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Enhancing Traceability in Organic Rice Supply Chain with Blockchain Technology Developed by Design Science Research Methodology

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Abstract: The organic rice supply chain in Indonesia, particularly in Banten Province, is characterized by high complexity and the involvement of multiple actors, which creates challenges related to transparency, traceability, and product authenticity. These issues reduce consumer trust and complicate regulatory supervision in organic farming systems. This study aims to design and evaluate a blockchain-based traceability model to enhance transparency, ensure product authenticity, and support food safety compliance in the organic rice supply chain. This research employs the Design Science Research Methodology (DSRM), encompassing problem identification, objective definition, artifact design and development, demonstration, and evaluation. Data were collected through interviews, field observations, and Focus Group Discussions (FGDs) involving organic rice supply chain actors, government regulators, and experts. The proposed model was empirically evaluated using Partial Least Squares-Structural Equation Modeling (PLS-SEM) based on responses from 220 participants. The resulting Organic Rice-Supply Chain Traceability (Organic Rice-SCT) model integrates farmers, farmer cooperatives, business actors, retailers, consumers, and government agencies within a blockchain-based system supported by quick response (QR) code technology. The findings indicate that operational excellence, cultural suitability, environmental conditions, quality assurance, and organizational resources significantly influence blockchain adoption. Conversely, data management, supply chain integration, technology maturity, and knowledge management show no significant effect. The model demonstrates its capability to improve supply chain visibility, reduce information asymmetry, strengthen regulatory oversight, and support compliance with Fresh Plant-Based Food (Pangan Segar Asal Tumbuhan, PSAT) certification. In conclusion, this study provides a validated blockchain-based traceability model that enhances transparency and trust in organic rice supply chains. Practically, the model supports stakeholders and regulators in ensuring food safety and product authenticity, while theoretically contributing to the literature on blockchain adoption in sustainable agricultural systems.

Keywords: Blockchain; Traceability; Organic rice; Agricultural technology; DSRM; PSAT ccertification; PLS-SEM; Supply chain traceability

1. Introduction

Design Science Research (DSR) is a research paradigm that focuses on the formulation and validation of specific facts. This approach emphasizes the development and application of designed artifacts, with the primary objective of enhancing the effectiveness of implementation. It has become one of the essential methodologies widely employed in the fields of engineering and computer science (Tuunanen et al., 2024). Research employing the DSR approach has been conducted by numerous scholars across various domains. For instance, a conceptual architecture for frozen food supply chains was designed to meet international regulatory requirements and enhance trust among stakeholders by providing transparent, auditable, and tamper-resistant data (Uyar et al., 2025). DSR was applied to develop a decentralized construction supply chain system that facilitates real-time updates of material information throughout the supply process and addresses uncertainties associated with construction material inventory management (Basheer et al., 2024).

Organic rice cultivation within the rice-wheat farming system is crucial for global food security, as well as for maintaining environmental sustainability and the economic well-being of farmers (Chanu et al., 2025). Organic cultivation systems are characterized by the strict avoidance of synthetic chemical inputs, the implementation of non-chemical weed management practices, and the utilization of internally generated biomass, which collectively contribute to enhanced environmental sustainability, improved soil fertility, and the long-term economic viability of farming systems (Istiyanti et al., 2024). Agriculture can reduce poverty, promote prosperity, and provide food for 10 billion people by 2050 (World Bank Group, 2025). In Indonesia, for example, the agricultural sector contributed 9.52% to economic growth in 2024 (BPS-Statistics Indonesia, 2024). This indicates that agriculture is one of the main drivers of economic development in Indonesia. As explained below, if the agricultural sector fails, the impact will be enormous. Currently, 815 million people are starving, and three out of every four people are malnourished, thus reflecting an imbalanced food system (FAO, 2019). Therefore, it is important for policymakers, extension services, and development agencies to strengthen economic resilience while maintaining social and ecological sustainability in biofortified rice farming systems (Istiyanti et al., 2024; Triyono et al., 2025).

Rice (*Oryza sativa*) is one of the most important cultivated plants in human history. Rice is believed to be originated in India or Indochina and brought to Indonesia by migrants from the Asian mainland around 1500 BCE (Deng et al., 2020). Agriculture, particularly organic rice systems, plays a crucial role for the country as it is not only related to fulfilling food security needs but also achieving environmental sustainability, farmers' welfare, and food sovereignty (Dayet et al., 2024). Thus, organic rice not only provides benefits for health and environmental sustainability but also serves as an economic pillar for farmers and local communities, while contributing to national food security (Nisak et al., 2025). Organic rice, particularly brown rice, contains higher levels of fibres, vitamins, minerals, and bioactive compounds that play an essential role in maintaining health (dos Santos Caramês et al., 2025). The rice supply chain in Indonesia is complex. Rice distribution inevitably passes through multiple parties, each playing a crucial role (Triyono et al., 2025).

A sudden increase in demand can lead to stockouts, food security issues, a lack of detailed information about the origins of products, a failure to provide transparency and traceability, and control difficulties (Madumidha et al., 2019). Other impacts include distrust, a lack of commitment and transparency, and an absence of information exchange, leading to increased losses (Yousuf & Svetinovic, 2019).

Numerous studies have highlighted the potential benefits of implementing blockchain technology within the rice supply chain. The integration of blockchain enhances transparency, accountability, and operational efficiency across all stages in the supply chain, including production, distribution, and sales (Putro et al., 2022). The application of blockchain technology in the rice supply chain has exerted a significant impact via increased transparency, data accuracy, and distribution efficiency (Odewole et al., 2024; Shobur et al., 2025).

The application of smart contract-based blockchain technology in the rice supply chain has been shown to provide significant benefits, including enhanced transparency, security, efficiency, and accountability (Haque et al., 2023). Furthermore, the implementation of a blockchain-based dynamic monitoring model enables continuous product traceability, prevents fraudulent activities, and fosters greater confidence among consumers and stakeholders (Peng et al., 2022).

The existing gap analysis indicated that there was limited research on organic rice supply chain tracing models using blockchain technology in Indonesia, particularly in the province of Banten. Consequently, it is impossible to trace the origin of organic rice seeds, identify the farmers and farmer groups involved, or determine the businesses and retailers involved.

Blockchain technology is employed in the development of a traceability model for the organic rice supply chain in Banten Province due to its capability to address critical challenges related to transparency, accountability, and data integrity. Considering the complexity of the supply chain that involves multiple stakeholders including farmers, farmer groups, enterprises, retailers, and end consumers, conventional systems often fail to deliver reliable and verifiable information regarding the origin, certification, and distribution of organic rice. Blockchain provides a decentralized and immutable data-recording mechanism that enables comprehensive product traceability, to ensure that all transactions are securely stored and can be verified by authorized parties.

This study aims to use Design Science Research Methodology (DSRM) to develop an organic rice supply chain tracing model in Indonesia, specifically in the province of Banten, by adopting blockchain technology.

The state-of-the-art technology is a supply chain model for organic rice using blockchain technology in the province of Banten. This model highlights several key differences compared to previous studies. These differences are evident in the supply chain participants, processes, platform, smart contract provisions, application functions, and challenges identified through interviews with organic rice supply chain participants and government officials from the Food Security Agency in the Province of Banten. Besides, interviews were conducted with experts in organic rice, supply chain management, and blockchain technology.

From the perspective of supply chain actors, the limitations of this study included the exclusion of organic rice seed suppliers, organic certification bodies, and institutions issuing certificates of good agricultural practices (Sertifikat Penerapan Penanganan Yang Baik, SPPB). Model testing was only conducted in Focus Group Discussion (FGD), yet the developed model has not been implemented in real-world activities.

2. Methodology

2.1 Location of Research

This research was conducted in Indonesia, specifically Banten. Banten is one of the provinces on the island of Java, this area was officially declared a province in 2000 with the decree of Law No. 23 of 2000 (BPS-Statistics of Banten Province, 2012). The area of this province reaches 9,662.92 km^2 and administratively, Banten province is divided into 4 cities and 4 districts (Novriyadi, 2025), as shown in Figure 1.

Figure 1. Administrative map of Banten Province
Source: Novriyadi, 2025

2.2 Design Science Research Methodology (DSRM)

DSRM was selected as it aligned with the objectives of this study, which focused on the development, testing, and refinement of technological solutions with an aim to enhance transparency in the organic rice supply chain. This methodological approach ensured that the research outcomes were academically significant while also providing practical value for stakeholders across the supply chain ecosystem. The following steps were undertaken to implement DSRM systematically.

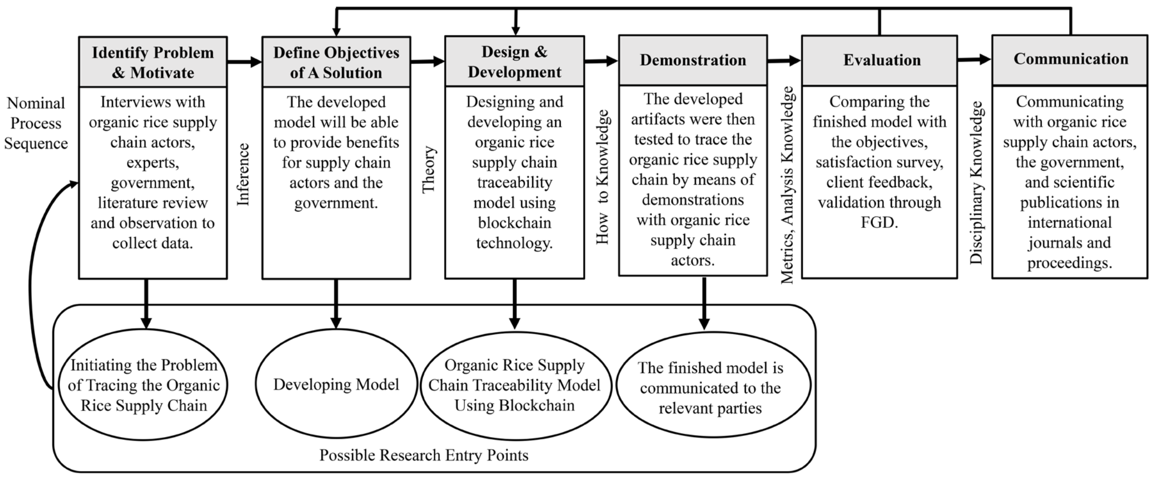

Figure 2. Model of design science research methodology
Source: Modified from Peffers et al. (2007)

The research framework based on DSRM was adopted to develop a blockchain-based traceability model for the organic rice supply chain in Banten Province. According to Peffers et al. (2007), the process involved six stages, i.e., identifying problems, defining objectives, design and development, demonstration, evaluation, and communication to ensure the model is effective, feasible, and aligned with stakeholders' needs.

The Figure 2, illustrates the sequential stages of the DSRM, encompassing problem identification and motivation, objective definition, design and development, demonstration, evaluation, and communication. The process begins with identifying challenges in tracing the organic rice supply chain through interviews, expert consultations, literature review, and field observations. Subsequently, research objectives are defined, followed by the design and development of a blockchain-based traceability model. The demonstration stage validates the artifact through practical testing with organic rice supply chain actors. The evaluation phase assesses the model's effectiveness and alignment with research objectives using feedback, validation, and Focus Group Discussions (FGDs). Finally, the communication stage disseminates the finalized model to stakeholders, policymakers, and the scientific community through formal publications. The framework also highlights potential research entry points and knowledge flows, ensuring methodological rigor and practical relevance.

2.3 Data Collection

2.3.1 Profiles of participants

Researchers conducted interviews and field observations to identify the problems within the organic rice supply chain in Banten Province. The interviews involved 12 supply chain actors, consisting of four farmers, three farmer group associations, two business enterprises, two retailers, and one representative from the Food Security Agency as the government regulator. After identifying the problems, a model for tracing the organic rice supply chain was developed using blockchain technology. This model was subsequently validated through a FGD attended by 19 participants, including 12 actors from the organic rice supply chain (farmers, farmer group associations, business enterprises, retailers, and end consumers), four government representatives acting as regulators, and three experts in this subject area.

2.3.2 Study procedures

This study was conducted over a period of six months, beginning with data collection to determine the research problems, followed by formulation of objectives, design development, demonstration, evaluation, and dissemination. The data collection process was carried out through face-to-face interactions with supply chain actors and government representatives, while the validation stage was implemented using a blended system.

2.4 Data Analysis

Based on the participant profiles and research procedures, the results of data analysis indicated that tracing the organic rice supply chain remained challenging, as the supply chain actors were not yet interconnected through a unified information system. Therefore, a traceability model for the organic rice supply chain was developed using blockchain technology. The results of model validation demonstrated that the proposed model had the potential to enhance traceability, strengthen trust among actors, facilitate government monitoring, and ensure the quality and authenticity of a product's origin.

3. Results and Discussion

3.1 Identify Problems and Motivations

Several problems were identified after the researchers conducted interviews with actors in the organic rice supply chain and the Food Security Agency. The key issues about the organic rice supply chain in Banten Province include ineffective communication, difficulties faced by farmers and farmer groups in marketing and selling products such as organic paddies or rice, and unstable selling prices. From the perspective of end consumers, tracing the origin of organic rice remains to be difficult, thus reducing trust in the safety and authenticity of the products sold. From the perspective of business enterprises, there is a lack of information regarding stock availability in each farmer group association, resulting in the necessity of purchasing rice from other provinces when local supply is insufficient. Given these challenges, this study was deemed indispensable for offering solutions to the stakeholders within the organic rice supply chain in Banten Province.

3.2 Objectives of the Study

Based on the identified problems, the objective of this study is to develop a traceability model for the organic rice supply chain by employing blockchain technology. The proposed model is expected to assist supply chain actors including farmers, farmer group associations, business enterprises, retailers, end consumers, and the Banten Provincial Food Security Agency as the regulatory authority, in achieving greater transparency across the supply chain. Specifically, the model aims to ensure product authenticity and prevent counterfeiting of organic rice, improve the efficiency of auditing for the fresh food of plant origin certification, enhance value addition, and guarantee the safety of organic rice products.

3.3 Design and Development

The design and development process included several steps:

(1) Specifying the artifact to be developed

The artifact developed in this study is a blockchain-based model designed to trace the organic rice supply chain in Banten Province. This model was conceptualized based on insights gathered from interviews with farmers, farmer cooperatives, businesses, retailers, end consumers, supply chain experts, organic rice specialists, blockchain technology experts, and representatives of the Banten Provincial Food Security Agency. The findings indicated that such a model could streamline transactions across multiple stages of the supply chain, including the sale of paddies from farmers to cooperatives, the distribution of rice from cooperatives to businesses, and the delivery of packaged rice from businesses to retailers. Moreover, by enhancing consumer confidence in the authenticity of organic rice, the model has the potential to increase sale volumes, thereby improving the profitability of supply chain actors and contributing to the overall improvement of their livelihoods.

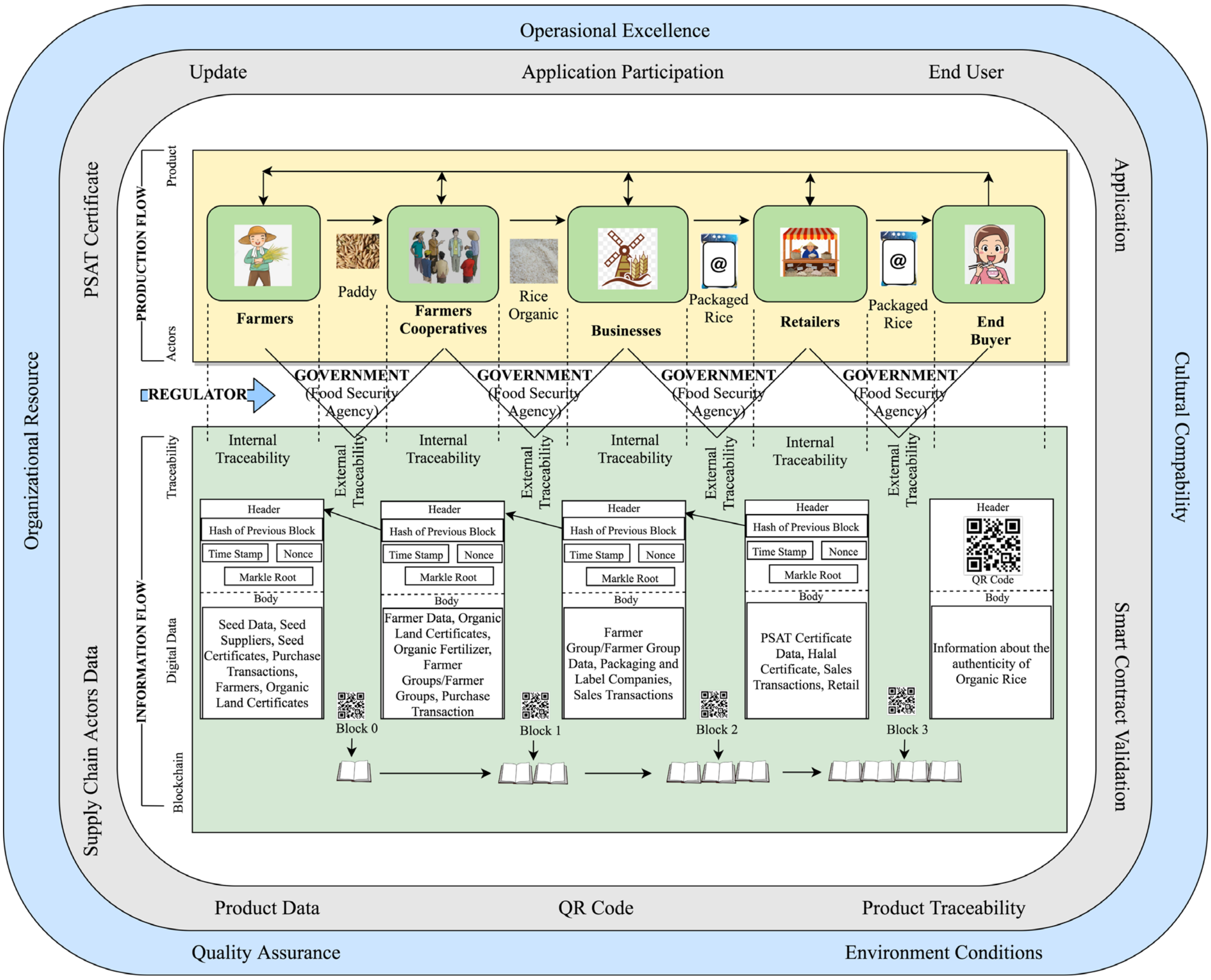

Figure 3. Organic Rice-SCT

(2) Designing the artifact

The initial stage of the development process involved analysing the manual system currently employed to trace the organic rice supply chain in Banten Province. At present, supply chain activities are conducted manually: farmers harvest paddies and sell them to farmer cooperatives; the cooperatives mill the rice and distribute it to businesses; businesses package the rice and sell it to retailers; and finally, retailers deliver the packaged rice to consumers. Building upon this manual system, a blockchain-based model for tracing the organic rice supply chain was conceptualized. The design of this model was informed by interviews with stakeholders across the supply chain including farmers, cooperatives, businesses, retailers, and consumers as well as experts in supply chain management, organic rice production, and blockchain technology. This process resulted in the formulation of the following model.

The model, designated as Organic Rice Supply-Chain Traceability (Organic Rice-SCT), showing in Figure 3, represents an integrated framework for supply chain traceability and quality assurance utilizing blockchain and quick response (QR) code technologies. The framework incorporates the participation of key stakeholders including farmers, cooperatives, mills, businesses, retailers, and end consumers under the supervision of government authorities to ensure compliance with food security and safety standards. At each stage of the supply chain, critical product data such as seed information, processing methods, certifications, and environmental conditions, are systematically recorded and embedded within QR codes to enable rapid verification. By facilitating real-time product authentication and end-to-end traceability, this system promotes transparency, enhances operational efficiency, and strengthens consumer confidence in the authenticity and safety of organic rice products.

3.4 Demonstration

The demonstration stage was designed to validate the extent to which the developed model could effectively address the identified research problem. In the context of the blockchain-based organic rice supply chain traceability model, this stage comprised the following steps:

(1) Scenario Development and Case Study

- Identification of supply chain actors

Following a series of discussions with the Banten Provincial Food Security Agency and stakeholders of the organic rice supply chain, the key actors involved in this study were determined. These actors comprise farmers, farmer cooperatives, business entities, retailers, the Food Security Agency as the regulatory authority, and end consumers, who require transparent access to information regarding the traceability of organic rice.

- Determination of distribution flow, organic certification, and potential data manipulation points

The distribution flow commences with farmers cultivating organic rice paddies, harvesting the grain, and processing it into rice. The harvested rice is then sold by the farmers, with all relevant information systematically recorded in the blockchain-based traceability system. Once the data are uploaded, farmer cooperatives gain access to information regarding the producers and the available quantities of rice. The cooperatives subsequently purchase the organic rice, conduct milling, and package the product in accordance with standardized sizes.

Before selling organic rice to business actors, the cooperatives are required to obtain the Fresh Plant-Based Food (Pangan Segar Asal Tumbuhan, PSAT) certification. In a similar manner, business entities must also apply for PSAT certification before marketing organic rice purchased from the cooperatives. Once certified, business actors distribute the packaged organic rice to retailers, who ultimately sell the products to end buyers.

- Development of a selected case study for demonstration

The case study selected for this research involved the identification of a specific organic rice farmer along with the total harvest volume produced. The farmer cooperatives purchased rice from the farmer and subsequently sold it to a business actor. The business actor then performed repackaging under its proprietary brand and distributed the organic rice to retailers for sale to end buyers. This case study provided the foundation for demonstrating the implementation of blockchain-based traceability in the organic rice supply chain.

(2) Mapping the Model to the Actual Organic Rice Supply Chain Process

The proposed model was mapped to the real-world organic rice supply chain to define its data flow and process interactions among stakeholders. For each actor, the model specified structured inputs and generated relevant output to ensure seamless integration within a blockchain-based traceability framework**.** Farmers provide initial inputs, including actor identity, harvested rice quantities, and sale transactions. Farmer cooperatives are responsible for submitting PSAT certification requests, executing purchases of unhulled rice, and recording subsequent milling and sale activities. Business actors submit applications for PSAT certification, input rice purchases from cooperatives, manage repackaging processes, and register packaged rice for distribution. Retailers likewise apply for PSAT certification, document purchases from business actors, and record final sale transactions to end buyers. The model generates comprehensive output, including detailed information on supply chain participants, provenance of both unhulled and packaged rice, status of stakeholders' certification, and transactional reports covering the complete flow from farmers to retailers. By aligning the model with actual supply chain processes, this framework enables end-to-end traceability, ensures data integrity, and enhances supply chain transparency to support sustainable and reliable organic rice distribution.

(3) Simulation of Product Search Flow

The integration of blockchain technology into the organic rice supply chain ensures traceability, transparency, and data immutability. As illustrated in Figure 4, information from farmers, cooperatives, business actors, retailers, and end buyers is recorded in a decentralized ledger. Each transaction, including cultivation data, compliance with PSAT certification, and distribution records, is stored in cryptographically linked blocks, thereby preventing data manipulation and enabling reliable auditing. Consumers are able to access comprehensive product provenance by scanning a QR code on the packaging. This approach enhances accountability, consumer trust, and efficiency, representing a significant advancement in the digitalization of sustainable agricultural supply chain**.**

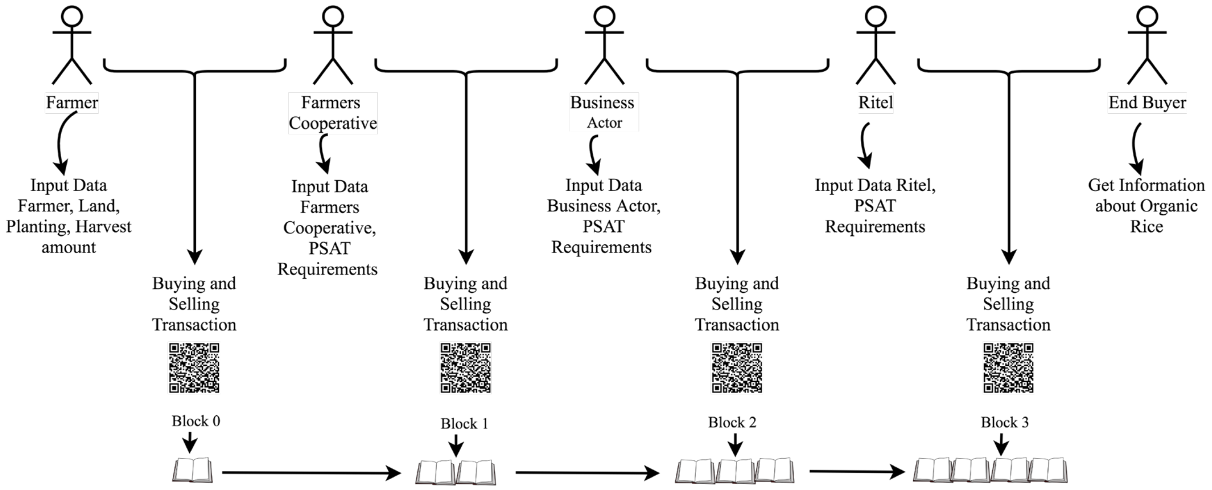

Figure 4. Simulation of the traceability of products

(4) Development of the Initial Model

The initial blockchain-based traceability model has been successfully developed, with a capacity to provide transparent tracking of organic rice provenance across the entire supply chain. By leveraging blockchain technology, the system prevents unauthorized modifications and enhances trust among stakeholders to ensure data security, immutability, and integrity.

To further improve its applicability, the model should be advanced towards the development of a functional prototype for the organic rice supply chain traceability system. This will enable real-time implementation and verification of its performance in practical environments.

The key variables that strengthen the structure and functionality of the model are systematically identified through a systematic literature review and subsequently validated to ensure methodological rigor.

3.5 Evaluation

The phase following the demonstration stage in the DSRM is the evaluation stage. The primary objective of this phase is to assess the effectiveness, feasibility, and relevance of the developed research artifact; in this case, the blockchain-based traceability model for the organic rice supply chain. If the evaluation method is conducted through FGD, the steps will be as follows.

3.5.1 Validation with FGD

FGD was conducted in a blended manner, with some participants coming to the food security agency in person and others joining online. The FGD, conducted on June 5, 2025, involved a total of 19 participants representing diverse perspectives in the organic rice supply chain. Specifically, 12 participants were drawn from supply chain actors, including farmers, farmer cooperatives, businesses, retailers, and buyers; four participants representing the Banten Provincial Food Security Agency; one participant was an expert in supply chain; one was an expert in organic rice; and one was an expert in blockchain technology.

The FGD generated substantive insights and constructive feedback aimed at refining the proposed blockchain-based traceability model. The discussions were instrumental in ensuring that the model aligned not only with the regulatory requirements of the Food Security Agency but also with the practical needs of stakeholders across the organic rice supply chain. The session derived the following key inputs and conclusions:

(a) Traceability is important for organic rice in order to ensure the authenticity of organic products, enhance transparency and consumer confidence, comply with regulatory standards, and provide assurance to end buyers.
(b) Food safety is a necessary measure to prevent possible biological, chemical, or other contamination, and all parties involved in the organic rice supply chain, including the government, must ensure the implementation of this requirement.
(c) The supervision policy of Food Security Agency requires that all packaged or branded organic rice products in circulation in the province of Banten must be supervised and have a distribution permit.
(d) Regional Food Safety Competent Authority of Banten Province is responsible for ensuring food safety and

quality for PSAT. Food safety must be ensured in accordance with Law No. 18 of 2012 (Republic of Indonesia, 2012) and Law No. 23 of 2014 (Republic of Indonesia, 2014).

(e) Organic rice in Banten Province meets the highest standard in Southeast Asia; however, due to high demand, counterfeiting may occur. It is challenging to distinguish between organic and non-organic rice because they taste the same.

(f) A certification mark is required to verify authenticity and provide assurance that the rice is genuinely organic.

(g) PSAT certification is crucial as a formal and legal proof that the rice meets the established food safety and quality standards stipulated by the government.

(h) Retailers are added to the traditional market supply chain. Applications on Layer 4 are removed and education is added. The data that must be entered is adjusted to meet the requirements of PSAT certificate.

(i) With the launched model, extensive information on the organic rice supply chain could be provided in Banten province. Additionally, the model could serve as a guideline or reference for the Food Security Agency to update information on organic rice.

(j) The developed technology is expected to serve as a foundation for providing services to various stakeholders. For this to be effective, the technology must be developed in collaboration with the government, which has the necessary tools for organic rice.

(k) The application should be designed for various users, particularly farmers, according to their specific needs.

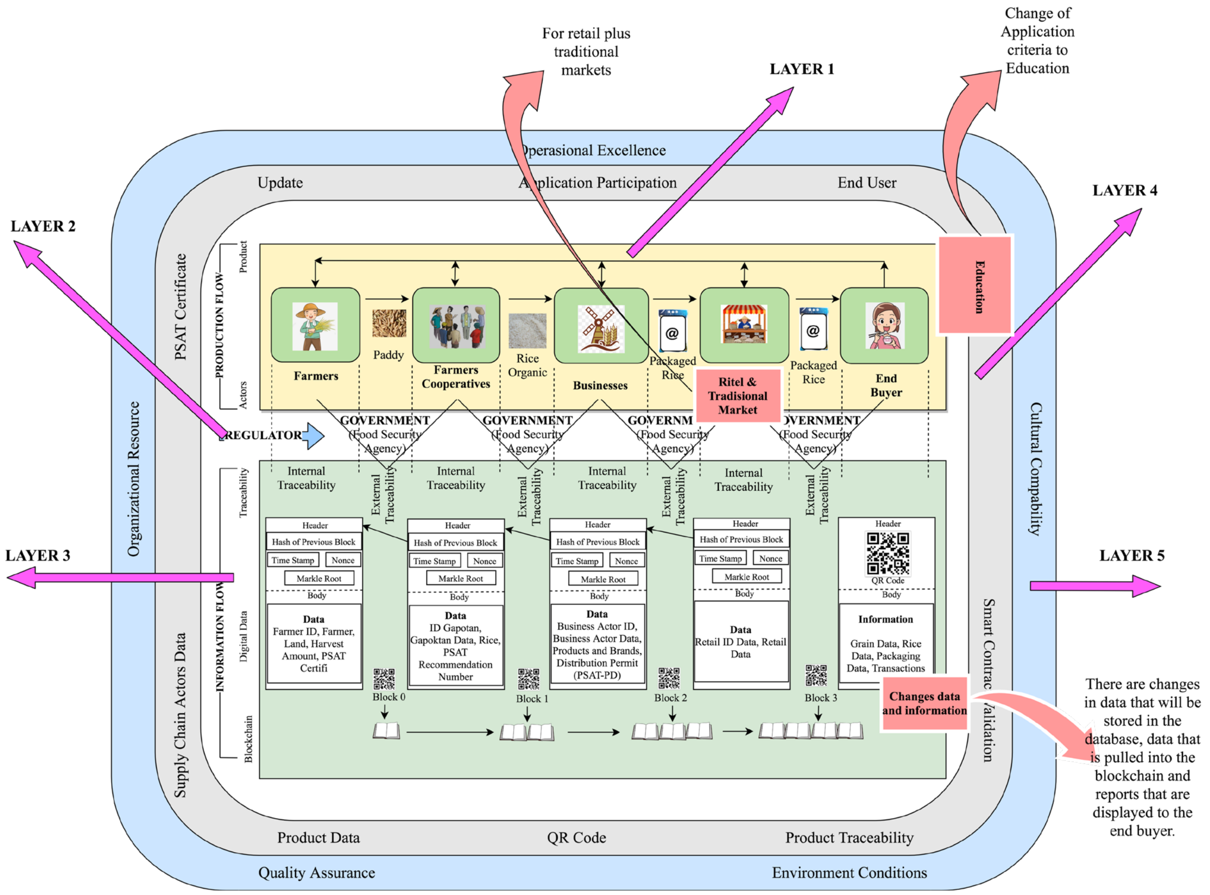

Figure 5. Improvement of Organic Rice-SCT

During the FGD, three components were identified that needed adjustment to meet the needs of supply chain actors and the Food Security Agency, which serves as the regulatory authority. The first improvement is in Layer 1, where the label “Retail” should be revised to “Retail and Traditional Markets”. The second adjustment involves Layer 3, where discrepancies were found between the input data and the information displayed to end buyers. The food safety assurance system was implemented through food safety management based on the Hazard Analysis and Critical Control Points (HACCP) system. It required a traceability system, as stipulated in Regulation No. 553/Permentan/KR. 040/12/2018, page 84. This included information on the type of commodity, quantity, origin, destination, condition, and time. The third adjustment concerns Layer 5, which initially contained nine variables. Subsequent analysis using Partial Least Squares-Structural Equation Modelling (PLS-SEM) to conduct on data collected from 220 respondents. A revised questionnaire comprising ten variables and 36 indicators was distributed via Google forms during the period from March 13 to May 13, 2025. The model represents these inputs as illustrated in Figure 5.

3.5.2 Final design

The finalized design, presented Figure 6, was validated through a series of FGD and subsequently tested PLS-SEM.

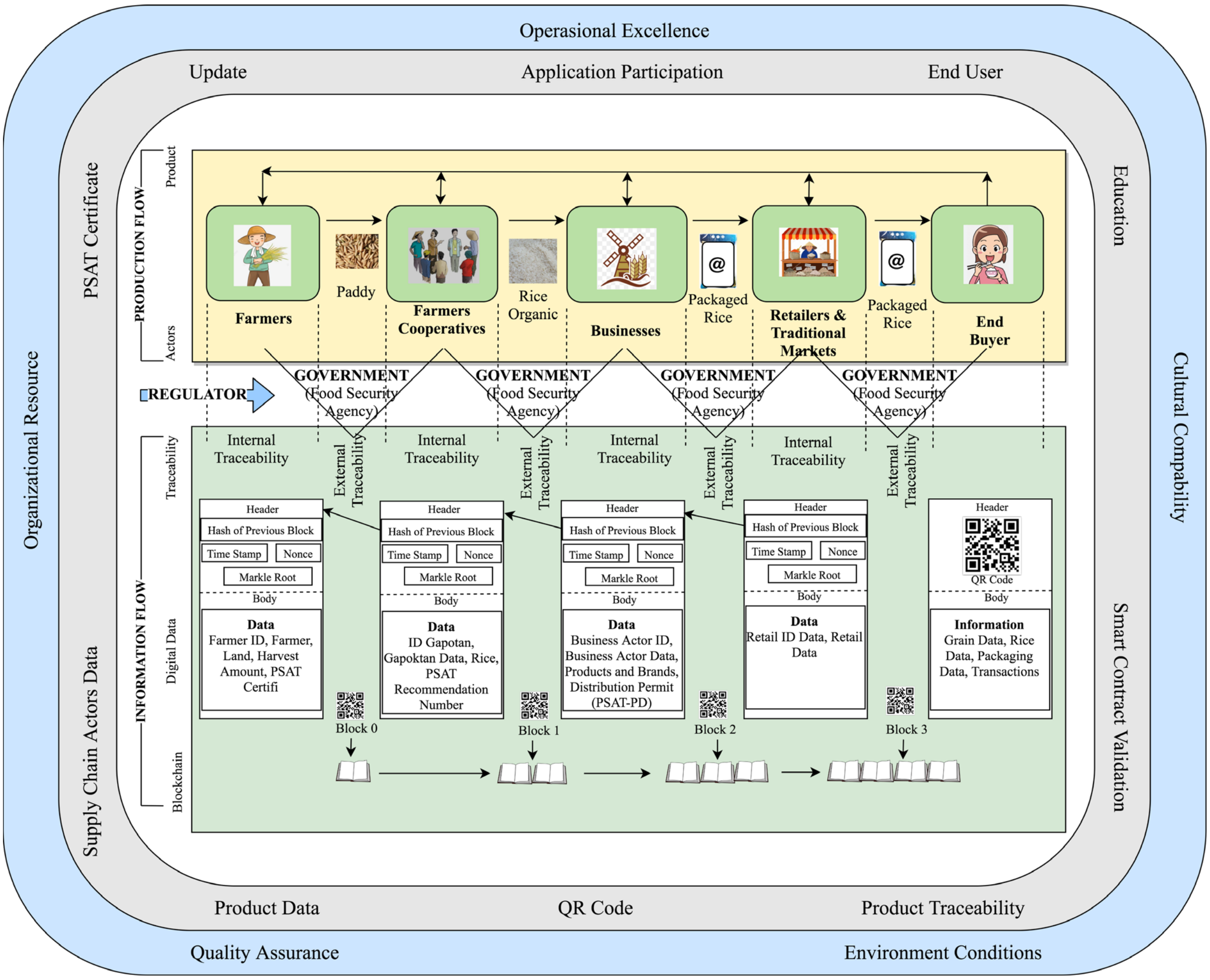

Figure 6. Model of Organic Rice-SCT

The organic rice supply chain traceability system is designed to ensure the traceability, transparency, and security of product data from the time grain harvested by farmers until it is purchased by the end buyer. The system involves the integration of government, businesses, and supporting technologies, such as blockchain and QR codes. The process begins when farmers harvest organic grain. The grain is then sold to famer coopertives. The buying and selling process occurs after the grain passes validation by the Banten provincial food security office. Farmer cooperatives then process the grain into rice; they carry out the milling process so that they can later sell rice to business actors.

Every actor in this supply chain is supervised and guided by government agencies, particularly the Food Security Office, which is authorized to certify PSAT products. The government plays an important role in external validation for every transaction. Validation is carried out for quality verification and certification audits to ensure that products are produced according to the organic standards. At each stage, the collection of data involves product identity, processing date, PSAT certificate number, production location, processing method, and distribution. This information is documented, digitally processed, encrypted, and stored using blockchain technology to ensure data integrity and security. To enable traceability by consumers, the product information is converted into a QR code that can be scanned via mobile devices. By scanning the QR code, consumers can view the complete journey of a product from the farm to the retail storefront or traditional market.

The system enhances quality assurance and operational excellence while supporting efficiency, external conditions, operational efficiency, cultural fit, and organizational resources. Blockchain technology ensures recorded data is immutable, and PSAT products certification assures product authenticity and quality. Overall, the architecture is capable of updating data, facilitating application, supporting end users, providing educational resources, validating smart contracts, enabling product traceability via QR codes, and managing product data.

3.5.3 User interface

From the model of Organic Rice-SCT presented in Figure 6, a corresponding user interface was subsequently developed and is illustrated in Figure 7. The interface is designed to be utilized by supply chain actors, including farmers, farmer cooperatives, business entities, retailers, and the Food Security Agency.

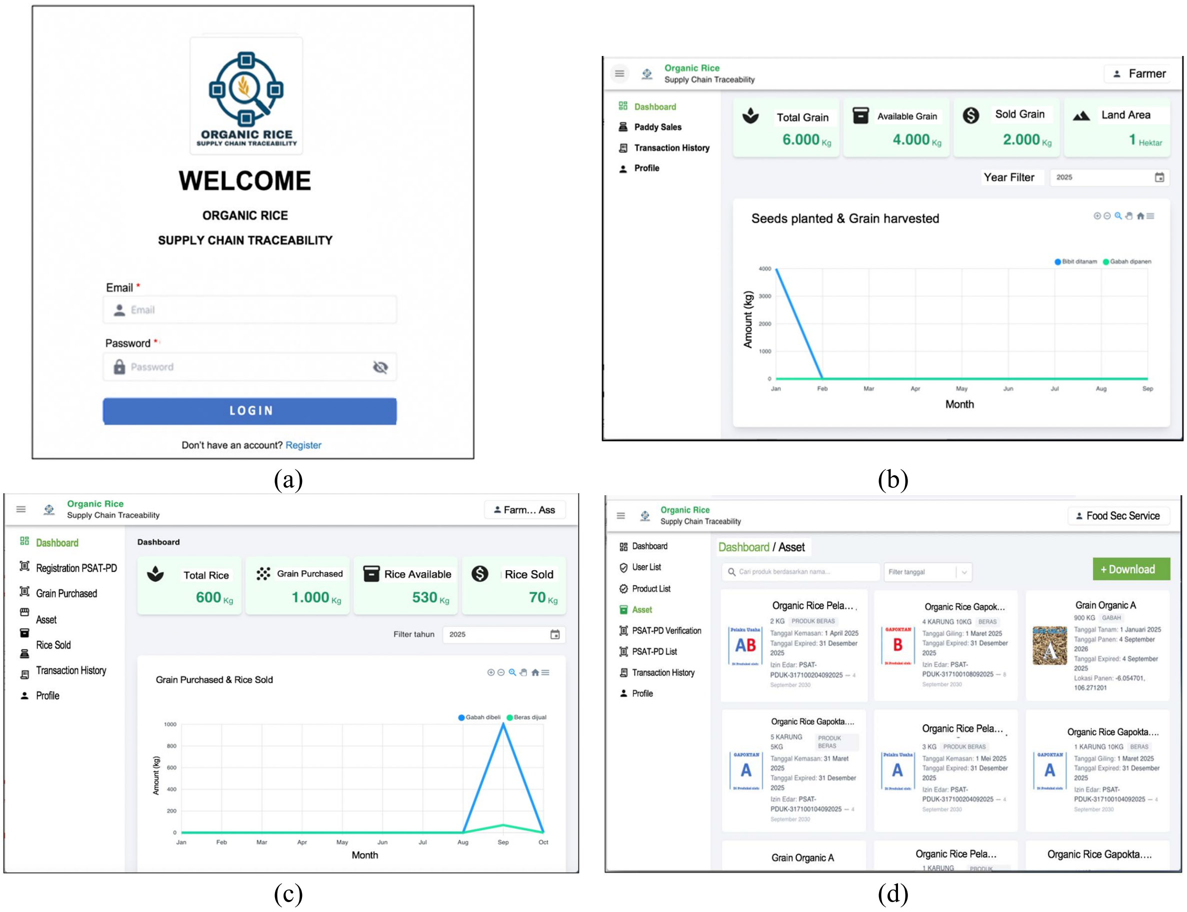

Figure 7. User interface: (a) Login page; (b) Farmer dashboard; (c) Dashboard for farmer cooperatives, business actors, and retailers; (d) Dashboard for Food Security Agency

Figure 7a shows the login page, which serves as the entry point to the application for all users, each of whom is assigned a unique account with distinct input forms and information access. Figure 7b presents the farmer dashboard, which displays the total harvested paddies, available stock, quantities sold, and cultivated land area. In addition, the dashboard features a graphical representation of the number of seeds planted and provides detailed information about the harvested paddies.

Figure 7c presents the dashboard interface for farmer cooperatives, business entities, and retailers. These three actors share similar functions in purchasing and selling rice, and therefore utilizing a common dashboard layout while maintaining distinct tables for their respective transactions. Figure 7d depicts the dashboard interface for the Food Security Agency as the regulatory authority. The interface of the regulator provides access to user lists, products, assets, verification of PSAT certification, PSAT records, transaction history, and profiles. Detailed information on the quantities of rice and paddies owned by various supply chain actors is available in the product dashboard.

3.6 Communication

The communication stage in DSRM represents a critical phase dedicated to disseminating the developed artifacts and research findings to relevant audiences, including academics, practitioners, policymakers, and other stakeholders. Since this study focused on the development of a blockchain-based traceability model for the organic rice supply chain, several structured activities were undertaken to ensure effective knowledge transfer and practical applicability.

First, a comprehensive research report was prepared to document the entire design process, methodological approach, and validation results in detail, thus providing a step-by-step reference for future studies. Second, a scientific article was written for submission to an internationally indexed journal, with an aim to contribute to the body of knowledge on blockchain-enabled traceability systems and the advancement in sustainable agricultural supply chain management. Finally, the research findings were disseminated to key stakeholders including government agencies, supply chain actors, and industry practitioners through structured presentations and targeted discussions, in order to ensure that the proposed model is both scientifically rigorous and practically relevant.

4. Conclusions

This research successfully designed a blockchain technology-based traceability model for the organic rice supply chain in Banten Province via adopting DSRM. The Organic Rice-SCT model was developed to address the deficiencies in transparency, traceability, and consumer confidence in the authenticity of organic rice products. The integration of supply chain actors and regulators performed by the system, in conjunction with the utilization of blockchain features such as smart contracts and QR codes, ensured data authenticity, transaction efficiency, and end-to-end quality validation. The PLS-SEM analysis indicated that operational excellence, cultural fit, environmental conditions, quality assurance, and organizational resources were significant factors in driving blockchain adoption in the supply chain system. The validity of the model was strengthened through the FGD with relevant stakeholders. In practice, this model could support the implementation of a reliable logistics information system, while in theory, it contributed to the existing body of literature on blockchain integration in sustainable agricultural systems. The results obtained from the FGD showed that the model had been built in accordance with the expectations of the supply chain actors, including farmers, farmer groups, business actors, retailers, end buyers, and Food Security Agency as a regulator.

This research had a significant contribution to all actors involved in the organic rice supply chain. For farmers and farmer cooperatives, the blockchain-based traceability model enhanced market access by providing transparent digital documentation, facilitated PSAT certification process, and increased consumer confidence in product authenticity. This dynamic, in turn, contributed to the enhancement in the selling value and welfare of farmers. For businesses and packagers, the system provided an integrated and real-time record of the production process, to facilitate the validation of quality and management of upstream supply. The immutable nature of blockchain-stored information enabled businesses to mitigate the risk of data errors and enhance operational efficiency.

Subsequent research should be directed towards the development of an information system for tracing the organic rice supply chain using blockchain technology. Furthermore, it is imperative to utilize an appropriate validation method to ensure the integrity of its application.

The organic rice supply chain was characterized by a comprehensive and transparent network comprising farmers, business actors, retailers, end buyers, and the government as a regulatory entity. This structured system enabled efficient traceability, thereby mitigating the risk of data manipulation or loss. This will not only bolster consumer confidence in the authenticity of organic products, but also promote operational efficiency. Theoretically, this research contributed to the extant literature on the integration of blockchain technology in agricultural systems, particularly in the context of organic rice. The traceability model developed using DSRM illustrates how the concept of traceability in the organic rice supply chain can be applied. Furthermore, a blockchain-based application needs to be developed.

Author Contributions

Conceptualization, R.T., H.L.H.S.W., and M.M.; methodology, H.S. and T.O.; software, R.T. and T.O.; validation, R.T., H.S., and H.L.H.S.W.; formal analysis, H.S.; investigation, R.T.; resources, R.T.; data curation, T.O., and M.M.; writing—original draft preparation, R.T. and H.S.; writing—review and editing, R.T., H.L.H.S.W., H.S., T.O., and M.M.; visualization, R.T.; supervision, H.L.H.S.W. and H.S.; funding acquisition, R.T. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

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Conflicts of Interest

The authors declare no conflicts of interest.

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