

Improving User Experience on Satellite Service Applications in Indonesia through Heuristic Walkthroughs and Prototype Development

Irwan Susanto ¹, Muhammad Eka Purbaya ^{2*}, Nabila Noor Qisthani ³, Nadira Belinda ⁴,
Fahtoni Sigit Kurniawan ⁵

^{1,2} Department of Digital Business, Telkom Institute of Technology Purwokerto, Central Java, Indonesia

^{1,2} Department of Digital Business, Telkom University, Central Java,

³ Department of Supply Chain, Telkom University, Central Java, Indonesia

⁴ Vocational School, Bogor Agricultural University, West Java, Indonesia

⁵ Transponder Assurance, Service Operation Unit, PT Telkom Satellite Indonesia

¹ irwans@telkomuniversity.ac.id, ² mekapur@telkomuniversity.ac.id, ³ nabilaqisthani@telkomuniversity.ac.id,

⁴ ndrbelinda@apps.ipb.ac.id, ⁵ fahtoni.sigit@telkomsat.co.id

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Abstract:

Introduction: The evaluation and optimization of user experience (UX) in high-tech applications, such as satellite service platforms, is of great importance. The Transponder Operation & Management System (TOMS) is a specialized application designed to support satellite transponder capacity management. While functional, early versions of the application exhibited various usability challenges, necessitating iterative development and thorough evaluation.

Objectives: This research aims to identify usability issues with the existing TOMS app and develop an improved prototype. The focus was on improving the user experience by improving navigation, design consistency, and feature accessibility.

Methods: The Heuristic Walkthrough method, which includes Guideline Checking, Heuristic Evaluation, and Cognitive Walkthrough, was used to evaluate the initial application and develop subsequent prototypes. Feedback from six evaluators during the two development phases guided improvements to aspects of accessibility, system visibility, and interface design

Results: The initial evaluation identified issues such as inconsistent navigation, lack of system feedback, and sub-optimal layout of core features such as dashboards and payload management. The developed prototype successfully improved these aspects by integrating a more intuitive navigation system, consistent visual design, and better accessibility through dropdown menus and interactive tooltips. Follow-up evaluations showed significant improvements in usability and user satisfaction

Conclusions: This research confirms the importance of iterative heuristic-based UX evaluation in developing high-tech applications. The improved TOMS application provides a relevant development model for satellite service platforms and has wider application potential in related fields. Further research is recommended to explore the scalability and adaptability of user-centered design for similar technical environments.

Keywords: cognitive walkthrough, usability evaluation, heuristic walkthrough, user experience optimization, satellite service platform.

1. Introduction

The digital era has brought about major changes in the way information technology services are used in various sectors, including satellite services. In this context, service providers rely not only on physical infrastructure but also digital-based applications that simplify service management and access

for users. The Transponder Operation & Management System (TOMS) application, developed by PT XYZ, is one example of an application that allows customers to monitor and manage their satellite transponder capacity. The application provides important information such as total capacity, utilized capacity, reserved capacity, as well as fault detection. However, with the growing customer expectations of user experience, applications like TOMS require a thorough evaluation to ensure their continued relevance in a competitive market.

Many studies have shown the importance of user experience (UX) in determining the success of an application. According to Nielsen, heuristic principles, such as visibility of system status, congruence with the real world, and design consistency, are key elements to ensure applications are well received by users (Jacobsen, 1999). Meanwhile, (Spencer, 2000; Wharton Cathleen et al., 1994) highlights that user task analysis through the Cognitive Walkthrough method can help identify barriers in user understanding of application interfaces. These studies show that integrating heuristic principle-based usability evaluation approaches and cognitive simulation can provide more holistic results in understanding and improving UX in digital applications.

Although TOMS had been designed to meet the customer's needs in managing satellite transponder capacity, an internal analysis of XYZ revealed that the application did not meet the expected minimum functionality standards. In addition, benchmarking results showed a gap between the features provided by TOMS and similar applications in the market. This mismatch posed a serious challenge in creating a cohesive user experience. As a result, users reported difficulties in understanding the app interface, which resulted in decreased customer satisfaction. Therefore, this study aims to evaluate the usability of TOMS and provide data-driven improvement recommendations.

In dealing with this problem, usability evaluation using a combination of Heuristic Evaluation (HE) and Cognitive Walkthrough (CW) methods is a promising approach. This combination combines the advantages of HE, which focuses on problem identification based on heuristic principles, with CW, which evaluates the cognitive processes of users while interacting with the system. HE allows evaluators to efficiently identify problems by using well-established heuristic standards (Jiménez et al., 2012), while CW provides insight into the context in which the problem arises through simulating the user's steps in completing the task (Caroline et al., 2023). This approach results in a more holistic understanding of usability, which is particularly relevant in the context of high-tech applications such as satellite services.

The advantage of the combination of HE and CW also lies in its ability to identify complex usability problems and suggest practically applicable solutions. Previous research shows that this combination can assist in addressing unique technical challenges, such as complex user interfaces and the need for real-time data processing in satellite service-based applications (Ebnehoseini et al., 2018; Sinabell & Ammenwerth, 2022). By integrating these two methods, the evaluation not only focuses on problem recognition but also generates relevant and contextualized improvement recommendations. This makes it an ideal tool for ensuring optimal user experience in integrated satellite service applications.

However, there is still a gap in the application of HE and CW combination in satellite service applications in Indonesia. Most existing research focuses on high-tech systems in general, while satellite service applications with unique challenges and user needs have not received sufficient attention (Rajananen, 2021). In the Indonesian context, where cultural differences and technological needs may affect user interactions, this research aims to adapt HE and CW approaches to reflect local

needs. Thus, this research not only fills the gap in the literature but also makes a practical contribution in improving user interface design for integrated satellite service applications.

This study aims to fill this gap by evaluating the usability of TOMS using a combined Heuristic Evaluation and Cognitive Walkthrough approach. The novelty of this study lies in the application of the combined evaluation method in the context of a satellite service application that has complex technical features. By providing recommendations for improvement based on the evaluation results, this study is expected to support PT XYZ's efforts in developing the TOMS application to be more intuitive, efficient, and responsive to user needs, and strengthen the company's competitiveness in the era of digital transformation. The scope of this study includes usability evaluation of TOMS, prototype development based on the improvement recommendations, as well as prototype validation to ensure that the proposed changes have a positive impact on user experience.

2. Methods

This research methodology is designed to evaluate the *usability of the Transponder Operation & Management System (TOMS)* application using the *Heuristic Walkthrough* approach. This approach combines *guideline checking*, *heuristic evaluation*, and *cognitive walkthrough* methods, which have proven effective in identifying usability problems and providing data-driven improvement solutions (Alhammad & Moreno, 2022; Leßenich & Sobernig, 2023). The research flow is adapted to the stages shown in figure 1, which consists of several logically structured main steps.

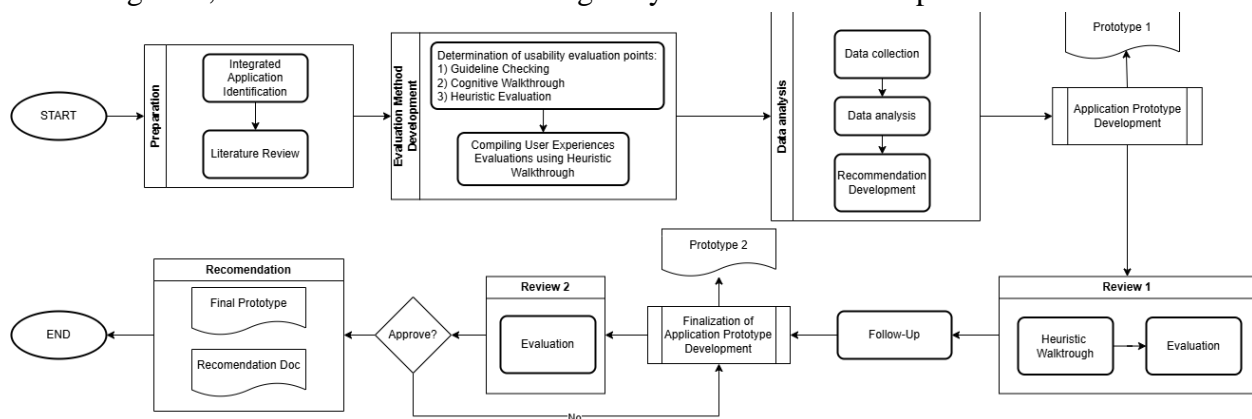


Figure 1. Research flow

The research began by identifying the TOMS application, which monitors satellite transponder capacity with advanced technical features requiring efficient user interaction. Interviews and internal document analysis at PT XYZ revealed key usability challenges, which were further explored through a literature review on usability evaluation methods, including heuristic walkthroughs applied to high-tech applications (Sari et al., 2021). The evaluation focused on three approaches: guideline checking to ensure adherence to Nielsen's principles, heuristic evaluation by experts to identify usability violations, and cognitive walkthroughs to assess the interface's learnability and task effectiveness. An evaluation protocol was developed, guiding evaluators through tailored tasks specific to TOMS's features. Data collection involved direct observation and documentation of usability issues, which were analyzed using Nielsen's severity scale to identify patterns and prioritize improvements. Based on the analysis, a prototype was developed to address issues related to system status visibility, interface consistency, and navigation flow. Validation through heuristic walkthroughs confirmed the

effectiveness of these improvements, and the prototype underwent iterative refinements based on formal reviews before finalization. The research culminated in a recommendation report detailing identified problems, proposed solutions, and their impact on user experience, providing PT XYZ with a practical guide for enhancing the TOMS application.

3. Results

Preparation

1.1. Application Identification

1.1.A. TOMS

The *Transponder Operation & Management System* (TOMS) application is a web-based management platform and mobile application designed to support the efficient management of satellite transponder capacity. TOMS was developed with key features to accommodate users' needs in managing, monitoring, and optimizing satellite services, especially those related to leased transponder capacity. The application has four main modules, namely **Dashboard**, **Payload**, **Carrier**, and **LFT**, which are designed to provide specific and integrated functions.

1. Dashboard

The Dashboard module provides a summary view of the leased satellite transponder capacity. The main function of this module is to present essential information regarding the capacity status in an easy-to-understand format, including:

- **Total Capacity:** The grand total of the leased transponder bandwidth.
- **Occupied:** Total transponder bandwidth that has been utilized.
- **Reserved:** Total reserved transponder bandwidth.
- **Interference:** The total transponder bandwidth that cannot be used due to interference or other technical disturbances.

This module is designed to help users quickly understand resource allocation and make data-driven decisions for operational needs.

2. Payload

The Payload module serves to display lease bandwidth allocation blocks based on the satellite and transponder used. Key features in this module include:

- **List of Payload:** Provides payload allocation details, including information such as Payload ID, payload type (utilized, idle, booked), start and end frequency, bandwidth, subscriber, and total carrier.
- **Search Payload:** Allows users to search for a specific payload by ID or other criteria.
- **Export Data:** A feature to download payload data in Excel format, facilitating further management and analysis.

This module provides flexibility in managing information related to bandwidth usage by customers with structured details.

3. Carrier

The Carrier module provides a list of *carrier assignments* along with detailed parameters. This module plays an important role in ensuring that bandwidth allocation is optimized. Features in the Carrier module include:

- **List of Carriers:** Displays detailed information about Carrier ID, carrier type (inbound, outbound, SCPC), start and end frequencies, bandwidth, subscriber location, as well as technical parameters such as data rate, coding, and modulation.

- **Search Carrier:** Provides a search function based on carrier type, Carrier ID (CID), or specific location.
- **Export Data:** Carrier data can be downloaded into an Excel file for documentation or analysis.
- **License Carrier Transmitter:** Provides LFT information associated with the selected carrier, supporting the management of transmission license data.

4. LFT (Link Frequency Test)

The LFT module is an advanced feature for testing and monitoring carriers based on specific technical parameters. Key features in this module include:

- **Create LFT:** Allows users to create a frequency test by entering parameter details such as LFT ID, frequency, bandwidth, LFT type (new or repair), as well as test status.
- **List of LFTs:** Presents LFT data by satellite, transponder, status, or time range. Data provided includes LFT ID, type, location, technician, and test status (Not OK, In Progress, Submitted, Approved).
- **LFT Dashboard:** Displays the LFT queue as well as a list of technicians currently working on a particular LFT, providing transparency in the testing process.
- **LFT Not OK:** Provides information regarding LFTs that fail to meet specifications. Once corrections are made, retesting can be performed without creating a new LFT ID.

The module is designed to ensure the integrity of satellite services through standardized testing, minimizing the risk of interruptions in transmission.

With its four main modules, TOMS serves as a comprehensive solution for satellite transponder capacity management. It not only provides full visibility of managed capacity but also supports better decision-making through integrated search, reporting and data analysis features. Its modular approach and focus on user experience make TOMS an essential tool in ensuring the efficiency and reliability of satellite services across multiple sectors.

1.1.B. User Persona

User personas are a crucial tool in UX evaluation, particularly for high-tech applications like the Transponder Operation & Management System (TOMS). As representations of target user groups, personas help design teams understand user needs, behaviors, and goals, ensuring usability evaluations remain relevant. For TOMS, which manages satellite transponder capacity with complex technical features, personas are essential to tailor task scenarios that reflect real user experiences.

Personas also reduce evaluator bias by providing objective guidance, helping evaluators focus on user needs rather than personal assumptions. This is especially important for TOMS modules like Dashboard, Payload, Carrier, and LFT, where clear alignment with user expectations is critical. Personas bridge the gap between complex system designs and user needs, enabling the creation of intuitive and effective solutions.

Additionally, personas enhance empathy within the design team, improving the overall quality of the user experience. For example, technicians requiring precise data or managers needing real-time capacity reports benefit from designs informed by detailed personas. In the case of TOMS, the persona "John," a 27-year-old IT professional managing satellite-based communication infrastructure, faced issues like bandwidth reductions, lack of disruption notifications, and unclear repair timelines. These challenges emphasized the need for a solution offering transparency, real-time updates, and guaranteed bandwidth stability to support efficient operations. In case, integrating personas in heuristic

walkthrough evaluations ensures that designs are user-centered, minimizes bias, and supports the development of task scenarios that align with specific user needs.

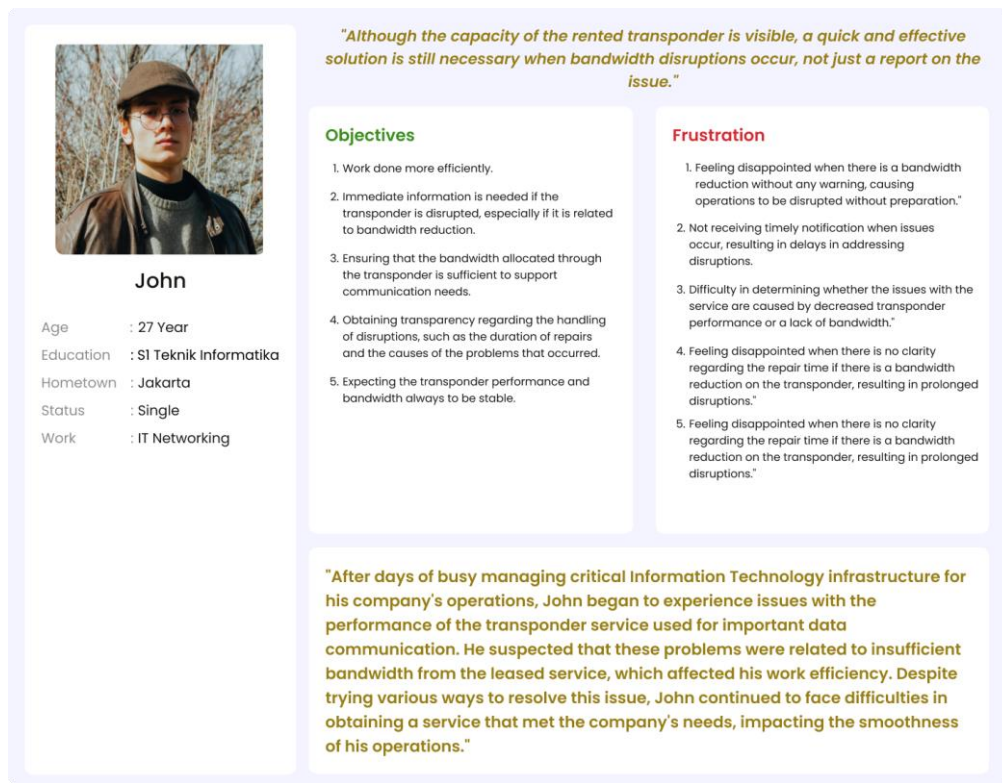


Figure 2. User Persona

1.1.C. User Journey Map

The application of user journey maps (UJMs) in user experience (UX) evaluation has been recognized as a vital methodology, especially in the identification phase prior to heuristic walkthrough testing. In the context of Transponder Operation & Management System (TOMS) applications, UJMs play an important role as a visual representation of user interactions and experiences when using a service or application. This representation allows developers and researchers to understand the specific needs of users as well as the pain points encountered during interaction with the application.

Research shows that UJMs can effectively highlight barriers and drivers in the user experience, thus encouraging a more user-centered design approach. (Smith et al., 2023) emphasizes that journey mapping provides insight into the real user experience, which is crucial in identifying critical areas for service improvement. In the case of TOMS, UJM helps analyze user interactions in the process of transponder capacity monitoring, fault identification, and carrier management, all of which require a deep understanding of user interaction patterns.

Furthermore, (Moretti et al., 2022) illustrates how UJMs can utilize non-expert perspectives to refine the problem space and increase user involvement in the design process. TOMS applications, with a high degree of technical complexity, are often used by users with varying levels of technical expertise. UJM can help uncover barriers that non-technical users may encounter, such as navigation on the Dashboard or Payload modules. These findings support the design of TOMS to meet user needs more inclusively.

The application of UJMs also supports the development of user personas - archetypal representations of user segments - which help in customizing application design to specific user needs. (Gao et al., 2024) notes that UJMs and personas encourage empathy within design teams, enabling them to make decisions based on a deep understanding of the user experience. In TOMS, personas developed from UJMs can reflect the specific needs of technical users, such as technicians performing LFT (Link Frequency Test) testing, as well as non-technical users who only need capacity information on the Dashboard module.

(Endmann & Keßner, 2016) emphasizes the importance of UJMs to gather the steps and experiences needed for effective personas development. For TOMS, this means understanding the user journey from registration to carrier management, including the challenges faced at each stage. In addition, (Lallemand et al., 2022) explains that journey mapping enables the synthesis of user research insights, which is essential for building accurate and empathetic personas.

The iteration inherent in UJM allows for continuous refinement of both the journey map itself and the personas based on user feedback. (Maddox et al., 2019) highlights how journey maps have been used effectively in healthcare settings to enhance communication between stakeholders and improve user experience. In the context of TOMS, this iteration can be used to align application design with user expectations, ensuring that the implemented solution addresses the pain points identified through UJM.

The integration of UJMs into the UX evaluation of the TOMS application provided a range of significant benefits. First, UJMs help to comprehensively identify user needs, including critical areas that require improvement. Second, the results from UJMs provide the basis for the development of more relevant and accurate personas. Third, UJMs support an iterative design process that is responsive to evolving user needs. Thus, UJMs not only strengthen the identification phase in heuristic walkthrough testing, but also ensure that the usability evaluation of TOMS is conducted with a truly user-centered approach

In this research, we developed two personas for the Transponder Operation & Management System (TOMS) application, each with different but complementary objectives. The first persona in Table 1 is designed to ensure the efficiency of transponder services and bandwidth utilization in supporting information technology infrastructure as well as long-distance data communication. The focus of this persona is on optimizing transponder resource management to maintain operational stability in support of the organization's strategic needs. Meanwhile, the second persona in Table 2 aims to ensure the performance of transponder services that support smooth communication and optimal bandwidth usage. This persona is designed to monitor service performance in real-time, so as to identify and address disruptions that may affect the user experience. By distinguishing between these two personas, this research aims to cover all key aspects of managing and optimizing transponder services, both in terms of resource efficiency and quality of service performance.

2. Evaluation Method Development

2.1. Determination of Evaluation Points

Usability evaluation points are determined based on three main approaches:

1. Guideline Checking

UX evaluation using guideline checking focuses on identifying usability issues by checking the application interface against a set of standard principles. Nielsen's (1994) principles (Rante et al., 2024)

are the main reference in this process as they provide guidance to ensure the interface effectively meets the user's needs. Based on recent research, here are the key points to focus on in UX observation using guideline checking, especially in satellite service applications: 1) System Status Visibility, 2) Appropriateness to the Real World, 3) Consistency and Standards, 4) Error Prevention, 5) Informative Feedback, 6) Flexibility and Efficiency of Use, 7) f. Minimalist and Aesthetic Design.

2. Heuristic Evaluation

Heuristic evaluation is a usability method that uses heuristic principles to identify interface design issues. For the Transponder Operation & Management System (TOMS), these principles were adapted to suit the needs of high-tech satellite services. The "Match between system and the real world" heuristic was excluded due to its limited relevance, focusing instead on nine principles like system status visibility, error prevention, consistency, and flexibility (Lyon et al., 2020).

Research highlights the need to customize heuristics for specific applications, particularly in high-tech environments. Lyon et al. (2020) emphasized that tailored heuristics are better at identifying usability issues relevant to technical contexts, focusing on efficiency, error reduction, and cognitive load. Similarly, Wang et al. (2023) demonstrated how heuristic criteria could address technical complexities for comprehensive evaluations, which is relevant for TOMS, given its diverse user base.

The approach also integrates heuristic evaluation with user feedback, as Jooste et al. (2014) suggested, ensuring iterative improvements. In TOMS, this combined method validates solutions with real user testing, enhancing the user experience while meeting the operational needs of satellite services.

3. Cognitive Walkthrough

The implementation of cognitive walkthrough (CW) in the UX evaluation for the Transponder Operation & Management System (TOMS) application is a strategic step to ensure that the application effectively meets user needs. CW serves as a usability inspection method that allows evaluators to simulate a user's problem-solving process in their interaction with the application. In TOMS, which has a high level of complexity with features such as Payload, Carrier, and LFT, this approach becomes relevant to ensure that users can complete their tasks without a hitch.

(Harrington et al., 2021) suggests that cognitive walkthroughs can facilitate better user engagement and ensure applications are used as intended. This is particularly important in high-tech applications such as TOMS, where users often face technical obstacles in understanding interfaces and features. By simulating task steps on modules such as payload search or LFT generation, CW can identify problem areas such as complicated navigation or lack of supporting information.

In addition, research (Boletsis, 2018) on the application of CW in virtual reality service design highlights how this method can be adapted for complex technical environments. In the context of TOMS, CW can be used to test specific features such as LFT queue monitoring or location-based carrier search. This method helps evaluate whether the feature is intuitive enough for different types of users, both experienced technicians and new users.

Research by (Bangash et al., 2022) emphasizes the importance of an iterative process in CW to refine features based on user feedback. In TOMS, this can be implemented by retesting the module after improvements, ensuring that the identified usability issues have been successfully addressed. With this approach, CW not only helps identify issues but also encourages continuous improvement focused on user experience.

2.2. Development of Evaluation Protocol

The Transponder Operation & Management System (TOMS) application evaluation process was conducted through two test forms that were systematically designed to cover important aspects of usability. These test forms include Guideline Checking and Cognitive Walkthrough on Form 1 as shown in the example in Table 3, and Heuristic Evaluation on Form 2 as shown in the example in Table 4. Both forms are structured to ensure that the evaluation covers all major modules in the application, with relevant tasks for each module.

1. Guideline Checking and Cognitive Walkthrough

Form 1 integrates Guideline Checking and Cognitive Walkthrough approaches to evaluate how users complete specific tasks in the TOMS application. Guideline Checking ensures that the assigned tasks conform to the established usability guidelines, while Cognitive Walkthrough focuses on analyzing the steps the user takes while completing the tasks. This protocol is designed to assess the user experience from the initial stage (login) to logout, covering all major modules such as Dashboard, Payload, Carrier, LFT, and Reporting.

The evaluation begins with Task 1, which measures the ease with which users can access the application through the login module. Next, Task 2 through Task 6 assessed user interaction with operational modules, such as viewing transponder capacity in the Dashboard, accessing payload details, using the search feature in the Carrier module, and managing LFT information. Each task was designed to reflect a real-world usage scenario, focusing on interface clarity, navigation efficiency, and information accessibility. The final task (Task 7) assesses the ease of the logout process to ensure that users can end the session without any constraints.

With this approach, the evaluation on Form 1 aims to identify the barriers that users face in each step of the task. This analysis also helped uncover the extent to which the application supported the efficient and intuitive completion of user tasks. The feedback from this evaluation forms the basis for improvements to the interface that are more responsive to user needs.

Table 3. Assignment 2 on Dashboard Module

Instructions	1. Access the Transponder dashboard via Transponder Services 2. View full details of Transponder capacity
Hint	Click on a pie chart to display more details about occupied capacity and specific information about how much is being used.
Task Checklist 2:	
No.	Checklist Questions
1	Is it possible to access the Transponder dashboard without any problems?
2	Is the diagram clearly visible on the dashboard page?
3	Does the information displayed on the diagram correspond to the capacity used?
4	Can users click on the diagram to see more details?
5	Is the information displayed after clicking on the diagram easy for the user to understand?

Questions After Completing Task 2:	
No.	Question
1	Do you find the information on the dashboard easy to understand?
2	What was your experience when trying to access capacity details via a pie chart?
3	Are you having difficulty navigating the information on the dashboard?
4	In your opinion, is there any important information that should be displayed on the dashboard but is not yet there?

2. Heuristic Evaluation

Form 2 uses the Heuristic Evaluation approach to evaluate the TOMS application based on nine heuristic principles relevant to high-tech applications. The principle "Match between system and the real world" was excluded as it was not relevant to the context of this application. The focus of the evaluation included aspects such as visibility of system status, design consistency, flexibility of use, and user support in preventing and resolving errors.

This evaluation starts by assessing the visibility of the system status, ensuring that the application provides adequate information about the operational status to the user. Aspects of consistency and design standards are also assessed to identify whether interface elements have uniform terminology and appearance. In addition, principles such as flexibility of use and minimalist aesthetics are important criteria in analysing whether the application can support users with different skill levels and is free of distracting elements.

This approach not only focuses on identifying problems but also measures the application's ability to provide solutions, such as clear error messages and easily accessible documentation. By evaluating applications through these nine principles, Form 2 provides a systematic framework for improving the usability of TOMS applications, ensuring that applications can optimally meet users' operational needs.

Table 4. Sample heuristic evaluation points 8 and 9

No.	Heuristic Principles	Evaluation Sub-Questions
8	Helps Users Recognize, Diagnose, and Recover from Errors	- Does the error message displayed explain what went wrong?
		- Are users given guidance to correct errors that occur?
		- Does the error message use language that is easy for ordinary users to understand?
9	Help and Documentation	- Does the app provide easily accessible help or user guides?
		- Does the documentation provide enough information to solve common problems users encounter?
		- Can users find help information without having to leave the app?

3. Data Analysis

Data collection in this study was carried out systematically through primary and secondary methods. Primary data was obtained through direct observation of the TOMS application currently available on the Playstore platform (existing application). This observation aimed to understand the integrated application development plan designed by the satellite service provider, of which TOMS will be a part. The main focus of the observation was to assess the extent to which the current TOMS app design could be adapted to the new unified app theme and standards.

For the secondary data, information collection was based on the user personas and user journey maps that had been created previously. This information provided insights into the user needs and challenges in the user journey of the TOMS app, which formed the basis for the development of the first prototype. After prototype 1 was designed, an evaluation was conducted by six professional evaluators with diverse disciplinary backgrounds. The evaluators consisted of one graphic design expert, one satellite communication technology specialist, one informatics management expert, one software engineering expert, and two experts in information technology. This composition of the evaluator team ensured that every aspect of the application, from interface design to technical efficiency, could be thoroughly assessed.

The diverse backgrounds of the evaluators provided a well-rounded perspective on the technical, interface and user aspects of the app. The data collected through this process served as an important foundation in formulating recommendations to improve the usability of the TOMS application as well as ensuring compatibility with the planned integrated application theme.

4. Initial Condition: Existing Application Evaluation (Stage 0)

In the early stages of this research, an evaluation was conducted of the Transponder Operation & Management System (TOMS) application that is available and accessible through the Playstore platform. This application is designed to support satellite transponder capacity leasing services with the following four main features:

- a. Dashboard: Displays a summary of leased satellite transponder capacity, providing customers with a real-time overview of capacity utilization status.
- b. Payload: Provides bandwidth allocation block information per leased transponder, allowing customers to understand resource allocation.
- c. Carrier: Displays carrier assignment details based on the assigned bandwidth allocation block.
- d. LFT (Link Fault Test): Facilitates the registration, listing, and monitoring of LFT queues, and provides a database of LFT measurement results for each carrier.

Some snapshots of the app's interface are described in Figure 3 and Figure 4, which provide an overview of the app's features and functionality.

- Figure 3 (left): Shows the main page before the user logs in. This page contains up-to-date information about the satellite service company and an interface to login using a username and password. Login access is only granted to customers who have leased satellite services. This page is focused on providing a summary of the leased transponder capacity.
- Figure 3 (right): Displays the interface after a successful user login. The main menu is displayed through a side drawer menu that can be opened and closed as needed. This menu provides navigation to the main features of the app.
- Figure 4 (left): Shows a dashboard view that shows the detailed service capacity status. This information helps users understand the available and utilized capacity allocations.

- Figure 4 (right): Displaying the interface for the list of payload service. This page allows the user to select a specific satellite and transponder to display details of the relevant bandwidth allocation block.

The next step was to customize this existing application with a unified application structure designed to provide a better user experience. This customization marked the beginning of the development of Prototype 1, which aims to improve the integration and efficiency of the application, while ensuring that the application meets the customer's operational needs more optimally.

5. First Iteration: Initial Prototype Development (Stage 1)

In the first stage of development, an initial iteration was conducted to adapt the Transponder Operation & Management System (TOMS) application to the new unified application structure. The main focus in this iteration was to improve the login system and enhance the features on the main page and dashboard of the application, as shown in Figure 5.

One significant change is seen in the login system. In the previous version of the app (Figure 2), any user could directly access the platform. However, in the initial prototype (Figure 4 right), access to the app is now restricted to users who have rented satellite services. New users must first register their service to get an account. Upon successful login, users are directed to the main page of the unified application, which displays total transponder capacity information via a scorecard. This page also contains the various services that can be accessed according to the customer's account type. In order to maintain privacy and data security, the navbar is intentionally designed in a closed state.

In the transponder dashboard shown in Figure 5 (left), users can view information on the percentage of transponder leased service capacity with a more structured visualization. This feature allows customers to monitor their service status more transparently. In addition, in Figure 5 (right), a list of payload page is displayed that requires users to fill in satellite and transponder options. This process gives users the flexibility to access information related to their bandwidth allocation.

5.1. Cognitive Walkthrough and Guideline Checking evaluation results

Table 5. CW and GC assessment results table

No.	Module	Critical	Non - Critical	Percentage of Issues Identified
1	Login	1	2	33%
2	Dashboard	7	6	89%
3	Payload	7	6	89%
4	Carrier	10	4	89%
5	LFT	13	4	100%
6	Logout	3	0	67%

An evaluation of the Transponder Operation & Management System (TOMS) application using Cognitive Walkthrough and Guideline Checking methods identified critical and non-critical usability issues across six key modules: Login, Dashboard, Payload, Carrier, LFT, and Logout. In the Login module, a critical issue was inconsistent interface design, such as mismatched colors, affecting the user experience, while two non-critical issues related to login efficiency were noted. For the Dashboard module, clarity in displaying service capacity information was lacking, with the capacity scorecard layout requiring improvement to enhance user understanding. In the Payload module, critical issues included dropdown menus appearing in inconvenient positions, making them difficult to use, necessitating a redesign for better accessibility. The Carrier module showed a less intuitive carrier list

layout, and clearer data categories were recommended to improve usability. In the LFT module, a lack of information on queue duration and service status hindered transparency, with evaluators suggesting the inclusion of turnaround times and improved navigation for better user accessibility. Lastly, the Logout module required design changes to make the logout option accessible on all pages via the profile icon, ensuring a smoother process. These findings highlight areas for improvement to optimize user experience.

5.2. Recommendation results using Cognitive Walkthrough and Guideline Checking

Based on the evaluation findings, improvement priorities for Prototype 2 include:

1. **Login Interface Design Improvements:** Harmonized colors and layout to improve visual consistency.
2. **Dashboard Enhancements:** Optimization of the layout and display of the capacity *scorecard* for clearer information.
3. **Revised Dropdown Menu on Payload:** Adjusted the position and layout of the dropdown menu to improve accessibility.
4. **Improved Information on Carrier:** Adjustments to data categories to make them more informative and easier to understand.
5. **Addition of LFT Information:** Provision of estimated queue duration and improved accessibility of the LFT list.
6. **Optimization of Logout Process:** Added profile icon on the navbar to make it easier to log out on every page.

With the implementation of these recommendations, Prototype 2 is expected to provide a better user experience and meet customers' operational needs more effectively.

5.3. Heuristic evaluation results

Evaluation of the Transponder Operation & Management System (TOMS) application was conducted based on heuristic principles with a severity scale that includes six levels, ranging from 0 (No Constraints) to 5 (Critical). Based on the results from the six evaluators, the average severity per evaluator showed varying values, with the highest average reaching 1.79 (minor to low) and the lowest 0.21 (no constraints). This shows that while most features work well, there are some issues that need immediate attention to improve the user experience.

Key Findings Based on Heuristic Principles:

H1 - Visibility of System Status: Users require an indication of system status such as progress bars or process indicators to improve visibility of application actions.

H2 - User Control and Freedom: Some evaluators noted the importance of more accessible "Cancel" or "Undo" buttons, especially when users want to cancel a particular process.

H5 - Recognition Rather Than Recall: Menu navigation needs improvement so that elements are always visible without the need for users to remember previous steps.

H7 - Aesthetic and Minimalist Design: The interface layout looks quite good, but there are suggestions to reduce irrelevant elements to improve user focus.

There are no issues categorized as 5 (Critical), however some aspects with a severity level of 3 (Moderate) require immediate attention as they disrupt the user's workflow.

HW assessment results table

No .	Heuristic Principle	Sub-Question	E 1	E 2	E 3	E 4	E 5	E 6
1	H1 - Visibility of system status	Is the system status (such as loading or ongoing processes) always visible?	0	0	0	1	0	0
3	H1 - Visibility of system status	Is there visual feedback such as a progress bar or status indicator when the application is performing certain processes?	0	3	0	0	0	0
4	H2 - User control and freedom	Can the user cancel an ongoing process (e.g., a "Cancel" button)?	0	0	0	2	0	0
5	H2 - User control and freedom	Is there an easily accessible "Undo" or "Back" option?	0	2	0	0	0	0
6	H2 - User control and freedom	Can the user easily edit or correct the data they have entered?	0	0	1	2	0	3
7	H3 - Consistency and standards	Is the interface consistent across all pages of the application?	0	1	1	0	0	2
9	H3 - Consistency and standards	Can the user predict the action of interface elements based on previous experience?	0	1	0	0	0	0
10	H4 - Error prevention	Does the application provide a warning before the user performs an action that could be risky (e.g., deleting data)?	0	1	1	0	0	0
11	H4 - Error prevention	Are buttons or elements that could potentially cause errors easily accessible by the user?	2	1	0	0	0	2
12	H4 - Error prevention	Is there a data validation feature that prevents users from entering incorrect information?	0	1	0	0	0	0
13	H5 - Recognition rather than recall	Are menus and features always visible, so users don't need to remember steps from one screen to the next?	0	1	0	1	0	0
14	H5 - Recognition rather than recall	Can the user see a list of available options without needing to recall previous information?	0	4	0	3	1	0
15	H5 - Recognition rather than recall	Are navigation elements always visible without having to search through hidden menus?	0	0	0	0	0	2
16	H6 - Flexibility and efficiency in use	Does the application provide shortcuts for expert users?	0	4	0	0	0	0
17	H6 - Flexibility and efficiency in use	Does the application allow users to complete tasks faster if they are already familiar with the functionality?	0	4	0	0	0	0
18	H6 - Flexibility and efficiency in use	Does the application have customization options that make it easier for users to use features according to their needs?	0	4	0	0	0	3
19	H7 - Aesthetic and minimalist design	Is the interface free from unnecessary or distracting elements?	0	3	0	0	0	0
20	H7 - Aesthetic and minimalist design	Is the use of colors and icons appropriate and helpful for users to understand the information?	0	1	1	3	1	0
21	H7 - Aesthetic and minimalist design	Does the interface layout appear simple and not overly crowded?	0	0	0	0	0	1
23	H8 - Help users recognize, diagnose, and recover from errors	Does the user receive guidance on how to fix the error?	0	3	1	2	0	1
25	H9 - Help and documentation	Does the application provide easily accessible help or user guides?	1	3	1	1	2	1
26	H9 - Help and documentation	Does the documentation provide enough information to resolve common issues faced by users?	1	3	1	1	2	1
27	H9 - Help and documentation	Can users find help information without leaving the application?	1	3	1	2	1	1

5.4. Recommendation results using Heuristic Walkthrough

The evaluation identified key issues affecting the TOMS app's user experience, leading to several improvement suggestions for the next prototype. To enhance system status visibility, progress bars or loading spinners should be added to provide users with real-time feedback during data processing. Navigation and user freedom can be improved by incorporating consistent "Undo" and "Cancel" buttons across all app pages. Adopting an aesthetic and minimalist design by removing unnecessary visual elements will create a cleaner and more focused layout. For better accessibility, a user guide should be integrated directly into the app for easy access. Menu navigation should be refined to ensure

all navigation elements are clearly visible without requiring users to recall previous steps. Lastly, adding flexibility through customization options or shortcuts will allow expert users to complete tasks more efficiently. These improvements aim to create a smoother and more intuitive user experience.

6. Second Iteration: Prototype Refinement and Finalization (Stage 2)

The revisions made in this stage were re-evaluated by the evaluators to ensure proper implementation, focusing on refining features and interface for a better user experience. One notable update involved changing the "Reset" button for forgotten passwords from purple to white, enhancing design consistency and visibility. The main page was also revised by adding a Transponder feature shortcut, reducing system load and allowing direct access to transponder capacity, as shown in Figure 7. Additionally, the Logout feature was separated from the Settings menu and relocated under the user icon, which also displays user profile details, including the Person in Charge (PIC).

To improve clarity, the transponder capacity layout was reorganized, with captions added to explain terms or features. Users can access these explanations by pressing and holding the relevant icons. Payload options were simplified with a dropdown design, eliminating clutter and facilitating easier data entry, followed by the appearance of a "Search" button for processing. This second iteration focused on enhancing accessibility, navigation, and information clarity, ensuring the final prototype meets user needs and provides a more optimal experience.

7. Recommendations for Improvement and Implementation

The development of the Transponder Operation & Management System (TOMS) application followed three main stages: evaluation of the existing application, development of Prototype 1, and refinement of Prototype 2, each aimed at enhancing the user experience. The initial evaluation identified issues with the interface design and complex navigation, highlighting the need for optimization in features like the login process and payload list. In Prototype 1, improvements were made to restrict login access to registered customers, introduce a scorecard display for transponder capacity on the dashboard, enhance dropdown menus for better accessibility, and separate the logout feature from the settings menu for more efficient navigation. Prototype 2 further refined the design by adjusting the "Reset" button color for consistency, adding shortcuts on the main page for direct transponder access, reorganizing the transponder capacity layout for clarity, and simplifying dropdown menus to prevent clutter. These recommendations, guided by user feedback and heuristic evaluation, ensured the application's improved accessibility, navigation, efficiency, and information clarity, delivering an optimal user experience tailored to operational needs.

4. Conclusion

This research has evaluated and developed a *Transponder Operation & Management System* (TOMS) application using a combined *Heuristic Walkthrough* approach that includes *Guideline Checking*, *Heuristic Evaluation*, and *Cognitive Walkthrough*. The evaluation results on the prototype showed some significant weaknesses in the user interface, such as an unintuitive layout, lack of visibility of system status, and navigation features that needed improvement. With the findings-based recommendations, the second iteration successfully improved these issues, including the refinement of the navigation menu, optimization of the visual design, as well as the addition of features that support user efficiency.

The findings of this study make an important contribution to the usability evaluation literature of high-tech-based applications, particularly satellite services. This study also proves that the adaptation of heuristic principles to the context of technical applications can lead to relevant and effective

solutions. With a focus on improving user experience, this research not only supports the development of TOMS, but also provides a framework that can be applied to similar applications in the future.

For future research, it is recommended to integrate user-based testing methods on a broader scale to evaluate the long-term impact of implementing design changes. In addition, the exploration of additional heuristic adaptations that are relevant to local contexts and technical needs can also enrich the research results in this area.

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