DESIGN OF SUTI WATER SYSTEM INVENTORY APPLICATION USING THE USER-CENTERED DESIGN (UCD) METHOD

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Abstract

Inventory management (stock) is an important factor for business operational continuity. The Suti Water bottled water business unit, managed by the Indonesian Islamic Boarding School Cooperation Agency (BKsPPI), was facing serious constraints where the manual recording system often resulted in delays and data inaccuracies, which had a significant impact on operational efficiency. This study aimed to overcome these challenges by designing and developing an inventory application prototype with a focus on optimizing the User Interface (UI) and User Experience (UX). The User-Centered Design (UCD) methodology was adopted to ensure that the application design was centered on the real needs of the Suti Water Main Distributor warehouse staff. Following development, the application's usability was evaluated using the System Usability Scale (SUS). The testing results showed a SUS score of 93.0, which placed the application in the 'Acceptable' category with an "Excellent" rating. These findings demonstrate that the developed prototype is an effective and highly accepted solution by the users. Furthermore, the application proved to reduce transaction recording time and significantly minimize data errors..

Keywords- *Inventory Application, System Usability Scale (SUS), User-Centered Design (UCD), Usability.*

1. INTRODUCTION

Inventory management is a crucial factor for sustainable business operations. Inventory refers to all resources and goods owned by a company or organization to meet needs and demands [1][2][3], including raw materials, work-in-process goods, and finished products ready for sale [4][5]. Good inventory management is essential as it plays a fundamental role in supporting the operations of individuals, households, institutions, and businesses [6]. Simply put, inventory is a collection of stored goods intended for sale to generate profit.

The Indonesian Islamic Boarding School Cooperation Agency (BKsPPI), the producer of Suti Water bottled water, has faced serious constraints in stock recording within its distribution unit. The name "Suti" itself is an acronym for Silaturahmi, Ukhuwah Islamiyah, Tafaqquh Fiddin, and Iqomatuddin. As the main distributor, BKsPPI strives to increase sales to support the quality and development of Islamic boarding schools. Suti Water's business activities include integrated sales, inventory management, and product storage.

Currently, stock recording in the warehouse is still performed manually, which is highly susceptible to input errors and potential misuse. The discrepancy between physical data and administrative records can lead to operational and financial losses. Therefore, a more modern and efficient inventory management system is urgently needed to mitigate these risks. The necessity to automate this process is supported by other research stating that, 'The creation of a new information system aims to overcome problems arising from manual processes, such as lack of efficiency and difficulty in monitoring. The development of integrated systems shows that communication and workflow automation are key to improving operational quality' [8]. Studies have shown that low data input accuracy and user acceptance are the main causes of information system implementation failure, directly impacting operational losses [7][9].

To bridge this gap, this study proposes the development of a digital inventory management application prototype. This application is specifically designed to help warehouse staff manage stock more accurately and efficiently, supported by optimal user

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experience. The User-Centered Design (UCD) approach was utilized to ensure that the application's interface and features genuinely meet the specific needs of Suti Water staff. An iterative and gradual approach in the development methodology is crucial for producing a functional and stable system aligned with business objectives [12]. UCD is a design methodology that focuses entirely on user needs and experience [10][11] aiming to produce a product that is easy and comfortable to use. The UCD approach has proven effective in other information system studies, including the design of a Software License Management System [4] and an e-Inventory application [14].

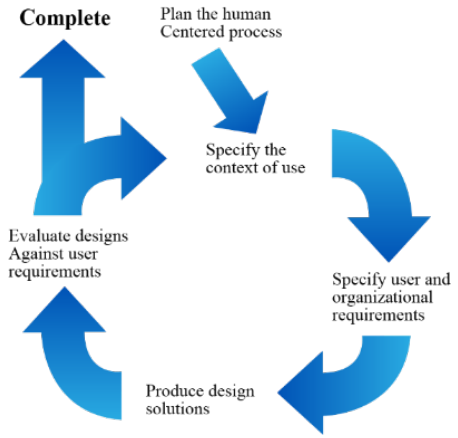

Figure 1. User-Centered Design Method

The UCD method has five main user-centered stages, as illustrated in Figure 1 [2][15]: (1) Planning the Process; (2) Determining the Context of Use, (3) Specifying the Requirements, (4) Generating Design Solutions (e.g., wireframe [16], and prototype [17]), and (5) Evaluating the Design. Other inventory management studies commonly focus on algorithmic efficiency through statistical methods such as Single Moving Average (SMA) for stock forecasting [18]. However, a fundamental research gap exists: the algorithmic approach (SMA) focuses on mathematical optimization (forecasting) [19], and often neglects Human Factors [20]. The novelty of this research lies in integrating UCD as the core methodology. UCD explicitly contrasts with SMA because it considers human factors [20] and prioritizes usability, which is a key success factor for system adoption by warehouse staff [13].

The novelty of this study lies in integrating UCD as the core methodology, which directly addresses the input errors and user discomfort that are the root causes of problems at Suti Water. Unlike the algorithmic approach that addresses forecasting errors, UCD prioritizes usability. This ensures that the data entered into the system is accurate from the outset, while also guaranteeing that the system is accepted by the warehouse staff. To objectively validate this UCD-based design contribution, the application's ease of use was evaluated using the System Usability Scale (SUS) method [21]. The selection of SUS is important because it provides a standard and reliable metric for assessing perceived user usefulness [22][23], which directly addresses the crucial acceptance requirement. Findings from the SUS test will confirm the success of UCD in bridging the gap between system requirements and user capabilities.

2. METHODOLOGY

This research adopted an iterative User-Centered Design (UCD) approach, aiming to design an application prototype centered on the specific needs of the warehouse staff. Data collection was carried out in the initial stages of UCD through qualitative methods, including:

1. Direct Observation: The Understand stage of UCD commenced with intensive direct observation conducted for four (4) working weeks at the Suti Water Main Distributor warehouse. This observation aimed to understand the manual workflow, quantitatively identify input error vulnerabilities, and record operational bottlenecks (such as process bottlenecks). The data collected in this stage served as the basis for defining the problem, specifically regarding the average recording duration per item and the frequency of data inconsistencies.
2. Interview and Requirements Analysis: Subsequently, in-depth interviews were conducted with one (1) Head Distributor to establish system requirements from a managerial and strategic decision-making perspective. Additional qualitative data was collected through open questionnaires

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administered to nine (9) operational staff directly involved in the stock recording process.

The findings from this data collection (manual processes are prone to errors, and staff require a practical system) formed the foundation for designing the application interface and features.

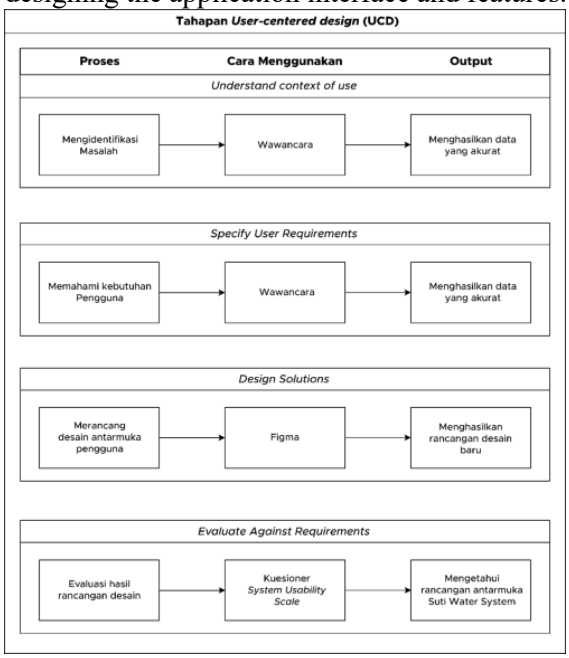

Figure 2. Stages of User-Centered Design (UCD)

The UCD process was applied in four main stages to ensure an optimal design:

1. Understanding the Context of Use: This stage ensured the application was designed specifically for the Suti Water warehouse working environment, which has signal limitations and a need for input speed, thereby addressing the previous data delay issues.
2. Specifying the User Requirements: This stage resulted in a list of minimalist core features that were highly aligned with the warehouse staff's workflow (e.g., Quick Scan or Bulk Input features), which subsequently contributed significantly to the high Usability score (93.0).
3. Generating Design Solutions: This stage focused on creating wireframes and mockups (e.g., using Figma) based on the principles of clear visual hierarchy and consistency to ensure the interface is easy to learn and operate.
4. Evaluating the Design Suitability: This stage utilized the SUS to validate the design. The evaluation was conducted iteratively after each prototype revision, ensuring that every usability issue was fixed before the final testing.

The researcher created the wireframes and User Interface (UI) prototype using Figma software during the design solution generation stage.

Usability evaluation was performed using the System Usability Scale (SUS).

1. Respondent Details: This study involved 10 respondents in the SUS testing, consisting of one (1) Head Distributor and nine (9) warehouse/administration staff directly responsible for the inventory.
2. Scientific Justification: The researcher chose a sample size of 10 respondents because the literature indicates that a sample of between 8 to 12 participants is adequate to obtain a reliable and stable SUS score in the context of a single usability evaluation [21].

The score calculation was performed by following the standard SUS formula, where the final score is interpreted against the average benchmark of 68 to determine the system's acceptance level (acceptability).

Table 1. Usability Scale

No	Question	Score
1	I think that I would like to use this application frequently.	1 – 5
2	I found the application unnecessarily complex.	1 – 5
3	I thought the application was easy to use.	1 – 5
4	I think that I would need the support of a technical person to be able to use this application.	1 – 5
5	I found the various functions in this application were well integrated.	1 – 5
6	I thought there was too much inconsistency in this application.	1 – 5
7	I would imagine that most people would learn to use this application very quickly.	1 – 5
8	I found the application very cumbersome to use.	1 – 5
9	I felt very confident using the application.	1 – 5

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10	I needed to learn a lot of things before I could get going with this application.	1 – 5

(Source: Adapted from Brooke, J., 1996 and Sauro & Lewis, J. R., 2018) [21]

Table 2. Score System Usability Scale

Score	Questions
Score 1	Strongly Disagree (SD)
Score 2	Disagree (D)
Score 3	Neutral (N)
Score 4	Agree (A)
Score 5	Strongly Agree (SA)

The researcher processed the respondents' answers to obtain the final System Usability Scale (SUS) score. The conversion steps were as follows: The researcher subtracted one from the response values of the odd-numbered items (1, 3, 5, 7, 9) (X-1). Meanwhile, the researcher obtained the score for the even-numbered items (2, 4, 6, 8, 10) by subtracting the response value from five (5-X). After obtaining the converted scores, the researcher summed all these scores and then multiplied the total by a factor of 2.5. This calculation resulted in the final SUS score with a range between 0 and 100..

$$\text{Score SUS} = \left(\sum_{i=1}^{5} (Pi - 1) + \sum_{j=1}^{5} (5 - Nj) \right) \times 2{,}5$$

Score SUS = ((Q1–1) + (5–Q2) + (Q3–1) + (5–Q4) + (Q5–1) + (5–Q6) + (Q7–1) + (5–Q8) + (Q9–1) + (5–Q10)) × 2,5

The researcher interpreted the SUS score based on several assessment categories, including the Acceptability Ranges (i.e., not acceptable, marginal, and acceptable), a grade scale (A to F), and an adjective rating (e.g., Worst Imaginable to Best Imaginable), the illustration of which is presented in Figure 3.

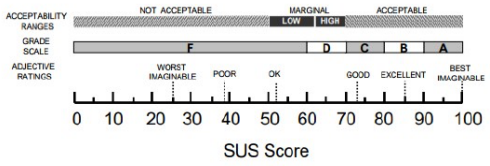

Figure 3. System Usability Scale (SUS) Score

3. RESULTS AND DISCUSSIONS

The researcher analyzed the user interface design by applying the User-Centered Design (UCD) and the System Usability Scale (SUS). Based on this analysis, recommendations were provided for better design through the development of a website prototype.

3.1 Results of Understanding the Context of Use

The researcher commenced this study with a field study, which included direct observation and questionnaire distribution at the Suti Water warehouse. The goal was to obtain a clear picture of the current system in operation. It was found that the manual inventory recording often led to inaccurate data and complicated product tracking. This crucial finding was then utilized to formulate a design solution specifically tailored to overcome the challenges faced by the users.

3.2 Results of Specifying User Requirements

The researcher conducted an interview with the head distributor and analyzed the user persona to deeply understand user requirements. The information obtained was then utilized to design features and interface displays that could effectively solve existing warehouse problems, such as manual recording and inaccurate inventory data.

3.3 Results of Design Solution

Once the user requirements were identified, the researcher initiated the application interface design. This process was carried out by compiling wireframes and prototypes using Figma, with the goal of creating a design that is not only functional but also intuitive for the warehouse staff in performing their routine tasks.

a. Login Page Prototype
   Users are required to log in first to be able to access the inventory system. They can use a previously registered account or opt for a faster login via a Google account. This authentication process is presented in Figure 4.

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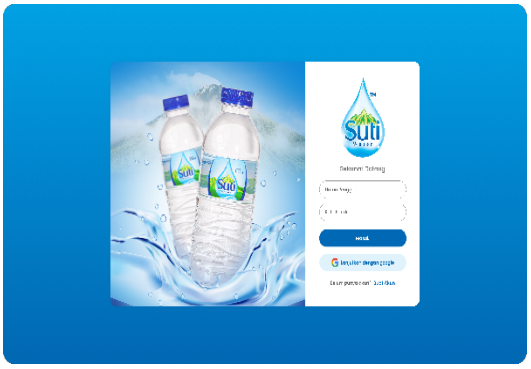

Figure 4. Suti Water System Login Interface Display

b. Homepage Prototype

Users who successfully log in will see the main display, which contains a summary of the inventory data. The top section shows key metrics, such as the type of items, the number of staff, and the total stock. In the middle section, two graphs provide clear data visualization to help users track changes and understand information. At the bottom, three panels display the list of low-stock items, the five latest incoming transactions, and the five latest daily outgoing transactions. The detailed display of this page can be seen in Figure 5.

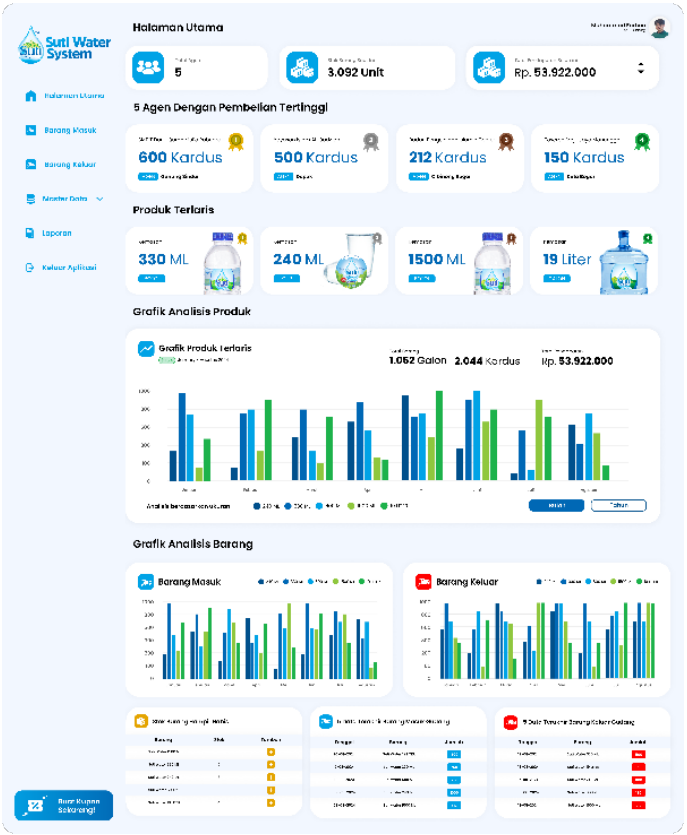

Figure 5. Homepage Interface Display

c. Incoming Goods Page Prototype

This display presents detailed information about items that have been recorded as incoming goods. This interface can be seen in Figure 6.

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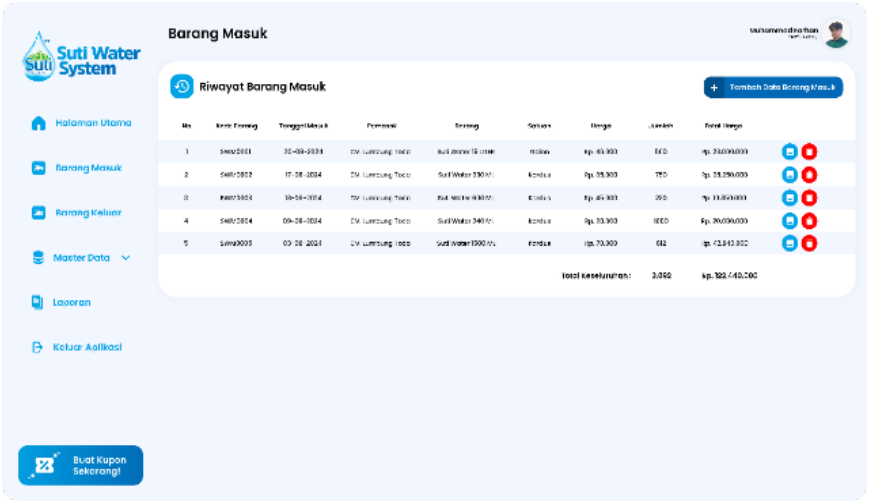

Figure 6. Suti Water System Incoming Goods Interface Display

d. Outgoing Goods Page Prototype
The Outgoing Goods display presents the inventory data that has been recorded as outgoing items. An example of this interface can be seen in Figure 7.

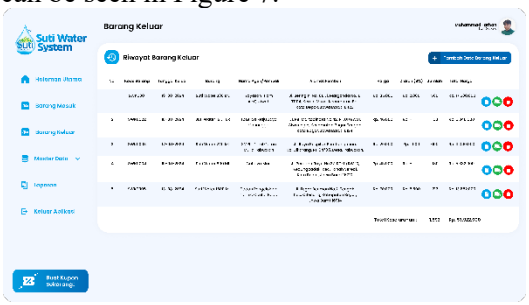

Figure 7. Suti Water System Outgoing Goods Interface Display

e. Supplier Page Prototype
In this display, users can manage supplier company data. The complete interface is presented in Figure 8.

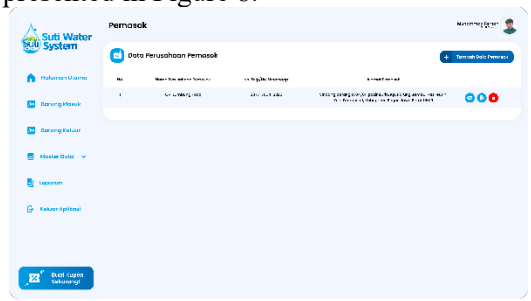

Figure 8. Suti Water System Supplier Interface Display

f. Item Page Prototype
In this display, users can view the details of Suti Water products such as name, type, unit, and price. The complete display is shown in Figure 9.

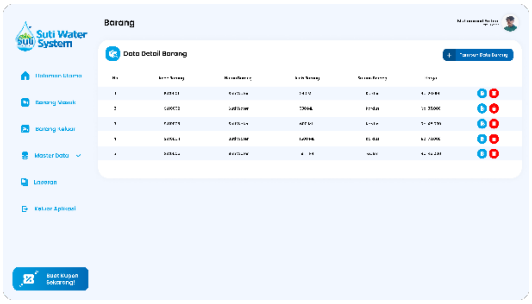

Figure 9. Suti Water System Item Interface Display

g. Agent Page Prototype
In the Agent display, users can view the detailed information of Suti Water agents, such as name, Person in Charge (PIC), contact number, and address. The complete interface is presented in Figure 10.

Figure 10. Agent Interface Display

h. User Data Page Prototype
In this display, users can view various information about the Suti Water System application users. An example of this interface is presented in Figure 11.

Figure 11. Suti Water System User Data Interface Display

Users can also access profile settings by clicking the profile photo in the top right corner of the screen. This action will open a display showing the user's detailed information and two buttons (to change the profile or password), as seen in Figure 12.

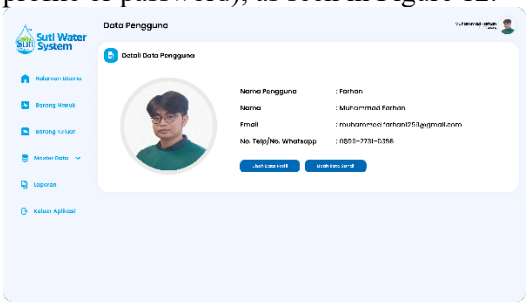

Figure 12. Suti Water System User Profile Detail Display

i. Report Page Prototype
"Users can print incoming or outgoing goods reports from the report display. To print the incoming goods report, they can select the date range and then click the 'Apply' button. This process is illustrated in Figure 13.

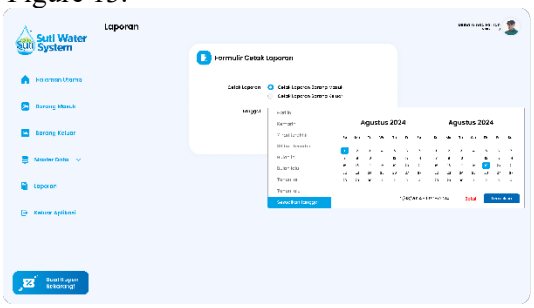

Figure 13. Suti Water System Report Interface Display

j. Discount Coupon Page Prototype
Users can create discount coupons by filling in the required data on this display. This coupon will be automatically applied to buyers who meet the minimum purchase requirement on the outgoing goods display, as shown in Figure 14.

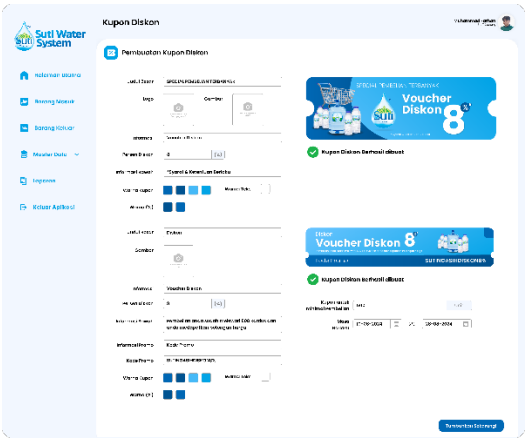

Figure 14. Discount Coupon Interface Display

3.4 Results of Evaluation Against Requirements

The researcher calculated the System Usability Scale (SUS) score from the questionnaire, which typically has a response value range of 1 to 5, resulting in a final score range of 0 to 100. The calculation method involved the following conversion: The researcher subtracted one from the respondents' choice value for the odd-numbered items (1, 3, 5, 7, and 9) (X-1). Conversely, the researcher subtracted the choice value from five for the even-numbered items (2, 4, 6, 8, and 10) (5-X). The final SUS score was determined by summing all the converted scores and multiplying the total by a factor of 2.5. The results of this calculation are presented in Table 3.

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Table 3. Calculated Questionnaire Data Scores

No	Response	Total	Value (Total x 2.5)
1	Response 1	37	93
2	Response 2	37	93
3	Response 3	36	90
4	Response 4	37	93
5	Response 5	37	93
6	Response 6	37	93
7	Response 7	37	93
8	Response 8	37	93
9	Response 9	37	93
10	Response 10	37	93
Total Sum of Scores			**930**
Average Score (Final Result)			**93**

The average score of 93 is shown in the table above. We compared this score with a benchmark line at the value of 85 to determine its position within each interpretation category, allowing us to understand how the average score is placed in the context of different comprehension categories.

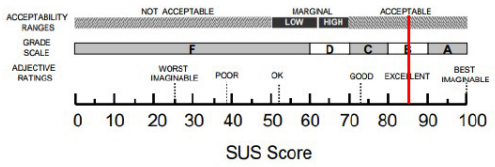

Figure 16. Calculated SUS Score Result

Based on the calculation from 10 respondents, the total SUS score obtained was 930, yielding an average value of 93. Further analysis indicated that the application falls into the 'Acceptable' category according to the Acceptability Range. Furthermore, the system achieved a Grade B on the Grade Scales and was rated 'Excellent' in the Adjective Rating. These findings indicate that the system has an excellent level of usability, is able to meet user needs, and exceeded user expectations.

3.4.1 Comparative Analysis of Operational Performance

This analysis aimed to measure the work time efficiency of the warehouse staff after implementing the Suti Water application, compared to the manual recording system. The testing was conducted by recording the average time required for 10 respondents to complete an identical set of tasks (e.g., inputting 10 incoming goods transactions and inputting 10 outgoing goods transactions)..

Table 4. Comparison of Transaction Recording Time Efficiency

Work Process	Average Time
Manual System (T-old)	1530 seconds (25 minutes 30 seconds)
Digital Application (T-new)	153 seconds (2 minutes 33 seconds)

The work time efficiency improvement (Efficiency, E) was calculated using the following formula:

$$E = \frac{\mathrm{T}\ old - \mathrm{T}\ new}{\mathrm{T}\ old} \times 100\%$$

Based on the data from Table 4, where T old is 1530 seconds and T new is 153 seconds, the efficiency calculation is as follows:

$$E = \frac{1530 \text{ seconds} - 153 \text{ sesonds}}{1530 \text{ seconds}} \times 100\% = 89.9\%$$

The calculation results indicate that the Suti Water System application yielded a transaction recording time efficiency improvement of 90% (rounded from 89.9%).

3.4.2 Causal Analysis of Key Features

The total SUS score of 93 validates that the prototype design successfully met user requirements. A causal analysis was conducted to identify which key features most influenced this high score. Generally, the high score stems from two aspects of the SUS:

1. Usability Aspect: The high scores on odd-numbered items (Q1, Q3, Q5, Q7, Q9) directly correlate with the Linear and Responsive Dashboard Design (UI). The clean design allows warehouse staff to instantly access critical data (Real-time Stock Overview) without navigating through multiple pages. The Quick Report Feature also contributes to the perception that the application 'is very easy to understand and can be used immediately' (Q3), as users can export data without the need for complicated coding or queries.

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2. Learnability Aspect: The high ease of learning, reflected by the low scores on even-numbered items (Q2, Q4, Q6, Q8, Q10), is closely related to the Error-Prevention and Guided Input features. The application eliminates free text input in critical fields (such as product name or code). Users are required to select from validated dropdown menus. This design directly addresses data inaccuracy and enhances interface clarity, thereby resolving the issue of the application being 'unclear and often confusing' (Q8), because users are automatically guided into the correct workflow.

3.4.3 Comparison of SUS Results with Similar Application Studies

The discussion of the results was evaluated contextually by comparing the SUS score of the Suti Water System application (93) with similar studies that also measured the usability of management or inventory applications:

Table 5. Comparison of SUS Results with Similar Application Studies

Comparative Study	SUS Score	Category	Source
Penerapan UCD (User Centered Design) Pada Perancangan Sistem Informasi Manajemen Aset TI Berbasis Web di Bid TIK Kepulauan Riau	87.2	Excellent	[2]
UI/UX Design of Web-based Software License Management System using User-Centered Design and System Usability Scale	86.25	Excellent	[4]
Design of suti water system inventory application using the user-centered design (ucd) method	**93.00**	**Excellent**	**Researcher**

The score of 93 achieved by the Suti Water prototype is significantly above the scores of comparative studies, which ranged from 86.25 to 87.2. This score difference, which reaches 5 to 6 points, demonstrates the design superiority resulting from the strict application of the UCD methodology.

4. CONCLUSION

This research successfully designed and developed a prototype for the Suti Water System inventory management application using the User-Centered Design (UCD) methodology as a solution to the manual recording problems that were prone to inaccuracy and data delays. The success of this study is confirmed through two main contributions:

1. Usability Success: Evaluation using the System Usability Scale (SUS) yielded an average score of 93.0. This score places the prototype in the 'Acceptable' category with an 'Excellent' adjective rating, strongly validating the successful implementation of UCD principles and ensuring the system will be accepted and easy to use by warehouse staff.
2. Operational Performance Improvement: The application made a significant contribution to increasing the efficiency of the inventory process at Suti Water. Based on the comparative analysis, the digital prototype was able to increase the average transaction recording time efficiency by 90% (compared to the manual system), while eliminating the risk of human error caused by free text input.

For the further development of the Suti Water System application, the following are recommended:

1. Stock Forecasting Integration: Develop a demand forecasting feature using statistical methods (Time-Series Analysis) to support strategic decision-making regarding minimum stock and optimal restocking.
2. Mobile Platform Expansion: Expand the prototype into an Android/iOS-based mobile application format to enable real-time and on-site recording of stock transactions in warehouse locations that may be distant from desktop devices.

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3. Longitudinal Validation: Conduct a follow-up evaluation study for a minimum of six months after full implementation (live system) to measure the percentage reduction in actual data errors and the stability of the usability score over time.

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