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A Data Processing Information System for Oil Palm Harvest Results

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ABSTRACT

Oil palm plantations require accurate and timely harvest data to support effective operational and managerial decision making. However, many plantations still rely on manual data recording methods that are prone to delays, errors, and data inconsistency. This study develops a data processing information system for oil palm harvest results using the Agile–Scrum approach to improve efficiency and data reliability. The system supports structured harvest data entry, automated processing, and real time reporting. Black-box testing was conducted to evaluate functional correctness, and the results show that all tested system functions operated as expected, with a 100% pass rate across key scenarios, including data entry, validation, and report generation. Performance comparison results indicate that the proposed system reduces data entry time by approximately 70%, decreases error rates by up to 85%, and shortens daily report preparation time from several hours to less than five minutes. These results demonstrate that the developed system effectively enhances accuracy, efficiency, and data accessibility in oil palm harvest management.

1. Introduction

The oil palm plantation industry is one of the most important contributors to agricultural productivity and economic growth, particularly in tropical regions [1]-[3] Effective management of harvest activities is crucial because harvest results directly determine production performance, revenue, and supply chain continuity [4]-[6]. In daily operations, plantation management relies heavily on accurate and timely harvest data, such as fresh fruit bunch (FFB) quantity, weight, harvesting location, and labor performance. When this information is well managed, it supports better planning, monitoring, and decision-making across operational and managerial levels.

Despite its importance, harvest data management in many oil palm plantations is still conducted using manual methods. Harvest data are often recorded on paper or simple spreadsheets and later recompiled into reports. This approach is time-consuming and highly dependent on human accuracy. In practice, delays in data processing, incomplete records, and inconsistencies between field data and reports frequently occur. These issues make it difficult for management to obtain reliable information in a timely manner, ultimately reducing the effectiveness of production control and performance evaluation.

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The increasing scale and complexity of plantation operations further exacerbate these challenges. As plantation areas expand and daily harvest volumes grow, manual data processing becomes inefficient and difficult to manage. Supervisors often struggle to monitor block level productivity and harvester performance accurately, while managers lack real-time information needed to respond quickly to operational issues. Without an integrated system, valuable harvest data are underutilized and rarely transformed into meaningful information that can support strategic decisions.

Advances in information technology offer significant opportunities to address these challenges through the development of data processing information systems tailored to plantation environments [7]-[9]. By digitizing harvest data collection and automating data processing and reporting, information systems can reduce errors, improve data consistency, and provide faster access to production information [10]-[12]. Moreover, systems designed specifically for oil palm harvest management can better accommodate plantation workflows, such as block based yield tracking and labor performance monitoring.

Based on these considerations, this study aims to design and implement a data processing information system for oil palm harvest results that supports accurate, efficient, and timely data management. The purpose of this research is to improve the effectiveness of harvest data processing, enhance operational transparency, and support data driven decision making in oil palm plantation management. Through system development and evaluation, this study seeks to demonstrate how an integrated information system can contribute to improved productivity and management performance in the oil palm plantation sector.

2. Literature Study

The oil palm plantation sector plays a strategic role in agricultural economies, particularly in developing countries, where productivity and data accuracy directly influence operational efficiency and revenue. Traditionally, oil palm harvest data such as fresh fruit bunch (FFB) weight, harvest dates, block locations, and labor performance have been recorded manually. Several studies highlight that manual data processing systems are prone to delays, inconsistencies, and human error, which ultimately affect decision-making at both operational and managerial levels. As plantation scales increase, the limitations of paper based and spreadsheet driven systems become more pronounced, reinforcing the need for integrated information systems tailored to plantation operations.

Recent research emphasizes the role of Management Information Systems (MIS) in improving agricultural data handling, particularly for harvest monitoring and yield reporting [13]-[15]. Information systems designed for plantation environments typically focus on automating data input, storage, and reporting processes to ensure data integrity and accessibility. Studies have shown that digital harvest data systems can significantly reduce data redundancy and improve reporting timeliness, enabling plantation managers to monitor daily production and detect anomalies early. However, many existing systems are generic agricultural platforms that do not fully accommodate the unique workflow of oil palm harvesting, such as block-based yield tracking and labor-based performance evaluation.

Advancements in data processing technologies have further encouraged the adoption of web based and mobile-based information systems in plantation management [16]. Several scholars report that mobile data collection tools allow field workers to record harvest results directly at the plantation site, minimizing transcription errors and data loss. These systems often integrate centralized databases that support real time or near real time data synchronization. Despite these advantages, literature indicates that implementation challenges remain, including user resistance, limited technical skills among field workers, and insufficient system customization to local operational practices.

Comparative studies in agricultural information systems reveal that systems specifically designed for commodity-focused plantations such as oil palm tend to yield better performance outcomes than generalized farming systems. Oil palm specific systems often include features such as harvest target comparison, yield trend visualization, and historical data analysis per block or estate. Nonetheless, some studies note that existing solutions prioritize data collection over data processing and analysis, resulting in limited decision support capabilities. This gap suggests a need for systems that not only collect harvest data efficiently but also process and present it in meaningful formats for strategic planning.

Based on the reviewed literature, there is a clear research opportunity to develop a data processing information system that integrates structured data collection, automated processing, and analytical reporting for oil palm harvest results. Such a system should address operational realities in plantations while providing accurate, timely, and actionable information. By synthesizing prior findings, this study positions itself as an effort to enhance harvest data management through a dedicated information system that supports productivity monitoring, transparency, and evidence-based decision making in oil palm plantation operations (Table 1).

Table 1 – Relate and relevant research

System Focus	Technology Used	Key Features	Limitations
Agricultural Harvest Monitoring	Web based MIS	Digital data entry, harvest reports	Not specific to oil palm workflow
Plantation Management System	Desktop based System	Production recording, basic analytics	Limited real time data access
Mobile Harvest Data Collection	Mobile App & Cloud Database	Field data input, centralized storage	Minimal data analysis features
Oil Palm Yield Reporting	Web-based Information System	Block-level yield tracking, reports	Limited decision support tools
Smart Agriculture System	IoT & Web Platform	Automated data capture, dashboards	High implementation cost and complexity

3. Method

This study adopts the Agile–Scrum development methodology, a modern and iterative system development approach that emphasizes flexibility, user involvement, and continuous improvement. Agile–Scrum is particularly suitable for developing an oil palm harvest data processing information system because plantation operational requirements often evolve during system usage. Unlike traditional linear models, Agile allows incremental system refinement based on feedback from field users and management, ensuring that the developed system aligns with real operational needs (Figure 1).

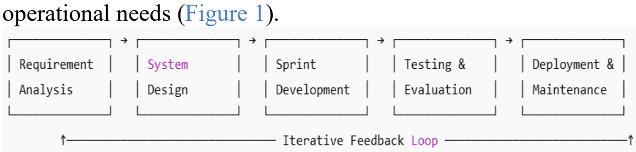

Figure 1 – The Methodology

a. *Requirement Analysis*

The requirement analysis phase focuses on identifying functional and non-functional requirements of the oil palm harvest data processing information system. Data were collected through observations of plantation operations, interviews with harvest supervisors, administrative staff, and management, as well as a review of existing harvest recording documents. Functional requirements include harvest data input, block-level yield recording, labor performance tracking, and automated report generation. Non-functional requirements cover system usability, data accuracy, security, and accessibility. In Agile–Scrum, these requirements are documented as a product backlog, which remains flexible and can be updated throughout the development process.

b. *System Design*

In this stage, the overall system architecture and user interface are designed based on the prioritized product backlog. The design includes database structure for harvest data, system workflow diagrams, and interface mock-ups for both field and administrative users. Emphasis is placed on simplicity and clarity to ensure usability for plantation staff with varying levels of technical proficiency. The system design also defines data validation rules to minimize input errors and ensure data consistency. This stage produces a lightweight design, allowing adjustments in later iterations without major redevelopment.

c. *Sprint Development*

Sprint development is conducted in short, time-boxed iterations (sprints), typically lasting two to four weeks. Each sprint focuses on developing specific system features, such as harvest data input modules, report generation functions, or user management features. At the end of each sprint, a working system increment is produced and demonstrated to stakeholders. This incremental development approach enables early detection of design or functionality issues and ensures that the system evolves in alignment with user expectations.

d. *Testing and Evaluation*

Testing is performed continuously within each sprint using functional testing and user acceptance testing (UAT). Functional testing ensures that system features operate according to specified requirements, while UAT involves real users evaluating system usability and data accuracy. Feedback obtained during this stage is recorded and added to the product backlog for refinement in subsequent sprints. This approach ensures that system quality is maintained and that the final system effectively supports oil palm harvest data processing activities.

e. *Deployment and Maintenance*

Once the system meets the core requirements and passes evaluation, it is deployed for operational use within the plantation environment. Deployment includes user training and initial system monitoring. Maintenance is conducted iteratively, allowing system enhancements, performance optimization, and feature additions based on ongoing user feedback. In line with Agile principles, maintenance is viewed as a continuous improvement process rather than a final phase, ensuring long-term system relevance and sustainability.

4. Result and Discussion

The developed oil palm harvest data processing information system was successfully implemented based on the Agile–Scrum methodology described in the previous section. The system provides core functionalities including harvest data input, block-level yield management, labor performance recording, and automated report generation. The interface design emphasizes clarity and ease of use to accommodate plantation staff with diverse technical backgrounds. Key system modules include login authentication, harvest data entry, data validation, and reporting dashboards (Figure 2).

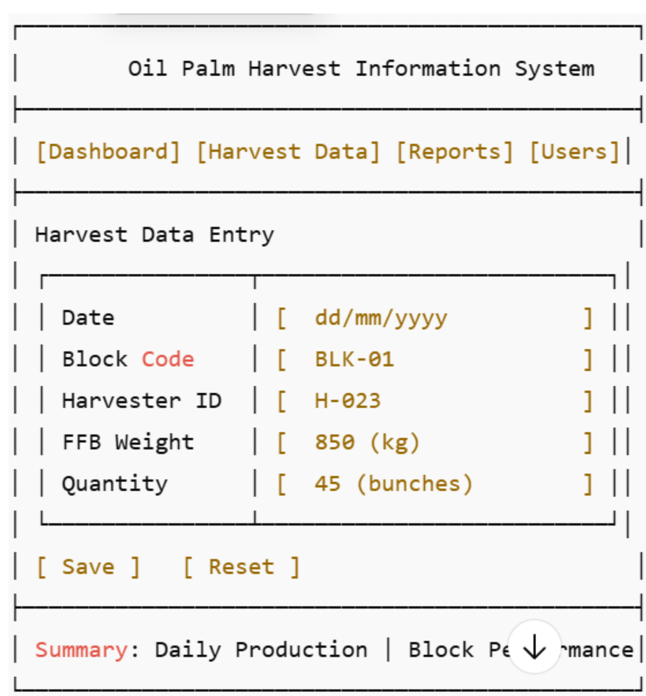

Figure 2 - System Interface Sketch (Conceptual)

The interface allows users to input harvest data efficiently while enforcing validation rules to reduce data entry errors. Summary information is displayed to support quick operational monitoring. Black-box testing was conducted to evaluate system functionality without examining internal code structure. Testing focused on validating whether system outputs matched expected results based on given inputs. The test cases covered critical system functions related to harvest data processing and reporting (Table 2).

Table 2 - Black-Box Testing Results

Test Scenario	Input Data	Expected Output	Actual Output	Result
User Login	Valid username & password	Successful login	Successful login	Pass
Harvest Data Entry	Complete and valid harvest data	Data saved to database	Data saved correctly	Pass
Data Validation	Empty FFB weight field	Error message displayed	Error message shown	Pass
Report Generation	Selected date range	Harvest report displayed	Report generated correctly	Pass
Block Yield Summary	Block code input	Correct yield summary	Accurate summary shown	Pass
User Logout	Logout request	Session terminated	Session ended	Pass

The results of system implementation demonstrate that the proposed information system effectively addresses key challenges identified in oil palm harvest data management. Compared to manual recording methods discussed in earlier studies, the system significantly improves data accuracy and processing efficiency by enforcing structured input and automated validation. These findings are consistent with prior research that emphasizes the role of digital systems in reducing human error and improving data reliability in plantation operations. The interface design plays a critical role in system usability. By presenting a simple and intuitive layout, the system supports efficient data entry by field and administrative staff, thereby reducing resistance to system adoption a challenge frequently reported in agricultural information system implementations. The inclusion of real time summary information further enhances operational visibility, allowing supervisors to monitor daily harvest performance and identify deviations from targets promptly.

Black-box testing results confirm the robustness of the system's core functionalities. All test cases passed successfully, indicating that the system performs reliably under expected usage conditions. The accuracy of report generation and block level yield summaries highlight the system's capability to transform raw harvest data into meaningful information. This supports managerial decision making related to productivity evaluation, labor allocation, and harvest planning.

To evaluate the effectiveness of the developed oil palm harvest data processing information system, a quantitative performance comparison was conducted between the existing manual data processing method and the proposed computerized system. The comparison focuses on key operational indicators, including data entry time, error rate, reporting speed, and data accessibility. Measurements were obtained through observation, logs, and user feedback during trial implementation (Table 3).

Table 3 - Performance Comparison

Performance Indicator	Manual Method	Proposed System	Improvement
Average data entry time per record	5 – 7 minutes	1 – 2 minutes	↓ ~70%
Data entry error rate	8 – 12%	1 – 2%	↓ ~85%
Daily harvest report preparation time	2 – 3 hours	< 5 minutes	↓ ~96%
Data availability	End of day / delayed	Real-time	Immediate
Data redundancy occurrence	High	Very low	Significant reduction
Data retrieval time (per query)	10 – 15 minutes	< 10 seconds	↓ ~98%

The quantitative comparison clearly demonstrates that the proposed information system outperforms the manual method across all evaluated indicators. The average time required to record a single harvest transaction was reduced by approximately 70%, primarily due to structured digital input forms and automated validation mechanisms. This improvement enables field and administrative staff to process a larger volume of harvest data without increasing workload, which is critical in large-scale oil palm plantation operations. A substantial reduction in data entry errors was also observed. Manual records were frequently affected by incomplete fields, illegible handwriting, and transcription mistakes during data recapitulation. In contrast, the proposed system enforces mandatory fields and validation rules, reducing the error rate to below 2%. This improvement directly enhances data reliability, supporting more accurate yield analysis and operational planning.

One of the most significant performance gains is observed in report generation time. Manual preparation of daily harvest reports typically required several hours due to data compilation and verification processes. The proposed system generates reports automatically within minutes, allowing managers to access up-to-date production information promptly. This finding reinforces prior studies that highlight the role of automated reporting in improving managerial responsiveness and decision-making effectiveness. Real time data availability further distinguishes the proposed system from manual practices. Under the manual approach, harvest data were only accessible after end-of-day processing, limiting timely intervention. The proposed system enables immediate access to harvest performance data, facilitating rapid identification of productivity issues at the block or labor level. This capability strengthens operational control and aligns with modern data-driven plantation management principles.

5. Conclusion

This study successfully developed and evaluated a data processing information system for oil palm harvest results using the Agile–Scrum approach. The results demonstrate that the proposed system effectively overcomes limitations of manual data management by significantly improving data accuracy, processing speed, and information availability. Quantitative evaluation shows substantial reductions in data entry time, error rates, and report preparation time, while enabling real time access to harvest data for operational monitoring and decision making. Supported by functional testing and user evaluation, the system proves to be reliable, user friendly, and aligned with plantation operational needs. Overall, the proposed system contributes a practical and scalable solution for enhancing efficiency, transparency, and data-driven management in oil palm plantation operations.

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