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User Interface Design and Evaluation of Food Waste Reduction Learning Platform: A Case Study of Mama4Planet

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Abstract

This research is driven by the need to promote behavioral change through education on reducing food waste, as exemplified by the initiatives of Mama4Planet. Therefore, there is a need to develop a digital learning media that meets the needs of stakeholders and users through interface design. This research uses a user-centered design approach. Requirement discovery was carried out through stakeholder and 15 users interview so that the outputs were three user personas, user journey maps, and value proposition canvases. A total of 8 user flows and 19 wireframes were also the outputs of this phase. Furthermore, prototyping was carried out by providing interactions between pages and other components that refer to the user flow. The evaluation stage was done through two iterations of usability testing with results showing an increase in completion rate, time-based efficiency, and SUS score from 63.8 or grade C- to 79.0 or A-.

A. Introduction

According to the 2024 Food Waste Index report, it is known that Indonesia produces 14.73 million tons of food waste per year, and is the highest in Southeast Asia. Food waste in this case can be in the form of a decrease in the quantity of food that occurs along the food supply chain including the distribution, marketing, and consumption processes, either due to damage, being thrown away without being used, or being left over from consumption [1], [2]. So, in addition to being a threat to the environment and a form of waste of resources, this issue is also ironic amidst the high rate of hunger and malnutrition because food that should be able to be used to feed 61-125 million people ends up as waste and a source of disaster [2].

Furthermore, according to the national data collected by the Ministry of Environment and Forestry, based on its type, food waste is the most produced. Meanwhile, if viewed based on its source, the household sector is the largest sector that contributes to waste generation. The high rate of food waste generation in the household sector is caused by poor consumer behavior from the planning, purchasing, storage, serving, consumption, and management stages of leftover food [3].

Behavioral change at the household level is one of the strategic efforts in preventing and reducing food waste. Therefore, preventing the occurrence of food waste from its source should be a priority through behavioral change at the household level as is the direction of strategic policy in preventing and reducing food waste [2]. In order to change behavior, the first step that must be taken is to increase public knowledge and awareness, which in this case study Mama4Planet wants to achieve through training and education related to the prevention, reduction and management of food waste [4]–[6].

Referring to the trend of increasing food waste production, and considering the various environmental impacts caused, food waste becomes an important issue that requires serious handling. To realize education that can reach more mothers in other areas, Mama4Planet tries to scale up education through digital media. To develop a digital learning media that meets the needs of stakeholders and users, it is necessary to design an interface. So, there are three research questions (RQs) that want to be answered through this study, they are:

- **RQ1.** What are the results of the stakeholder and user needs analysis of the Mama4Planet food waste reduction learning platform interface design?
- **RQ2.** What are the results of the Mama4Planet food waste reduction learning platform interface design?
- **RQ3.** What are the results of the Mama4Planet food waste reduction learning platform interface design evaluation?

B. Research Method

This research was conducted by referring to the four basic activities of interaction design with the adoption of the User-Centered Design (UCD) approach according to Rogers et al. (2023). The UCD approach was chosen because it is the right method by involving users during the development process so that it can produce a design with good usability [7].

As shown in the Table 1, this research combines qualitative and quantitative methods to gain a comprehensive understanding of the problems being studied [8]. Therefore, this research design is called a mixed method because it involves two research methods, namely qualitative and quantitative. Sequentially, this research will begin with the use of qualitative methods, then the results will be used for the evaluation process which is a quantitative stage. Therefore, this research is also classified as exploratory [9].

Table 1. Research Design

Attributes	Information
Classifications	Mixed-method, exploratory research
Research Category	Case study
Paradigm	Interpretive, evaluative
Research Aims	1. Knowing the needs of stakeholders and users for the design of the Mama4Planet food waste reduction learning platform interface. 2. Developing design solutions in the form of a Mama4Planet food waste reduction learning platform interface design. 3. Knowing the results of the evaluation of the Mama4Planet food waste reduction learning platform interface design.
Sampling Methods	Purposive-convenience sampling, snowball

As seen in the Figure 1, the process of discovering requirement begins with formulating questions to be asked to stakeholders related to the development of the Mama4Planet learning platform. Furthermore, a readability test is conducted to ensure that the questions to be asked can be easily understood by the interviewees. After the list of questions has been revised based on the feedback obtained from the readability test, the author then begins conducting online interviews. Interviews with stakeholders involved three respondents who were representatives of the three main teams related to the development of the Mama4Planet learning platform, namely the Training of Trainers team, the Gamification team, and the Project Owner who is also part of the Web Development team. The results of the interviews were then analyzed using deductive coding or labeling carried out at the beginning which refers to the outline of the description of the context of use in the user-centered design theory consisting of identifying stakeholders and user groups, user characteristics, identifying goals and user tasks, and the system environment [10], [11].

Next, based on the information obtained from stakeholder interviews, the author compiled a list of questions to be asked to explore user needs. The list of questions also went through a readability test stage before finally being submitted through interviews. The interviews were semi-structured but still referred to the list of questions that had been made. User interviews were conducted online and offline involving five people for each user group as representatives, namely the parents, teachers, and cadres. The interview results then went through a deductive coding stage by adjusting the needs to create user personas, value proposition canvas, user journey maps, and feature implementation.

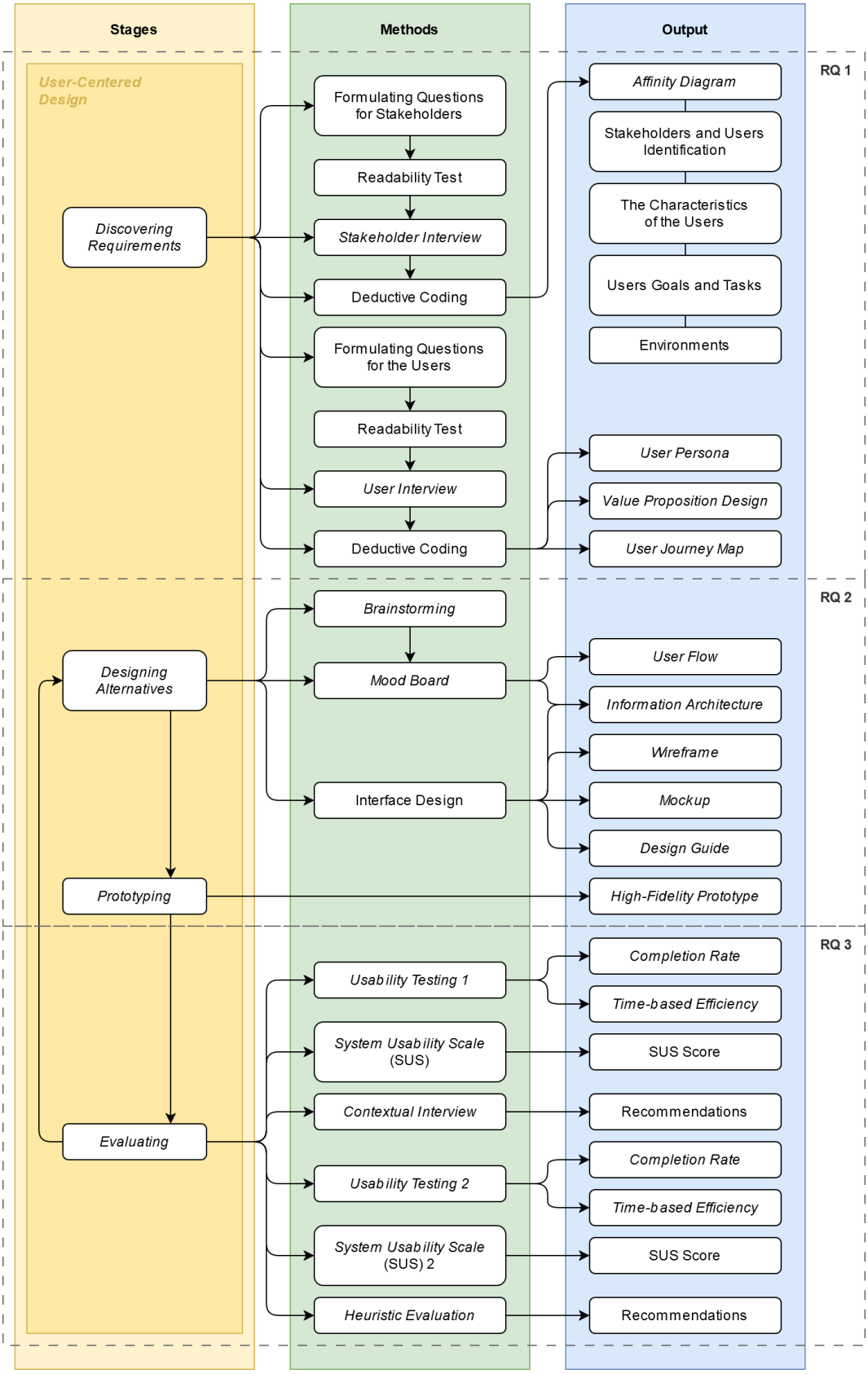

Figure 1. Design Stages

The next stage is to create a design solution that meets the needs. This stage is the second stage of the four basic activities of interaction design that aims to produce conceptual design and concrete design. Conceptual design is a conceptual model that describes what users can do with the product and the concepts needed to understand how users will interact with the product being created. Then, the term concrete design refers to a detailed solution design that includes color schemes, terms, images, sounds, menu designs, and icons [12].

At this stage, the author brainstorms with stakeholders asynchronously to exchange ideas related to user flow in accessing learning through the platform so that the output is produced in the form of a mood board. In addition to gaining insight into best practices from similar applications, the insight generated from the mood board will also influence the flow and arrangement of information in the user flow and information architecture outputs.

Next, the author does the interface design with conceptual output in the form of wireframes and concrete output in the form of mockups and design guides. The creation of wireframes refers to the information architecture and user flow that have been created and carried out to describe the structure, content, and how each function will be connected to each other. Then the author creates a static high-fidelity design that contains colors, images, and text that simulates the product when it is released so that the resulting output is a concrete design called a mockup [13]. The design style used in the interface design is documented by the author through a design guide which aims to make it easier for the Mama4Planet team in the future to continue the process of developing the product.

The third stage is the creation of a prototype which is done by providing more detailed interactions on the mockup so that the output produced is called a high-fidelity prototype. The purpose of creating a prototype is to help the author communicate the idea of a design solution by presenting an interactive prototype so that it can provide a more real experience for stakeholders and users regarding how the platform will be used.

The final stage of interaction design is the evaluation of the design solutions that have been developed. The evaluation was carried out to measure the quality of usability and the level of user acceptance of the Mama4Planet learning platform [12]. The evaluation was carried out in two iterations so that the results were stable and good enough to be developed in the future. In the first iteration, usability testing, System Usability Scale (SUS) assessment, and contextual interviews with users were carried out. In the second iteration, usability testing and SUS assessment by users and also a heuristic evaluation by experts were carried out.

Usability testing and SUS assessment are always conducted in one session involving fifteen users who are respondents in the previous requirement gathering stage. In the implementation of usability testing, respondents will be asked to perform several tasks related to the use of the Mama4Planet learning platform. The outputs of the usability testing are completion rate and time-based efficiency. In the same session, respondents will be asked to provide a SUS assessment.

Since the SUS is a quantitative metric, a minimum number of samples should be used. According to [14], there is no fixed number of samples that must be used. However, the more samples involved, the more precise the result will be. Although

fewer than 15 samples can be used, a larger sample size is recommended for greater accuracy [15]. In this research, the amount of sample involved during the SUS assessment is 15, which are the same users involved since the discovering requirements phase and usability testing. Additionally, the primary goal of the quantitative evaluation methods in this study is to indicate the product's improvement over time. Therefore, the relatively small sample size does not pose a significant issue.

In the first iteration, contextual interviews were conducted with users to find out why users took certain actions when usability testing was carried out and to study user responses to the prototype that had been created. This contextual interview was conducted as a way for the author to gain insights in the form of suggestions for improvement. After the design solution was improved, the author then conducted a heuristic evaluation involving two experts in the field of digital product and design. This heuristic evaluation was conducted to obtain qualitative assessments from experts based on Nielsen's heuristic criteria [16], [17]. The assessments given by the experts then became material for the author to make improvements and produce the final design of the Mama4Planet learning platform design solution.

C. Result and Discussion

RQ1. What are the results of the stakeholder and user needs analysis of the Mama4Planet food waste reduction learning platform interface design?

The research began with an interview by asking 44 questions to stakeholders. The outputs produced were then grouped based on four categories of usage context, namely identification of stakeholders and user groups, user characteristics, identification of user goals and tasks, and system environment. The discussion of the usage context is further explained as follows:

1. **Stakeholders and Users Identification**
   Stakeholders involved in the Mama4Planet program include local governments, ministries, educational institutions, and international organizations related to food and nutrition. The role of stakeholders includes reviewing modules and socializing the program to local communities. However, based on their involvement in platform development, stakeholders are not directly involved. The learning platform is expected to assist the government in making waste management policies, supporting education at TPS3R, and changing community behavior.
   There are three groups of Mama4Planet learning platform users that are distinguished based on their teaching targets, namely teachers, cadres, and parents. The Posyandu cadre user group can take part in learning to then be taught to mothers. Teacher users to be taught directly to their students. Then, mother users, both those who take care of the household or work, to be taught to their children and even their husbands. In the long term, the use of the Mama4Planet learning platform is expected to be used by more people from various backgrounds without any exceptions.
2. **The Characteristics of the Users**
   Users of the Mama4Planet learning platform are expected to be dominated by access via mobile phones. The main target users are lower-middle class

people in areas with emergency waste issues. Based on gender, the platform may be accessed more by mothers even though there are basically no gender restrictions. Platform access only requires a gadget and internet, with free modules that support learning and gamification as incentives. Mother users are generally not familiar with e-learning platforms. Furthermore, according to its technical capabilities, many users may need assistance to access the Mama4Planet learning platform. Therefore, a WhatsApp-based help center is needed to facilitate accessibility.

3. **Users Goals and Tasks**

The main goal of users through the platform is to provide education based on each user group; cadres for counseling materials, teachers for teaching materials at school, and parents to get children used to reducing food waste at home. The ultimate goal is behavioral change starting from daily habits to reduce household food waste.

Access to the platform is done individually to record progress and involves pre-tests and post-tests to measure the user's understanding. Learning materials are arranged continuously and must be followed in sequence. Afterwards, users can choose to participate in optional gamification activities, where they can collect points to get prizes.

4. **Environments**

There are ten aspects of the system environment identified from the results of interviews with stakeholders. These aspects are accessibility, language and communication style, system limitations, devices, external interventions, trial periods, guidance, updates, third-parties, and feedback. Table 2 shows a further description of each aspect of the Mama4Planet learning platform environment.

Table 2. Platform Context of Use

Aspects	Description
Accessibility	- The platform provides learning materials through video (included audio) with closed captions to facilitate users with impairments. - There is no need for users to be able to distinguish colors.
Language and Communication Style	The learning platform uses Indonesian language that is easy for the general public to understand, with images and words that are also tailored for a child audience. The platform also provides explanations for the scientific terms used.
System Limitations	- The video material is a maximum of 15 minutes long. - Access to the material is valid for life. - Gamification is optional and aims to measure the extent to which the material is practiced by training participants. Gamification is a form of Mama4Planet evaluation, so it is impossible to eliminate it because it is part of the evaluation of the implementation of the Mama4Planet program. - Ease of access and fast web response are needed to reach a wider community and are worthy of supporting cooperation with stakeholders from the local government. - Application development complies with personal data standards and can display information about stored data both

Aspects	Description
	anonymously and originally to users.
Device	The learning platform can be accessed via mobile phones, tablets, laptops, or computers. However, access via mobile phones is preferred.
External Interventions	External intervention is needed both with the government and other organizations. Intervention is needed such as for reviewing materials, mutually beneficial integration with other programs, promotion, and funding support.
Trial Periods	The trial before being released to the public will be conducted with 5-15 people to try using the Mama4Planet platform. From the trial, feedback will be obtained to be improved and at the same time become material for Frequently Asked Questions (FAQ).
Guidance	The guide is provided in the form of pop-up guidance when users access the website, FAQ page, and helpdesk. However, it is expected that the Mama4Planet learning website can be self-explaining.
Updates	Possible updates are on the topics materials and the activity for gamification. However, the possibility of updates in terms of time is probably only one to two times a year.
Third-parties	There is no third-party usage yet.
Feedback	- For training, after completing the learning, participants will receive a certificate. - For gamification, feedback will be present in the form of a competition with a leaderboard.

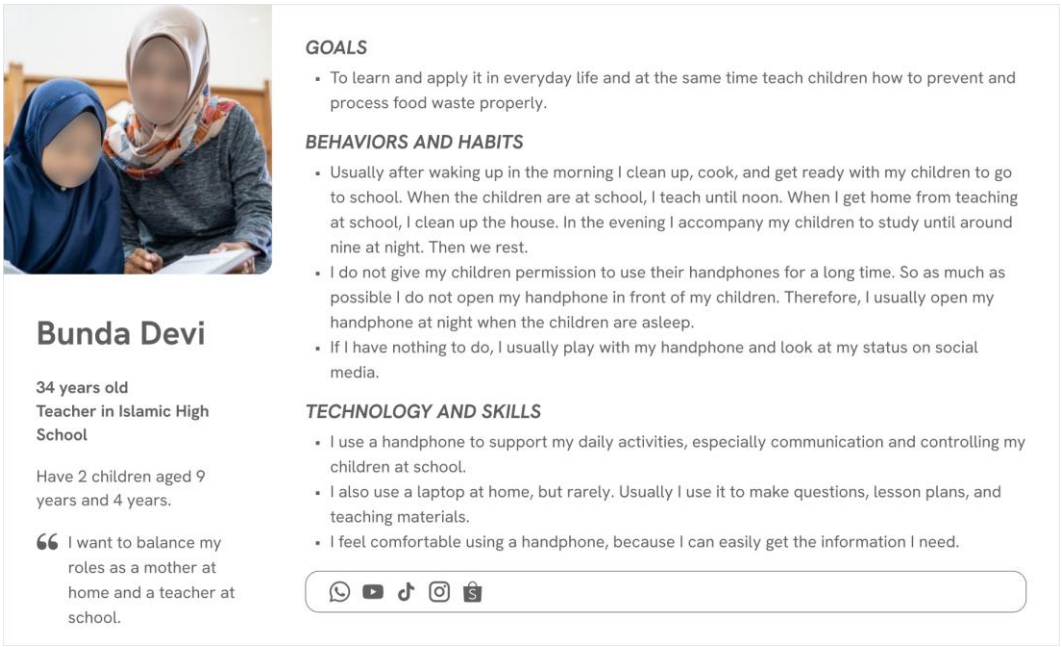

Figure 2. User Persona for Parents

Next, interviews were conducted involving five users each for three personas, namely teachers, parents, and cadres. A total of 42 questions were asked, then the

results were analyzed to produce outputs in the form of user personas, value proposition canvas, and user journey maps. Figure 2 contains the parent persona, namely Bunda Devi, who is a mother of two children. Bunda Devi is a teacher at an islamic high school. Bunda Devi's daily routine is quite regular, such as preparing breakfast and cleaning the house before going to school. Then, during the day after teaching, Bunda Devi returns to continue housework and accompanies her children to play and study until the evening. With this routine, Bunda Devi does not use her handphone much, especially to set an example and support limiting her young child's screen time. Therefore, Bunda Devi usually only uses her handphone when her children are asleep at night.

From the previously created personas, platform value proposition was developed using the value proposition canvas. Each persona has its own value proposition canvas which is divided into two main parts, they are the customer profile and the value map. Figure 3 is a value proposition canvas for parent personas. In the gains section, 8 out of a total of 14 gains were selected with a frequency of occurrence of more than 1. Then, in the pains section, 4 pains were obtained with each frequency of occurrence of 1. Therefore, in the pains section, no prioritization was carried out based on frequency. Furthermore, after being mapped on the value map, 2 gain creators, 6 pain relievers, and 8 product and service ideas were obtained that can be implemented on the Mama4Planet learning platform.

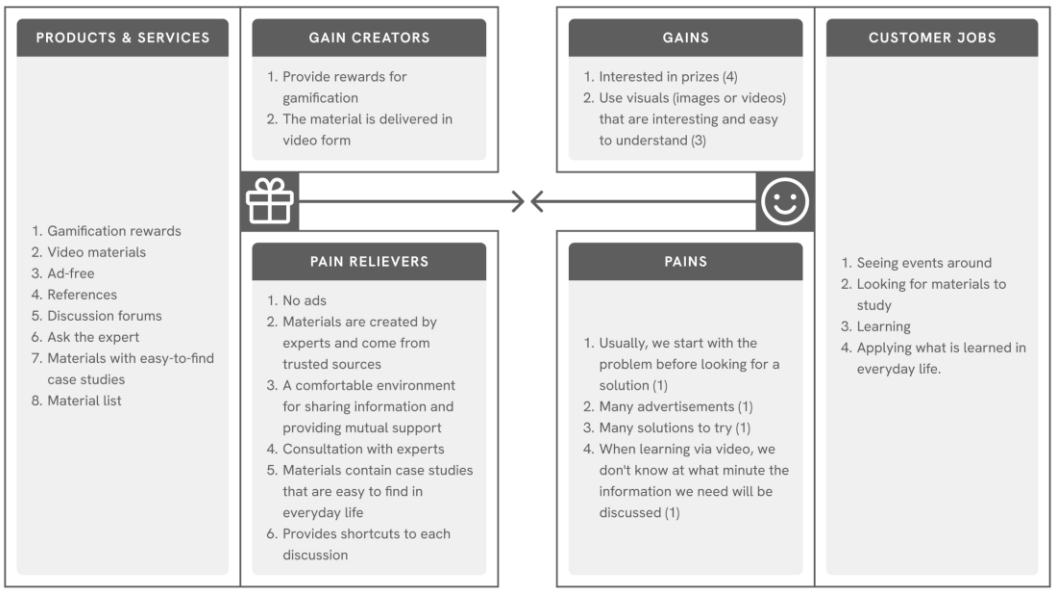

Figure 3. Value Proposition Canvas for Parents Persona

The next phase is to describe the steps taken by each persona to achieve a certain goal based on a scenario. The user journey map is created by referring to the three personas that have been created in the previous stage. Therefore, at this stage there are three user journey maps produced. Figure 4, depicts the user journey map for the parent persona. In the user journey map scenario, Bunda Devi is depicted when she wants to learn how to process food waste. The scenario begins with the activity of observing the surrounding environment. Bunda Devi realizes that the many invitations to attend celebrations near her house bring their

own blessings so that her family gets a lot of processed food to take home from the event. Because she is afraid that the cooked food will be wasted, Bunda Devi takes the initiative to search for information on the internet by browsing and searching for videos on YouTube. At this stage, Bunda Devi feels dissatisfied because when she does not understand what she is learning, she has to look for information from other sources. Next, Bunda Devi will practice what she has learned. At this stage he feels happy if the information he practices is proven and easy to do.

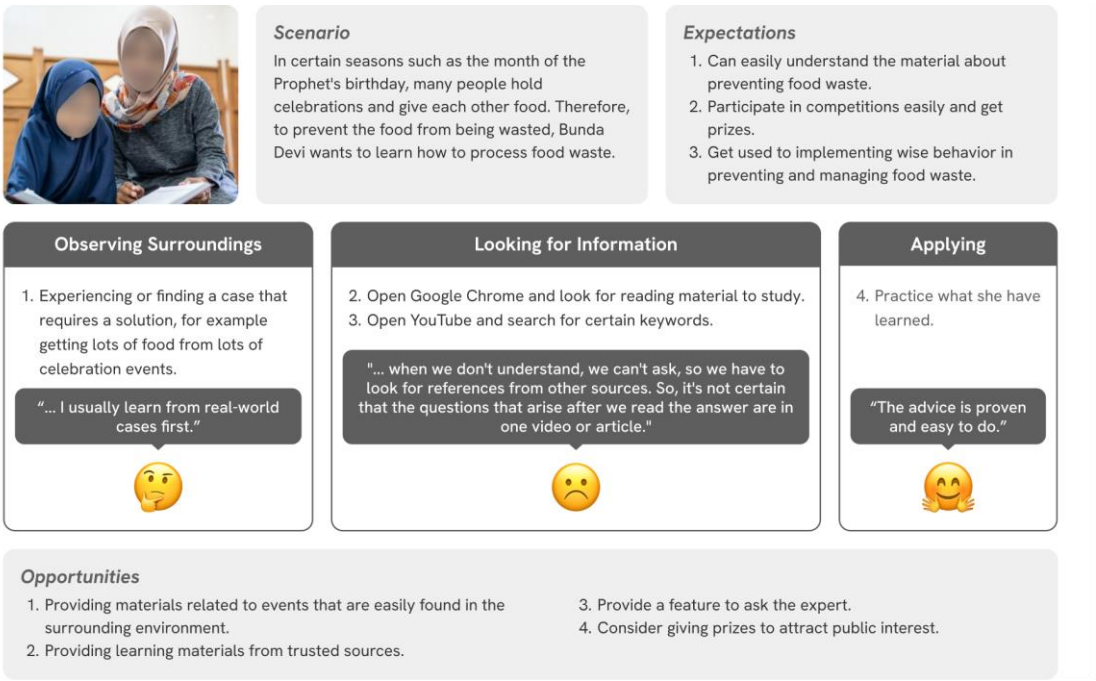

Figure 4. User Journey Map for Parents Persona

The list of needs to be implemented is obtained from the products and services items on the value proposition canvas of the three user personas. Table 3 shows the implementation of solutions for each need. As shown in table, there are two functional need ideas related to gamification features, four functional need ideas related to learning features, and four non-functional needs related to learning features. In addition, two non-functional needs were also found that apply to the entire platform, namely ad-free and easily accessible via mobile phones. Based on discussions with stakeholders, one additional functional need was also obtained in the form of an Tanya Ahli feature that is possible to be developed and one functional need in the form of a Discussion Forum that is not possible to be developed.

Table 3. Solution Implementations

Products and Services	Implementation
1. Gamification rewards	Part of gamification feature
2. Gamification challenges	Part of gamification feature
3. List of materials	Part of learning feature

Products and Services	Implementation
4. References	Part of learning feature
5. Download materials	Part of learning feature
6. Video materials	Part of learning feature
7. Materials with easy-to-find case studies	Part of learning feature
8. Materials that are interesting for children	Part of learning feature, non-functional
9. Materials that are tailored to the needs of their users	Part of learning feature, non-functional
10. Provide materials to teach children	Part of learning feature, non-functional
11. Ask the expert	Tanya Ahli feature
12. Ad-free	Non-functional
13. Mobile-friendly	Non-functional
14. Discussion forum	Not possible to develop due to limited human resources (admin) to manage the community

RQ2. What are the results of the Mama4Planet food waste reduction learning platform interface design?

The next stage is designing alternatives that begins with brainstorming with stakeholders contextually and asynchronously via WhatsApp messages. From the brainstorming that was carried out, two mood boards were agreed upon which became the inspiration for developing the design solution, namely Coursera and AksiAsri365. The next stage of designing a design solution is creating a user flow that describes the steps that can be taken by users to achieve certain goals effectively when using an application/system [18]. There are eight user flows generated in the initial stage, namely the user flow of creating a new account and logging in, taking part in learning, continuing learning, taking part in competitions, working on competition challenges, viewing rankings, changing profiles, and using the Tanya Ahli feature.

The next stage is the creation of information architecture to facilitate the process of organizing information that will be loaded on the Mama4Planet learning platform. In this study, the information architecture artifacts are arranged in a hierarchical form [19]. A black box shape is used to represent a page and a white box shape is used to represent a section on a page. As in Figure 5, there are 16 pages that can be found through the Mama4Planet learning platform information architecture.

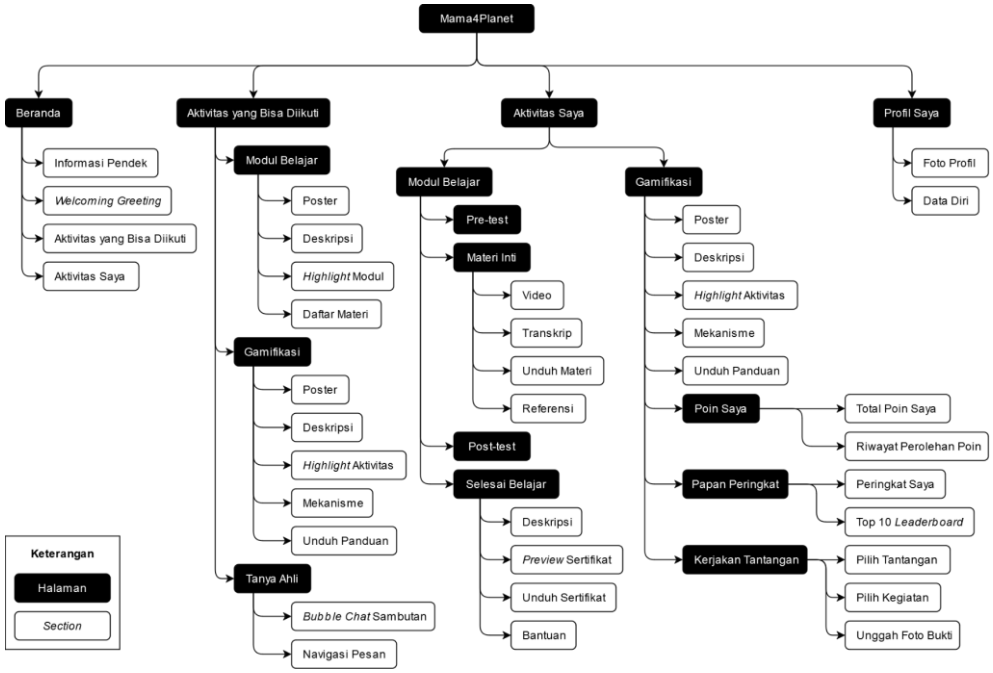

Figure 5. Mama4Planet Learning Platform Information Architecture

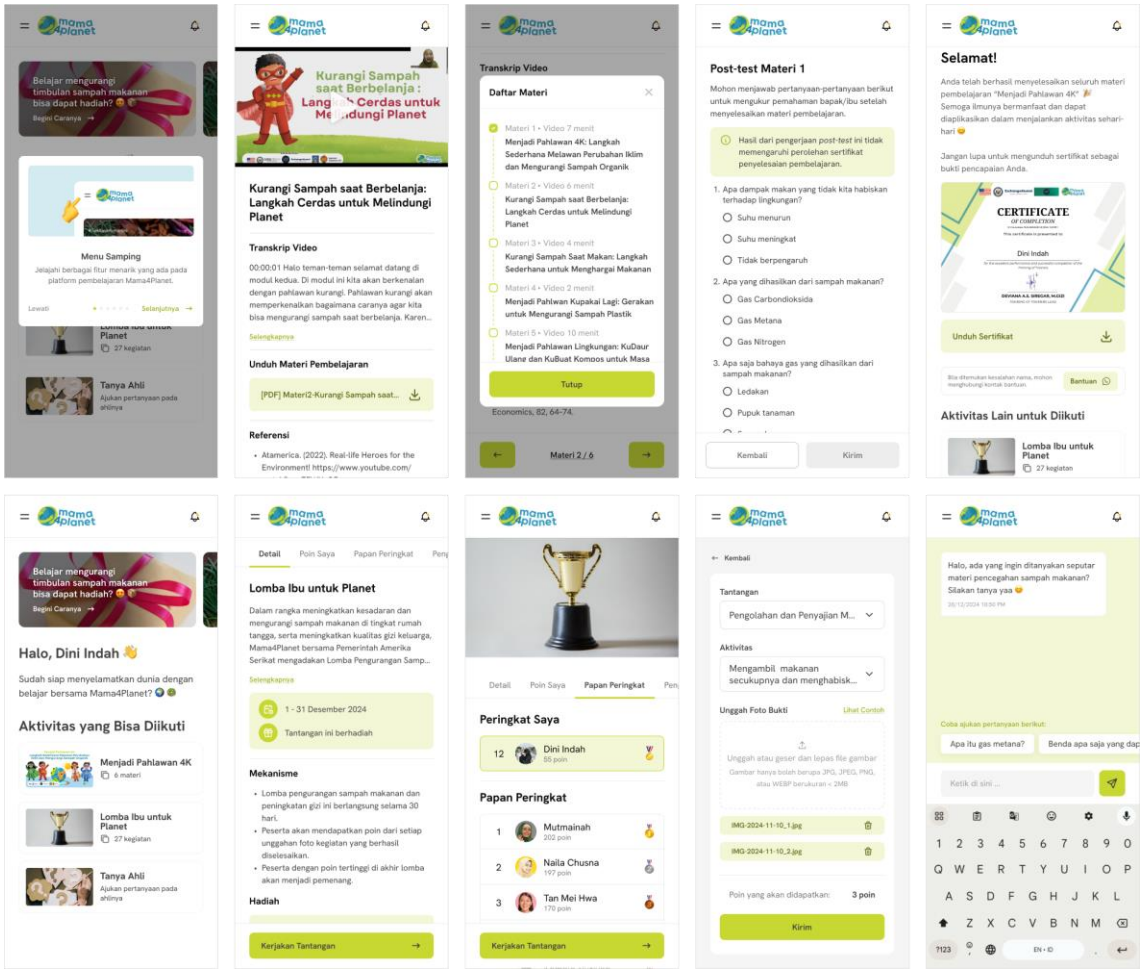

Figure 6. Mama4Planet Sample Mockups

Low-fidelity design is made in the form of wireframes. The wireframes is made based on the main pages in the information architecture. The next step is to develop the wireframes that has been made into mockups by adding more realistic elements. The mockup is made using Figma application as seen in Figure 6. During the creation process, each element used is made into components as documentation in the form of a design guide as well as to facilitate further development of design solutions.

The final step of designing alternatives and prototyping is to create a high-fidelity prototype by providing interaction on the components of the design solution. The final result of the high-fidelity prototype can be accessed through bit.ly/deliverables-m4p. This prototype is also used for the evaluation stages.

RQ3. What are the results of the Mama4Planet food waste reduction learning platform interface design evaluation?

The evaluation stages carried out in this study are divided into two iterations. In the first iteration, the evaluation of design solutions was carried out by involving respondent participation through usability testing, System Usability Scale (SUS) assessment, and continued with contextual interviews. In the second iteration, the evaluation was carried out through usability testing and SUS assessment by users, and a heuristic evaluation was carried out by two experts.

In the usability testing conducted, the author collected quantitative data in the form of completion rate and time-based efficiency. Then, other quantitative data that was also collected was the SUS score. The results of the quantitative data analysis in the first iteration of the evaluation will be compared with the results of the quantitative data analysis in the second iteration of the evaluation.

In the usability testing conducted, one of the aspects assessed was the completion rate or the level of user success in completing the requested task. The assessment was given using four success codes with the criteria explained in Table 4 [20].

Table 4. Completion Code Description

Completion Code		Description
SS	Success	The user successfully completes the task given according to the expected path.
SP	Success	The user successfully completes the task but indirectly or with a longer path than the expected amount of path.
HC	Half-complete	The user only successfully completes part of the task given.
FL	Failed	The user can't complete the given task and presses the give up button when working on the task.

Based on Table 5, it can be seen that in task 1 there are no more user respondents who have completed part of the task. Then, in the second iteration, there were also no users who failed to complete the task as in task 2 and task 5 of the first iteration. The number of user respondents who succeeded with the ideal number of steps increased significantly, especially in task 6, task 7, and task 8.

Table 5. Comparison of Completion Rate Results

	Iteration 1				Iteration 2			
	SS	**SP**	**HC**	**FL**	**SS**	**SP**	**HC**	**FL**
***Task* 1**	1	0	14	0	13	2	0	0
***Task* 2**	12	2	0	1	11	4	0	0
***Task* 3**	14	1	0	0	13	2	0	0
***Task* 4**	12	3	0	0	13	2	0	0
***Task* 5**	11	3	0	1	10	5	0	0
***Task* 6**	6	9	0	0	10	5	0	0
***Task* 7**	5	10	0	0	12	3	0	0
***Task* 8**	8	7	0	0	14	1	0	0

Next is the comparison of time-based efficiency values in the first evaluation iteration with the second evaluation iteration. The time-based efficiency units are goals per task obtained from the formula calculation [21]. Based on Table 6, it can be seen that the majority of tasks experienced an increase in time-based efficiency values. However, among the tasks that experienced an increase, there was one task that experienced a decrease in time-based efficiency values, which is task 1. If we look back at the previous completion rate assessment, task 1 experienced a relatively significant increase from the first to the second iteration. In the first iteration, almost all respondents unknowingly only managed to complete part of the task. Therefore, prototype improvements were made so that in the second iteration respondents were able to complete the entire task. Thus, the time needed by respondents to complete task 1 increased. Therefore, there was an increase in the time-based efficiency value of task 1 in the second iteration of the design solution evaluation.

Table 6. Comparison of Time-Based Efficiency Results

	Iteration 1	**Iteration 2**
***Task* 1**	0,0734	0,0225
***Task* 2**	0,0086	0,0152
***Task* 3**	0,0454	0,0610
***Task* 4**	0,0115	0,0291
***Task* 5**	0,0100	0,0196
***Task* 6**	0,0412	0,0427
***Task* 7**	0,0114	0,0391
***Task* 8**	0,0200	0,0459

The last comparison is the SUS scoring that use the question statement items using the Indonesian version of SUS [22]. Based on the scores obtained as presented in Table 7, it is known that in questions P1, P9, and P10 there is no increase or decrease in the average score. The consistent value in P1 is 5, P9 is 4, and P10 is 4. The values for P1 and P9 are good, because in odd SUS questions, the ideal value is getting closer to 5. However, what is noted is in P10 because ideally the score for even questions is better if the value is smaller. This means that based

on the statement P10, user respondents need to get used to using the Mama4Planet platform first. Furthermore, when viewed from the overall result obtained in each iteration, there is an increase in the score from 63.8 to 79.0. In terms of grade, this shows an increase from C- to A-. Then, in terms of adjectives, this is interpreted from "Good" to "Excellent".

Table 7. Comparison of System Usability Scale Results

	Iteration 1	**Iteration 2**
P1	5	5
P2	3	2
P3	4	5
P4	4	2
P5	4	5
P6	2	1
P7	4	5
P8	3	2
P9	4	4
P10	4	4
SUS Score	**63,8**	**79,0**
Grade	**C-**	**A-**
Adjective	***Good***	***Excellent***

To help the author in interpreting the evaluation results, in the first iteration, contextual interviews were conducted with user respondents as a method for collecting qualitative data. The results of the contextual interviews conducted with user respondents obtained 30 findings. Of these findings, there were 4 findings that did not require improvement, 4 findings that were not improved, then the remaining 22 findings were improved with 19 improvement items. These findings became material for improving design solutions to then be evaluated in the second iteration.

Qualitative data collected in the second iteration were obtained through the implementation of a heuristic evaluation. The heuristic evaluation was conducted by involving an IT product manager with >3 years of experience in an FMCG company and a product designer with >2 years of experience in an online travel agency company. There are ten heuristic principles used which were put forward by Jakob Nielsen in 1994 and updated in 2024. From the 12 findings of the heuristic evaluation, there were 9 points of improvement in design solutions and 3 findings that were not improved.

D. Conclusion and Future Work

This study uses a User-Centered Design (UCD) approach with four stages: needs exploration, solution design, prototyping, and evaluation. Needs exploration involves stakeholder and user interviews with outputs in the form of a description of the context of use, user persona, value proposition design, and user journey map. Design solutions are created based on a mood board and produce 8 user flows, 19 wireframes, high-fidelity prototypes, and a design guide.

The evaluation was conducted in two iterations using usability testing, contextual interviews, and heuristic evaluation. The results showed a significant increase in completion rate, time-based efficiency, and SUS score from 63.8 ("Good") to 79.0 ("Excellent"). This proves that the effectiveness of the design solution results produced is good enough to be implemented further.

From the current findings, it is known that the output of this study is in the form of a prototype. Therefore, future work is needed to obtain the real performance insights of the website implementation. An approach based on the learning theory perspective is also required, since the current study focuses primarily on the interface design and evaluation. Other considerations related to stakeholder involvement is also important to reach out more user to use the platform. In addition, the team needs to manage platform user data, so an admin dashboard is also needed to make it easier for them to manage user data and the content of the platform.

E. Acknowledgment

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