Modeling user interface design for panic button application for deaf people using user-centered design method

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Abstract. An emergency can occur at anytime, anywhere and at anyone. The local government offers an application called "Panic Button" as a solution to these problems. This application aims to help people who experience or see emergency conditions so that they can be followed up by the authorities. However, this application has not been targeted for disability users. The procedure for using this application still has weaknesses that make it difficult for users with hearing loss, especially when an emergency event is confirmed. Normally, emergency events confirmation uses telephone calls to the incident reporter (user). This confirmation method is a big problem for those users with disabilities to be able to confirm the details of emergency events. In this research, a user interface re-design was carried out at the application interface to be able to accommodate the users necessary. The user interface modeling is done using the User-Centered Design (UCD) method to produce a user interface design that suits the user's characteristics and limitations. USE Questionnaire was used to test the resulting prototype and results in a usability value of 87% with an excellent category after the third iteration. These results indicate that the results of the re-design that have been done have met the needs of the deaf, with the use of appropriate communication for people with hearing loss so that they can confirm emergencies properly.

1. Introduction

The Government of Bandung City and Telkom Indonesia work together to build the Bandung City panic button, the X-Igent panic button. This panic button aims to overcome the emergency department in the city of Bandung. Crime emergencies that are handled by the police and other emergencies are handled by emergency services in the city of Bandung. When the user presses the panic button on the X-Igent application, the next process is emergency confirmation in a voice telephone call made by the Bandung Command Center (BCC). This panic button has a constraint on the effectiveness of the task, namely emergency confirmation done by telephone and not integrated with the application. According to the BCC, there is no emergency confirmation specifically for persons with hearing impairment causing persons with hearing impairment to not be able to interact when an emergency confirmation is made. When communicating, the deaf use several ways, namely using writing, mouth gestures, and sign language [1]. Therefore it is necessary to adjust the X-Igent panic button so that it can be used also for people with hearing impairment.
The method used in this study is User-Centered Design because people with hearing impairment have the characteristics of hearing limitations above 90 dB and this method is a method designed with user characteristics. The UCD method involves the user in the design process so that it can result in a user interface that convenient for deaf people [2]. Usability testing uses the USE Questionnaire method because this method was chosen in previous studies [3, 4], which the design method was using UCD. USE Questionnaire measured some usability goals such as (1) usefulness, (2) ease of use, and, (3) ease of learning [5]. It also supported by Arnold Lund [6], which states that the usefulness and ease of use factors can drive user satisfaction.

2. Method

2.1. Similar research studies
Based on research conducted in a paper entitled "Deaf Mobile Application Accessibility Requirements" [7]. The research was carried out to find out the important requirements that must be considered for making a deaf application [7]. In the study, the authors conducted a study concerning the results of previous studies that in making applications for deaf people there are four main requirements namely video, animation, text, and audio. Based on the previous research, this study aims to make it easier for people with hearing impairment when responding to telephone confirmations after reporting emergency conditions through the panic button application by applying text and video.

2.2. Purposive sampling
Purposive sampling is a data source sampling technique with certain considerations. This particular consideration, for example, the person who is considered most knowledgeable about what researchers expect [8]. Purposive sampling is often used in qualitative research [8]. The advantage of purposive sampling lies in the accuracy of researchers choosing data sources by the variables studied. In the process of determining purposive sampling must determine certain criteria in the sample [8]. Researchers determine two characteristics used in determining the sample, namely 1) persons with hearing impairment with a level of 90 dB 2) people who have studied the science of learning about people with hearing impairment and often interact with them. Based on these criteria, two speakers were pure deaf people with 90db and above and teachers in the special hearing need school. Therefore the researcher got 5 teachers and 6 hearing-impaired speakers because of the limited time, energy, funding, and information obtained by the researcher.

2.3. User-Centered Design (UCD)
This method involves user involvement, empirical measurement and testing, and repetitive design [2]. The UCD method has four stages for design [9]. 1) Specify the context of use to obtain the required information such as characteristics of the user, and user manner based on interviews and observations. 2) Specify requirements aim to produce user persona and their needs 3) Produce design such as defining conceptual models, wireframes, mock-ups, and prototypes. 4) Evaluate design was applied to the USE Questionnaire method. Those processes will be repeated until it reaches the desired usability value.

2.4. USE questionnaire
This research used the USE Questionnaire method to measure the designs are suitable for the deaf. Usability is a quality attribute that explains or measures how easy it is to use an interface. The usability testing was using a four-scale Likert.

The questionnaire used needs to be tested for validity first before being used by calculating the correlation of items. The questionnaire is said to be valid if it can meet the correlation of r-table values. The variable X is an item score, Y is the total score, and n is a lot of subjects. The equation 1 is used to calculate validity($r_{xy}$) [10]:

$$r_{xy} = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{(N\Sigma x^2 - (\Sigma x)^2)(N\Sigma y^2 - (\Sigma y)^2)}}$$  \hspace{1cm} (1)
Before being used, a questionnaire must also be reliable to get consistent results. In reliability testing using the Cronbach Alpha method, equation 2 is for calculating the reliability value of the instrument\(r_{11}\) [11]:

\[
r_{11} = \left( \frac{n}{n-1} \right) \left( 1 - \frac{\Sigma \sigma^2}{\sigma^2} \right)
\]  

(2)

In the variable \(n\) is the number of items tested, \(\Sigma \sigma^2\) variable is the total value of the variance in each item, while \(\sigma^2\) variable is the total variance and if the results are reliable low then it can be sure some items are not reliable based on the classification of the reliability coefficient t.

2.5. Measurement scale
The measurement of the usability percentage results can be determined according to the level of the category used. To get the level of categories with the range obtained from the calculation of intervals which the variable \(K\) is the number of categories. Equation 3 calculates the range value [3].

\[
\text{Intervals} = \frac{\text{range}}{K}
\]  

(3)

Based on equation 3, it produces a range of interval and category values that are used to make the scoring weighting as an indicator that categorizes the usability value that has been obtained. There are five categories: Excellent (86%-100%), Very Good (71%-85%), Good (56%-70%), Fair (40%-55%), and Poor (25%-39%).

3. Results and discussion

3.1. Specify context of use
At this step, researchers conducted a similar application analysis and interviews and observations aimed at finding data related to the user. Interviews were conducted with BCC to identify problems and information about the panic button application. There are still no special communication features that can be used by people with hearing impairment. The panic conditions defined by BCC are namely theft, fire, accidents, health services (ambulance), fights, and acts of crime experienced. The number of interactions that users need to do when performing a specific emergency with a swipe up then select events so that it is not by the basic principles of design.

Using interviews with sampling users, it is also known that deaf people had habits using smartphones to play games and social media. Observations were made on 6 people with hearing impairment when using the prototype of the existing panic button application. The users seemed confused when using the application the first time confirming the emergency incident using a voice telephone. The user could use the application with directives from researchers and still ask several times.

3.2. Specify requirement
Based on the characteristics of hearing-impaired which have hearing limitations above 90dB, it is difficult to understand something abstract, relying more on visual abilities, people with hearing impairment lack mastering the prototype panic button. User needs that have been obtained from the user persona so that it can be determined as follows: (1) There are instructions for using the panic button application; (2) There is a communication that depicts visually so that the deaf can communicate well; (3) The choice of sentences and designs that are simple and not difficult to be understood. Based on related studies in making applications for deaf people several important requirements must be considered, namely the use of audio, video, animation, and text [7, 12]. But audio is considered a less important aspect for people with hearing impairment because they tend not to use hearing [7].
3.3. Produce design
Based on the results obtained in the previous stage, the design and features built on the prototype. This stage determined the conceptual model that aims to assist the writer in designing a sketch framework. Conceptual models were obtained from the user persona, mental models, task analysis, and scenario contexts. The conceptual model determined the response of each task, the elements used in the task, and the layout of the elements used. Based on the conceptual and wireframe, the prototype was built. The prototype features are as follows 1) List of panic category 2) Login 3) Panic Button 4) Confirm feature using symbol 5) Chat 6) Video call 7) Profile 8) Profile edit 9) Logout. Based on information obtained in the previous stage, depictions of events using symbols such as theft are depicted with people carrying goods with the dollar logo, fires are depicted with houses set in large fires, accidents are depicted with two cars colliding, emergency departments are depicted with ambulances, fights are depicted with two people who were fighting, the crime experienced was described by the police because the police were handling the crime. So from the results of the analysis of similar applications previously obtained the latest design mock-up that can be seen in Figure 1.

Figure 1. Mockup Application.

3.4. Evaluate design
At this stage, the application that has been made is then evaluated using the USE Questionnaire method which aims to find out the usability issues in the design being built. Tests carried out on 5 people with hearing impairment allow us to find 80% of usability problems [13, 14]. Before testing, questionnaires that have been tested for validity and reliability have been tested. After getting a valid and reliable questionnaire, then usability testing will be carried out on 5 people with hearing impairment using an arranged task which was defined before. Based on testing in the first, second, and third iterations, we get the value of usability like the graph in Figure 2.

Figure 2. Results of usability testing.
In the usability testing results of the first iteration test, some factors still get an average value of usability with an interval value of 71-85% with a good category. Based on observations during the test, the photo sending feature cannot be used optimally, so that these fail to impress the low of usefulness and ease of use factors related to the specific event confirmation. The improvements are made to overcome these deficiencies in iteration 2. In the second iteration, it shows better results, but still, the user got difficulties such as (1) Users cannot confirm emergency events using sign language because no confirmation feature uses video calls. This lacks influence on the factors of usefulness, ease of use, and satisfaction associated with applications that cannot be used optimally; (2) the user cannot know whether the report has been received or sent on the chat page when the deaf after pressing the help button. This lacks influence on the factors of usefulness, ease of use, ease of learning and satisfaction which make users confused because the information has not been received or not. Based on observations that have been obtained in the second iteration usability testing, then improvements are made to overcome these lacks, such as: (1) Add a confirmation feature using a video call to confirm using sign language; (2) Add read and auto chat features when confirming to use chat so users know that the report has been received or sent. The results of the third testing are reached an excellent category which impresses that the design has provided convenience and satisfaction for users because the design has been able to support deaf communication ways such as writing, mouth gestures, and sign language [1].

4. Conclusion
Involving the user in the design process using the UCD method could give important information about their character, understanding, and behaviour which were valuable for the design phase. The use of symbols when confirming events can affect the value of the usefulness factor. Chat, send photos and video call features that aim to provide event confirmation can affect the value of the ease of use factor. The third iteration can prove that the application “panic button for the deaf” can be used properly by the deaf. However, these results obtained from research at two schools of special hearing needs in Bandung. Different cultures and skills of technology might affect the way of deaf communication. Future research is needed to cover a different persona to get better results.

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