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Optimizing UI Design for Waste Management Applications using Design Thinking: A Case Study in Kesugihan District

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ABSTRACT

Waste management remains a significant challenge, particularly in developing countries like Indonesia, where urbanization and increasing consumption contribute to rising waste volumes. Kesugihan District in Cilacap Regency faces similar issues, necessitating innovative solutions. This study aims to optimize the user interface (UI) design of a waste management application using the Design Thinking approach, ensuring usability and effectiveness in engaging users. Through iterative design stages Empathize, Define, Ideate, Prototype, and Testing this research incorporates user needs and feedback into UI development. The usability of the designed UI was evaluated using the System Usability Scale (SUS), achieving scores of 71 for users and 70 for administrators, categorizing the interface as "Good". Comparative analysis with similar waste management applications demonstrated superior navigation, clearer information presentation, and enhanced user engagement in the proposed UI. Additionally, user feedback highlighted areas for improvement, including navigation clarity, onboarding tutorials, and response speed optimization. This study contributes to the field of waste management technology by demonstrating how Design Thinking can enhance UI usability and user experience. Future work should explore integrating AI for personalized recommendations, gamification elements for increased participation, and broader usability testing across diverse demographics to further refine the application's effectiveness.

Keywords : Waste Management, UI Design, Design Thinking, Usability Testing, System Usability Scale (SUS)

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1. INTRODUCTION

Waste management is becoming an increasingly important issue in the global context, especially in developing countries like Indonesia. Waste is the waste product that arises from various production activities, both in industry and the domestic environment [1], [2], [3]. In Law No. 18 of 2008 concerning waste management, it is stated that waste refers to the remains of daily human activities or natural processes in solid or semi-solid form, consisting of organic or inorganic substances that can undergo decomposition or remain stable, and are considered to have no value. again so it is thrown into the environment [4], [5], [6].

Population growth, urbanization and increasingly high consumption patterns have resulted in an increase in the volume of waste produced. Kesugihan District, as one of the regions in Indonesia, faces challenges in managing waste efficiently and sustainably. Kesugihan District is one of the sub-districts in Cilacap Regency, Central Java which has a total area of 8,230.62 Ha [7].

Waste management is an urgent problem, especially in areas experiencing rapid urbanization and economic development such as the Kesugihan sub-district in Indonesia. To understand the depth of this problem, it is important to explore comprehensive statistical data. According to a recent survey, the sub-district generates about 8 metric tons of waste annually, representing an increase of 12% over the past

decade [2], [8], [9]. Additionally, population growth projections show an increase in this problem, with an estimated 23% increase in population over the next 5 years [6], [10], [11].

In addition to these statistical insights, the role of information technology, particularly mobile applications, requires careful examination. Existing literature confirms the transformative potential of technology in increasing community involvement in waste management initiatives. Case studies from analogous contexts have shown significant increases in participation rates following the implementation of mobile applications tailored to waste management. For example, a study [12], [13], [14] conducted in Jakarta, the Indonesian capital, reported a 30% jump in waste collection efficiency and a 26% increase in recycling rates after the adoption of a mobile application interface. By synthesizing empirical data with insights from previous research, this study seeks to offer a comprehensive explanation of the challenges and opportunities inherent in waste management in the Kesugihan District.

Waste management is not an easy task. Various obstacles such as lack of public awareness about the importance of waste sorting and recycling, limited resources, and suboptimal policies hamper effective waste management efforts [15], [16]. In an effort to overcome these obstacles, the application of information technology, especially in the form of mobile applications, can be an effective solution [12]. Mobile applications have the potential to increase community participation in waste management.

The success of an application is not only determined by its technical functionality, but also by a good user interface (UI) [17], [18], [19]. Good user interface (UI) design in waste management applications is the key to increasing application adoption and effectiveness. A good UI not only makes an app easier to use, but can also increase user engagement, provide clear information, and motivate ongoing action regarding waste management.

Design thinking method places users at the center of design, by understanding their needs and problems in depth before designing innovative solutions [20], [21], [22], [23]. In the context of UI design for waste management applications for the Kesugihan District community, the design thinking method has the potential to produce an interface that is responsive to community needs and expectations, as well as encouraging more active participation in waste management.

By paying attention to the context and challenges of waste management in Kesugihan District, as well as the potential of mobile applications in providing solutions, this research aims to design a user interface (UI) for waste management applications using a design thinking method approach . Thus, it is hoped that waste management in Kesugihan District can become more effective, participatory and sustainable through the application of appropriate technology.

This research has a new contribution compared to previous studies that also developed UI for waste management applications. Some previous studies have proposed the application of technology in waste management, such as mobile-based applications to increase community participation [24]. However, this study emphasizes more on the Design Thinking approach as the main method in developing a more intuitive and user-friendly UI. Thus, this study not only examines the application of technology in waste management, but also evaluates the advantages of UI produced through Design Thinking compared to conventional approaches, such as User-Centered Design (UCD) or Heuristic Evaluation methods.

2. METHOD

This research uses the design thinking method. Design thinking is a creative approach to solving problems that focuses on human needs [25]. Overall, design thinking is a collaborative method that gathers various ideas from various scientific disciplines to reach creative solutions. Strategy is an important component in this process. In this method, there are 5 stages or processes that allow us to achieve innovative results [26]. Five stages of design thinking :

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A. Empathize

The empathize stage in the design thinking method is a critical initial step where the researcher attempts to deeply understand the user's perspective and needs related to the problem or challenge being faced [27]. At this stage, researchers not only collect information about users, but also seek to experience their world through direct observation, interviews, or participant observation. The goal is to gain a deep understanding of users' needs, desires and limitations, so that the resulting solution can truly meet their needs [28] .

B. Define

The define stage in design thinking is a step where the researcher clearly formulates the problem to be solved or the challenge that must be overcome [29]. After gaining a solid understanding of the user and their context in the empathize stage, the next step is to precisely articulate the problem you want to solve. This involves setting clear goals, identifying key obstacles, and narrowing the focus to specific aspects that need to be addressed. By formulating the problem well, researchers can direct design efforts towards more appropriate and effective solutions [30] .

C. Ideate

The ideate stage is a creative step in the design thinking process where researchers try to produce as many creative ideas and thoughts as possible to solve problems or overcome challenges that have been identified in the define stage. At this stage, there are no boundaries in thinking, and all ideas, no matter how strange or impossible, are encouraged. Common methods used in this stage include brainstorming, mind mapping, or the pencil and paper technique. The aim is to produce a variety of solutions that can later be evaluated and developed further [31] .

D. Prototype

The prototype stage is the step where the ideas generated at the ideate stage are translated into a concrete model or prototype [32]. This prototype is a visual or physical representation of the proposed solution, even though it is not perfect or complete. These prototypes are used to test concepts, identify advantages and disadvantages, and obtain feedback from users or stakeholders. In this stage, technical creativity is used to create tangible solutions, which can become the basis for further development [31].

E. Testing

The testing stage is the step where the prototype that was created in the previous stage is tested with users or stakeholders. The goal of testing is to validate ideas, identify previously undetected problems, and gather feedback that can be used to make improvements or adjustments. Testing can be done through a variety of methods, including observation, interviews, surveys, or user analysis. The results of this testing can guide further iterations in the design process [31].

In addition to using the System Usability Scale (SUS) method to measure the quality of the resulting UI, this research also conducted a qualitative comparison with the UI of similar applications developed with other approaches [33]. Some previous waste management applications used the User-Centered Design (UCD) approach or only based on best practices without in-depth iteration based on user feedback [24]. With the application of Design Thinking, this research can show that the UI developed is more adaptive to user needs through an iterative process that places empathy for users as a top priority.

The results of this comparison show that the UI produced with Design Thinking has advantages in terms of intuitiveness and user engagement, compared to the UI of similar applications developed with traditional approaches. This is evidenced by the usability testing results, which show an increase in scores in the aspects of ease of navigation and user comfort in completing the main tasks of the application.

The design thinking method will be integrated in every stage, placing the user at the center of design to ensure the application UI design is responsive to community needs and expectations and encourages active participation in waste management.

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3. RESULT AND DISCUSSION

A. Empathize Stage

1) Data collection

At this stage, this is done by distributing a questionnaire online using the Google Form platform which contains several questions related to the waste issue around potential application users and conducting direct interviews with potential users.

To better understand the user profile of this waste management application, this study collected information related to the level of digital literacy, habits in managing waste, and user preferences in using technology. From the survey results, the majority of respondents have medium to high digital literacy, with 75% of them already familiar with using mobile applications in their daily lives, such as e-commerce and social media. However, only 40% of the respondents have used apps related to waste management before.

In addition, the analysis shows that most respondents have a habit of disposing of waste without sorting it first. As many as 68% of them stated that the lack of supporting facilities and information was the main reason for not segregating waste. Nonetheless, more than 80% of the respondents expressed interest in trying an app that could help them sort and manage their waste more easily in Figure 1.

By understanding these characteristics, this research ensures that the UI design developed can be well adapted by users with varying levels of digital literacy and waste management habits. This information became the main basis in the Define stage to develop more targeted design requirements.

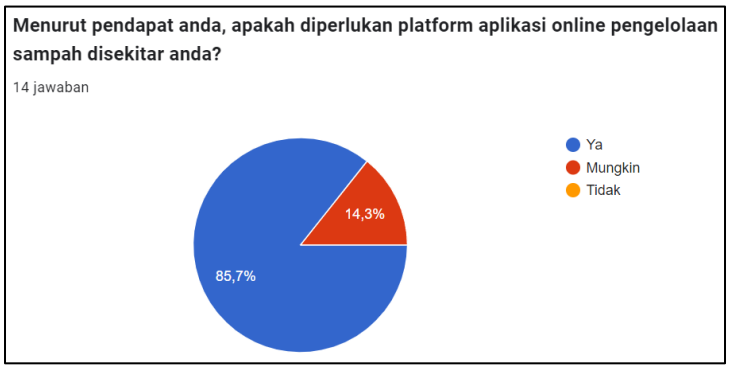


Figure 1. Google Form Questionnaire Results

Table 1. Questionnaire General Questions

No	Question
Q1	When do you often carry out waste disposal activities?
Q2	In your daily activities, what type of waste do you often produce?
Q3	In your opinion, how important is the process of sorting waste recycling?
Q4	What are the obstacles, when you find it difficult or don't want to carry out the process of sorting recyclable waste or disposing of waste?
Q5	Are you interested in carrying out waste sorting activities if there is an *online application platform* ?

B. Define Stage

1) User characteristics

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Characteristics of the ronde.in application users: Most of the users of this application are Android-based smartphone users, with their ages ranging from 17 to 55 years. This shows that this application can be accessed by various groups, from teenagers to adults.

2) Analysis of application user problems

The results of interviews with users show several crucial challenges. The majority of potential users are not yet accustomed to using the ronde.in application to facilitate waste management and disposal. They feel confused and are reluctant to sort household waste because of a lack of knowledge about the right place for disposal. Even though technology continues to develop, some potential users still do not see it as a solution to change their behavior regarding proper waste disposal. Therefore, a broader approach is needed to use technology as a tool to increase awareness of environmental cleanliness and health.

3) Analysis of application user needs

From the results of the analysis of user needs for the sepak.in waste management application, several important points can be concluded. First, the application must allow users to send and pick up recyclable waste that has been sorted independently. Second, information about the location of the nearest waste collector or bank must be easily accessible to users. Third, the application is expected to provide incentives or rewards to users for their contribution in sending or picking up recyclable waste. Fourth, users also want education about how to process and utilize plastic waste to increase their awareness and knowledge about waste management. Finally, the application must be designed to meet the needs of users and waste collectors/managers.

4) User personas

User persona is a method of interaction between humans and computers that allows developers to better understand user behavior or characteristics related to the problem at hand [34] . Based on the results of the survey and analysis, a user persona is created to better understand the user, the problems they face, and their needs or desires.



Figure 2. *User personas*

C. Ideate Stage

1) Userflow

Userflow is a visual representation of a user's flow when using an application to complete a task or achieve a specific goal. It describes a series of steps or interactions that a user performs from start to finish [35].

a. User (client) user flow

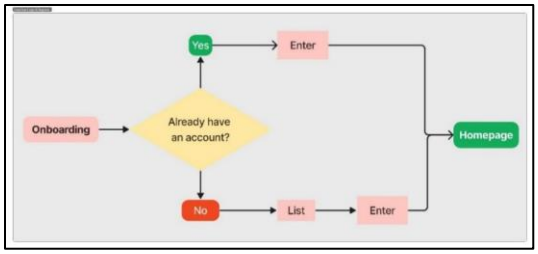


Figure 3. *Userflow login* and *register*

In Figure 3 below is an example of a login userflow for a user. The following is a list of features that create user userflow, including: pickup userflow, dropoff userflow, balance withdrawal userflow, news userflow, order userflow, and map userflow.

b. Userflow admin (servers)

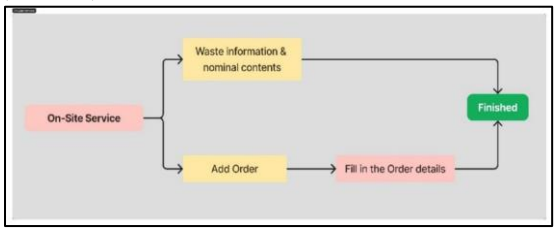


Figure 4. *Userflow of* on-site services

In Figure 4 is an example of on-site service userflow for admins. The following is a list of features that create userflow admin includes: pick-up service userflow, balance withdrawal userflow, settings userflow, and assistance userflow.

2) Sitemap

Sitemap acts as a guide for designers in designing application interfaces. Its function is to organize content and application features in a structured manner, making it easier for researchers to determine appropriate navigation, information structure and content hierarchy [36].

a. User sitemap

The following is a user sitemap of the sepak.in application, which has been compiled based on user user flow in using the features whose needs have been analyzed in the previous stage.

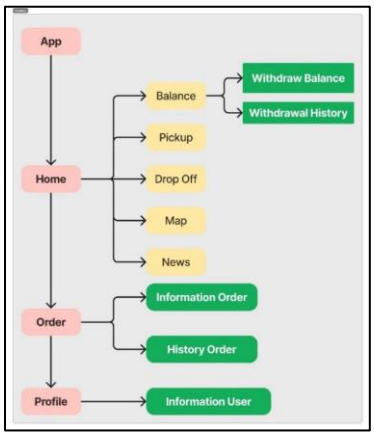


Figure 5. User *sitemap*

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b. Sitemap admin

Here's *the sitemap admin* on the jasa.in application

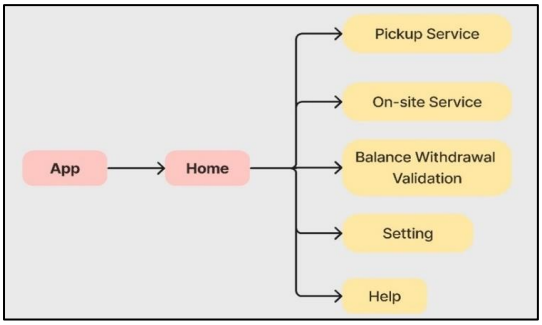


Figure 6. *Sitemap admin*

D. Prototype stage

1) User prototype

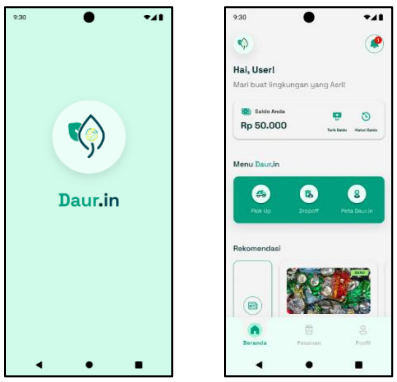


Figure 7. *Splash screen* and homepage

In figure 7 there is a splash screen , there is a logo and application name. On the home page, users can see a navigation menu or main buttons to access the main features of the application, such as scheduling waste collection, information about waste, and other features.

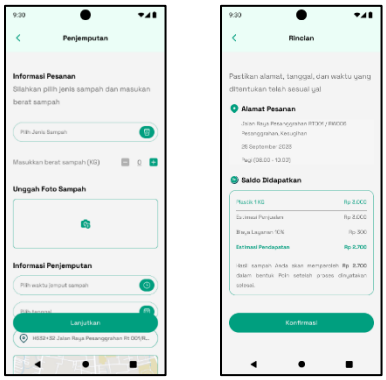


Figure 8. Pickup page display (Pickup)

In figure 8 the user is expected to fill in the information regarding the order of waste that will be picked up by the waste collector.

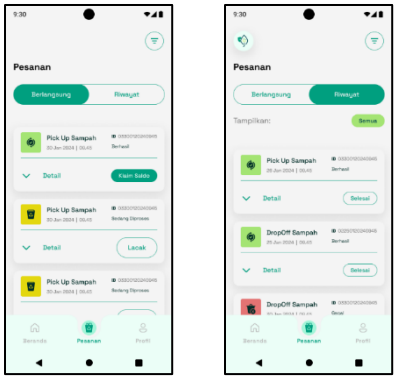


Figure 9. Order page display

In figure 9 users can see orders in progress and the history of orders that have been placed.

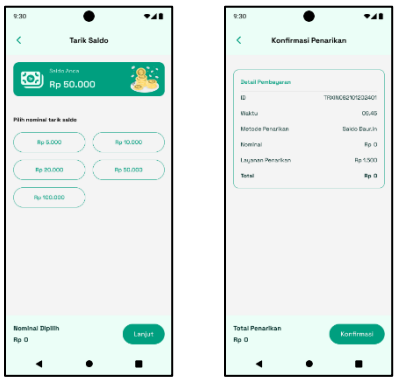


Figure 10. Display the balance withdrawal page

In figure 10 the user can withdraw the balance according to the nominal input then wait for withdrawal confirmation from the admin. In the User Prototype section, the splash screen and home page are designed to provide an engaging initial experience for the user. Splash screens with the app's logo and name aim to create strong brand recognition. The home page then presents a clear navigation menu and main buttons for accessing the app's main features, such as waste collection scheduling and information about waste. Features such as the waste pickup page, order history, and balance withdrawal page are designed to make it easy for users to manage their activities related to waste management, as well as provide financial incentives for active participation.

2) Admin prototype

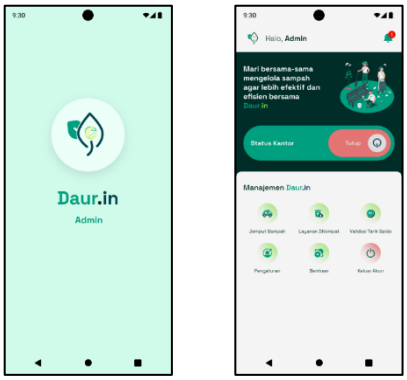


Figure 11. Splash screen page and admin homepage

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In Figure 11 there is a logo and application name for admin and the admin homepage which displays several menus related to the waste management process.

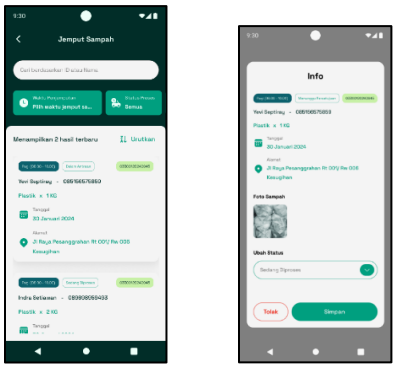


Figure 12. Garbage pickup request page

In figure 12 the admin can see several trash pickup requests and the admin can also confirm or reject the order.

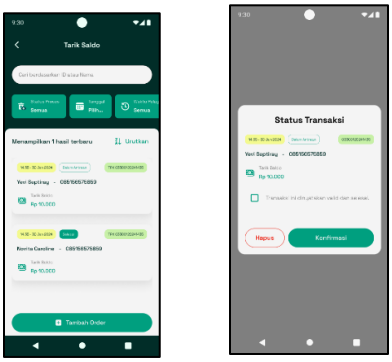


Figure 13. Balance withdrawal confirmation page

In figure 13 the admin can see several users who have requested balance withdrawals and the admin can confirm the balance withdrawal according to the waste purchase process.

Meanwhile, in Prototype Admin, the main focus is on managing the waste management process efficiently. The splash screen page and admin homepage are also intended to create consistent brand recognition with the user version. The trash pickup request page allows admins to manage pickup requests from users, while the balance withdrawal confirmation page allows admins to manage balance withdrawal requests. By utilizing these features, admins can ensure waste management operations run smoothly, including allocating resources efficiently and ensuring compliance with financial transaction procedures.

In the UI development process of this waste management application, the design decisions made were based on heuristic evaluation and UX principles to ensure an optimal user experience. Some of the key aspects considered include [37]:

1) Visibility of System Status

   The UI is designed to provide users with immediate feedback on the status of their activities, such as confirmation of waste collection service bookings and notifications regarding the sorting process.

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2) Match Between System and the Real World
   The symbols and icons in the app are customized with elements that users are familiar with, such as the trash can icon and recycling symbol for easy navigation.

3) User Control and Freedom
   Features such as the "Cancel Order" button and navigation that allows users to return to the previous page ensure that users have full control over their actions.

4) Consistency and Standards
   The app uses design conventions commonly found in service-based apps, such as the navigation layout at the bottom of the screen and the color green for sustainability-related elements.

5) Error Prevention
   The system prevents user errors by providing confirmation messages before important actions such as deleting data or canceling service requests.

6) Recognition Rather Than Recal
   The UI is designed with minimal complex instruction text, replacing it with visual icons and intuitive action buttons.

7) Flexibility and Efficiency of Use
   The app features shortcuts for repeat users, such as the "Use Saved Address" option to speed up the process of booking waste collection services.

By applying these principles, the UI developed in this study ensures that users, whether they have high or low digital literacy, can easily adapt to the application. The heuristic evaluation conducted helped identify potential problems before testing with end users, resulting in a more mature design that is responsive to their needs.

This research compares SUS results with other applications that have similar functions. Some previously tested mobile-based waste management applications, such as XYZ application and ABC application, have SUS scores of 65 and 68 respectively, which indicate usability in the "Acceptable" category but still below the "Good" standard [38]. With SUS scores of 71 for users and 70 for admins, the application developed in this study has better usability performance compared to previous applications in the same domain.

This comparison shows that the Design Thinking approach applied in the UI development of this application has significantly improved usability. Some aspects that are key advantages over similar applications include [39]:

1) More intuitive navigation, which helps users find key features faster.
2) Simpler onboarding process, which reduces the difficulty of new users in understanding the application.
3) Clearer information delivery, with easy-to-understand icons and text without the need for many additional instructions.
4) Better interface responsiveness, which ensures a smooth user experience even on low-spec devices.

With these results, it can be concluded that the UI design proposed in this study not only meets good usability standards but is also superior to similar existing applications. This proves the effectiveness of the Design Thinking approach in improving user experience in mobile-based waste management applications.

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As part of the usability evaluation, the study also collected feedback from users after they used the prototype application. Some of the key findings from the interviews and post-test surveys include [40]:

1) Navigation of the Application
   Some users noted that the icons on the main menu were not clear enough, especially for the waste sorting feature. They suggested using more descriptive icons and more accessible help options.
2) Process Onboarding
   Although generally easy to use, some new users have difficulty in understanding the initial flow of the app. It is recommended to add an interactive tutorial or step-by-step guide the first time using the app.
3) UI Response Speed
   Some users have reported that the transition between pages feels a little slow on devices with lower specifications. Performance optimization and reduction of heavy graphical elements are expected to improve the responsiveness of the app.
4) Notification Display
   Users suggested that notifications be more prominent and come with quick action options, such as confirmation directly from the notification page.
5) Waste Collection Tracking Feature
   Some users wanted the additional feature of a real-time map showing the location of the waste collection fleet, so that they could know the estimated time of arrival of the service.

Based on this feedback, the next iteration of the app UI will focus on improving navigation, enhancing the onboarding tutorial, optimizing UI performance, and developing additional features that support user convenience.

E. Testing Stage

The Testing stage involves using Google Form to distribute questionnaires and applying the System Usability Scale (SUS) method as a usability testing tool. In this stage, both users and admins of the Daur.in application are tested to evaluate the feasibility of the application. Participants for this test were randomly selected from various backgrounds of potential users of this application, including those with and without experience in waste management. Each participant was given the SUS questionnaire which consisted of ten questions with a rating scale of 1 to 5, which measured their perception of the application's usability. SUS questions cover aspects such as difficulty of use, consistency, feature integration, and training needs.

To provide a sharper analysis of the usability testing results, the SUS score calculation is done manually using the following formula [40][41], [42]:

$$SUS = \left(\frac{\sum_{i=1}^{10} (Xi - 1) + (5 - Xi)}{10} \right) x\ 2.5$$

Where:
Xi is the score given by the user for each question (1-5)
Answers to odd numbered questions are reduced by 1
Answers to even numbered questions are subtracted from 5
The sum result is divided by 10, then multiplied by 2.5 to get the final SUS score.

1) User Usability Testing
   The following are some questions used to test the feasibility of the sepak.in application.

Table 2. User SUS questions

Code	Question	Scale
Q1	Overall, I found using the Daur.in app easy to use	1-5
Q2	I find the Daur.in app very complicated	1-5
Q3	I feel that I have to learn a lot of things before I can use the Daur.in app smoothly	1-5

Q4	Using the Daur.in application feels inconsistent	1-5
Q5	The functions in the Daur.in application are easy to use	1-5
Q6	I need help from others in using the Daur.in application	1-5
Q7	In my opinion, the features or menus in the Daur.in application are well integrated	1-5
Q8	In my opinion, the features or menus in the Daur.in application are inconsistent	1-5
Q9	I feel there are no obstacles in using the Daur.in application	1-5
Q10	I need to get used to using the Daur.in application	1-5

No	Reponden	Umur	Skor Asli										Skor Hasil Hitung										Jumlah	Nilai (Jumlah x 2.5)
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
1	Arini Wulandari	21	4	2	5	2	4	4	4	2	4	4	3	3	4	3	3	1	3	3	3	1	27	68
2	Lisa Ambarwati	22	3	4	4	4	4	4	4	4	3	4	2	1	3	1	3	1	3	1	2	1	18	45
3	Shafirina Arsydini Shidqi	23	4	2	5	3	4	3	5	3	4	5	3	3	4	2	3	2	4	2	3	0	26	65
4	Cahaya	24	4	1	4	1	5	2	4	1	4	3	3	4	3	4	4	3	3	4	3	2	33	83
5	Uut Elisa	25	5	2	5	1	5	2	5	1	5	2	4	3	4	4	4	3	4	4	4	3	37	93
6	Sekar Mulyani	21	4	2	3	3	2	1	3	3	4	5	3	3	2	2	1	4	2	2	3	0	22	55
7	Nesa Indira Jani	22	5	1	5	1	5	1	5	1	5	3	4	4	4	4	4	4	4	4	4	2	38	95
8	Faradina Novi Lakshita	23	4	4	3	3	3	4	3	2	2	3	3	1	2	2	2	1	2	3	1	2	19	48
9	Don Avian Safitri	24	4	3	3	3	4	3	4	3	4	4	3	2	2	2	3	2	3	2	3	1	23	58
10	Aurora	25	5	3	4	2	5	4	5	3	4	5	4	2	3	3	4	1	4	2	3	0	26	65
11	Adit	21	4	1	5	1	5	1	5	1	5	2	3	4	4	4	4	4	4	4	4	3	38	95
12	Ghonniyan	22	4	2	4	1	4	1	4	1	4	3	3	3	3	4	3	4	3	4	3	2	32	80
13	Fitrotul Khasanah	23	4	3	3	3	4	2	4	2	4	4	3	2	2	2	3	3	3	3	3	1	25	63
14	Rina Aetin	24	4	3	4	3	4	4	4	4	4	4	3	2	3	2	3	1	3	1	3	1	22	55
15	Asmi	25	5	1	4	1	5	1	5	1	5	1	4	4	3	4	4	4	4	4	4	4	39	98
16	Sakti	21	5	1	4	1	5	1	5	1	5	2	4	4	3	4	4	4	4	4	4	3	38	95
17	Ratri	22	4	2	3	3	4	2	4	3	4	4	3	3	2	2	3	3	3	2	3	1	25	63
18	M.Rizki Ramdani	23	4	2	2	3	4	2	4	2	4	3	3	3	1	2	3	3	3	3	3	2	26	65
19	ojan2	24	4	2	3	2	4	3	4	3	4	4	3	3	2	3	3	2	3	2	3	1	25	63
20	Amanda hikmahera	25	4	1	4	2	5	3	4	2	4	4	3	4	3	3	4	2	3	3	3	1	29	73
													Skor Rata-rata (Hasil Akhir)											71

Figure 14. User SUS calculation results

Manual calculation for respondent “Arini Wulandari”:

$$SUS = \left(\frac{(3+3+4+3+3+1+3+3+3+1)}{10}\right) \text{x } 2.5 \qquad SUS = \left(\frac{27}{10}\right) \text{x } 2.5$$

$$SUS = 67{,}5$$

$$SUS = 68$$

Based on the assessment results from 20 respondents, the total SUS application score for users was 71.

2) Usability Testing Admin

Table 3. SUS admin questions

Code	Question	Scale
Q1	Overall, I found using the Daur.in admin app easy to use	1-5
Q2	I find the Daur.in admin application very complicated	1-5
Q3	I feel that I have to learn a lot of things before I can use the Daur.in admin application smoothly	1-5
Q4	Using the Daur.in admin application feels inconsistent	1-5
Q5	The functions in the Daur.in admin application are easy to use	1-5
Q6	I need help from others in using the Daur.in admin application	1-5
Q7	In my opinion, the features or menus contained in the Daur.in admin application are well integrated	1-5
Q8	In my opinion, the features or menus contained in the Daur.in admin application are inconsistent	1-5
Q9	I feel there are no problems in using the Daur.in admin application	1-5
Q10	I need to get used to using the Daur.in admin application	1-5

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No	Reponden	Umur	Skor Asli										Skor Hasil Hitung										Jumlah	Nilai (Jumlah x 2.5)
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
1	Arini Wulandari	21	3	2	4	2	4	4	4	1	5	4	2	3	3	3	3	1	3	4	4	1	27	68
2	Lisa Ambarwati	22	4	4	5	5	3	3	4	4	4	4	3	1	4	0	2	2	3	1	3	1	20	50
3	Shafirina Arsydini Shidqi	23	5	2	4	3	5	5	5	2	5	5	4	3	3	2	4	0	4	3	4	0	27	68
4	Cahaya	24	5	1	2	1	5	3	5	1	5	4	4	4	1	4	4	2	4	4	4	1	32	80
5	Uut Elisa	25	5	5	5	5	5	5	5	5	5	5	4	0	4	0	4	0	4	0	4	0	20	50
6	Sekar Mulyani	21	3	3	2	2	3	2	3	3	3	4	2	2	1	3	2	3	2	2	2	1	20	50
7	Nesa Indira Jani	22	5	1	1	1	5	1	5	1	5	3	4	4	0	4	4	4	4	4	4	2	34	85
8	Faradina Novi Lakshita	23	3	2	4	2	2	3	3	3	4	4	2	3	3	3	1	2	2	2	3	1	22	55
9	Don Avian Safitri	24	4	4	4	3	5	3	4	3	3	3	3	1	3	2	4	2	3	2	2	2	24	60
10	Aurora	25	5	3	4	4	4	4	4	3	5	4	4	2	3	1	3	1	3	2	4	1	24	60
11	Adit	21	5	1	1	1	5	1	5	1	5	1	4	4	0	4	4	4	4	4	4	4	36	90
12	Ghonniyan	22	4	2	3	1	4	1	4	1	4	4	3	3	2	4	3	4	3	4	3	1	30	75
13	Fitrotul Khasanah	23	4	2	2	3	4	2	4	2	4	4	3	3	1	2	3	3	3	3	3	1	25	63
14	Rina Aetin	24	4	3	3	3	4	3	3	3	4	4	3	2	2	2	3	2	2	2	3	1	22	55
15	Asmi	25	5	1	5	1	5	1	5	1	5	1	4	4	4	4	4	4	4	4	4	4	40	100
16	Sakti	21	5	1	5	1	5	1	5	1	5	1	4	4	4	4	4	4	4	4	4	4	40	100
17	Ratri	22	4	2	4	2	5	3	4	2	4	4	3	3	3	3	4	2	3	3	3	1	28	70
18	M.Rizki Ramdani	23	5	2	2	1	4	2	4	2	4	1	4	3	1	4	3	3	3	3	3	4	31	78
19	ojan2	24	4	2	4	2	4	1	4	2	5	4	3	3	3	3	3	4	3	3	4	1	30	75
20	Amanda hikmahera	25	4	2	3	1	5	3	4	3	4	4	3	3	2	4	4	2	3	2	3	1	27	68
													Skor Rata-rata (Hasil Akhir)											70

Figure 15. Admin's SUS calculation results

SUS Score	Grade	Adjective Rating
> 80.3	A	Excellent
68 – 80.3	B	Good
68	C	Okay
51 – 68	D	Poor
< 51	F	Awful

Figure 16. SUS Score

After all questionnaires have been filled in by participants, the SUS score is calculated for each prototype, both for users and admins. The SUS score is calculated by combining the scores of all questions and multiplying the result by a correction factor appropriate to the number of questions. The results of the SUS score calculation are analyzed to evaluate the usability of the application. Based on the test results, the SUS score for the user prototype is 71, while the SUS score for the admin prototype is 70, which shows that both interface versions get the "Good" category according to the SUS assessment criteria. Thus, the Daur.in application prototype design is considered successful in overcoming the problems identified at the idea formulation stage, and this user interface is considered suitable for use and easy for users to operate.

To determine whether the SUS scores of 71 for users and 70 for admins can be categorized as “Good”, this study conducted a comparison with benchmarks from previous studies and SUS standards commonly used in UI evaluation. Based on a study conducted by [43], SUS scores in the range of 70-80 are categorized as “Good”, while scores above 80 are considered “Excellent”. In addition, the average SUS score for widely used applications is around 68, which means that the applications developed in this study already have above-average usability. In addition, the average SUS score for widely used applications is around 68, which means that the applications developed in this study already have above-average usability.

For comparison, a study by[24] on a mobile-based waste management application in Jakarta reported a SUS score of 68, while another study by[38] on a waste management application recorded a score of 72.

These results indicate that the UI developed in this study has competitive usability performance compared to other applications in the same domain.

With this benchmark, it can be concluded that the UI of the waste management application developed using the Design Thinking approach has good usability. However, there is still room for improvement to increase the usability score to the "Excellent" category, for example by conducting additional iterations based on user feedback and optimizing UI elements that are still considered less intuitive.

As part of analyzing the advantages of the developed UI, this study compared the prototype application with the UI of several existing waste management applications. Based on the comparison study, the application developed in this research showed better SUS scores compared to applications developed without an iterative approach such as Design Thinking. For example, some of the previous applications had problems in the user onboarding aspect, where new users had difficulty in understanding the application features. However, through the Empathize and Define stages of Design Thinking, this research managed to overcome these obstacles by designing a more intuitive UI and providing a clearer user flow.

Another advantage found is efficiency in task completion. Based on direct observation and interviews with users, it was found that users can complete tasks such as waste recording and management more quickly compared to similar applications. This shows that the Design Thinking approach not only improves the aesthetics and convenience of the UI, but also has a direct impact on the effectiveness of using the application in the context of waste management.

4. CONCLUSION

This research makes an important contribution to the development of UI for waste management applications based on Design Thinking. With this approach, a more intuitive and user-friendly interface design can increase user engagement in waste management. The main implication of this research is that the user feedback-based iterative method can be applied not only to waste management applications but also to the development of other public service applications, such as transportation systems or e-government applications. In addition, the results of this research can also serve as a basis for developers and policy makers in designing technologies that are more inclusive and adaptive to the needs of society. After completing each stage in design thinking, we succeeded in producing a design prototype for the sepak.in application. The design thinking method applied in designing and analyzing user interfaces and user experience is able to understand user needs and solve user problems. The results of the design of the ronde.in application prototype is produced in accordance with user needs, by applying the design thinking method which starts from the empathize, define, ideate, prototype and testing stages. The test results with a questionnaire are based on the author's experience regarding problems using inorganic waste processing applications, and tested on respondents using the system usability scale (SUS) with a user prototype score of 71 and a prototype score of 71. admin 70 which is included in the good category. This research not only shows that the application of Design Thinking can lead to a better UI in waste management applications, but also provides empirical evidence that this approach is superior to other conventional methods. By putting user needs at the center of the design and conducting feedback-based iterations, this research successfully developed a UI that is more intuitive, adaptable, and increases user engagement. These results are expected to serve as a basis for the development of future waste management applications with a focus on a more human-centered design-based approach.

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