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Prototype design of an integrated information system for production process and financial recording of agro-industrial MSMEs with the support of blockchain technology

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ABSTRACT

Agroindustrial SMEs have a strategic contribution within the value chain; however, they continue to face challenges such as manual financial recording, limited integration of production data, and low transparency and accountability of information. This study aims to design and develop a prototype of an integrated information system for production processes and financial recording in agroindustrial SMEs, leveraging blockchain technology to strengthen data integrity and auditability. The research employed a user-oriented system engineering approach through several stages: needs identification, system and interface design, prototype development, internal testing, and evaluation. The results show that the developed prototype can integrate production and financial recording, automate financial reporting, and provide audit trails via timestamps and transaction hashes, serving as a limited implementation of blockchain principles. The prototype has the potential to reduce manual recording errors, accelerate information processing, and improve data transparency and accountability. However, the blockchain implementation remains limited to the audit trail mechanism, while broader field testing and integration into a distributed blockchain network are still required for further implementation.

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INTRODUCTION

Agro-industrial Micro, Small, and Medium Enterprises (MSMEs) constitute an important sector of the national economy, as they contribute to increasing the value added of agricultural products, creating employment, and strengthening local supply chains. However, most agro-industrial MSMEs still face various obstacles in managing their production processes and financial records, which are typically carried out manually and remain unintegrated. Separate recording between the production and finance divisions often leads to data inconsistencies, reporting delays, and difficulties in comprehensively evaluating business performance. These problems result in low operational efficiency and limit MSMEs' ability to make accurate, data-driven decisions. Amid increasingly intense global competition, the digitalization of business processes has become an urgent necessity to enhance the competitiveness and sustainability of agro-industrial MSMEs (Amoako et al. 2022).

One approach to address these problems is to develop an integrated information system. Such a system connects data from various business activities, from the production process to financial recording, thereby generating information that is consistent, transparent, and easily accessible. An integrated information system can connect production and financial data, enabling SMEs to obtain more timely and relevant information for cost control and managerial decision-making. Accounting information systems have also been examined in relation to SME financial performance in Indonesia (Lopung and Rulindo 2023). This cross-process integration not only accelerates information flow but also helps entrepreneurs control costs, optimize resources, and increase productivity. Nevertheless, efforts to implement information systems in MSMEs are often hindered by limited technological capacity and human resources (Muljono et al. 2021). Therefore, a system development approach that is simple, measurable, and tailored to users' actual needs in the field is required (Casino et al. 2021).

Various studies have examined the development of information systems in the MSME sector. Asmawati et al. (2017) designed a production information system for small-scale food producers that records customer orders, checks production capacity, and displays production schedules and raw material stock. Blockchain adoption in food supply chains offers opportunities to improve information transparency and traceability, although successful implementation depends on addressing technological and organizational challenges (Tönnissen and Teuteberg 2023). Susanto and Meiryani (2019) demonstrated that adopting cloud-based accounting systems can improve the accuracy and speed of MSME financial recordkeeping. Meanwhile, *blockchain* technology has been increasingly applied in accounting and supply chain management due to its ability to ensure security, transparency, and tamper-resistant audit trails. Dai and Vasarhelyi (2017) stated that *blockchain* could serve as a new foundation for more trustworthy accounting and assurance systems. Kamilaris et al. (2019) demonstrated that *blockchain* can improve *traceability* in global food supply chains. A study by Meidayanti et al. (2019), entitled "Analysis and Design of Beef Supply Chain Traceability System Based on Blockchain Technology," similarly demonstrated that *blockchain* can enhance data transparency and accountability in the beef supply chain by implementing *traceability* mechanisms. Blockchain technology has been applied to agri-food supply chain traceability systems to improve the transparency, integrity, and verifiability of transaction records. Marchese and Tomarchio (2022) developed a prototype based on Hyperledger Fabric to manage product traceability information across the agri-food supply chain. However, most of these studies remain focused on specific aspects, such as supply chains or financial transactions alone, and have not yet integrated production and financial functions simultaneously within the *context* of agro-industrial MSMEs.

Based on this review, a significant research gap emerges: the absence of an integrated information system design that applies *blockchain* principles to connect production and financial data at the scale of agro-industrial MSMEs. Existing systems are generally partial in nature and have not been able to guarantee data integrity across business processes. This represents a major challenge, as the dynamic production processes and high transaction volumes typical of MSMEs require an efficient, accurate, and easy-to-use system. By applying *blockchain* principles, the information system is expected to provide an immutable *audit trail*, thereby enhancing trust and transparency among *stakeholders*.

The main research question addressed in this study is how to design a prototype of an integrated information system for production processes and financial recording, based on *blockchain* principles, that can improve operational efficiency and data integrity in agro-industrial MSMEs. The core problem lies in how to connect cross-functional data within a single *platform* that is secure, verifiable, and easy for MSME actors to operate. This study hypothesizes that implementing a blockchain-based integrated information system can reduce manual recording errors, accelerate reporting, and strengthen financial accountability for MSMEs. The objective of this article is to describe the process of designing and developing a prototype integrated information system based on blockchain principles that combines production processes and financial recording, and to evaluate its potential to improve efficiency, transparency, and accountability in agro-industrial MSMEs.

METHODS

This study adopted a user-centered information system development approach tailored to the needs of agro-industrial MSMEs. The method employed follows the stages of appropriate-technology engineering, with the primary objective of producing a prototype information system that integrates the production process and financial recording using blockchain principles. This method was carried out in five main stages, as shown in Figure 1. The research was conducted at two locations: the computer laboratory of the Agribusiness Study Program at Poliwangi and the sites of the MSMEs involved in the study. The subjects of this research were three MSMEs engaged in agricultural product processing, with active production processes and manual financial recording. The three MSMEs involved in this study are souvenir centers specializing in dried/crispy snack products.

Needs Identification and Field Study

In the initial stage, the research focused on gathering in-depth information on the needs of agro-industrial MSMEs regarding the management of production processes and financial recording. The main activities included observations and interviews, aimed at directly observing the MSMEs' operations to understand the production and financial management patterns in use. These activities involved MSME owners, operational staff, and other supporting personnel to identify the main problems. In addition to the MSMEs, interviews were also conducted with the Cooperative Office. The output of this stage was a System Requirement Specification (SRS) document based on input gathered from the field.

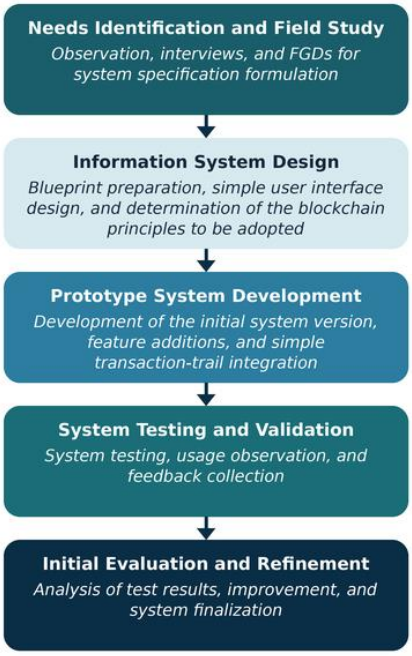


Figure 1 Research stages

System Design

At this stage, the research focused on designing the information system architecture, including the production and financial process flows, a simple user interface, and the *blockchain* principles to be adopted. The output of this stage was a *blueprint* document, a simple interface design, and the determination of the *blockchain* principles applied. The system was designed to be appropriate, simple, and usable by MSME actors without a technological background.

Prototype System Development

At this stage, the information system prototype began to be developed based on the prepared design. This activity included implementing automatic timestamps, generating unique transaction codes, storing data change history, preparing simple audit logic, creating simple automated processes, and performing internal testing and minor bug fixes as needed. The output of this stage was a system capable of recording every transaction with time evidence and a unique ID, consistent with the fulfillment of the *blockchain* audit trail principle.

Testing and System Validation

Testing and system validation were carried out by evaluating system performance through: (1) *usability testing*, which involved inviting users (partner MSMEs) to operate the system in a simulated real-world condition after receiving brief training on system use; (2) a *pre-post test*, which compared performance indicators (recording time and data accuracy) before and after system implementation; and (3) a user satisfaction analysis, using a questionnaire to evaluate ease of use, benefits, and potential operational savings. Validation was carried out in collaboration with information systems and accounting experts to ensure the system's compliance with production practices and financial recording standards (Queiroz et al. 2021). The output of this stage was system performance evaluation data and input for further improvement.

The efficiency indicators used in this study were recording time per transaction, input errors per 10 transactions, time required to prepare financial statements, and the number of automatic financial reports the system could generate. The efficiency formula used is given in Equation (1).

$$Efficiency\ (\%) = \frac{Pre\ test\ Value\text{-}Post\ test\ Value}{Pre\ test\ Value} \times 100 \quad (1)$$

RESULTS AND DISCUSSION

System Requirements Identification

Requirements identification is an important initial stage in developing the information system prototype. This stage aims to understand the real problems users face and determine the features the system needs to provide maximum benefit. In this study, system requirements were obtained from two main sources: the Banyuwangi Regency Cooperative Office and several agro-industrial MSMEs engaged in food processing. The results of interviews with the Cooperative Office indicate that several important factors must be present in an integrated information system for agro-industrial MSMEs, including: (1) transparency of MSME financial reports to facilitate the monitoring of assisted MSMEs; (2) the ability to automate the calculation of the cost of goods manufactured, the preparation of financial statements, and profit analysis to minimize manual recording errors; (3) a financial reporting format that complies with banking standards to facilitate the loan application process; (4) a multi-user system with different access rights for MSMEs and supervising parties such as the Cooperative Office; (5) a *real-time* dashboard for directly monitoring business conditions; and (6) a *blockchain* audit feature to maintain data security and integrity through an immutable *audit trail*.

Based on interviews with the Cooperative Office, the need to integrate production and financial data was also considered important for supporting regional MSME monitoring and mentoring programs. MSME actors expressed a preference for a simple interface that could be operated without *complex* technical knowledge. This is consistent with Amara et al. (2024), who found that perceived ease of use is among the factors influencing the intention of Indonesian MSMEs to adopt digital bookkeeping.

The second source of requirements came from direct interviews with agro-industrial MSMEs as the system's primary users. The interview results revealed that MSME actors wanted a system that: (1) is easy to use without requiring an IT background; (2) integrates production and financial records to avoid duplicate data entry; (3) can record expenses and income simply yet accurately; (4) automatically calculates the cost of goods manufactured; (5) automatically generates profit-and-loss and cash flow statements; and (6) presents a business summary in an easily understandable dashboard. In addition to the interviews, the researchers conducted direct observations of the production workflow and financial recording practices at the MSMEs. The findings from these observations include the following:

1. Recording is still done manually (notebooks, phone notes, WhatsApp).
2. There is no direct link between production data and financial data.
3. The cost of goods manufactured is calculated only by estimation.
4. Inventory is not clearly recorded.
5. Financial statements are prepared only when needed, or not prepared at all.
6. Data is difficult to trace back in the event of an error.
7. Business decisions are not data-driven.

The development of this integrated information system prototype is grounded in the real conditions of agro-industrial MSMEs, which

still record their production and financial processes manually and separately. This condition results in unstructured data, making analysis difficult and hindering the preparation of accurate financial statements. As shown in Figure 2, the system was designed to meet the needs of its main *stakeholders*, namely MSMEs as direct users and the Cooperative Office as the supervising party. The main objectives of the system include transparency, systematic recording of production processes, digital financial recording, and data security. The system's outputs consist of an application prototype, financial and business feasibility reports, and an MSME status monitoring list. These outputs indicate that the system functions not only for recording purposes but also as an analytical and decision-making tool for both MSMEs and supervising institutions. Thus, the designed input–process–output model addresses the main problems faced by MSMEs and provides an important foundation for the sustainable digitalization of their businesses.

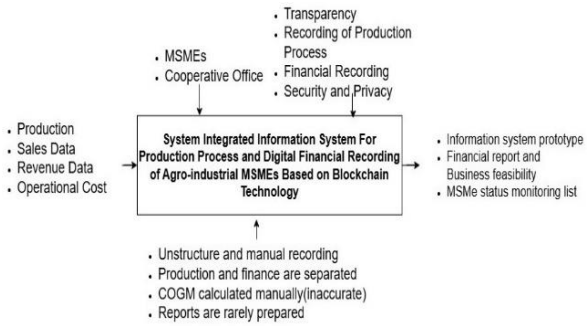


Figure 2 Input–output diagram

One important diagram used to illustrate the system's requirements is the *use case* diagram, which visually depicts the context of interactions between actors and the system. Each *use case* specifies the behavior (functionality) of the system being described that the actor requires to achieve a particular goal. A *use case* diagram illustrates the relationship between actors and the system and describes the interactions between one or more actors and the system to be built. The *use case* diagram in this study consists of two parts: the MSME *use case* and the Cooperative Office *use case*. The first part, the MSME *use case*, is shown in Figure 3.

Figure 3 shows the full scope of MSME activities within the system, including data input, data management, automated report generation, government reporting, and blockchain-enabled transparency. The MSME actor serves as the system's primary user, responsible for entering all operational business data. In addition to the MSME *use case*, this stage also formulated the *use case* for the Cooperative Office. The Cooperative Office actor acts as the supervisor, mentor, and evaluator of MSME accountability. The Cooperative Office begins interacting with the system via the "Receive Report" use case, in which MSMEs submit reports digitally. After receiving a report, the Cooperative Office can directly "View MSME Financial Report" through the system interface to monitor the business's financial condition. However, the Cooperative Office does not merely view the report; it also verifies the report's authenticity through "Verification via Blockchain Audit." At this stage, the system displays the transaction hash and *timestamp* data stored on the *blockchain* to verify that the report has not been tampered with. If necessary, the Cooperative Office can perform "Transaction/History Tracking" in detail to examine data changes and the flow of financial transactions over time, including who entered the data and when.

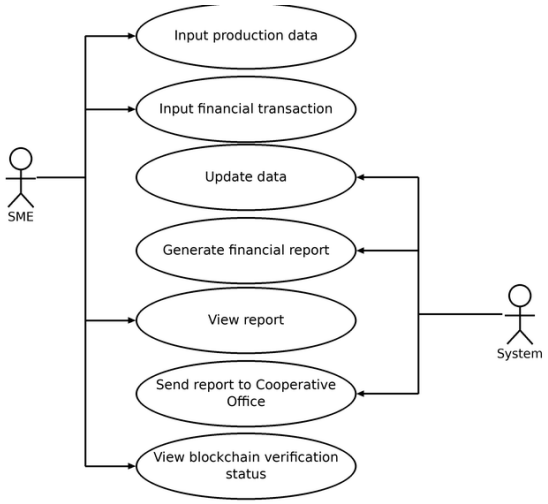


Figure 3 Use case diagram of the MSMEs

Based on the verification and tracking results, the Cooperative Office then performs the "Provide Evaluation" *use case* for the MSME, which may take the form of corrections, improvement suggestions, or recommendations regarding financial and production management. The Cooperative Office subsequently uses this information to "Make Mentoring or Financing Decisions." Such decisions may include providing capital support, training programs, certification, or market access assistance. Throughout this process, the system automatically displays financial

reports, blockchain hash information, and transaction history to ensure transparency and accountability. This ensures that the decisions made by the Cooperative Office are based on valid, unmanipulated, and accountable data. The Cooperative Office *use case* is shown in Figure 4.

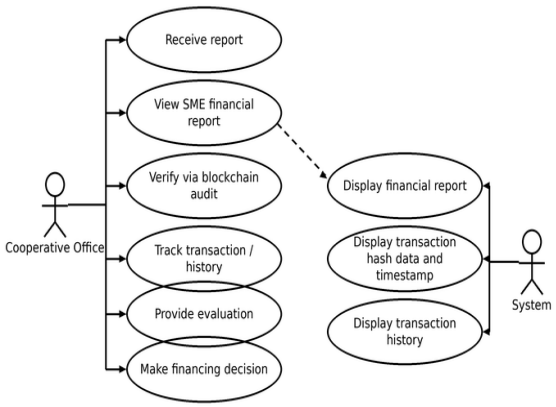


Figure 4 Use case diagram of the Cooperative Office

System Architecture Design

The system architecture illustrates how the workflow of the integrated production and digital financial recording information system, based on *blockchain* principles, was designed to support transparency, accountability, and operational efficiency in agro-industrial MSMEs. The system connects three main components: MSME actors as the primary users, the Cooperative Office as the mentoring/supervisory party, and the *backend* infrastructure, consisting of a database and *blockchain*, which stores data and serves as evidence of accountability. On the *frontend*, MSMEs input production and financial data directly into the web-based system (step 1). Once the data has been recorded, the system generates a financial report that can be viewed by the MSME (step 3). This financial report is then forwarded to the Cooperative Office (step 4) for use in monitoring business feasibility, administrative compliance, and financing potential. The system architecture is shown in Figure 5.

The recording process does not end with the display of the report; rather, all transaction data entered by the MSME is forwarded by the web system (step 6) and subsequently stored in the database. The database serves as the primary storage for all operational data, including production records, costs, revenue, inventory, and financial statements. However, to prevent data manipulation, the system also employs *blockchain* technology. Selected critical data (for example, the hash of a transaction or report) is sent from the web system to the *blockchain* (step 7), where it is stored permanently, rendered immutable, and time-stamped, thereby serving as authentic transaction evidence and creating an *immutable ledger*. The *blockchain* then stores this record of transaction evidence and forwards it to the *blockchain* audit component as a reference for data integrity (step 8).

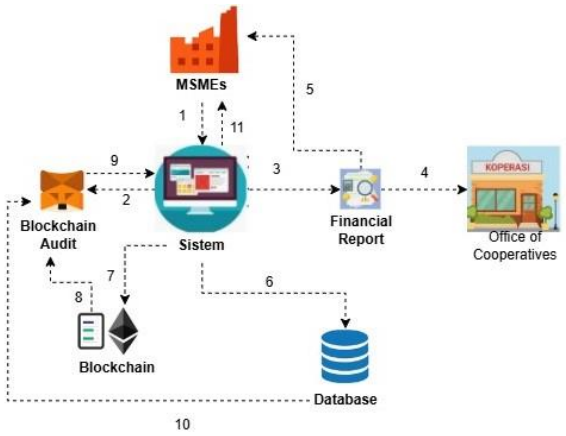


Figure 5 System architecture

The Blockchain Audit component functions as a verification interface, comparing the data stored in the database with the hash recorded on the *blockchain* (flows 2 and 9). If the data matches, the report's authenticity is confirmed; if not, the system can detect an indication of data alteration. This audit process fosters transparency and trust, not only for MSMEs and the Cooperative Office but also for other parties, including auditors, investors, and financing institutions. The system was designed to provide a *timestamp*- and hash-based *audit trail*, applying *blockchain* principles to maintain data integrity (Ølnes et al. 2017).

Prototype System Development

The system's financial report display demonstrates how the developed prototype can automatically generate a neat, professionally formatted profit-and-loss statement. This allows MSMEs to formally distribute the report to the Cooperative Office, auditors, financing institutions, or internal archives without manual typing. In other words, the system not only records data but also provides administrative outputs that are ready for formal use. The financial report display is shown in Figure 6.

Structurally, the report follows a standard accounting format, beginning with total revenue, then the cost of goods sold (raw materials, direct

labor, and production overhead), and ending with gross profit. The system then presents operating expenses (such as electricity, transportation, packaging, and other costs) to arrive at net profit. Each component is accompanied by a nominal value and a percentage of total revenue, allowing users to clearly see the proportion of costs. For example, raw materials account for 40% of revenue, while net profit reaches 28%. This presentation makes it easier for MSMEs to interpret their financial condition analytically rather than merely numerically, thereby facilitating the evaluation of production efficiency and profitability. A key advantage of this system is the automatic analysis feature at the bottom of the report. The system directly calculates the monthly *Return on Investment* (ROI). It provides an interpretation (for example, "28% – Very Good"), enabling MSME actors without an accounting background to still understand the health of their business. The *blockchain* audit display is shown in Figure 7.

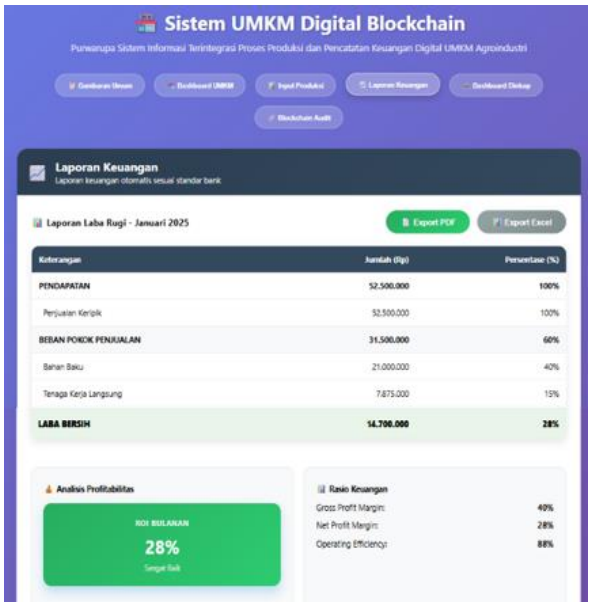


Figure 6 Financial report display

As shown in Figure 7, the system implements the principles of transparency and accountability through the *real-time* integration of activity logging and *blockchain* verification. At the top, the system displays a Recent Activity Log that lists activities performed by users, such as production entries, financial transactions, raw material purchases, and selling price updates. Each activity is recorded together with a description, a *timestamp*, and a unique hash code. The presence of this hash indicates that every transaction is not only stored in the database but is also recorded as a digital trace that can be verified through the *blockchain*. In this way, the system ensures that all operational activities are recorded chronologically and cannot be concealed.

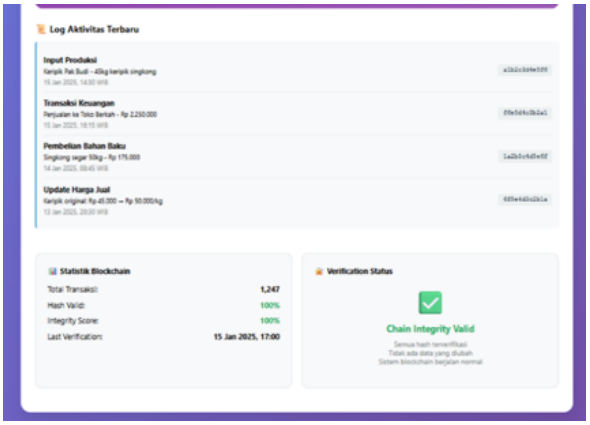


Figure 7 Blockchain audit display

The Cooperative Office dashboard displays Credit Recommendations that classify MSMEs by their financing eligibility. The "Credit Ready" category indicates that an MSME has well-organized financial statements, healthy cash flow, and guaranteed data integrity, making it eligible for capital access. "Needs Mentoring" indicates that an MSME has growth potential but requires further guidance before receiving credit. In contrast, "Not Ready" indicates that an MSME still needs to improve its recording practices or business performance. This feature is highly important because it helps the Cooperative Office make objective, data-driven decisions rather than relying solely on subjective observation. In other words, this system directly supports government MSME financing programs. The Cooperative Office dashboard is shown in Figure 8.



Figure 8 Cooperative Office dashboard display

Overall, this dashboard demonstrates that the system not only assists MSMEs in recording and reporting but also provides an analytical tool for

the Cooperative Office to conduct monitoring, evaluation, mentoring, and more strategic policymaking. The integration of production and financial recording in a single system allows production activities to be monitored in real time and production costs to be calculated more accurately, in line with Amaro et al. (2025), who reported similar benefits in an SME that centralized its production data in a unified database. The integration of MSMEs' financial and operational data with business health analysis provides a macro-level picture of the regional MSME ecosystem. Thus, this system serves as a Decision Support System (DSS) for the government to develop agro-industrial MSMEs in a measurable, evidence-based manner.

The results of this study also indicate an improvement in MSMEs' operational efficiency following the use of the developed information system prototype. Efficiency, in the context of MSME financial recording, was measured using four main indicators: transaction recording time, the number of input errors, the time required to prepare financial statements, and the number of automatic reports the system could generate. These four indicators were selected because they reflect the administrative burden on business owners and the accuracy of operational data. The indicators used in the measurement are shown in Table 1 below:

Table 1 Efficiency indicators

Efficiency Indicator	Scale	Target Direction
Recording time per transaction	Minutes	The smaller, the more efficient
Input errors per 10 transactions	Frequency	The smaller, the better
Time to prepare financial statements	Minutes	The faster, the more efficient
Number of automatic financial reports	Report units	The more, the better

The data in Table 2 were obtained through direct measurement (observations and time recordings) conducted at the sites of the partner MSMEs under two conditions: before (*pre-test*) and after (*post-test*) the implementation of the *blockchain*-based integrated information system. The recording time and the time required to prepare financial statements were measured by calculating the average time MSME actors took to complete these processes, using a stopwatch/time log across several transaction samples and the same reporting period, before and after system implementation.

Table 2 System efficiency calculation results

Indicator	Efficiency Calculation	Result (%)	Interpretation
Recording time per transaction	((3.6-1.8)/3.6)*100	50% faster	Input process improved
Input errors per 10 transactions	((4.33-1.33)/4.33)*100	69.28% fewer	Data accuracy improved
Number of automatic financial reports	((5-0)/5)*100	100% increase	Fully automated reporting
Time to prepare financial statements	((95-26.3)/95)*100	72.32% more efficient	Significant time savings

Based on the measurement results obtained before and after the implementation of the system, a significant increase in efficiency was observed across all indicators tested. In terms of transaction recording time, the average duration decreased from 3.6 minutes to 1.8 minutes per transaction, corresponding to a 50% improvement in time efficiency, indicating that the data input process became faster after the system was implemented. The improvements in transaction recording and financial reporting time indicate the operational benefits of the developed information system. These findings can be discussed within the broader context of digital transformation performance in SMEs (Costa Melo et al. 2023). Furthermore, the rate of data input errors decreased from an average of 4.33 errors per 10 transactions to 1.33, an improvement of 69.28%,

indicating increased accuracy in MSME financial data recording. Regarding the number of automatically generated financial reports, the system produced 5 types of reports that previously had to be prepared manually (0 automatic reports), representing a 100% increase and confirming that the financial reporting process had become fully automated. Meanwhile, the time required to prepare financial statements showed the most notable efficiency gain, decreasing from 95 minutes to 26.3 minutes, a time saving of 72.32%. Overall, these results demonstrate that implementing the blockchain-supported integrated information system made a tangible contribution to improving operational efficiency, data accuracy, and the speed of financial reporting among agro-industrial MSMEs.

CONCLUSION

This study successfully designed and developed a prototype integrated information system that combines production processes and financial recording for agro-industrial MSMEs by applying *blockchain* principles to maintain data integrity and transparency. The requirements identification results indicate that MSMEs need a system capable of recording daily production, automatically calculating costs and revenue, and generating financial reports in *real time*. The developed prototype can automate the recording of production processes and financial transactions, directly display profit-and-loss reports, and provide a *timestamp*- and hash-based *audit trail* in accordance with *blockchain* principles, thereby supporting accountability and reducing the risk of data manipulation. Nevertheless, this study has certain limitations, as the prototype has not yet been extensively tested on MSMEs in the field and has not yet fully implemented *blockchain* within a distributed network infrastructure.

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