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Goal Directed Design Method on UI/UX Design Mobile-Based Application for Preventing Waste Dumping

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***Abstract*— The issue of waste dumping persists a significant challenge in Indonesia, particularly in the context of South Sumatra Province. In 2022, the quantity of unmanaged waste in South Sumatra Province was documented at 521,075 tons per year. In the course of 2024, South Sumatra was subjected to a total of 58 floods. This illustrates that flooding remains a significant challenge that necessitates the development of innovative solutions, as it can impede the attainment of the Sustainable Development Goals (SDGs), particularly those pertaining to SDG 11, namely the maintenance of sustainable cities and communities. The act of discarding refuse into air ducts represents a significant contributing factor to the occurrence of flood disasters. Accordingly, this research was undertaken with the objective of designing an interface for the Jagoan Sungai application, which is intended to prevent waste dumping. The application was designed with the specific purpose of facilitating the reporting of instances of littering in river environments by individual communities. The application was designed using the Goal Directed Design method and subsequently evaluated using the User Experience Questionnaire (UEQ) method and the Think Aloud method. The UEQ test results indicate that the scores for the six scales exceed 0.8, indicating a high level of user satisfaction. The Think Aloud test results demonstrate that while no significant improvements are necessary, additional information should be incorporated into the application to enhance the user experience further.**

***Index Terms*—goal directed design; sustainable development goals; think aloud; ; UI/UX; user experience questionnaire; waste dumping**

I. INTRODUCTION

The issue of waste remains a significant challenge in Indonesia. The results of the South Sumatra Asset and Liabilities Committee Forum meeting, which addressed the issues of waste generation and the performance of waste retribution in South Sumatra, indicate that the province generated 886,632 tons of waste in 2022. Of this amount, 58.77% (or 521,075 tons) was unmanaged waste. This quantity comprises 18.9% plastic waste, 13% wood, twigs, or leaves, and 10.63% paper [1]. The improper management of waste can give rise to a range of environmental and public health concerns, including the exacerbation of flooding events [2]. According to the Indonesian Disaster Information Data, there were 425 floods between 2015 and 2024, with 58 occurring in South Sumatra during 2024 alone. These floods resulted in significant losses, including damage to 716 houses, the deaths of five individuals, the suffering of 8,094 people, the destruction of four educational facilities, and financial losses reaching four million rupiah [3]. This illustrates that flooding is a matter that necessitates the involvement of multiple stakeholders, including the government and the community [4].

Flooding has the potential to impede the realization of the Sustainable Development Goals (SDGs). Floods present a significant risk to the achievement of SDGs point 11, which pertains to sustainable cities and communities [5]. There are multiple factors that can contribute to the occurrence of flooding. One such factor is the accumulation of waste materials around riverbanks, which can result from improper waste disposal practices by local communities [6]. The behavior of the people of South Sumatra Province who dispose of garbage in the river is inextricably linked to the absence of public awareness regarding river hygiene [7]. Various initiatives have been implemented to address the issue of waste dumping in rivers. One such approach is the dissemination of knowledge about waste management, the impact of waste on the environment, and the imposition of penalties on individuals who continue to violate these regulations [8]. Nevertheless, these endeavors have yet to yield sufficient results to effectively address the waste management challenge in Indonesia, particularly in South Sumatra. At present, grievances pertaining to the contravention of waste disposal protocols in rivers are still submitted via email or WhatsApp, or through neighborhood associations. The processing of reports

from the public is a time-consuming process when complaints are made in this way. It is therefore necessary to create a system that allows members of the public to report individuals who are responsible for littering in rivers. However, before this system can be developed, it is essential to design a user interface that is in line with the user's objectives and that allows them to input the information they require. The user interface plays an important role in the development of the system, as the design of the application must be neat, organized and in accordance with the user's needs [9].

The Goal Directed Design method is a user interface (UI) and user experience (UX) design method developed by Alan Cooper (2007) that prioritizes the experience and goals of users [10]. By focusing on the user's goals, it is possible to achieve user satisfaction [11]. The efficacy of the Goal Directed Design method in developing application UI/UX designs that align with user goals and needs is supported by research [12]. The design outcomes produced by this method are well received, as evidenced by research [13]. The refinement stage of the Goal Directed Design method allows for the production of a user-friendly interface design that aligns with user needs [14]. To assess the usability of the application interface design, researchers employed the User Experience Questionnaire (UEQ) method and the Think Aloud method. The User Experience Questionnaire (UEQ) is a usability measurement method that provides a comprehensive measurement of user experience and satisfaction [15]. The Think Aloud method is an application testing method that involves users in continuous verbalization of their thoughts and feelings when using the system [16]. According to Ericsson and Simon (1993), the number of respondents required for the Think Aloud method is limited to approximately 8 to 10 users, as this number is sufficient for understanding user behavior in completing the given task scenario [17]. Based on the aforementioned description, the researchers will design the UI/UX of the Jagoan Sungai application with the objective of facilitating the community in realizing a clean river and public complaint services against acts of garbage disposal in the river.

II. METHODOLOGY

The objective of this research is to identify the underlying causes of waste accumulation in rivers within the South Sumatra Province. The data utilized in this research are primary data, namely qualitative and quantitative data in the form of interview results and questionnaires from prospective application users. The research employs the Goal Directed Design method. Goal Directed Design is a User Interface (UI) and User Experience (UX) design method that prioritizes the user's experience and objectives [12]. Alan Cooper developed the Goal Directed Design method, comprising six stages [11], as illustrated in Figure 1.

A. *Research*

The initial phase of the process is research, which entails the collection of data through observation and interviews. This stage is designed to identify behavioral patterns among users and subsequently formulate goals and motivations, both specific and general, derived from product usage [14]. This stage yields insights pertaining to user behavioral patterns and user expectations of the product [18].

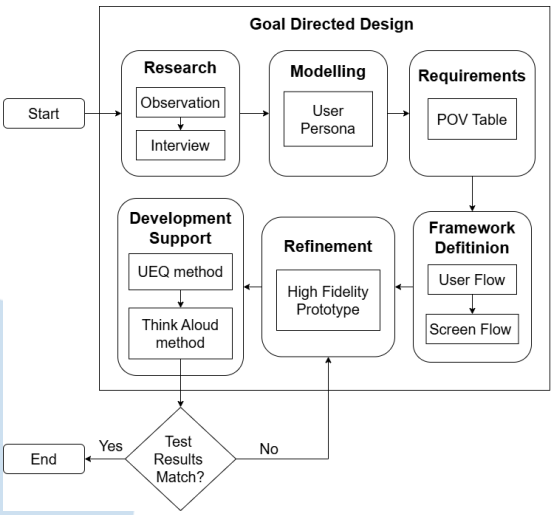

Fig. 1. Goal Directed Design Stages

B. *Modeling*

Following the completion of the research phase, the modelling stage is initiated. This stage involves the depiction of user behaviour, goals and interactions within the application. At this juncture, an analytical process is undertaken, resulting in the formulation of a user persona [19]. The objective of creating user personas is to identify the actual target users [20].

C. *Requirements*

The subsequent phase, termed "requirements," is designed to delineate and ascertain the necessities of the functionalities that will be incorporated into the software application [21]. The result of this phase is the delineation of user objectives, user necessities, user conduct, and the technical elements essential for the design phase [18].

D. *Framework Definition*

The subsequent phase is the definition of the framework. The framework definition stage entails the creation of a preliminary, yet stable, interaction framework and design concept, presented in the form of a user flow and screen flow [22].

E. *Refinement*

Following the creation of wireframes in the framework definition stage, the subsequent stage is

refinement, which is concerned with the specifics and visualization of the application design [19]. The outcome of this phase is a highly detailed prototype that is capable of interacting with users, who will be subjected to a subsequent evaluation process [21].

F. Development Support

Once the application user interface design has been created, the subsequent stage is development support. This involves the evaluation and testing of the aforementioned design, with the objective of ensuring that the application meets the needs and objectives of the users [14]. The outcomes of this phase are documented in the form of test results and interface design improvements, which are implemented in order to attain an acceptable level of design quality [23].

The testing methods employed are the User Experience Questionnaire (UEQ) and the Think Aloud approach. The Think Aloud method is a technique employed in the evaluation of software applications. It entails the active engagement of users through verbal commentary regarding their experiences and perceptions while interacting with the system. This approach enables observers to identify potential areas for enhancement, particularly in relation to the interface design [24]. Prior to testing, users will be provided with instructions and guidance regarding the completion of their assigned tasks. Users will then perform the tasks in accordance with the scenario that has been established. It is imperative that users refrain from any conscious deliberation during the testing process [16].

Meanwhile, UEQ represents a comprehensive usability testing method that yields detailed insights into user experience and satisfaction [15]. The UEQ comprises six measurement scales, each comprising two or three items, resulting in a total of 26 items and seven answer scales [25]. This is illustrated in Figure 2.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Fig. 2. UEQ Questionnaire Instruments

III. RESULT AND DISCUSSION

This research presents a user interface design for the Jagoan Sungai application, developed through the Goal-Directed Design method. The following section presents a description of the results and discussion of this research project.

A. Research

In the initial phase of the research, interviews were conducted with prospective users, specifically the Pahlawan Urban Village Office of Palembang City and the community situated adjacent to the river. The findings of these interviews are presented in Table I.

TABLE I. SUMMARY OF THE RESULTS OF THE INTERVIEW.

No	Question Topic	Answer Conclusion
1.	The following section presents the user feedback on the proposed application.	The proposed interface design for this application was accepted on the grounds that it has the potential to enhance public awareness of river cleanliness and to deter those who continue to dispose of waste in the river.
2.	The objective of this study is to ascertain user goals and expectations with regard to app development.	It is reasonable to anticipate that the application will foster a greater understanding and concern for the importance of maintaining the river's cleanliness.
3.	The objective is to ascertain the user needs and desires in relation to the application.	The objective was to implement a feature that would be advantageous to the community and serve as a deterrent for individuals engaging in the disposal of waste materials in the river.
4.	The information sought by the user is readily available within the application.	The following information pertains to the cleanliness of the river and potential methods for removing the accumulated waste.
5.	The objective is to ascertain user interest and the desired characteristics of the app design.	The app was met with considerable enthusiasm by those who were given the opportunity to test it. They indicated their intention to utilize the app and engage with its features. The target audience desires an application that is straightforward to navigate, with a minimalist design and intuitive functionality.

B. Modeling

The second stage is the modeling stage, which involves the depiction of user behavior, goals, and interactions within the application. At this juncture, an analysis is conducted to generate a user persona that aligns with the findings of the interview**.** This research presents two user personas: Employees of the Urban Village Office and the Community Around the River as shown in Figure 3 and Figure 4.

Fig. 3. User Persona 1

Fig. 4. User Persona 2

C. *Requirements*

The third stage is the establishment of requirements, which entails the creation of a scenario context. This is achieved by formulating goals and requirements in the form of a POV table, in alignment with the objectives of the user persona, as illustrated in Figure 5.

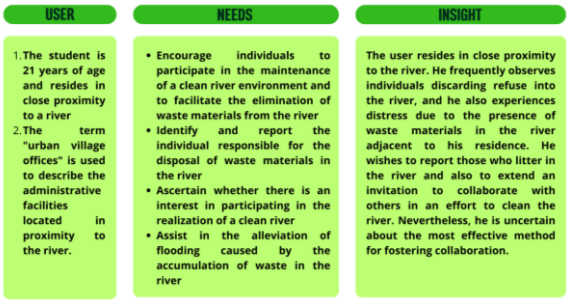

Fig. 5. POV User

D. *Framework Definition*

The fourth stage is framework definition, which entails the creation of a stable interaction framework and design concept in a preliminary form, typically in the form of a user flow and screen flow diagram. A user flow is defined as a description of the sequence of actions that users can take in order to achieve their desired outcomes when utilizing a given application [26]. The user flow of this application is illustrated in Figures 6 through 11.

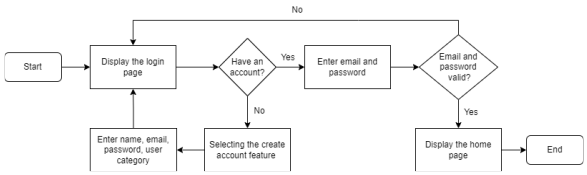

Fig. 6. User Flow Login and Register

Figure 6 illustrates the sequence of actions required for a user to either log in or register. The system will initially present the login page, after which the user is prompted to enter the email address and password associated with their registered account. In the event that an account has not been previously established, the user is first required to create an account and subsequently log in to the system.

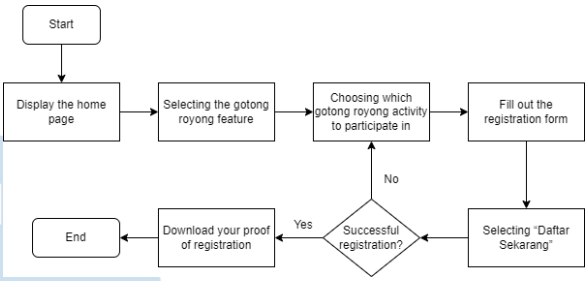

Fig. 7. User Flow Registering Gotong Royong Activities (General User)

Figure 7 illustrates the user flow for registering mutual cooperation activities. Subsequently, the system will display the home page, after which the user may select "Gotong Royong," which will result in the appearance of a list of available gotong royong activities. Subsequently, the user selects the activity in which they wish to participate. Subsequently, users will be directed to the registration form page, where they will complete the requisite registration information.

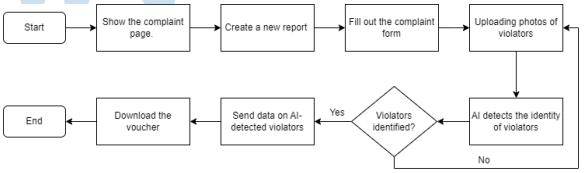

Fig. 8. User Flow of Creating a Violation Complaint (General User)

Figure 8 illustrates the user flow for the violation complaint feature. Subsequently, the system will display the complaint page, after which the user must click the button labeled "Buat Laporan Baru" Subsequently, the user is prompted to complete the complaint form. Subsequently, the system will utilize artificial intelligence (AI) to ascertain the identity of the perpetrator. Subsequently, if the AI is able to successfully identify the perpetrator, the user is prompted to transmit the report to the Environmental Service for processing. In the event of an unsuccessful attempt, the user is prompted to re-upload the

photograph of the violator. It is imperative that the photograph be of sufficient clarity for the AI to be able to accurately identify the individual in question.

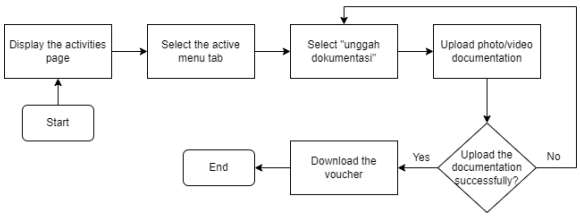

Fig. 9. User Flow Upload Activity Documentation (General User)

Figure 9 illustrates the user flow for uploading activity documentation. Subsequently, the system will display the activity page. The activity page contains three menus: active, upcoming, and history. Subsequently, the user selects the "Aktif" menu tab and clicks the "Unggah Dokumentasi" button. Subsequently, the user uploads the photographic or videographic documentation as evidence of their participation in the gotong royong activity.

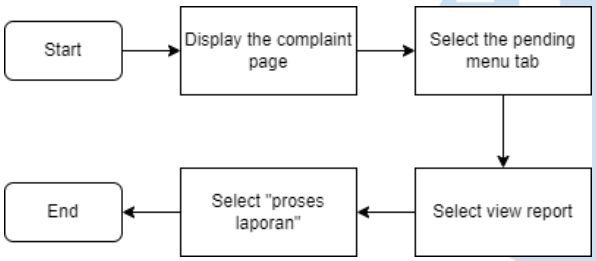

Fig. 10. User Flow Processing Complaints (Officer)

Figure 10 illustrates the user flow for processing complaints by officer. Upon accessing the system, the officer is presented with the complaint page, which features three menu tabs: pending, processed, and history. The officer selects the pending tab to view the report and initiate the processing of the report. Once the officer has completed the requisite actions, the report is transferred to the processed tab, indicating that it is currently under review by officer.

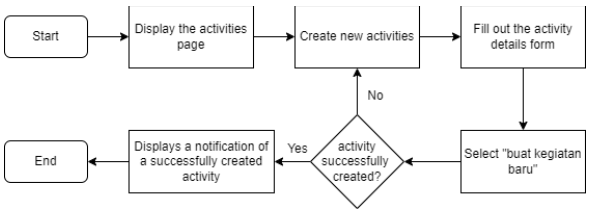

Fig. 11. User Flow of Creating a New Activity (Officer)

Figure 11 illustrates the user flow for creating a new activity. Subsequently, the system will display the activity page, after which the user must click the button labeled "Create New Activity." Subsequently, the officer is required to complete the comprehensive information form pertaining to the gotong royong activity.

Fig. 12. Screen Flow (General User)

Fig. 13. Screen Flow (Officer)

The screen flow of general users and officer, as illustrated in Figures 12 and 13, respectively, were defined at the framework definition stage.

E. Refinement

The fifth stage is the refinement of the design, which will take the form of a prototype. This prototype will be a high-fidelity representation of the final system and, as such, will be a comprehensive and accurate reflection of the design.

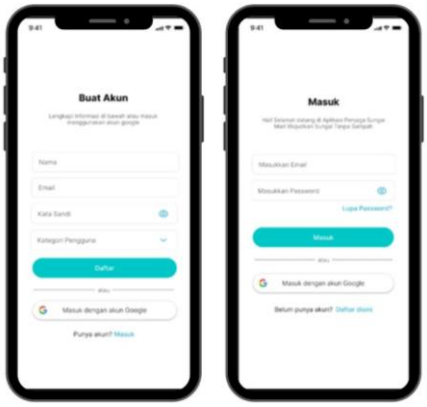

Fig. 14. Login and Sign Up Display

Figure 14 represents a login and sign-up display, or the option to create an account for new users. In order to gain access to the system, users are required to create an account. This entails entering their full name, email address, and password, as well as indicating whether they are a general user or officer. Alternatively, users may opt to register using a Google account. In the event that a user already has an account, they are required to enter the previously registered email address and password, or alternatively, they may log in with a Google account. Furthermore, in the event that a user has forgotten their account password, they may utilize the forgotten password feature to change the old password.

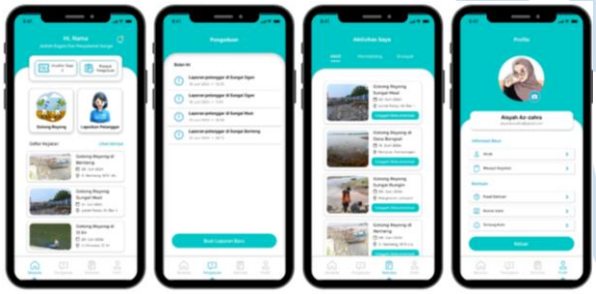

Fig. 15. Hi-Fi General User Display

Figure 15 depicts the home menu, along with the complaints, activities, and profiles for general users. The home menu presents a list of scheduled gotong royong activities. Moreover, the complaint menu enables users to create a new complaint report by completing the requisite form, which is made available upon clicking the "Buat Laporan Baru" button. Moreover, the activities menu contains a list of current and forthcoming activities, as well as a record of those previously undertaken. Additionally, users are able to upload documentation pertaining to their activities within this menu. The profile menu, which follows, comprises profile features, activity history, the help center, contact information, and a section on the application's background. Furthermore, users may exit the application from this menu.

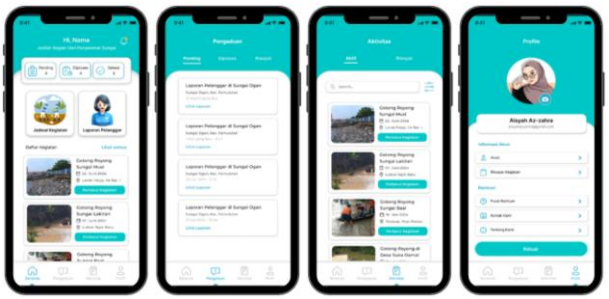

Fig. 16. Hi-Fi Display of Officer

Figure 16 depicts the home menu, along with the complaints, activities, and profiles for officers. The home menu presents a list of scheduled gotong royong activities. The home menu allows officers to update information pertaining to existing activities. Moreover, the complaints menu comprises three primary sections: pending, which encompasses reports that have not yet been processed; processed, which includes reports that are currently undergoing processing; and a historical record of public complaints. Moreover, the activity menu presents a list of current activities and a record of past collaborative endeavors. Subsequently, the profile menu is presented. This menu contains the following features: profile, activity history, help center, contact us, and about us. Additionally, this menu allows officers to exit the application.

F. Development Support

The final stage is that of development support. At this juncture, usability testing of the application user interface is conducted with 100 respondents using the User Experience Questionnaire (UEQ) methodology to ascertain whether the application aligns with the needs and objectives anticipated by users. The responses provided by the respondents can be observed in Table II.

TABLE II. THE RESULTS OF THE SURVEY

No	Question Item								
	1	*2*	*3*	*4*	*…*	*23*	*24*	*25*	*26*
1	6	6	3	3	…	3	3	3	4
2	6	7	1	1	…	1	1	2	7
3	5	6	2	3	…	3	2	3	7
4	6	6	1	1	…	3	2	3	6
5	7	6	1	1	…	1	1	1	7
…	…	…	…	…	…	...	...	...	...
96	6	6	2	2	…	1	2	6	6
97	6	6	4	3	…	2	2	6	3
98	7	5	7	7	…	1	1	7	6
99	6	5	1	1	…	2	2	7	6
100	6	7	2	2	…	1	1	6	6

Subsequently, the respondent data in Table 3 undergo a transformation to ascertain the negative and positive values associated with each item. The transformed data from the respondents is presented in Table III.

TABLE III. TRANSFORMED DATA.

No	Question Item								
	1	*2*	*3*	*4*	*…*	*23*	*24*	*25*	*26*
1	2	2	1	1	…	1	1	1	0
2	2	3	3	3	…	3	3	2	3
3	1	2	2	1	…	1	2	1	3
4	2	2	3	3	…	1	2	1	2
5	3	2	3	3	…	3	3	3	3
…	...	...	...	...	…	...	...	...	...
96	2	2	2	2	…	3	2	-2	2
97	2	2	0	1	…	2	2	-2	-1
98	3	1	-3	-3	…	3	3	-3	2
99	2	1	3	3	…	2	2	-3	2
100	2	3	2	2	…	3	3	-2	2

The average value of an impression and scale variance were then obtained from the results of data transformation, as illustrated in Figure 17.

UEQ Scales (Mean and Variance)		
Attractiveness	1.702	1.14
Perspicuity	1.795	0.81
Efficiency	1.655	1.10
Dependability	1.440	1.49
Stimulation	1.970	0.54
Novelty	1.675	0.85

Fig. 17. Average Impression and Variance

The results demonstrate that all 6 UEQ scales, including Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty, exhibit average results above 0.8. These findings are utilized to analyze the benchmark data, which can be observed in Figure 18.

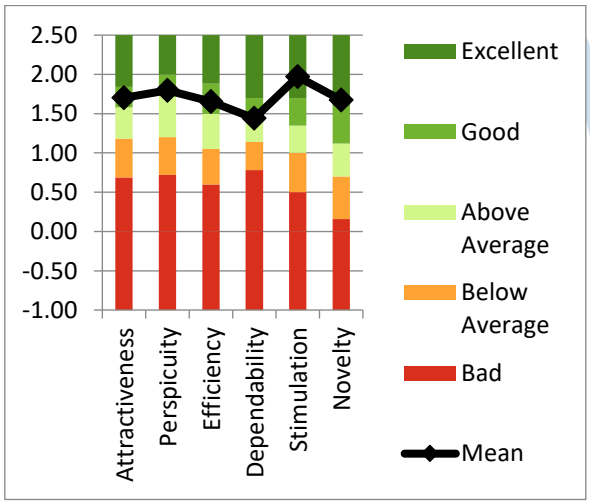

Fig. 18. UEQ Benchmark Chart

The results of the measurement of the average value of the UEQ score indicate that the Jagoan Sungai application is rated in the "good" category in various aspects, including attractiveness (1.7), perspicuity (1.8), and efficiency (1.66). Furthermore, the aspects of stimulation and novelty were rated highly, with scores of 1.97 and 1.68, respectively. The dependability aspect was rated above average, with an average score of 1.44. These results indicate that users of the Jagoan Sungai application are satisfied with the attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty of the application.

Following the implementation of the UEQ method for testing purposes, the Think Aloud method was employed for a subsequent round of testing. The testing phase involved the participation of 10 users, comprising both general users and village officers, and was conducted in accordance with the task scenario delineated in Table IV.

TABLE IV. TASK SCENARIO

No	Task Scenario
T1	Registration and login to the Jagoan Sungai application (general users and officers)
T2	Search and register for available gotong royong activities (general users)
T3	Upload documentation of gotong royong activities that have been participated in (general users)
T4	Make a violation complaint (general users)
T5	View a list of current, registered, and historical activities (general user)
T6	Processing complaints (officer)
T7	Creating new activities and changing gotong royong activities (officers)
T8	View a list of pending, processed and historical complaints (officer)
T9	Edit profiles (general users and officers)
T10	Exit the app (general users and officers)

In accordance with the fundamental tenets of evaluation as espoused by Jakob Nielsen, the data obtained will be classified and assigned a severity rating based on the mean severity rating value of each problem identified [16]. Subsequently, the problems are sorted to ascertain the priority for improvement, based on the mean value of the highest severity rating and the number of users who have identified the problem [17]. The severity rating value scale is presented in Table V.

TABLE V. SEVERITY RATING VALUE SCALE

Scale	Terms	Description
0	No Problem	This is not a usability issue.
1	Cosmetic Problem	The issues pertain solely to the display aspect and do not impact user comfort.
2	Minor Problem	The issue requires attention, but it is not a high priority.
3	Minor Problem	The following issues have been identified as requiring improvement.
4	Catastrophe	The issues encountered by users are of a significant and intricate nature, necessitating the implementation of enhancements.

The results of the user problem identification process following the testing phase are presented in Table VI.

TABLE VI. SEVERITY RATING GENERAL USERS

User	Task Scenario						
	T1	*T2*	*T3*	*T4*	*T5*	*T9*	*T10*
1	0	1	0	0	0	0	0
2	0	0	0	1	0	0	0

User	Task Scenario						
	T1	*T2*	*T3*	*T4*	*T5*	*T9*	*T10*
3	1	0	0	0	1	0	0
4	0	1	1	0	0	0	0
5	0	0	0	2	0	1	0
6	0	0	1	0	1	0	0
7	0	0	0	1	0	1	0
8	0	0	0	1	0	0	0

TABLE VII. SEVERITY RATING OFFICER

User	Task Scenario					
	T1	*T6*	*T7*	*T8*	*T9*	*T10*
1	0	0	2	0	1	0
2	0	1	1	0	1	0

A total of 20 problems were identified based on the results of the user scenario tasks. This results in a total of 16 problems with a severity rating of 1 and 2 problems with a severity rating of 2. The provision of recommendations for improvements to the Jagoan Sungai application presents a challenge in terms of the categories of appearance and information or content. Recommendations are formulated and ordered according to a severity rating scale, commencing with the highest value, designated as 4 (catastrophe), and culminating with the lowest value, 2 (minor problem). The rating of 1 (cosmetic problem) is disregarded, as it is deemed to have a relatively minimal impact on users. The majority of these problems were found in tasks T4 and T7. Conversely, the fewest problems were identified in tasks T1 and T6, with a single problem each, and in task T10, which was rated as very easy to complete by all users.

In general, the application is satisfactory and offers users a convenient means of accessing the desired information. No significant enhancements are required; however, the content within the application would benefit from the incorporation of supplementary details.

IV. CONCLUSION

The findings of the research indicate that the Goal Directed Design method is an effective approach for the design of the user interface and user experience of the Jagoan Sungai application. The user interface design of the Jagoan Sungai application was produced through the stages of the Goal Directed Design method. Subsequently, the user interface design of the River Hero application was evaluated using the UEQ method with 100 respondents.

The results of the test demonstrated that the attractiveness scale attained a score of 1.7, clarity scored 1.8, and efficisency scored 1.66. Furthermore, the stimulation and novelty aspects were rated in the very good category with scores of 1.97 and 1.68, respectively. The accuracy aspect was scored above average with an average score of 1.44. The results of the think-aloud testing yielded 20 issues, as determined by the outcomes of the user scenario assignment. Of these, 16 were classified as level 1 problems and 2 as level 2 problems.

These findings suggest that no substantial enhancements are necessary, but rather that additional information should be incorporated into the application. The results of the tests conducted using both methods indicate that the Jagoan Sungai application is generally well received and aligns with user needs.

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