

Human Computer Interaction Design in Web Based Warehouse Management Systems Using the Task Centered System Design (TCSD) Method

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Abstract

In the digital transformation era, web-based warehouse management systems play an essential role in ensuring operational efficiency, yet their effectiveness depends not only on functional accuracy but also on a user-centered interface design. This study aims to redesign the interface of Company XYZ's warehouse management system using the Task-Centered System Design (TCSD) method within the Human-Computer Interaction (HCI) framework. TCSD emphasizes mapping real user tasks, analyzing user-centered requirements, prototyping through scenarios, and conducting usability evaluations. Data were collected through direct observation, structured interviews, and literature review, followed by interface prototyping in Figma and testing with the Maze platform. Six main warehouse tasks login, item distribution, returns, receiving, cycle counting, and searching were evaluated with five participants. The results demonstrated a Task Success Rate (TSR) of 100% across all tasks, with the shortest average Time on Task (ToT) for login (7.89 seconds) and item search (8.58 seconds), and the longest for cycle counting (58.10 seconds). Click Rate (CR) and Error Rate (ER) varied depending on task complexity, with login and item search showing higher ER values, which were influenced by predefined task flows. Overall, findings confirm that TCSD yields a practical and measurable design aligned with user workflows, producing an interface that is efficient, user-friendly, and adaptable to warehouse operations. This research contributes to HCI studies by demonstrating the effectiveness of scenario-based design in logistics systems, while also highlighting the need for larger-scale usability testing in future work.

Keywords: HCI, UI, UX, TCSD, Warehouse Management System

1. INTRODUCTION

In today's digital era, web-based information systems play a crucial role in supporting the operational efficiency of companies, including those in the logistics and warehousing sectors [1]. Digital transformation encourages companies to integrate information technology across the entire business process chain, ranging from transaction recording, stock monitoring, goods distribution, to performance reporting [2]. The systems developed are expected not only to manage data accurately and in real-time but also to facilitate user interaction when accessing, processing, and utilizing that information [3].

The performance of an information system is determined not only by its functional capabilities, but is also heavily influenced by the quality of the User Interface (UI) and User Experience (UX) [4]. An intuitive UI can minimize staff

training time, reduce the risk of data input errors, and accelerate work processes [5]. The international perspective also highlights the importance of HCI in the context of modern industry. Research [6] emphasizes that human-machine interaction is a key element in the implementation of Industry 4.0, as the quality of human-system interaction greatly influences technology adoption. In line with this, other studies have found that the application of HCI in operator assistance systems can improve work efficiency and reduce operational errors [7]. Meanwhile, research [8] highlights the effectiveness of task-based simulations using digital twins in improving supply chain communication.

On the other hand, suboptimal UI/UX design can hinder technology adoption, decrease productivity, and even cause resistance among internal users [9]. This becomes critical in the context of warehousing, where even small mistakes in



managing product data can impact the entire supply chain. Even in small-scale retail sectors, the implementation of web-based information systems has proven to increase stock accuracy, expedite record-keeping processes, and reduce the risk of errors that could harm business operations [10].

A study [11] emphasizes that designing UI based on users' actual workflow can enhance ease of use, with the implementation of Task-Centered System Design (TCSD) resulting in high usability scores. This approach not only focuses on visual aesthetics, but also ensures that every interface element is aligned with the real needs and workflow of users. In an educational context, research [12] applied TCSD to redesign e-learning interfaces and proved that accurate mapping of user tasks has a positive impact on design effectiveness, demonstrating the flexibility of this method across different application domains.

The application of TCSD in the public service domain has also been demonstrated by research [13] that designed the interface for a company's official residence auction system and evaluated it using the Maze platform, yielding a usability score of 84. This result shows that combining task-based design with scenario-based testing can provide objectively measurable results. Research [14] combined TCSD with the User Experience Questionnaire (UEQ) to develop a website interface and showed that a task-based approach can provide a quantitatively satisfying user experience, including in aspects such as navigation comfort, ease of understanding, and usage efficiency.

In the context of mobile application development, a study [15] indicated that TCSD-based design can improve the efficiency of user interactions by focusing on the needs of specific daily tasks. This advantage affirms that TCSD can produce interfaces that adapt to different interaction patterns on each platform. Similar applications in the e-commerce sector [16] have also proven that aligning UI features with user business process flows can improve the relevance of the design to company operations, which ultimately impacts user satisfaction and productivity.

Similar research [17] demonstrated that TCSD can be integrated with real-data-based testing using Maze, resulting in objective metrics such as Task Success Rate (TSR), Time on Task (ToT), and Error Rate (ER) to measure interface effectiveness. This integration allows system designers to iterate on designs based on concrete data rather than assumptions, thus minimizing the risk of design errors at the implementation stage.

Recent international reviews also support the use of task-based approaches in industrial and logistics systems. Research [7] underscores the added value of HCI in supporting operators in manufacturing systems, whereas research [8] proves that task-centered process simulations can enhance logistics coordination through the application of digital twins. These findings strengthen the rationale for using TCSD in this research.

The TCSD method has been widely used in information system development across various sectors [18], but there are still limited studies specifically implementing it in web-based goods management systems in the logistics sector. In fact,

warehousing system characteristics require speed, accuracy, and ease of user interaction in various processes such as receiving goods, distribution to technicians, stock searching, and periodic inventory counting [19]. These needs demand a design method capable of mapping out users' actual workflows in detail to be translated into efficient interface designs.

The object of this study is the web-based information system at XYZ Company's Warehouse, which is used to support goods distribution, returns, stock-taking, and inventory searches. Observations revealed problems in the interface, such as a less modern appearance, non-intuitive navigation, and the absence of a stock-taking report printing feature in Excel format, which complicates the archiving and reporting process. To address these issues, a redesign of the interface is proposed using TCSD, emphasizing the mapping of users' actual task flows. [18]

Based on these various studies, a redesign of the web-based Warehouse Management System UI is needed to result in a user-friendly Warehouse Management System. Although many approaches have been applied, most still focus on visual and technical aspects without directly mapping user needs based on their actual daily activities. Thus, this research falls within the realm of human-computer interaction (HCI) because it emphasizes designing interactions between users and web-based warehouse management systems. The research focuses on redesigning the interface using the TCSD approach to align with actual workflows, resulting in a more effective, efficient, and user-friendly experience.

Although the Task-Centered System Design (TCSD) method has been widely applied in domains such as e-learning and e-commerce, its implementation in web-based warehouse management systems remains limited. The main advantage of TCSD in this context lies in its ability to adapt interface design to the actual workflow of warehouse users, where operational complexity and time sensitivity are critical. Therefore, this study contributes to the Human-Computer Interaction (HCI) field by demonstrating how task-centered design can be effectively utilized to enhance efficiency, usability, and data accuracy within logistics and warehousing environments.

II. RESEARCH METHODOLOGY

This study adopts the Task-Centered System Design (TCSD) method in the process of designing a web-based warehouse management information system interface at Company XYZ. TCSD was chosen because this approach focuses on user needs based on real tasks (task-driven), making the resulting design more contextual and aligned with actual work processes in the operational environment. Compared to traditional approaches that are oriented toward technical features, TCSD is more effective in designing UI/UX, as it considers users' specific activities as the basis for interface design [8].



Task-Centered System Design (TCSD)

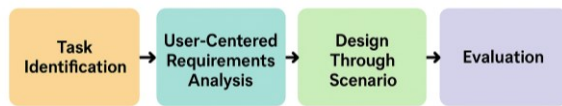


Figure 1. TCSD Method Stages

Figure 1 explains Task-Centered System Design (TCSD), which is an interface design method that focuses on mapping users' real tasks as the foundation for system design. TCSD consists of four main stages: Task Identification, User-Centered Requirements Analysis, Design Through Scenario, and Evaluation [18]. The main advantage of TCSD lies in its practical and measurable nature, as designs are tested using real scenarios, resulting in a system that better meets user needs [20].

Data collection in this study was conducted through three main methods. First, direct observation of warehouse operational activities was carried out to understand the workflow of the system and user interactions with the existing interface. Second, structured interviews with Warehouse staff were used to explore user needs and complaints regarding the information system in use. Third, a literature study was conducted on relevant scientific journals and technical documentation of previous systems to strengthen the theoretical framework and provide comparative analysis.

A. Task Identification

The first stage aims to identify users' main tasks within the context of the current system. This process was carried out through direct observation and interviews with warehouse staff and technicians to map activities such as login, goods distribution, goods receipt, stock counting (cycle count), and item data search. A similar approach has been applied in studies on hospital management systems to understand scenario-based user needs [19]. This study presents the task flow in a concise form to maintain readability and space efficiency in the journal manuscript. Each button click is considered to include page transitions that occur in the UI/UX design, although the details of these transitions are not explicitly shown. This simplification does not diminish the integrity of the tested interaction flow.

B. User Centered Requirements Analysis

After the tasks are identified, the next stage is to analyze user requirements. In this phase, the necessary interface elements to support task completion are mapped. Representations such as user personas and task flow diagrams are used to describe user characteristics and workflows. This stage also serves to simplify the interface both functionally and visually. The systematic implementation of these steps has been discussed in studies on UI development for TCSD-based e-learning applications [12].

C. Design Through Scenario

The interface design is developed based on real user interaction scenarios with the system. Interactive prototypes

are created using Figma, with elements that reflect the actual workflows of warehouse staff and technicians. This scenario-driven principle is crucial to ensure cohesion between the design and its context of use [17]. UI design studies for humanitarian organizations and point of sale applications have shown the effectiveness of this approach in tailoring designs to users' specific needs [21].

D. Evaluation

In the fourth stage of the Task-Centered System Design (TCSD) method, namely the Evaluation stage, this study used the Maze platform as a tool to evaluate the usability of the interface prototype designed in Figma. The Maze platform enables scenario-based testing, allowing users such as warehouse staff or technicians to interact directly with the prototype to complete a series of tasks that reflect real usage conditions. This evaluation yields quantitative data such as Task Success Rate (TSR), Time on Task (ToT), Error Rate (ER), and Click Rate (CR) as shown in Formula 1-4. The evaluation adopts the same approach as studies evaluating shared-service ICT systems that resulted in high usability scores [22].

- Task Success Rate (TSR)

$$TSR = \frac{\text{Number of tasks successfully completed}}{\text{The total number of tasks given}} \times 100\% \quad (1)$$

- Time on Task (ToT)

$$ToT = \text{Average time required to complete one task} \quad (2)$$

- Error Rate (ER)

$$ER = \frac{\text{The number of errors that occurred}}{\text{Total number of interactions}} \times 100\% \quad (3)$$

- Click Rate (CR)

$$CR = \text{Number of clicks made to complete a task} \quad (4)$$

The number of participants in this test was five people, consisting of two warehouse admins and three internship students who had previously been directly involved in warehouse operational activities. This number was chosen based on recommendation that five users are sufficient to identify most system usability problems [23]. In addition to efficiency considerations, the composition of participants was also selected to represent two main user groups: regular users (admins) and temporary users (technicians/interns), so that the test results could reflect the variations of interactions occurring in the actual work environment.

III. RESULT AND DISCUSSION

This section presents the results of system interface design and evaluation based on the main stages of the TCSD method.

A. Task Identification

The first stage of the Task-Centered System Design (TCSD) method is Task Identification, which involves identifying the main tasks performed by users within the context of the ongoing system. At the XYZ Company Warehouse, observations and interviews with warehouse staff revealed a number of key activities that are routinely carried out in goods management. The following Table 1 is the identified User Tasks.

Table 1. Task User Identification

Task User	Description
Logging In	The user logs in using their registered account on XYZ Company.
Distribution to Technician	Users who want to assign items to technicians record the outgoing items to the technicians in the system. In this task, users can print a Handover Report as documentation for the transfer of items to the technician.
Return from Technician	Users who receive items back from the technician record the receipt of items into the system, including their condition whether damaged, used but still usable, or unused.
IDO Receiving	Users record the receipt of items from the central warehouse or from another warehouse into the system.
Cycle Counting	Users check items and reconcile the physical inventory in the warehouse with the data in the system.
Searching Item	Users monitor or check item data or item status.

Based on field findings, although the web-based warehouse information system used by Company XYZ already supports most of these activities, there are still significant limitations. One of these is the absence of a feature to print stock opname (inventory count) reports in Excel format, which forces warehouse staff to record manually for reporting purposes. Additionally, the current system interface appears somewhat outdated and the navigation is not entirely intuitive, thereby slowing down the recording and distribution process of items.

B. User Centered Requirements Analysis

The second stage is User-Centered Requirements Analysis, which aims to analyze user needs based on the main tasks identified in the previous stage. This analysis focuses on mapping out the interface elements that users need to complete their tasks, so that the designed system truly supports actual workflows.

Observations and interviews with warehouse staff at Company XYZ reveal several important needs related to the system in use. First, a simple and fast login interface is necessary so that users can quickly access the system without technical difficulties. Furthermore, forms for recording incoming and outgoing items need to be made more concise, with support for automatic searches based on item codes. In

terms of navigation, the system is expected to have a more intuitive menu structure following workflow, such as incoming, outgoing, return, stock opname, and reporting. The item search feature also needs to be responsive so that staff can quickly find inventory information using only keywords. Equally important, the system should provide a feature to print stock opname reports in Excel format to facilitate archiving and formal reporting processes. Lastly, the visual design of the interface is expected to be more modern and consistent, so that it is not only functional but also comfortable to use.

This analysis is also presented in the form of user persona representations and task flow diagrams to describe the characteristics of users (warehouse staff and technicians) as well as their workflows. These representations form the basis for designing interfaces that do not focus solely on technical features, but also on user experience. Thus, the results of this requirements analysis will serve as a reference for the next stage, namely Design Through Scenario, where the interface prototype begins to be developed based on the user interaction scenario workflows. The following are task flow diagrams for each feature.

1. Login

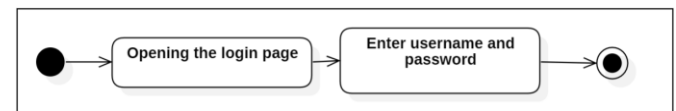


Figure 2. Login Task Flow

This task flow (Figure 2) illustrates the process of users logging into the system. The process starts with opening the application, entering email and password, after which the system verifies the entered data. If successful, the user is directed to the main dashboard. This process ensures that only verified users can access the system.

2. Distribution to Technician

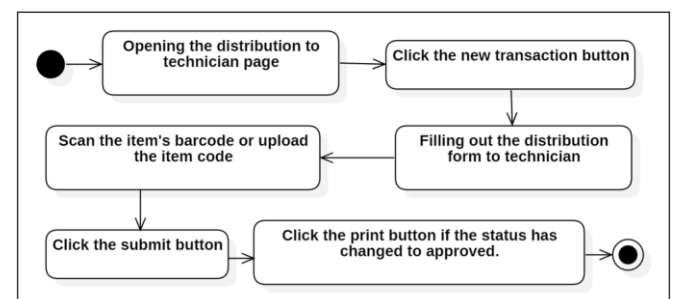


Figure 3. Distribution to Technician Task Flow

This flow (Figure 3) shows the distribution of items or components from the warehouse section to the technician. Starting with a request for items by the technician, the warehouse officer enters items by ID or name, then processes the distribution by recording it in the system. Once the process is complete, the items can be handed over to the technician. The system logs each step for tracking purposes.

3. Return from Technician

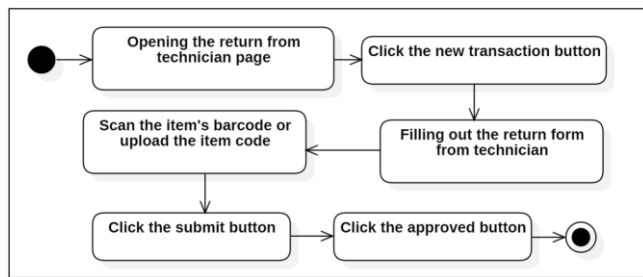


Figure 4. Return from Technician Task Flow

This task flow (Figure 4) explains the return of items from the technician to the warehouse. Items that have been used or were not used are returned to the warehouse. Officers check the condition of the items, record their status (good, damaged, or unserviceable), and then enter the return data into the system to update the stock database.

4. IDO Receiving

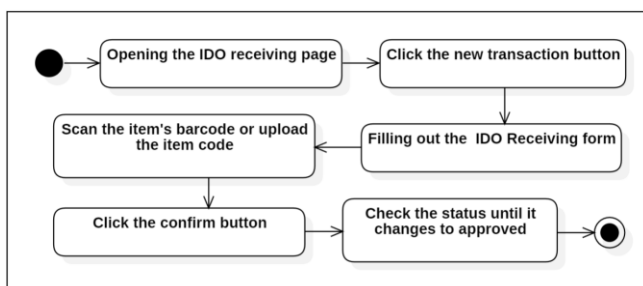


Figure 5. IDO Receiving Task Flow

IDO (Internal Delivery Order) Receiving (Figure 5) is the process of receiving items from the internal logistics party. This task flow covers steps starting from verifying the IDO, checking the received items against the list in the system, to updating the stock data in the system once the items have been fully received. This process is important to maintain inventory accuracy.

5. Cycle Count

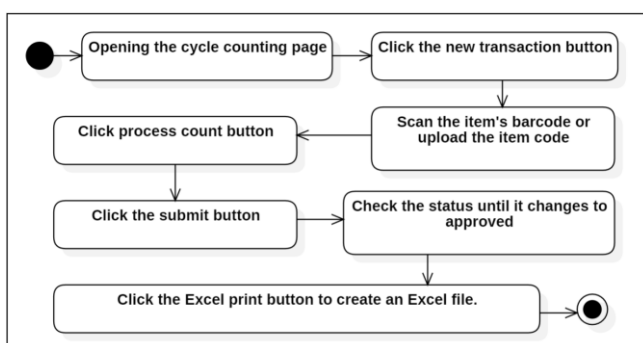


Figure 6. Cycle Count Task Flow

This flow (Figure 6) illustrates the process of periodic physical inventory counting (stock opname) over a certain

period (cycle count). Starting from determining the area/group of items to be counted, recording the physical quantity, and then comparing it with the system data. If there are discrepancies, an investigation and data adjustment in the system will be conducted to maintain stock integrity.

6. Searching Item

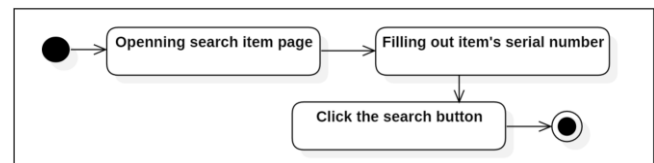


Figure 7. Searching Item Task Flow

This task flow (Figure 7) shows the process of searching for items in the system. Users can enter the item ID to search for items. The system displays search results in real-time, complete with information such as storage location, stock quantity, and item status. This feature makes it easier for staff to find items quickly and accurately.

C. Design Through Scenario

The Design Through Scenario stage is carried out by creating an interface prototype based on real user interaction scenarios with the system. This process utilizes the results of Task Identification and User-Centered Requirements Analysis to ensure that the interface design is truly aligned with the warehouse staff's workflow. The prototype is designed using Figma, focusing on simplifying navigation, maintaining visual consistency, and ensuring that all functions needed for operations are complete.

1. Login

The login page is designed simply, with two main inputs (username and password) and a login button as shown in Figure 8. This design follows standard practices for operational information systems, emphasizing functionality and quick access. This approach aligns with TCSD principles, as it emphasizes the user's basic need: fast and secure access to the system before performing operational tasks.



Figure 8. Login Page Prototype

2. Main Dashboard

The main dashboard page serves as the main navigation center that directs users to the core features of the system as shown in Figure 9. From this page, users can choose between two main paths, namely the Technician Dashboard or the Dismantle Dashboard. This separation is not without reason, but rather reflects the reality of the workflow in the warehouse, where there are differences in responsibilities and functions between technicians and the dismantle department. Thus, from the very beginning of using the system, the interface directs users according to their respective roles and task scenarios. The main dashboard display is also designed with an emphasis on simplicity and visual clarity. With this approach, the system can reduce confusion and speed up the orientation process for new users.

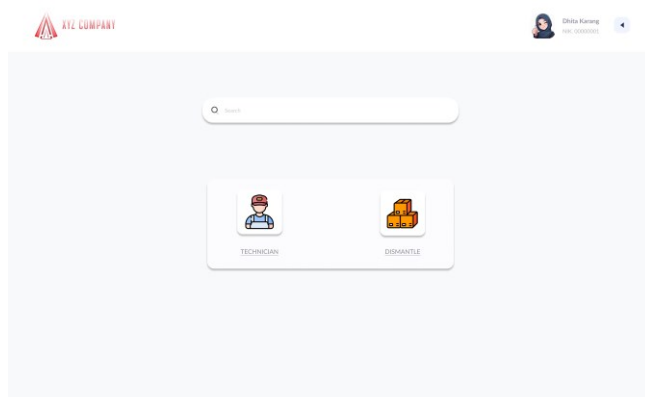


Figure 9. Main Dashboard Page Prototype

3. Technician Dashboard

The Technician Dashboard offers a visual summary of distribution and return charts, warehouse inventory status, and a warehouse location map, as shown in Figure 10. These visual components are designed not only to inform, but also to support quick decision-making by enabling users to immediately identify trends. For example, users can see the volume of goods distributed versus returned over time. Real-time inventory status ensures technicians always know stock availability, reducing the risk of misallocation or delays in distribution. The warehouse map enhances situational awareness by providing spatial context, making it easier to locate items or monitor storage capacity. The main navigation panel on the left seamlessly guides users to the Distribution and Return pages. The Dismantle Dashboard is intentionally designed similarly, with the only variation being the set of menu options. This uniformity exemplifies the principles of task-centered system design (TCSD), in which consistent interaction patterns across modules reduce the need for retraining and minimize user cognitive load.

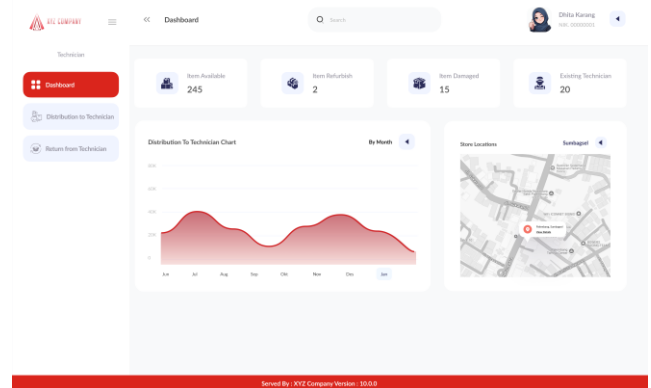


Figure 10. Technician Dashboard Page Prototype

4. Distribution to Technician Page

The distribution page displays a table containing a list of goods delivery transactions, both ongoing and completed, allowing users to monitor activity status in real time as shown in Figure 11. In addition, a New Transaction button is available, enabling users to quickly add new transactions without having to switch to another page. This design has been deliberately chosen to streamline workflows and provide transparency regarding warehouse activity history.

The structure of this distribution page is then reused on the Return, IDO Receiving, and Cycle Counting pages. As a result, users do not need to learn an entirely new interface pattern each time they switch tasks. The differences between pages lie only in the content of the data tables presented and the navigation menu on the left side, which dynamically adjusts according to each page's function. This consistency in the interface pattern aligns with the principles of Task-Centered System Design (TCSD), namely maintaining uniformity of interaction so that users can transfer experience from one task to another without any additional cognitive burden.

No	Transaction No	Warehouse Code	Warehouse Name	BU Code	BU Name	Technician Code	Technician Name	Transaction Date
1	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
2	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
3	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
4	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
5	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
6	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
7	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
8	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
9	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022
10	123456789	0101	LMBC	0101	BU KTU	100201	Zayyan	13/05/2022

Figure 11. Distribution Page Prototype

5. Distribution to Technician Form

This form contains details of item distribution transactions to technicians, such as technician name, item type, quantity, and location as shown in Figure 12. The structured layout is intentionally designed to minimize cognitive load by grouping related fields and ensuring that users can complete the process

in a linear and predictable manner. A similar form structure is applied to the Return Form, with only minor differences in the type of input required and the action buttons provided. This deliberate consistency across multiple transaction forms is aligned with the principles of Task-Centered System Design (TCSD), where uniformity in interaction patterns allows users to transfer knowledge from one task to another without additional learning effort.

Figure 12. Distribution Form Page Prototype

6. IDO Receiving Form

The IDO Receiving Form is designed to record items received from the central warehouse or other units as shown in Figure 13. Unlike distribution/return, this form focuses on data such as item source, condition, and quantity received. By providing a specific form, the system adapts the interface to the user's task needs, in accordance with TCSD principles.

Figure 13. Receiving New Form Page Prototype

7. Cycle Count Form

The Cycle Counting Form is used for periodic inventory recording as shown in Figure 14. This form is more complex as it involves many inputs for the results of physical counts to be compared with system data, along with an option to print reports in Excel format. This complexity represents a more complicated task scenario but can still be handled with a simple interface thanks to the TCSD approach.

Figure 14. Cycle Count New Form Page Prototype

8. Searching Item

The searching item page is designed to make it easier for users to find items based on ID or name as shown in Figure 15. Search results display storage location details, item status, and other relevant information. This feature supports warehouse operational needs to speed up information access, while also completing the item distribution, receiving, and recording task cycle

Figure 15. Searching Item Page Prototype

D. Evaluation

The evaluation was conducted using the Maze platform with 5 participants, consisting of 2 warehouse admins from Company XYZ and 3 internship students. The participants were asked to complete six main task scenarios that had previously been identified in the Task Identification stage, namely login, item data search, cycle counting, goods receiving (IDO Receiving), goods return from technicians, and goods distribution to technicians.

The results of the usability evaluation of the prototype are shown in Table 2. All scenarios were successfully completed with a Task Success Rate (TSR) of 100%, indicating that each participant was able to finish all tasks without failure. The tasks with the fastest Time on Task (ToT) were login with an average of 7.89 seconds and item data search with an average of 8.58 seconds, showing that both basic functions are quite intuitive. Conversely, the tasks with the longest ToT were cycle counting with an average of 58.10 seconds, followed by goods distribution to technicians with an average of 48.31

seconds, which is reasonable since both involve more complex data entry processes.

Table 2. Prototype Usability Evaluation Results Using Maze

Task Scenario	TSR (%)	ToT (seconds)	Click Rate	Error Rete (%)
Logging In	100	7.89	4.73	77.27
Distribution to Technician	100	48.31	17.82	11.05
Return from Technician	100	25.37	9.35	2.17
IDO Receiving	100	39.14	21.15	8.53
Cycle Counting	100	58.10	18.10	8.99
Searching Item	100	8.58	5.00	37.50

From the perspective of Click Rate (CR), login and item search required relatively few interactions, whereas IDO Receiving (21.15 clicks) and cycle counting (18.10 clicks) demanded more interaction. Goods distribution to technicians was also a fairly complex task, with an average of 17.82 clicks. In terms of Error Rate (ER), the highest was found in login at 77.27% and item search at 37.50%. These values do not entirely indicate user confusion, but are more due to test scenarios that required participants to follow a specific task flow, resulting in additional interactions being recorded as errors. On the other hand, goods return from technicians showed the lowest ER at 2.17%, indicating that its flow is clearer and easier for users to follow.

The test results show that all task scenarios were successfully completed, with a Task Success Rate (TSR) reaching 100%. This confirms that the interface design developed using the TCSD method is capable of supporting the completion of all core warehouse activities without significant obstacles. Nevertheless, quantitative data from Time on Task (ToT), Click Rate (CR), and Error Rate (ER) provide a more detailed picture of user interaction patterns that are important to analyze.

In the login scenario, an Error Rate (ER) of 77.27% was recorded. This figure does not point to a design weakness, as the login page follows common practices of web-based information systems. The high error percentage is more related to the testing method, where every additional click or attempt outside the ideal scenario was counted as an error. In other words, extra interactions by participants do not indicate system failure but rather reflect variations in how users complete the task. This finding aligns with the perspective presented in [6], which states that systems with rigid interaction flows often result in higher error recording, even though the tasks can still be completed functionally.

For the item searching feature, the Error Rate is also relatively high (37.50%). This is not due to poor interface design, but rather participants' tendency to try various keywords to find items. This pattern suggests that the search function is readily accessible, but users naturally interact more dynamically than dictated by the testing scenario. A similar

phenomenon is observed in task-centered design-based logistics research, where additional interactions often occur during data search processes but do not reduce task success [8].

Conversely, in more complex scenarios such as distribution to technician and cycle counting, the Error Rate is relatively low (11.05% and 8.99%). This demonstrates that even though these scenarios involve more steps and interactions, workflows structured with TCSD are able to guide users clearly. This result is consistent with findings in [7], which emphasize that task-oriented HCI design can reduce errors even in highly complex processes.

In relation to international literature, this study's findings support the conclusion that a task-based approach is effective in improving efficiency and user experience. Research has shown that task-centered simulations using digital twins can enhance supply chain coordination [8]. This research demonstrates the same consistency, proving that TCSD not only makes warehouse management systems easier to use, but also generates measurable data that can be used for continuous improvement.

Furthermore, in comparison with the company's previous warehouse system which featured less intuitive navigation and lacked an Excel export option for stock-taking reports the redesigned TCSD-based interface demonstrated clear improvements in usability and efficiency. Post-test interviews revealed that participants found the new interface more straightforward and responsive, with faster access to key functions such as item searches and transaction recording. These findings confirm that the redesigned interface not only enhances user satisfaction but also reduces operational errors and manual workloads relative to the legacy system.

Overall, the test results confirm that the TCSD-based interface design aligns with the operational needs of the warehouse. The variations in error rate that emerged were more influenced by user interaction patterns in the testing scenarios rather than design shortcomings, thereby supporting the conclusion that the system has achieved a high level of usability while also providing objective feedback for future development.

IV. CONCLUSION

This study successfully designed a web-based warehouse management information system interface prototype for Company XYZ by applying the Task-Centered System Design (TCSD) method as one of the approaches in Human-Computer Interaction (HCI). The research results show that all main warehouse task scenarios namely login, distribution of goods to technicians, return of goods from technicians, receiving goods (IDO Receiving), cycle counting, and item data search could be completed by participants with a Task Success Rate (TSR) reaching 100%. Evaluation data through the Maze platform indicated that the shortest durations were for login with an average of 7.89 seconds and for searching items with an average of 8.58 seconds, while the most complex tasks were cycle counting with an average time of 58.10 seconds and IDO

Receiving with 39.14 seconds. The Error Rate (ER) values varied from 2.17% to 77.27%, which were partly influenced by the task flow-based testing scenarios.

The main strength of this study lies in the implementation of TCSD, which has proven to produce an interface design that meets the real needs of warehouse users, while also contributing to the field of HCI by emphasizing the importance of alignment between user workflows and interface design. The quantitative evaluation using Maze is also an added value, as it provides an objective overview of the prototype's performance. However, a limitation of this research is the relatively small number of participants, so the evaluation results do not yet fully represent a broader user population.

For future research, it is recommended to conduct testing with a larger and more diverse number of participants to increase the validity of the results, as well as to further develop the system to the actual implementation stage so that the effectiveness of the design can be directly tested in the daily operational context of the warehouse. Thus, this study can serve as a foundation for further development in the application of the TCSD method in web-based information systems in the logistics and warehousing sectors, focusing on HCI principles.

From a practical perspective, this research offers broader implications for the logistics and supply chain sectors. The Task-Centered System Design (TCSD) approach can serve as a reference model for other organizations aiming to develop web-based warehouse management systems that are more adaptive to user operational needs. Furthermore, the task-oriented design principles can be extended to multi-warehouse and distribution network systems to enhance efficiency, minimize recording errors, and accelerate decision-making processes across different operational levels.

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