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UI/UX Design of Waste Management Application Using Design Thinking Method

Regar Chairul Soleh[1], Maukar[2]
[1,2]Universitas Gunadarma, Indonesia
E-mail: regarchairul552@gmail.com[1], maukar@staff.gunadarma.ac.id[2]

Abstract

Effective and sustainable waste management is a global challenge that requires innovative solutions. This study proposes optimizing waste management through UI/UX design approach using the design thinking method. The stages of Empathize, Define, Ideate, Prototype, and Testing are employed to design the "SISAKU" mobile application to enhance community participation in waste management. The prototype testing involved 30 respondents, with a System Usability Scale (SUS) result of 80.29%. Evaluation shows that the application design successfully provides intuitive and engaging guidance, increasing public awareness and involvement in waste management. The implementation of lean canvas as a business model provides strategic direction for sustainable development. This research highlights the importance of a user-centered design approach and design thinking method in addressing complex issues such as waste management.

Keywords: *Waste Management, UI/UX Design, Design Thinking, User Experience.*

1. Introduction

Effective and sustainable waste management is a major issue faced by many countries around the world. In recent years, awareness of the importance of good waste management has increased, but there are still many challenges that need to be overcome. One of the main challenges is the lack of active community participation in waste management, which can hinder efforts to achieve sustainable waste management goals. [1]. In the ever-evolving digital era, information technology and user interface (UI) design have become an integral part of everyday life. However, the application of good user interface design (UI) and user experience (UX) in waste management is still minimal. [2] Many waste management systems still use interfaces that are complex and difficult for users to understand. This can reduce public interest and participation in waste management. In addition, the lack of understanding of the importance of good waste management is also an obstacle in achieving the goal of sustainable waste management. [3]. Therefore, this research aims to optimize waste management through the UI/UX design method. By applying the principles of good UI/UX design and is expected to create a user interface that is intuitive, easy to use, and visually appealing so that it can be applied to assist users in carrying out tasks related to waste management more efficiently.

In addition, this research also aims to increase public understanding of the importance of good waste management through informative and educative design. By providing clear and easy-to-understand information about the benefits of sustainable waste management, it is expected to increase public awareness and motivation to actively participate in waste management.

2. Reseach Methodology

Design thinking leads to solution-based problem solving by thinking and working using five simple and clear stages. stages. The following design thinking method is used for problem solving in this research:

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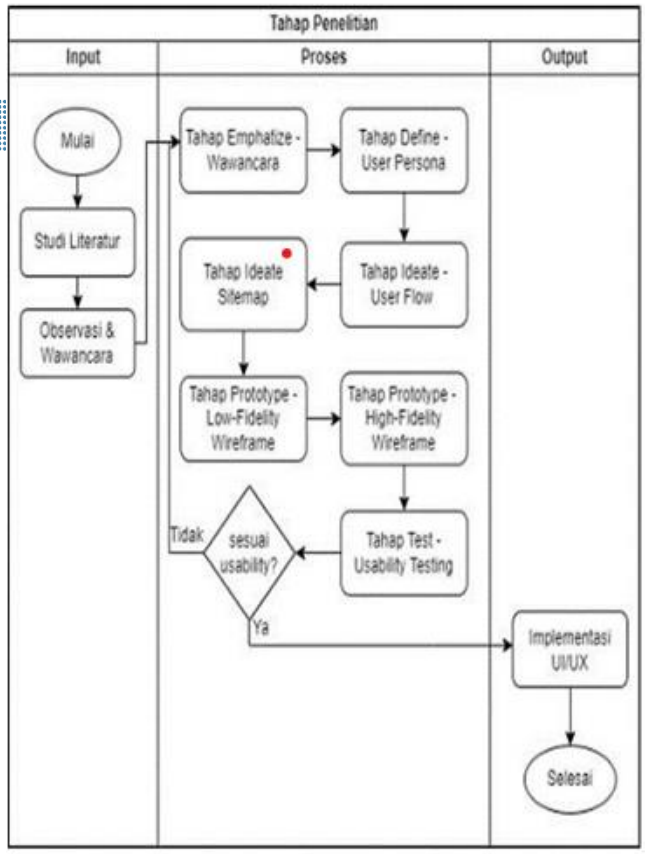

Figure 1. Research stages

a) Literature Study
The literature study stage is an important step in the research process to build a strong understanding of the research topic, detail the background, and identify new and relevant factual issues. Determining the objectives and benefits after that the author uses the literature study to strengthen the facts and information needed in the research.

b) Observation and Interview
Researchers conducted observations of several waste bank officers and the Joglo area and surrounding communities to understand what needs and problems faced by users. This research started from October 2023 to November 2023. An interview is a communication process in which one individual interacts with another to exchange information, views, opinions, or experiences. The main purpose of an interview is to gather comprehensive, accurate, and objective information.

c) Design Thinking
The SISAKU application waste management research as UI / UX uses the design thinking method. Design Thinking is an approach that focuses on creating value for users and identifying in-depth market opportunities. This method tries to understand the needs and expectations of users in depth, so that the resulting solution is in accordance with user needs.

d) User Needs Analysis
User Identification:
The survey conducted to understand user perspectives revealed various challenges faced by users regarding the issues at hand. Many respondents were aware of measures to reduce plastic waste and methods for processing it.[4] However, a significant portion of respondents lacked knowledge on how to effectively process plastic waste to make it beneficial and reusable.

User Characteristics Identification:
The characteristics of SISAKU application users include the following:
1) Users are smartphone users with Android-based devices.
2) The application is usable by both males and females.
3) Users of the application range from ages 15 to 55 years old.
4) The target location is within the Joglo, Jakarta Barat area and its surroundings.

User Needs Identification:
User needs were identified through interviews and surveys conducted in earlier stages. Numerous inputs were gathered from users through these interactions.[5] However, due to time constraints, specific user needs or issues were prioritized for consideration.

User Persona:
Based on the collected data and user characteristics, pertinent information required for creating user personas includes name, age, needs, and goals.

Table 1. User Persona

Nama	Usia	Keluhan	Solusi
Maesaro	50	mengalami kesulitan dalammengatur jadwal pengumpulan sampah di lingkungannya. Dia juga khawatir tentang dampak negative pembuangan sampah ilegal di lingkungannya.	Aplikasi SISAKU dapat membantu ibu maesaro dengan fitur pemberitahuan jadwal pengumpulan sampah dan laporan fitur untuk melaporkan aktivitas pembuangan sampah ilegal di lingkungannya.
Wahyu Adam	21	memiliki kesadaran lingkungan yang tinggi tetapi tidak tahu bagaimana cara terlibat dalam praktik pengelolaan sampah yang berkelanjutan. Dia jugamengeluhkan kurangnya insentif atau penghargaan bagi mereka yang aktif dalam daur ulang.	Aplikasi SISAKU dapat memberikan motivasi kepadawahyu dengan fitur poin atauinsentif yang diberikan kepada pengguna yang aktif dalam praktik pengelolaan sampahyang berkelanjutan.
Ani	19	Ani sering kesulitan menemukan tempat pembuangan sampah yang terdekat dan aman. Dia juga merasa kurangnya informasi tentang cara memilah dan mengelola sampah dengan benar	Aplikasi SISAKU dapat membantu Ani dengan fitur peta yang menunjukkan lokasi tempat pembuangan sampah terdekat dan informasi tentang cara yang tepat untuk memilah dan mengelola sampah.

e) How Might We
How Might We (HMW) be a way to formulate problems into questions that can spark creativity and innovative solution ideas. This approach helps writers embrace problems in a positive way and focus on potential solutions.[6] HMW data processing is obtained based on the results of interviews at the empathize stage, the problems that have been obtained are then converted into the form of questions (how) or how. The problem question can be answered by the way it is solved (might).[7] In processing problem data into questions and finding ways to solve these problems, assisted by classifying user personas to get a solution.

Table 2. How Might We

How	Might
Bagaimana cara pengguna dapat dengan mudah mencari informasi jadwal buang sampah?	Membuat desain fitur buang sampah di halaman utama
Bagaimana pengguna dapat menemukan informasi terkait	Membuat desain fitur info berita pada halaman utama aplikasi

How	Might
sampah?	
Bagaimana cara pengguna mendapatkan sebuah insentif setelah melakukan buang sampah	- Membuat desain fitur point atau skor akumulatif setiap kali membuang sampah. Poin ini dapat dihitung berdasarkan volume atau jenis sampah yang dibuang. - Membuat desain fitur penukaran point yang diperoleh pengguna dengan berbagai hadiah atau diskon dari mitra bisnis lokal.
Bagaimana cara pengguna dapat melakukan transaksi setelah buang sampah?	Membuat desain fitur *top up*, tarik saldo, dan redeem pada kategori informasi saldo
Bagaimana cara pengguna dapat melakukan pelacakan sampah yang telah dibuang?	Membuat desain fitur order, untuk melakukan *tracking* sampah
Bagaimana cara pengguna mendapatkan pemberitahuan terkait sampah yang telah dibuang?	Membuat desain fitur notifikasi untuk mendapatkan informasi terbaru, apakah sampah telah dibuang atau sedang proses
Bagaimana cara pengguna mudah dalam menggunakan aplikasi?	Membuat desain aplikasi yang sederhana atau user friendly dan menerapkan prinsip dasar desain atau *visual hierarchy*

f) Identification of Product Objectives

The purpose of designing the SISAKU application prototype is as an offer and solution in educating the public in tackling plastic waste and bridging the community with waste banks or waste collectors so that their recycled plastic waste becomes economically valuable. The goals that users can achieve through the SISAKU application are as follows:

1) Recycled plastic waste to be sold can be picked up at the seller's location.
2) Can donate recycled plastic waste so that it can be used by others.
3) Can see information about the location of the nearest collectors or waste banks.
4) The community can get education about the processing and utilization of plastic waste.

3. Results and Discussion

3.1. Wireframe Login & Register

On the login page, users are prompted to enter their email address and password to access the application. Meanwhile, on the registration page, users without an account are asked to input their email, password, and confirm the password to create a new account. Upon registration, users are directed to confirm their password, and upon successful confirmation, they are redirected back to the login page.

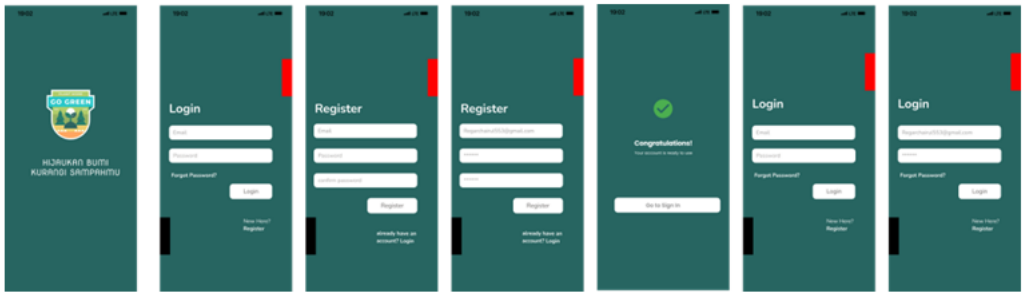

Figure 2. Wireframe Login & Registries

3.2. Wireframe Home screen & Redeem Point

The home page of the SISAKU app features main functions such as history, explore achievement, landfill list, report, pickup, customer service, and news. Additionally, there are four other categories in the bottom navbar: notifications, barcode scan, profile, and waste disposal history. Meanwhile, the point exchange page allows users to redeem points or vouchers earned from transactions within the SISAKU app, serving as an incentive for user engagement.

Figure 3. Wireframe Home screen & Redeem Point

3.3. Wireframe Pick Up

The pickup feature allows users to dispose of waste by arranging for collection by designated personnel. Users don't need to go to waste collection points; instead, they can gather their waste at home, and the personnel will pick it up from there. On this page, users can select the type of waste to be disposed of, with information categorized accordingly. Price estimates are provided for each type of waste, as personnel will verify the waste's condition to determine the appropriate price. The pickup transaction page appears after user's complete waste disposal using the pickup feature. It displays detailed information about the disposed waste, including quantity, estimated sales, service fees, and income estimates. Transactions are verified before being declared successful and completed if the data is valid.

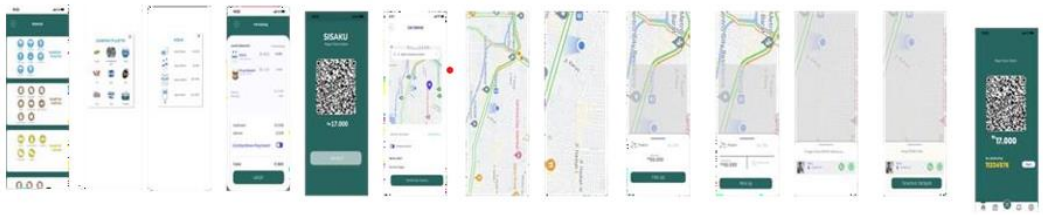

Figure 4. Wireframe Pick Up

3.4. Location TPA

The waste location page is information related to waste location points in the surrounding area. The waste location page contains information on the city or region, the distance traveled and the map route to the nearest landfill location.

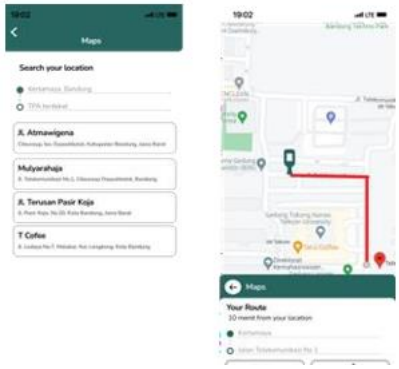

Figure 5. Location TPA

3.5. News Info

The news info page contains relevant news about waste, besides that this page is also a means of education which is one of the points or vision and mission of the Sisa SampahKu or SiSaKu application. With the news info feature, it is hoped that it can also be a means of conveying the objectives of the SiSaKu business unit regarding how to process, manage, and so on related to waste.

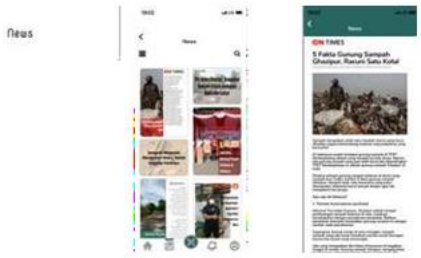

Figure 6. News Info

3.6. Trash Reporting

The trash reporting page is a feature used by users to report the type and location of trash they want to report. This high-fidelity wireframe is designed to facilitate users in conveying information clearly, including options for trash categories, discovery locations, and additional descriptions. This feature aims to expedite the trash reporting process, improve waste management efficiency, and make a positive contribution to the environment.

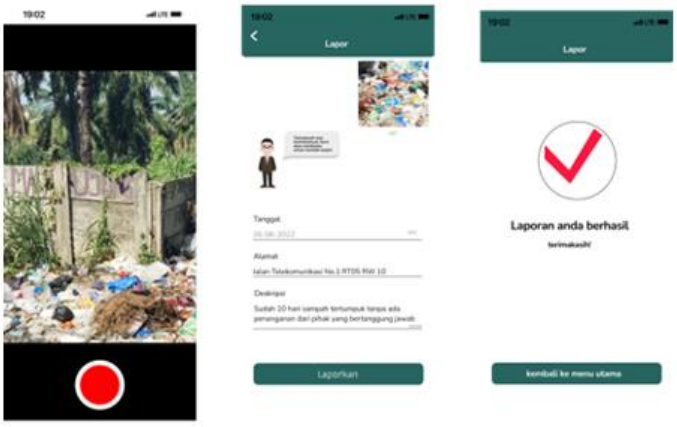

Figure 7. Trash Reporting

3.7. Task and Scenario

Creating testing scenarios is a crucial step prior to testing UI/UX designs or products. These scenarios ensure structured and purposeful testing, leading to effective and valid results. In UI/UX development, testing scenarios are vital to ensure the final product meets user needs and delivers a positive experience. [8] Respondents will execute the prototype autonomously based on user requirements outlined in the Sisa SampahKu or SISAKU app design.

Table 3. Task and Scenario

No	Tugas	Skenario
1	Buang Sampah Pickup	Pengguna akan melakukan pembuangan sampah dengan dilakukan penjemputan sampah oleh petugas. Silahkan gunakan fitur Pickup pada aplikasi SISAKU.
2	Mencari Lokasi Buang Sampah	Pengguna akan melakukan pencarian lokasi buang sampah terdekat atau daerah yang ingin dilihat. Silahkan gunakan fitur Lokasi Buang pada aplikasi SISAKU.
3	Melakukan Reedem Tukar Point	Pengguna akan melakukan penukaran point aplikasi. Silahkan gunakan fitur Achievment history atau Your point pada aplikasi SISAKU.
4	Mencari Info Berita	Pengguna akan mencari informasi yang relevan dengan aplikasi. Silahkan gunakan fitur Info Berita pada aplikasi SISAKU.
5	Lapor Sampah	Pengguna melihat sampah dilingkungannya lalu melakukan pelaporan sampah disekitarnya. Silahkan gunakan fitur Lapor sampah pada SISAKU.
6	Customer Service	Pengguna mengalami kendala saat menggunakan aplikasi SISAKU. Silahkan gunakan fitur CS pada SISAKU.
7	Profile	Pengguna akan melihat profile di aplikasi SISAKU. Silahkan gunakan fitur profile pada SISAKU

3.8. Testing

At the test stage, the last stage where testing the results that have been made by 30 respondents. By using several tests, namely usability testing with maze design and system usability scale (SUS) testing. The following is testing for the Maze Design and SUS phases.

3.8.1. Usability Testing (Maze Design)

In the testing phase, the Maze Design platform was used to conduct usability testing by giving missions and questions to 30 respondents, who were divided into two roles: Community and Waste Bank Officer. The purpose of testing is to see the understanding and habits of users in using the designed system.

Table 4. Usability Testing (Maze Design)

No	Nama Blok	Direct Success Rate	Indirect Success Rate	Avarage Duration	Misclick Rate	Mission Usability Score
1	Buang sampah Pick Up	100%	0%	11.7s	5.4%	98%
2	Mencari info berita	92.9%	0%	9.6s	25.6%	92%
3	Lapor sampah	100%	0%	6.3s	4.5%	98%
TotalMAUS						80.29%

3.8.2. System Usability Scale (SUS) Results

Using the System Usability Scale (SUS) technique to measure usability is a good step in evaluating user satisfaction and effectiveness of the UI/UX design created. In conducting usability testing, 30 respondents will fill out a questionnaire containing 10 questions with the Usability Scale technique, which consists of various groups, such as parents, waste bank administrators, waste bank administrators, and waste bank managers groups, such as parents, waste bank administrators, and the public, with odd and even instruments to minimize bias and get more accurate data. The following is the Usability Test Measurement Scale in the table below:

Table 5. Usability Test Measurements

Range	Kualifikasi	Hasil
85-100%	Sangat Baik	Berhasil
65-84%	Baik	Berhasil
55-64%	Cukup	Gagal
0-54%	Kurang	Gagal

Determination of the usability test scale is carried out so that researchers can measure the success rate of the SISAKU application prototype design that has been made.

3.8.3. System Usability Scale Testing

After testing using MIUS and MAUS beforehand. Furthermore, conduct research using the System Usability Scale parameter which contains 10 questions with answers on a scale of 1-5.

Table 6. Hasil Nilai Kuisoner Masyarakat

No.	Responden	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Hasil
1.	Responden1	3	3	3	3	3	2	3	3	4	1	70
2.	Responden2	3	3	3	3	3	4	3	3	3	3	78
3.	Responden3	3	3	3	3	4	3	3	3	3	3	78
4.	Responden4	3	3	4	3	3	4	3	3	3	1	75
5.	Responden5	4	3	3	3	3	3	3	3	3	1	73
6.	Responden6	4	4	4	3	4	4	4	4	3	3	93
7.	Responden7	4	4	4	4	4	4	4	4	4	3	98
8.	Responden8	3	3	3	3	3	3	3	3	3	3	75
9.	Responden9	3	3	3	4	3	4	4	4	3	3	85
10.	Responden10	3	3	3	3	3	3	3	2	3	1	68
11.	Responden11	3	4	3	4	4	3	3	4	3	1	80
12.	Responden12	4	4	4	3	4	4	4	4	4	3	95
13.	Responden13	3	4	4	3	3	3	3	1	3	1	70
14.	Responden14	4	3	3	4	3	4	3	4	3	3	85
15.	Responden15	4	4	3	4	3	3	4	4	3	3	88
Total												81

Table 7. Hasil Nilai Kuisoner Pengelola

No.	Responden	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Hasil
1.	Responden1	4	4	4	4	4	4	4	4	4	1	93
2.	Responden2	4	3	4	3	4	2	4	4	3	1	80
3.	Responden3	4	3	3	3	4	4	3	4	3	3	85
4.	Responden4	3	3	3	3	3	3	3	3	3	3	75
5.	Responden5	4	3	4	3	3	3	3	4	4	1	80
6.	Responden6	3	4	4	3	3	3	3	3	4	1	78
7.	Responden7	3	4	3	3	3	3	3	3	3	3	78
8.	Responden8	4	4	3	3	3	4	3	3	3	3	83
9.	Responden9	4	4	4	4	4	3	4	4	4	1	90
10.	Responden10	3	3	3	1	3	3	3	3	3	1	65
Total												81

Table 8. Hasil Nilai Kuisoner Start Up

No.	Responden	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Hasil
1.	Responden1	4	4	3	3	4	3	4	3	3	3	85
2.	Responden2	3	4	3	3	3	3	3	3	3	1	73
3.	Responden3	4	4	3	3	4	4	3	4	3	1	83
4.	Responden4	4	4	4	4	4	4	3	4	4	1	90
Total												83

Based on the results of System Usability Scale (SUS) testing, it is concluded that the average level of usability satisfaction from the perspective of the manager's perspective reaches 80.29%. Meanwhile, the average value of SUS testing is 81 for the community, 81 for managers, and 83 for startups. This shows that overall, the UI/UX design of the application received a positive assessment from various user segments.

4. Conclusion

The SISAKU app's UI/UX design, developed through Design Thinking, Facilitates waste management, educates users, and simplifies waste disposal digitally. Effectively identifies solutions for user issues, reflected in the app features. Achieves positive usability satisfaction, averaging 80.29% from management and receiving favorable ratings from all user segments. Implementing lean canvas aids in formulating future strategies. Iterate UI/UX design based on user feedback for functionality and comfort. This research contributes to waste management and design literature, potentially offering innovative solutions for environmental conservation.

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