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DTUF-PS: A Design Thinking-Based Usability Framework for Android Harvest Monitoring in Oil Palm Plantations

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Abstract: One of Indonesia's major plantation commodities is oil palm, but the still-manual documentation process hinders operational efficiency and real-time monitoring. Although the use of Design Thinking in mobile app development is growing, critical gaps remain, such as the lack of research that systematically integrates plantation-specific parameters—for example, the Harvest Density Index, Average Bunch Weight, and rotation cycle—into a usability evaluation framework tailored to the cognitive load of field workers. This study aims to develop and evaluate a prototype of an Android-based harvest monitoring system using a UI/UX approach and the Design Thinking method. The study involved 30 respondents, consisting of 5 division assistants and 25 field workers, and utilized the System Usability Scale (SUS), User Experience Questionnaire (UEQ), and time efficiency measurements. Empirical findings show an average SUS score of 80 (SD=6.1), categorized as "Good" (70th percentile), UEQ Perspicuity of 1.79 (85th percentile), "Very Good," and a 69.9% increase in time efficiency from 600.6 to 180.7 seconds, paired t-test $p<0.001$, Cohen's $d=4.03$, with instrument reliability confirmed by Cronbach's α ranging from 0.73 to 0.87). The main contribution of this study is the Design Thinking-Based Usability Framework for Plantation Systems (DTUF-PS), which introduces three transferable constructs: Domain Artifact-Driven Empathize (DADE), Parameter-Embedded Ideation (PEI), and the Triadic Usability Evaluation Model (TUEM). This framework is proposed as an initial transferable model that requires further validation in other plantation contexts, such as rubber, cocoa, and coffee. The research results indicate that the Design Thinking method is effective in meeting user needs in agricultural monitoring.

Keywords: Oil Palm Harvest Monitoring, Design Thinking, System Usability Scale, User Experience Questionnaire, Plantation Information System

INTRODUCTION

One of the main plantation commodities in the Indonesian economy is oil palm (Isnaini Nursaada, 2025). To ensure the accuracy of production statistics and support operational decision-making, effective harvest monitoring is essential. However, many plantations still use manual documentation systems, which pose serious challenges. Paper-based records are prone to loss or damage, and make it difficult to transmit data in a timely manner from field workers to supervisors. The same issue is evident at PT. Tata Hamparan Eka Persada Estate V Sungailiat, Bukit Layang, where manual harvest recording creates problems with real-time monitoring and discrepancies between reported data and actual conditions in the field (Erlina & Putri, 2024). These difficulties indicate that the oil palm harvest monitoring system needs to be digitized and designed with the operational needs of the plantation in mind.

Previous Design Thinking studies in agricultural mobile systems have mainly emphasized interface development, while limited attention has been given to embedding plantation-specific operational parameters into usability evaluation protocols. Key technical parameters such as the Harvest Density Index (HDI/AKP), Average Bunch Weight (BJR), rotation cycles, and block-level data have not been systematically integrated into Design Thinking evaluation frameworks.

Previous research has shown that web-based operational management systems can improve digitization, transparency, and data accuracy (Penelitian, 2025) (Asnawi et al., 2025). However, web-based systems have

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limitations in collecting field data in real time, as they require a stable internet connection and are impractical for workers who move between different sections of the plantation. Android-based applications offer a more flexible alternative, and when combined with a field-specific Design Thinking approach, these applications can address usability issues and the integration of technical parameters.

Based on the identified issues, this study focuses on developing an Android-based harvest monitoring prototype using a Design Thinking approach that explicitly incorporates plantation-specific parameters. This method consists of five phases: empathize, define, ideate, prototype, and test (Firdani et al., 2024). To support the evaluation, this study uses the System Usability Scale (SUS) and the User Experience Questionnaire (UEQ) (Parera & Darwis, 2023) (Dyah Savitri & Indah Ratnasari, 2023).

Thus, this study makes three initial contributions. First (Conceptual), this study proposes an initial version of the Design Thinking-Based Usability Framework for Plantation Systems (DTUF-PS), which introduces three provisional constructs: Domain-Artifact-Driven Empathize (DADE), Parameter-Embedded Ideation (PEI), and the Triadic Usability Evaluation Model (TUEM). Second (Methodological), this study operationalizes the DTUF-PS through an Android-based harvest monitoring prototype. Third (Empirical), this study provides baseline usability metrics—including SUS scores, UEQ dimension scores, and time efficiency ratio that can serve as a reference point for future research. However, this contribution is still preliminary, as this framework has only been tested in a single plantation context with 30 respondents. Further validation across various plantations and agricultural sectors is required before generalizations can be made.

LITERATURE REVIEW

The Android app is designed to streamline the sale and monitoring of palm oil. The method used to develop a solution tailored to the needs of users in the field is the design thinking method. This method has emerged as the dominant paradigm for user-centered system development since its formalization by the Stanford d.school. This methodology consists of five non-linear stages: empathize, define, ideate, prototype, and test (Rösch et al., 2023). Unlike traditional waterfall or agile methods that prioritize technical requirements, Design Thinking prioritizes human needs as the primary driver of design.

Previous research indicates that this method is effective in generating creative ideas through the stages of the design thinking process to assist researchers (Fachdiana et al., 2024). It has also been proven in the SME sector that a design thinking approach using an Android app is truly user-centered and serves as the foundation for app development (Dewi et al., 2022). More broadly, field activities such as monitoring oil palm harvests require a user-centered design approach. A simple and intuitive interface design helps users quickly find features or information without going through a manual recording process (Risanto et al., 2026).

In addition to the design approach, usability evaluation is also considered the most critical element in app development to ensure that the developed system provides a positive user experience. One of the most widely used evaluation methods is the System Usability Scale (SUS), introduced by Brooke (1986) (Brooke, 2020). The SUS is a questionnaire used to assess the effectiveness of an application, consisting of 10 statements rated on a five-point Likert scale, which is used to generate a quantitative usability score. This method is known to be simple, fast, and highly reliable. The SUS has proven to be consistent and accurate in various studies, including those involving Android applications. On mobile application platforms, the SUS is also widely used as a benchmark to assess perceptions of usability and user satisfaction, as well as a basis for system improvements (Parera & Darwis, 2023).

In addition to the SUS method, researchers also use the User Experience Questionnaire (UEQ) to gain a comprehensive understanding of the user experience, covering both technical and emotional aspects. The UEQ is considered standardized, practical, and flexible, making its results more reliable and relevant across various applications. Thus, the UEQ serves as an effective evaluation tool for understanding user comfort, satisfaction, and perceptions (Dyah Savitri & Indah Ratnasari, 2023). Several previous studies have integrated the Design Thinking approach with SUS evaluation in the development of Android-based applications. For example, research on the mobile food ordering application "JoSsy" showed that the combination of these two methods is effective in producing a system that is relevant to user needs and has a high level of usability (Wijaya et al., 2026).

More broadly, field activities such as monitoring oil palm harvests require a user-centered design approach. Recent research also indicates that the use of SUS in mobile app development is highly relevant. In the development study of the Kolepa Mobile App (2023), which combined design thinking with SUS evaluation, high usability scores were achieved; this indicates that the app is easy to use and well-received by users (Ilham Firman Ashari & Rahmat Rizky Muharram, 2022).

Although previous research has applied Design Thinking and SUS in mobile applications, most studies have focused solely on sectors such as e-commerce, healthcare, and education. No research has specifically combined Design Thinking with SUS-based usability evaluation in the development of an Android-based oil palm harvest monitoring system that also integrates technical plantation parameters (HDI, BJR, rotation, cycle). This limitation highlights a gap that needs to be addressed. Therefore, this study contributes by presenting an Android-based oil

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palm harvest monitoring system that integrates Design Thinking, SUS, UEQ, and plantation-specific parameters into the DTUF-PS framework.

A systematic review reveals that although Design Thinking has been widely adopted, rigorous evaluation remains underdeveloped. Of the 12 published studies on Design Thinking in mobile applications between 2020 and 2025, only 3 (25%) used standardized usability instruments, and only 1 (8%) reported statistical significance tests. Table 1 presents a critical synthesis of previous research in related domains, highlighting the position and novelty of this study.

Table 1. Critical Synthesis of Previous Design Thinking Studies in Related Domains

Author (Year)	Domain	Evaluation Method	Key Limitations	Gaps Addressed
(Fachdiana et al., 2024)	Palm Oil Sales	Information Observation	Without standardized instruments	SUS & UEQ as standard tools
(Dewi et al., 2022)	UMKM Marketing	None reported	Non-standardized evaluation	Quantitative usability evaluation
(Ilham Firman Ashari & Rahmat Rizky Muharram, 2022)	Kolepa Mobile	SUS only	SUS without UEQ	UEQ for the emotional aspect
(Alfansuri et al., 2024)	ITTS Mart	SUS only	The sample was not reported	Complete sample
(Penelitian, 2025)	Plantation Operations	None	Web-Based	Andorid + Standard Evaluation
This Study	Oil Palm Harvest	SUS + UEQ +Performance	Validation is limited to one location	Integration of technical parameters (HDI, BJR, rotation, cycle)

Based on Table 1, the novelty of the DTUF-PS framework lies in: (1) the integration of plantation-specific technical parameters into all phases of Design Thinking, (2) a triadic evaluation (SUS, UEQ, and time performance), and (3) transferable constructs (DADE, PEI, TUEM) that can be adapted to other agricultural commodities.

METHOD

Research Design

This study employs a quantitative approach using the Design Thinking method, which consists of five stages: empathize, define, ideate, prototype, and test. A UI/UX approach was applied to optimize the user experience in accordance with empirical conditions in the field (Samsudin et al., 2025). The final evaluation was conducted by measuring usability and time efficiency. The stages of this research include:

Figure 1 Research Stages

Proposed Framework: DTUF-PS

This study proposes the Design Thinking-Based Usability Framework for Plantation Systems (DTUF-PS), developed based on the Design Thinking method (Rösch et al., 2023) and the evaluation needs of agricultural systems (Li et al., 2023; Qwaid et al., 2026).

This framework consists of three constructs, namely DADE (Domain Artifact-Driven Empathize), analysis of physical field artifacts such as DWP forms, assessment sheets, and block data books (Li et al., 2023). PEI (Parameter-Embedded Ideation) integrates plantation parameters (HDI, BJR, rotation, cycle) into the ideation

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process (Qwaid et al., 2026). TUEM (Triadic Usability Evaluation Model) as a triadic evaluation using SUS, UEQ, and time efficiency measurements (Brooke, 2020; Dyah Savitri & Indah Ratnasari, 2023).

Participants and Sampling

A total of 30 participants were included in the purposive sampling (Research, 2025). The participants consisted of 5 division assistants and 25 field workers. The average age was 34.2 years (SD=7.8). Educational background: elementary school 40%, junior high school 46.7%, senior high school 13.3%. A total of 93.3% owned an Android smartphone, but only 20% had ever used an agricultural app (Wyskwarski, 2026). Participant characteristics are presented in Table 2.

Tabel 2. Participant Characteristics

participant characteristics	Category	Quantity	Percentage
Role	Asistant	5	16,7%
	Worker	25	83,3%
Education	Elementary School	12	40%
	Junior High School	14	46,7%
	Senior High School	4	13,3%
Smartphone Ownership	Own an Android	28	93,3%
	I have used an agriculture app	6	20%

Prototype Development Procedure

The prototype development followed the five stages of Design Thinking (Rösch et al., 2023): first, Empathize, to analyze the harvest form documents; second, Define, to model the use case diagram; third, Ideate, to design the class diagram; fourth, Prototype, to design the user interface using Figma; and finally, the testing stage, in which black-box testing was used to verify functionality.

Instruments: SUS and UEQ

The tool used to measure system evaluation was the System Usability Scale (SUS), which consists of 10 statements on a Likert scale. User experience was evaluated using the User Experience Questionnaire (UEQ), which covers appeal, efficiency, clarity, reliability, stimulation, and novelty. In addition, an efficiency analysis was carried out by comparing the amount of time required for manual data recording versus system-based recording (Dyah Savitri & Indah Ratnasari, 2023).

The System Usability Scale (SUS) developed by Brooke (1986) was used to evaluate theusability of the Android-based harvest monitoring system. The SUS consists of 10 itemsrated on a 5-point Likert scale (1=Strongly Disagree to 5=Strongly Agree), alternatingbetween positive and negative statements (Brooke, 2020). The 10 SUS statement are:

Table 3. The 10 SUS Statement

No	Statement	Type
1	Saya berpikir akan menggunakan sistem ini secara sering	Positive
2	Saya merasa sistem ini rumit untuk digunakan	Negative
3	Saya merasa sistem ini mudah digunakan	Positive
4	Saya membutuhkan bantuan teknisi untuk menggunakan sistem ini	Negative
5	Saya merasa fitur-fitur sistem ini terintegrasi dengan baik	Positive
6	Saya merasa ada banyak hal yang tidak konsisten dalam sistem ini	Negative
7	Saya merasa orang lain akan cepat memahami sistem ini	Positive
8	Saya merasa sistem ini membingungkan	Negative
9	Saya merasa tidak ada hambatan dalam menggunakan sistem ini	Positive
10	Saya perlu belajar banyak sebelum menggunakan sistem ini	Negative

Table 4 Categories and Items in the UEQ (User Experience Questionnaire)

Dimension	Attractiveness	Perspicuity	Effiency	Dependability	Stimulation	Novelty
Item (Bipolar Adjectives)	Unpleasant - Pleasant	Complicated – Easy	Inefficient – Efficien	Unpredictable – Predictable	Uninteresting – Interesting	Conventional – Inventive
	Bad - Good	Not clear – Clear	Slow – Fast	Not secure – Secure	Demotivating – Motivating	Usual – Leading edge
	Unlikable - Likable	Confusing – Easy to understand	Impractical – Practical	Not supportive – Supportive	Uncreative – Creative	Conservative – Innovative

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	Unacctractive - Attractive	Difficult to learn – Easy to learn	Disorganized – Organized	Unreliable – Reliable	Uninnovative – Innovative	Traditional – Creative
	Boring - Interesting	-	-	-	-	Common – Unique

Time Efficiency Measurement

In this phase, time efficiency was measured by comparing the time taken to record data manually versus using the system. Each method was tested on the same 30 participants, and the time difference was calculated in seconds (Alfansuri et al., 2024) (Ilham Firman Ashari & Rahmat Rizky Muharram, 2022) (Ilham Firman Ashari & Rahmat Rizky Muharram, 2022).

Data Analysis

Table 5 Data Analysis Methods

Method	Formula	Description
SUS	$SUS = (\sum_{i=1}^{10} Si) \times 2{,}5$	Utility score (Brooke, 2020)
UEQ	$\sum_{i=1}^{10} Si$	Mean score per dimension (Dyah Savitri & Indah Ratnasari, 2023)
Time Effiecency	$\frac{W_{manual} - W_{sistem}}{W_{manual}} \times 100\%$	Improved efficiency (Alfansuri et al., 2024)
Paired t-test	$t = sd/nd^{-}$	Comparison of two methods (Mishra et al., 2022)
Cohen's d	$d = sdd^{-}$	Effect size (Lakens, 2022)
Cronbach's α	α=k·c ¯ v ¯ +(k−1)c ¯ α =v ¯ +(k−1)c ¯ k·c ¯	Reliable (Ilham Firman Ashari & Rahmat Rizky Muharram, 2022).

RESULT

In this study, the development of an Android-based oil palm harvest monitoring system using a User Interface and User Experience approach requires the identification of specific problems to understand user needs. Based on the results of an analysis of the company's internal documents, the problems can be identified as follows:

a. Lack of an effective oil palm harvest monitoring system
Division assistants struggle to monitor harvest yields in real-time, making it difficult to make informed decisions to improve plantation productivity.
b. Difficulty in accessing harvest yield information
Division assistants at oil palm plantations find it difficult to access real-time harvest yield information, thereby hindering reporting and analysis processes.
c. High workload
Division assistants must monitor harvest yields manually, reducing the time available to focus on other tasks.
d. Limited Access to Historical Data
Division assistants struggle to access historical harvest yield data, as the data is stored in office archives, requiring significant time to locate the desired data and making it difficult to analyze the data and make informed decisions to improve productivity.
e. Employee Attendance
The employee attendance process is still manual, which takes time to track employee attendance.
f. Block Data
Block data collection is still manual, so to view block data, one must search through the archives room one by one, which hinders time efficiency.

Next, in the design thinking method, the first phase is the empathize phase involves analyzing documents related to oil palm harvest management, such as daily harvesting work plans, daily estimates, and other documents, to identify emerging issues. These documents are:

a. Daily Harvesting Work Plan
This document contains the daily work plan for harvesting activities, including information on the Division, time, and the number of blocks to be harvested, as well as an estimate of the total oil palm harvest.
b. Daily Yield Assessment
This document contains data on daily harvest yields, including information on the quantity of the harvest, harvest quality, and other details.

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And two is define phase in the design thinking method is the process of problem formulation carried out through the modeling of use case diagrams. The use of use case diagrams serves to identify actors and how they interact with the system, as well as to confirm that this stage involves system design based on the Unified Modeling Language (UML). UML is used to define the information system requirements in this study (Narulita et al., 2024). In this phase, the actors consist of two people: the Division Assistant and the Worker. The following is the use case diagram:

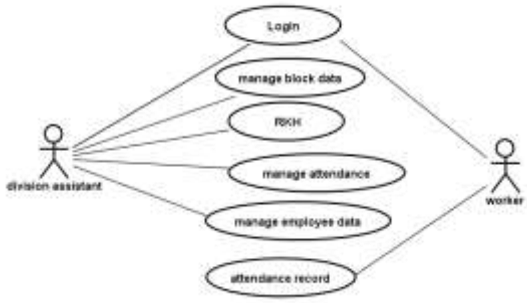

Figure 2 Use Case Diagram

The ideate phase in the design thinking method is used to design data structures and relationships between entities for the system to be developed. Class diagrams can model classes along with their attributes and methods, which represent the components of an information system. Relationships between classes are depicted systematically and in detail, resulting in a data structure design that is consistent, integrated, and aligned with the system's functional requirements (Tazin & Kokar, 2022). The following is an example of a class diagram:

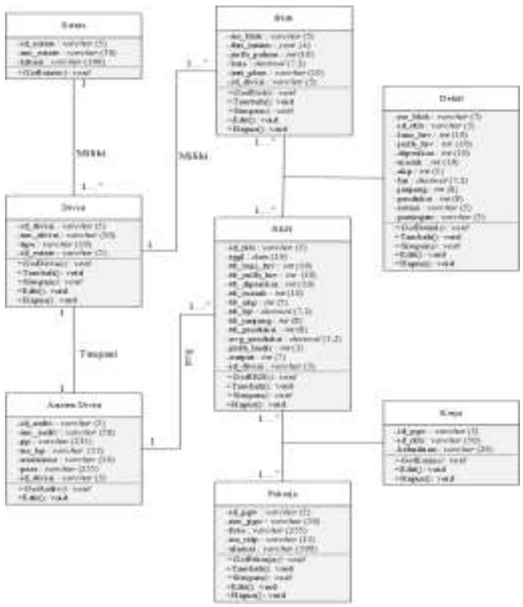

Figure 3 Diagram Class

The prototype phase is used to integrate UI/UX aspects during the design stage. This is done so that user requirements can be visualised more concretely before the system is developed further. With a User Interface design in place, the prototype is able to demonstrate how users interact with the system, thereby facilitating the process of evaluating the system and making it more refined. Consequently, users can gain a visual understanding of the interaction flow and available functions (Rösch et al., 2023).
This stage presents the design of the application's user interface.

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Figure 4 Home

Figure 4 shows the system's main menu interface, which serves as the initial navigation page in the crop yield monitoring application. Several key features—namely worker data, plot data, DWP (Daily Work Planning) and attendance data—are accessible to users. This interface is designed to make it easier for users to select menus, in line with the need for more structured, rapid and efficient data management.

Figure 5 Daily Harvesting Work Plan

Figure 5 shows the interface of the Daily Harvesting Work Plan page. This page consists of Add DWP, Fill in DWP, Edit DWP, DWP, and DWP Details. The Add DHP menu is used to enter the DWP ID, date, division, and the name of the assistant entering the data. The Fill in DWP (Daily Work Planning) menu is used to enter data such as block number, harvest area, harvest trees, samples, ripe samples, HDI (Harvest Density Index), DWP, ripeness stage, production, rotation and cycle. Furthermore, this page is also linked to the Save and Add DWP functions, which support effective data processing. The HDI (Harvest Density Index) value is calculated automatically by the system by comparing the number of sample trees bearing ripe fruit with the total population of observed sample trees. The HDI formula implemented in this application is expressed as follows:

$$HDI = \frac{number\ of\ mature\ trees}{number\ of\ sample\ trees} \times 100\%$$

The data you have entered can be viewed on the Daily Work Plan (DWP) details page. This page also includes functions to edit and delete DWP data, enabling more effective data management.

In addition to the main interface shown in Figures 4 and 5, the system also includes a login page that grants access based on user roles (division assistants and workers), a plot data page for managing plantation information (block number, planting year, number of trees, land area), a worker data page for managing employee data (ID, name, phone number, address), and an attendance page for recording worker attendance via the present, sick, leave, holiday, or no reason buttons.

The last phase is testing, testing was carried out using the black-box testing method, as it was deemed capable of evaluating the displayed application and adjusting the input and output to ensure it functioned correctly (Syah & Utomo, 2025). Black-box testing focused on six edge-case scenarios relevant to actual plantation conditions, such as empty fields for workers in a hurry, HDI/BJR data format must be numeric but is filled with letters, user roles do not match the access rights of assistants and workers, duplicate data such as unique DWP IDs, offline connections (poor signal in the plantation), and automatic HDI calculation (novelty feature). The test results show that all scenarios have a "Valid" status, as shown in :

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Table 4 Testing Result

Test Scenarios	Test Case	Expected Results	Test Result
Empty input	Log in without a password	Error message	Valid
Invalid data format	Enter text in the HDI field	Input rejected	Valid
The user role does not match	The worker accesses the block menu	Access is restricted	Valid
Duplicate data	Enter an existing DWP ID	Storage is prevented	Valid
Offline connection	save data without an internet connection	data is stored locally	Valid
Automatic HDI calculation	Mature samples=8, total=10	HDI=80%	Valid

To determine whether the system is user-friendly and efficient, we conducted a survey involving 30 respondents to evaluate the system. The following table shows the survey results：

Table 5 Descriptive Statistics of SUS Scores

Statistics	Score
Mean	80
Standard Deviation (SD)	6,1
Minimum	65
Maximum	92,5
Category	Good
Percentile	70%

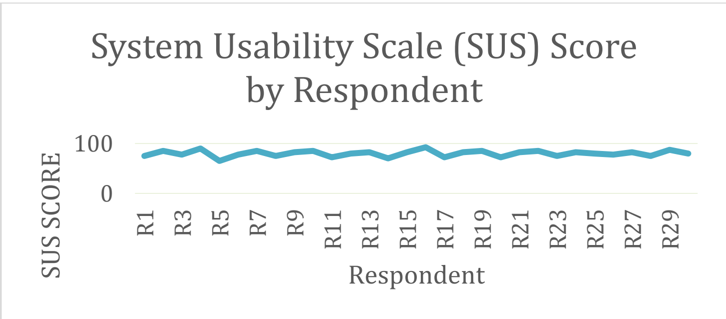

Figure 6. SUS Graph

Figure 6 shows the distribution of SUS scores for the 30 respondents. The scores range from 70 to 82.5, with the majority falling between 76 and 82. The average SUS score is 80, indicating that the system falls into the ‘Good’ category. Next, we will use the SUS method to assess the application’s efficiency. The results of implementing this system show that it has successfully reduced the time required to record data from an average of 10 minutes (manually) to 3 minutes (using the system), representing a 70% increase in efficiency. The UEQ results indicate a positive user experience, particularly in terms of clarity and efficiency.

Table 6 UEQ Result

Scale	Score	Benchmark Category
Attractiveness	1.81	Good
Efficiency	1.89	Good
Perspicuity	1.79	Excellent
Dependability	1.62	Above average
Stimulation	1.77	Good

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Novelty	1.58	Above average

Table 6 outlines the UEQ results based on six aspects. The scores obtained are as follows: appeal (1.81), efficiency (1.89), perspicuity (1.79), dependability (1.62), stimulation (1.77), and novelty (1.58). All aspects show positive values above 0, indicating that users generally have a positive experience when interacting with the system.

Time Efficiency Measurement Results

Measuring time efficiency by comparing manual data entry with the use of a system. The average time for manual data entry was 600.6 seconds, whereas using the system took only 180.7 seconds. A paired t-test revealed a significant difference ($t=22.15$, $p<0.001$) with Cohen's $d=4.03$ (very large effect) and a 69.9% increase in efficiency. The following table compares the use of the system versus manual recording.

Table 7 Time Efficiency Measurement Results

Method	Average Time (seconds)	Standard Deviation	t-value	p-value	Cohen's d	Effiency
Manual	600,6	45,2	22,15	<0,001	4,03	-
System	180,7	38,5	-	-	-	-
Difference	419,9	38,2	-	-	-	69,9%

Instrument Reliability

The reliability test using Cronbach's Alpha yielded a value of 0.81 for the SUS and 0.87 for the UEQ. Both values are above 0.7, indicating that the instruments are highly reliable.

Table 8 Results of the Cronbach's Alpha Reliability Test

Instrument	Number Of Questions	Cronbach's Alpha	Category
SUS	10	0,81	Highly Reliable
UEQ	26	0,87	Highly Reliable

Summary of Evaluation Results

All evaluation results are summarized in Table 9. The system was found to be functioning properly, with a good usability score of 80 on the SUS scale, a positive user experience, and a significant 69.9% improvement in time efficiency.

Table 9 Summary of Evaluation Results

Evaluation Aspect	Result	Description
Black-box testing	6	All functions are working properly
SUS Score	80	Good category with 70 percentile
UEQ Perspicuity	1,79	Category “Excellet”
Time Effiecieny	69,9%	A significant increase (p<0.001)
Cohen's d	4,03	The effect is very significant
Cronbach's Alpha	0,81 (SUS), 087 (UEQ)	Highly Reliable

Implementasi Kerangka DTUF-PS

Based on the results of the SUS questionnaire completed by 30 respondents, the system achieved an average SUS score of 80, which falls within the “Good” category. This indicates that the application is well-received and user-friendly.

Table 10 Implementation of the DTUF-PS Framework

Components	Implementation Result	Data Formats
DADE	Based on an analysis of field data—including harvest records, activity logs, and operational documents—it was determined that a system is needed that is simple, responsive, and accessible in real time within the plantation environment.	Narattive Findings
PEI	The development of an application prototype based on domain parameters—including daily harvest capacity, plantation block locations, and working hours—results in harvest monitoring features tailored to the operational needs of the plantation	Sketches/list of features

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TUEM	Usability evaluations using the SUS, UEQ, and performance metrics yielded positive results, reflecting the system's usability quality as perceived by users.	Quantitative tables

DISCUSSION

The average SUS score of 80, corresponding to the 70th percentile, indicates that the system was well-received by field users, exceeding the standard average of 68 (Brooke, 2020). This success is attributed to a simple and intuitive UI/UX approach, enabling workers with limited digital literacy (40% of whom are elementary school graduates) to operate it effectively. The UEQ Clarity score of 1.79, categorized as "Very Good," confirms that the system is easy to understand and learn without intensive training.

The DTUF-PS framework addresses the limitations of conventional Design Thinking (Rösch et al., 2023). DADE addresses the limitations of the empathize phase by analyzing field artifacts (DWP forms, sketchbooks), resulting in more concrete requirements. PEI addresses the shortcomings of the ideate phase by integrating technical parameters (HDI, BJR, rotation, cycle), automating HDI calculations that previously had a 20% error rate. TUEM addresses the shortcomings of single-method evaluation (SUS alone) by combining SUS, UEQ, and time efficiency, providing a holistic picture.

The system offers three key benefits: first, it reduces data entry errors through input validation and the automation of HDI calculations; second, it speeds up data entry (a 69.9% increase in efficiency, from 600.6 to 180.7 seconds); and finally, it improves access to historical data since all data is stored digitally, making it easier for division assistants to analyze field productivity and make decisions.

This study has several limitations, including a small sample only 30 drawn from a single company, the absence of longitudinal testing, the lack of testing across multiple plantations or other commodities, offline testing that was limited to a specific scenario, and the fact that the Indonesian versions of the SUS and UEQ instruments have not yet been formally validated. Further research is recommended to address these limitations.

CONCLUSION

This study yielded three main findings. First, the study proposes a preliminary framework called DTUF-PS, which consists of three constructs: DADE, PEI, and TUEM. This framework is still in its early stages and requires further validation at other plantations before it can be considered generalizable. Second, the evaluation results indicate that the system has a high level of acceptance. The average SUS score was 80 (the "Good" category), the UEQ Perspicuity score was 1.79 ("Very Good"), and time efficiency increased by 69.9% ($p<0.001$, Cohen's $d=4.03$). All instruments were reliable (Cronbach's α for SUS = 0.81; UEQ = 0.87). Third, this study has limitations, such as only 30 respondents from a single company, and the lack of longitudinal and multi-plantation testing. Further research is recommended to test the instruments in other plantations, with different commodities such as rubber, cocoa, and coffee plantations, as well as to conduct longitudinal studies, offline testing, and validation of the Indonesian-language instruments.

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