Design of Town Watch Mobile Application for Disaster Mitigation in Mount Semeru Area

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ABSTRACT
Semeru Mount is one of the active volcanoes in Indonesia. Semeru had more than three big eruptions between December 2022 to February 2023. Residents living around Mount Semeru need a special application to support monitoring the condition of their area that can be accessed to get real-time information about events around their area to improve preparedness for natural disasters. Previously, this monitoring activity required significant resources, such as cost and labor. With these problems in mind, we propose an approach solution in the form of a mobile-based application design called "Town Watch," as advanced to the previous approach with manual monitoring. Based on geotagging and crowdsourcing concepts with contributions from residents and volunteers. The design of the application was conducted using the Human-Centered Design methodology. This approach focuses on creating an application design that is efficient, easy to understand, and user-centered. The target users will initially be Brawijaya University students involved in community service projects in the Mount Semeru region. The design was evaluated through usability testing and USE Questionnaire, with the results reaching an impressive 92% fulfilment of user needs, thus categorized as an excellent solution and well accepted by users

Keywords: *crowdsourcing, human-centered design, user experience, usability testing, use questionnaire.*

1. INTRODUCTION

In early December 2021, Mount Semeru, located on the border of Lumajang Regency and Malang Regency, experienced an eruption resulting in at least 51 fatalities and forcing 10,395 residents to flee safer locations, supported by BNBP [1]. A refugee named Ponidi, in an interview with BBC Indonesia, revealed that there was no prior warning or information about the eruption, so residents in the affected area could not prepare the necessary things, which resulted in casualties when the disaster occurred, supported by BNI [2]. Although Mount Semeru provides many benefits to the people around it, Mount Semeru also has considerable potential for natural disasters. Therefore, people living around Mount Semeru need accessible and relevant information about the situation of the area they live in, including recommended safety measures during natural disasters.

To obtain information about events, an activity known as Town Watching was implemented in Sidomulyo Village, located in Pronojiwo Sub-district, Lumajang District. 'Town Watching' is a community initiative that emerged in Japan in 1970. The main objective of 'Town Watching' is to raise community awareness of natural disasters by observing and documenting residential areas through cameras. The concept of 'Town Watching' was later adopted to provide disaster education to communities in Indonesia. This adaptation aims to increase the community's understanding of disaster mitigation actions that can be taken before, during, and after a natural disaster. The results of the 'Town Watching' implementation have shown an increased understanding and awareness of the community in Sidomulyo Village regarding natural disaster mitigation efforts, supported by Maryanto [3]. Brawijaya University students are still carrying out the 'Town Watching' activity as part of the community service program in the area. However, this activity faces several challenges, requiring a significant budget and additional manpower. Therefore, to overcome these challenges, the idea of developing an application called 'Town Watch' emerged. This application is designed to help and facilitate community access to disaster mitigation information and guidance.

The Town Watch application aims to facilitate the implementation of Town Watching activities and become a solution for natural disaster mitigation by being a tool that can be used for more efficient information dissemination for people living around Mount Semeru. The Town Watch application allows the community to provide and receive real-time disaster event information through images and text. In developing the Town Watch application, user experience design becomes a very important aspect with the task of ensuring that the application created can be used easily by users and provides comfort. In contrast, users interact with the application, supported by Hassenzahl [4]. The

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user experience design process for the Town Watch app applies the Human-Centered Design approach to ensure efficiency, usability, and suitability to user needs. The Human-Centered Design approach will focus on understanding the application's purpose, the context of use, the tasks that users will perform, user characteristics, and application design workflows. This design approach results in an application expected to provide maximum benefits and a satisfying interactive experience, supported by Wulantari [5].

The Town Watch application is intended for mobile devices. The use of mobile devices for the Town Watch application was chosen based on a survey conducted by the Indonesian Internet Service Providers Association (APJII) on February 24, 2022. The survey results show that 89.03% of internet users use mobile devices, and around 77.64% access the internet via mobile data from cellular operators, supported by APJII [6]. Besides that, mobile devices also have advantages such as fast access and the presence of cameras, so mobile devices are considered capable of supporting the Town Watch application to overcome the problems and challenges in the area around Mount Semeru.

Information gathered from Brawijaya University students who participated in service in the Mount Semeru area found that Android mobile devices significantly dominate the use of devices in the area. Given this information, the design of the Town Watch application is specifically aimed at meeting the needs of Android mobile devices to provide optimal performance and accessibility for users. This paper provides an overview of this application's design, features, and potential impact in improving monitoring and security measures in the Mt. Semeru area using a Geotagging and crowdsource approach. target users, especially Brawijaya University students involved in community service around Mt. Semeru influenced the development of this application so that the application could fit users' needs and be easily used by the community to access information about their neighborhood.

2. LITERATURE REVIEW

Previous studies support this research with similar topics, methods, and testing processes. Manurung conducted the first research titled 'Development of User Experience in Mobile Applications for Disaster Response Facilities with the Human-Centered Design (HCD) Method Approach'. Berlian conducted the second research with the title 'Designing User Experience for Integrated Community Interaction Applications Using the Human-Centered Design Method', and the third is research by Marjorie Tirza Eunike with the title 'Development of User Experience for Mobile Applications for Public Service Information for Malang City with the Human-Centered Design Method Approach.'

2.1. Human-Centered Design (HCD)

Human-centered design is a method used in system design. This method focuses on the utility and user needs of the system being developed, intending to improve the functionality and accessibility of the system, supported by Standarization [7]. The HCD process follows the stages of ISO 9241-210, including user context understanding and specification, user requirements determination, solution design, and design evaluation.

2.2. User Experience (UX)

User Experience, as defined by ISO 9241-210, refers to how users interact with and respond to an application during use. Effective User Experience design must consider user behavior an important factor in the design process. This is reflected in the elements that exist in User Experience design, namely the surface plane, skeleton plane, structure plane, scope plane, and strategy plane, supported by Tolle [8].

2.3. Material Design

Material Design is a UX design and implementation guide developed by Google. Material Design concentrates on material, motion, and layout to provide users with a more personalized, adaptive, and expressive UX, supported by Pressman [9].

2.4. Usabillity Testing

Usability testing is a design test that measures the design of the user's ability to learn and use the application, supported by Gibbons [10]. The measurements taken are based on ISO/IEC 9126-4, measuring effectiveness, efficiency, and satisfaction. To find out the effectiveness and efficiency of the design to users can be measured by Equation 1 and Equation 2, supported by Garret [11]. Measurement of satisfaction in this study was carried out using

the USE Questionnaire. Usability results are obtained after measuring the three aspects are completed using Equation 3, supported by Garret [11].

$$Effectiveness = \frac{\Sigma_{successful\ task}}{\Sigma_{Assigned\ tasks}} x\ 100\% \quad (1)$$

$$Overall\ Efficiency = \frac{\Sigma_{j=1}^{R}\Sigma_{i=1}^{N} n_{ij}\, t_{ij}}{\Sigma_{j=1}^{R}\Sigma_{i=1}^{N} t_{ij}} x\ 100\% \quad (2)$$

$$Usability = \frac{\Sigma_{measurement\ aspects}}{3} x\ 100\% \quad (3)$$

2.5. USE Questionnaire

USE questionnaire is an evaluation method on application UX using a survey created by Arnold M. Lund and U.S West Advanced Technologies. The USE questionnaire has 30 questions, divided into 4 parameters: usefulness, ease of use, ease of learning, and satisfaction. The measurement value in this study uses a Likert scale of 1 to 7. Measurements are made to each parameter using Equation 4 to get satisfactory results using Equation 5, supported by Manurung [12].

$$NP = \frac{\Sigma_{Points\ per\ question}}{(\Sigma_{Participant}\Sigma_{question})7} x\ 100\% \quad (4)$$

$$Overall\ Satisfaction = \frac{\Sigma_{NP}}{4} \quad (5)$$

3. METHODOLOGY

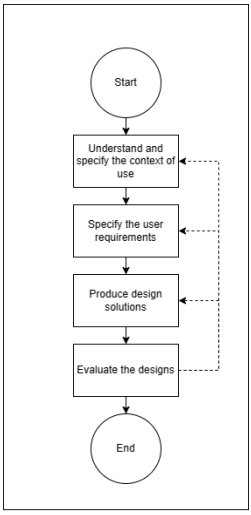

Figure 1 Research Methodology

Figure 1 illustrates the stages of research that explain the steps in designing the Town Watch application using the Human-Centered Design (HCD) method based on ISO 9241-210. There are four phases in the user experience design process using the HCD approach. The first phase is user understanding and needs identification based on existing problems. The second phase generates solution ideas, while the third phase involves transforming those ideas into concrete designs. The fourth phase is design evaluation, supported by Manurung [12]. The 'Understanding Context and Defining System Usability Specifications' stage is part of the strategy phase in user experience design that helps define the scope of the application. The 'Requirements Specification' stage is the next step that involves identifying user requirements based on the problem. This phase falls under the scope of the strategy phase in the user experience design process. The 'Design' stage is the phase where the design solution is realized based on the pre-defined needs. This phase includes information architecture, user flows, visual design guides, wireframes, and application prototypes.

4. RESULT AND ANALYSIS

Following the methodology of human-centered design outlined in ISO 9241-210, the process involves four sequential stages: Understanding and defining the context of use, determining user requirements, providing Designing solutions, and finally, evaluating the design with the users. This iterative process allows the team to revisit previous stages to align with the project's requirements.

4.1. Understanding and Specifying Context of Use

Understanding the usability context of the system is included in the strategic planning phase of the user experience design process. This research collected information to understand the system's usability obtained through an interview process with experts in the field of volcanology and geothermal and also the initiator of urban observation activities in Sidomulyo Village. The interview process also involved Brawijaya University students doing community service around Mount Semeru. This stage provides an overview of Town Watching activities, the challenges faced during the implementation process, the characteristics or environmental conditions, and the intensity of gadget use during Town Watching activities.

Table 1. Requirements for Town Watch Application

4.2. Specify The User Requirements

The determining user requirements stage specifies the information obtained from the interviews conducted during the strategy planes phase and is included in the scope planes stage. The information obtained is transformed into a clear picture of the features that will be the functional requirements of the Town Watch application. Based on the information gathered in the previous stage, town-watching activities need to be restructured with the Town Watch application, which can simplify the process and make town-watching activities more interactive.

Information gathered from an expert indicated a need for an application that could assist the town-watching process. In addition, there is information from Brawijaya University students involved in community service around Mount Semeru that the process of disseminating information about incidents in the area through traditional means, such as discussions during Town Watching activities, is considered ineffective because it is only spread to participants who are present. Therefore, the Town Watch application aims to improve communication and dissemination of information about incidents to the community more widely and efficiently.

In addition, the application used needs to be adapted to the environmental conditions in the target implementation area. Other information reveals that community service students and local residents, including civil servants in the area, use mobile phones with Android operating systems. Based on this information, we analyzed and specified the user requirements, the results of which are listed in **Table 1**.

4.3. Design Solution

Designing the fundamental content that will be presented to users, user flows, one of which can be seen in Figure 2, depicting the interaction flow of the application for users to achieve their goal, which is creating reports. Additionally, creating storyboards provides a general overview of user activities while using the Town Watch application during Town Watching activities. Furthermore, the application's information architecture is designed using

a top-down approach, considering the broadest scope of information and functions required to achieve strategic goals, considering considerations from the strategy planes phase, supported by Material Design 3 [13].

The design process then enters the application skeleton creation stage, part of the skeleton plane phase. The skeleton plane provides an overview and rules of the application's content layout, such as buttons, images, and text, to optimize the arrangement of predefined elements, supported by Pratama [14]. In this phase, there is wireframe creation for each screen in the designed application. The wireframes were created to provide an overview of the content layout in the page interface, taking into account the existing elements and the design system used in the application interface design. Next, a screen-flow is created to provide an overview of the interaction between each wireframe. The design of page wireframes and screen flow for creating new event report posts in the Town Watch application can be seen in Figure 3 continuing with the design of the visual as shown in **Figure 4**.

Figure SEQ Figure * ARABIC 2 Upload Incident Report Flow

The Surface plane stage represents the part of the application that is displayed to the user containing text and illustrations, as well as how functions and interactions can be performed by the user, supported by Nielsen [15]. The user interface of the Town Watch application follows Google's Material Design 3 design rules as the design system is applied. Material Design is a design system developed by Google that offers users a personalized, adaptive, and expressive user experience, supported by Pressman [9]. This design system is then implemented into the wireframes created in the skeleton plane phase.

The design system that has been put into practice undergoes iterations to reduce design issues before testing. Among the enhancements made to the interface before testing, alterations to the home page stand out. These changes involve the addition of buttons for viewing, commenting, and saving posts for future reference. Further enhancements were implemented in the description section, allowing users to access information without navigating to a different page. The design refinements during this phase are illustrated in **Figure 5** and **Figure 6**.

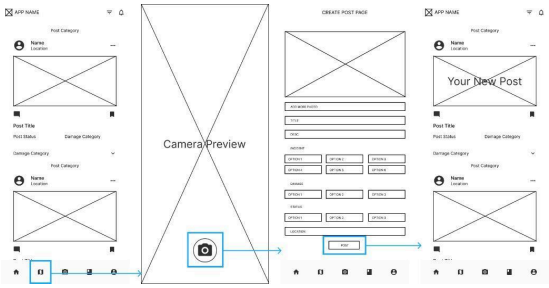

Figure 3 Wireframe and Screen Flow for Creating a New Incident Report Post

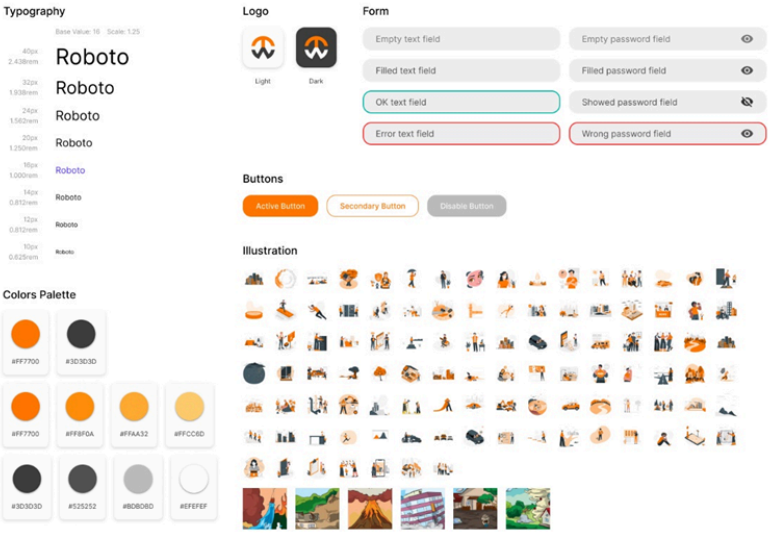

Figure 4 The Visual Systems Design of The Application

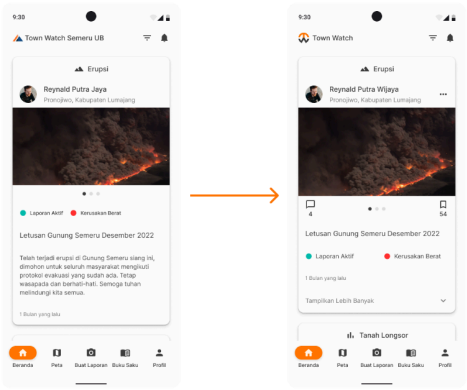

Figure 5 The Changes in The User Interface of The Home Page

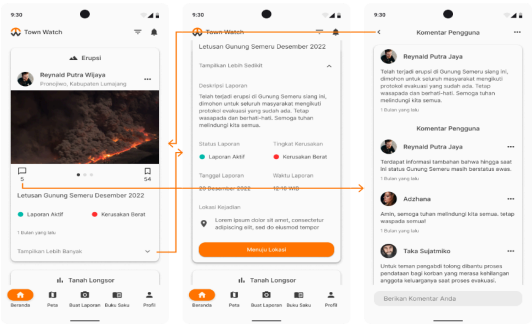

Figure 6 User Interaction Flow Design for Viewing Detailed Incident Report Information After Design System Implemented

4.4. Evaluate The Design

The evaluation of the design is done when the solution design is completed. In this phase, the interface of the solution design is tested using usability testing and the USE Questionnaire to measure the design's effectiveness, efficiency, and satisfaction aspects. In the testing process, there is a task scenario for users to test the features in the design based on activities carried out by Brawijaya University students who do community service around Mount Semeru. The design testing process involved 20 students, 4 of whom were community service students of Mount Semeru. The task scenario designed for testing can be seen in Table 2.

Table 2. User Task Scenario

Effectiveness evaluation is calculated using Equation 1, where the overall user success rate is calculated and then divided by the total number of participants, which is 20 people. The calculation results showed that the effectiveness aspect of the design received a value of 98%. Efficiency testing was carried out by calculating the total task completion time required by trial participants until successful, without considering the time spent on failed tasks, using Equation 2. The total time required by trial participants to complete the task is the time required by trial participants to complete the entire task. Then, the total is divided by the time participants took to complete all successful and failed tasks. The calculation results show that the efficiency aspect of the design is 93.76%. The USE questionnaire was used to assess user satisfaction. The USE questionnaire has 30 questions given to participants with four parameters: usability, ease of use, ease of learning, and satisfaction. The results obtained were then calculated using Equation 3 for each of the four parameters, and the average was taken as the overall result. The satisfaction test results obtained using the USE questionnaire showed a score of 83.86%.

After obtaining the results of the three usability aspects, the average is calculated, shown in Table 3. The final result shows that the usability level of the Town Watch design is 91.91%.

Table 3. Usability Score Results

Usability Aspect	Results Score
Effectiveness	*98.12*
Efficiency	*93.76*
Satisfaction	*83.86*
Average	**91.91**

From the test results that have been carried out, there are five problems found by users, which can be seen in Table 4. The problems found are then used as suggestions for improvement given by users. The analysis is then carried out to improve the problems found; one of the design improvements can be seen in the problem with code SP-1, where the absence of a button to apply filters on the upload filtering feature has been resolved. In the design, an 'Apply Filter' button was added to the home page filter view after the user selected the category of information to be viewed on the home page. The improvements made to SP-1 can be seen in Figure 6.

Table 4 Issues Found

Issues ID	Issues Description
SP-1	The absence of a button to apply filters in the upload filtering feature.
SP-2	The registration button for the account is not very visible.
SP-3	The top navigation on the user map page is not useful.
SP-4	Report categories are inactive on the report creation page.
SP-5	There is no indication that the report has been edited.

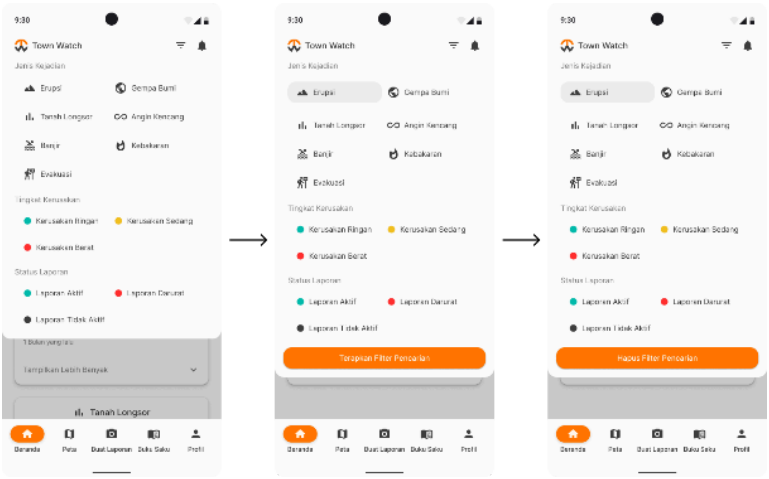

Figure 6 Feature Filter Improvement

5. CONCLUSION

Designing the Town Watch application using a human-centered design approach began with understanding and defining the system's context. This involves gathering information about existing Town Watching activities. The next step is to determine user needs by detailing information to determine the features that must be present in the application. From the user needs that have been determined, a solution is designed to create a design that can overcome the problems identified in the previous stage. This design was then tested by involving 20 students from Brawijaya University to evaluate the level of usability through the Usability Testing method and using the USE questionnaire. The test results showed that the effectiveness aspect scored 98.12%, the efficiency aspect scored 93.76%, and the satisfaction aspect measured through the USE questionnaire scored 83.86%. Thus, the overall usability level reached 92%, indicating that this design concept is very good.

The excellent results of the design of the Town Watch Application using Geotagging and a crowdsourcing approach make it ready to move to the next level of development and be implemented as an application to support mitigation in the Semeru disaster area. Implementing the design into a real mobile application has to be carefully done, considering the contribution of people and volunteers in the evaluation steps.

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