & Pramono, D. (2022). Integrasi sistem pelacakan digital dalam distribusi produk pertanian organik. Jurnal Pertanian Cerdas, 10(1), 55–68.

Yusuf, M., & Setiawan, A. (2022). Peran teknologi digital dalam penguatan rantai pasok agribisnis nasional. Jurnal Ekonomi dan Teknologi Pertanian, 5(1), 44–58.

Zhang, Y., Cao, Y., & Liu, J. (2023). Blockchain adoption for organic agri-food supply chain: Opportunities and challenges. Journal of Cleaner Production, 385, 135698.

Creswell, J. W., & Poth, C. N. (2018). Qualitative Inquiry and Research Design: Choosing Among Five Approaches (4th ed.). Sage Publications.

Moleong, L. J. (2021). Metodologi Penelitian Kualitatif (Edisi Revisi). Remaja Rosdakarya.

Sugiyono. (2022). Metode Penelitian Kualitatif, Kuantitatif, dan R&D. Alfabeta.