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Designing User Experience for Improving Mobile Application Accessibility Online Transport Booking for Visually-Impaired User With User-Centered Design: A Case Study of Grab

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Abstract−The online transportation ordering mobile application is an application that helps users in ordering transportation facilities that can be accessed by anyone using mobile phones and internet users are no exception for people with visual impairments. Users with visual impairments with limited accessibility will have difficulty accessing the application. Based on the results of the initial survey, it was found that the online grab transportation ordering application is currently still less accessible and an increase in accessibility is needed. This study aims to design the right user experience to improve the accessibility of the application so that users with visual impairments can access the application properly. In this research, the method used is User Centered Design (UCD) which focuses on user needs and characteristics who are visually-impaired users. The study's findings are recommendations for the interaction design of the Grab application. Based on the needs and characteristics of the users, the resulting accessibility improvements are in the form of a simpler design than the previous design and features designed to overcome the pain points of users with visual impairments. Furthermore, the design that has been made is tested using the Cognitive Walkthrough method, which contains user scenarios to achieve certain goals. The evaluation results show that the scenario completion rate has increased and the number of errors made when completing the scenario has also decreased. It can be concluded that using the UCD method can improve the usability of the application.

Keywords: Mobile Application; Transportation Ordering; Grab; Visual Impairments; User-Centered Design; Cognitive Walkthrough

1. INTRODUCTION

Technology is currently developing very rapidly in almost all areas of life. Technology can also connect humans with other humans without distance and time limitations. One application of technology is in the field of transportation. Currently, transportation can be accessed online only by using mobile phones and the internet by users, including persons with disabilities. Data from the 2018 National Socio-Economic Survey (Susenas) shows that compared to non-disabled people, only 34.89 percent of people with disabilities have access to information via mobile phones or laptops. On the other side, internet access for people with disabilities is 8.50%, compared to 45.46% for people without impairments [1]. The categories of disability include mentally retarded, physically disabled, visually impaired, deaf, speech-impaired, deaf, and hard-of-hearing [2]. The visually impaired are among the people with impairments who are most commonly encountered. A blind person is someone who has problems in vision, either low vision or totally blind where the damage in vision is caused by obstacles in visual perception abilities [3][4].

If those who are blind or visually impaired are given access to smartphones, they will soon adopt them into their daily lives, making use of their possibilities for socializing, learning, and entertainment as well as gaining more freedom through applications [5]. This is evidenced by interviews and observations conducted in Sentra Wyata Guna Bandung City, employees are accustomed to operating smartphones, especially those with an Android-based operating system for daily activities such as ordering transportation online independently. Currently, one of the features that can be used by blind people in accessing smartphones is the talkback and haptic features. Talkback is a feature that allows users to access the device without having to look at it [6]. The Haptic feature can help to translate information into vibrations [7]. Talkback and haptic features should be fully employed to boost the accessibility of using mobile applications for persons with visual impairments.

One of the online transportation ordering applications currently available is the Grab application. Grab is one of the most popular online transportation ordering applications today. Based on information from one of the blind people, it was concluded that the Grab application still has shortcomings, making it a little difficult to access [8]. In a study conducted by Ristiani et al. (2021) stated that several things related to the interaction experience of the visually impaired in using the Grab application need to be studied further, including design problems that make usability perceptions decrease [9]. This is due to visually impaired behavior patterns that are different from normal users. For this reason, further research is needed on the behavior of visually impaired users so that they can be used to improve the interaction design for online transportation orders using the Grab application. In previous studies, the method used to design interfaces based on the characteristics of visually impaired users as User Centered Design as discussed in the research of Bagas Priowibowo, Veronikha Effendy, Danang Junaedi in 2020,

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Arvin Claudy Frobenius in 2021, Reza Rahmawan, Annisa Herdiani, Dawan Dwi Jatmiko S. in 2020. These three researchers designed an user interface for specific application that resulted in an accessible design for blind people [10]–[12]. So this study used the User Centered Design (UCD) method, where a design method that places the user at the center of the system development process [13]. Also supported by research conducted by Jean-Pierre Peters et al, the UCD method can be applied to users with visual impairments, because the user experience that will be designed focuses on the task and character of the user, collecting data from users so that the design fits their needs [14]. This method can explore the behavior patterns of visually impaired users so that they can provide more insight into an interface to design/interaction design.

The evaluation method in previous research was not appropriate to use because it was not following the characteristics of the user. To get deeper evaluation results, it is necessary to observe every step when the user accesses the application. So, the cognitive walkthrough method is used, because the cognitive walkthrough focuses on the ease of design [15]. This method is more suitable to be used to observe the steps taken by users when accessing the grab application. The advantage of using a Cognitive Walkthrough is that this method can be used to identify important usability problems easily, quickly, and cheaply [16]. In the study of Kurnia S. et al. (2017) on interface usability testing research with a case study of the Braille Smart application on blind students who found things that caused low usability so that improvements were needed to the application [17]. Another study was conducted by Sholikhin et al. (2018) who evaluated the user experience of the Game Left 4 Dead 2 using Cognitive Walkthrough which managed to explore some of the game's weaknesses based on the results of an in-depth analysis of each error that appeared [18]. The last research conducted by Kuriakose et al. (2020) explains haptic features that can be used by blind people. This feature is useful in the design of navigation support when the visually impaired are in situations that cannot rely on audio modalities such as in a noisy environment [19]. The difference between this study and three existing UCD research that was explained before is this study uses a different evaluation method, namely the cognitive walkthrough whereas previous research used the USE questionnaire, Heuristic, and QUIM Evaluation methods. In that three studies using relying on sound modalities, this research not only uses Talkback but also uses the haptic vibration feature. Uses haptic features in the application to make it more accessible. In the research described, when the situation does not allow to rely on sound, haptic features can replace it.

This study aims to design an interaction design to provide a new user experience for blind people in ordering online transportation via the grab application. By using a user-centered design method that produces designs according to the needs of users, which are visually impaired people, the accessibility of the grab application increases.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The interaction design used in this study uses the UCD method which consists of 4 stages. User-Centered Design is user-centered, at every stage of design and development, an iterative method that emphasizes comprehension of the user and their context is used [20].

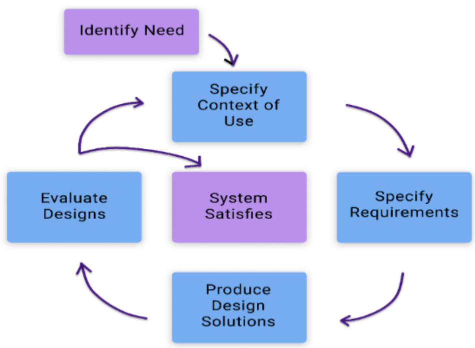

Figure 1. Research Stages[21]

2.2 Related Studies

At this stage, a literature review is conducted to collect research-related information for use as a reference and reference such as studying the User-Centered Design method, Cognitive Walkthrough as an evaluation method, blind people with disabilities, using talkback and haptic features.

2.3 Specify Context of Use

This stage is used to identify users who will use the product. Data collection will be carried out by determining the user first, then observing and analyzing the data interview with the primary user is the visually impaired which

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will generate qualitative data in the form of a representation of user characteristics. After collecting data from interviews conducted by prospective users, the data will be used to create a user persona, which will influence building design solutions based on demographics, skill levels, behaviors, activities, and needs. In this stage, an understanding of the context of use is also carried out in an application, like who will use the application, what is focused on, and in what state the application is in.

2.4 Specify Requirements

At this stage determine user needs for building applications that suit what is user need. Requirements for the application at this stage are obtained from the user and have related to the context of the application to be built. A process that is conducted at this stage includes identifying user needs, creating user mental models, and performing analysis tasks.

2.5 Create Design

At this stage, planning a solution based on user needs that goes through some steps, starting from determining the conceptual model, designing interaction design sketches and mockups, to building a prototype.

2.6 Evaluate Design

In this study, the design evaluation that has been made uses the cognitive walkthrough method. A Cognitive Walkthrough is a method that focuses on assessing the system's usability for ease of learning through exploration [22]. A Cognitive Walkthrough is a series of tasks representing the steps in an interface that conducted users to achieve certain goals [16]. A Cognitive walkthrough is based on method theory where the evaluator evaluates each step necessary to complete the task. This based script finds problem utility that could disturb navigation learning [23]. The cognitive walkthrough method is divided into two stages: preparation and execution, which can be seen in the image below [24].

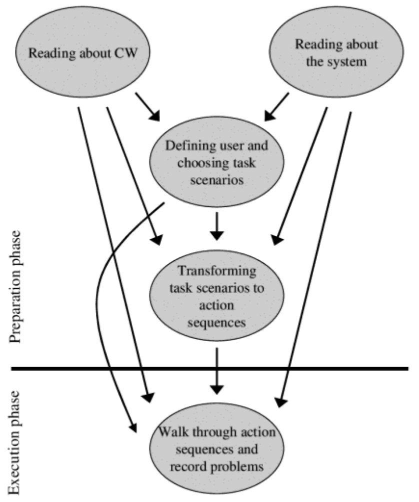

Figure 2. Stages of Cognitive Walkthrough

3. RESULTS AND DISCUSSION

3.1 Specify Context of Use

Understanding the user characteristics of the system represented in the user persona is the context of use. A user persona is created using the information gathered from the observation and conclusion interviews. The author uses a purposive sampling technique to determine the number of samples that will be targeted by users because in this study the number of blind people is too large, so it has not been identified with certainty. Therefore, the target users in this study were employees at the Sentra Wyata Guna, Pajajaran, Bandung City, totaling 5 people from the category of low vision blind and totally blind. The determination of the number of 5 people is based on S. Nasution (1998) explaining that the determination of the sample unit (respondent) is considered adequate if it has reached the level of redundancy or a condition where the data is saturated, meaning that adding more samples (respondents) will not provide information. new meaning[25]. Persona contains information that is grouped based on several personal variables including, demographics, skill level, behavior, environment, attitudes and activities, and requirements that are used as a guide to determine system requirements.

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Table 1. User Persona

Demographic	Age: 42 - 52 years old Male gender Live: Home Occupation: Employee Type of Visual Impairment: Low Vision & Totally Blind Low vision can see light and objects from a very close distance (blurred vision) Loss of vision from birth and in adolescence
Device	Smartphones (Android)
Skill Level	Has been operating a smartphone since he was a teenager Able to operate a smartphone with the help of the Talkback feature (Screen reader) Able to read and write braille
Behavior	Can use smartphone Can use a computer/laptop but sometimes still need the help of others Accustomed to using smartphones to communicate, browse the internet, find information and use social media or e-commerce applications Familiar with voice-based interaction on the device
Environment	Using an Android-based smartphone Using a smartphone anywhere Access online transportation bookings while traveling
Attitude & Activity Needs	Travel where you want when you have free time Going to work and going home always using the online-transportation booking application Can order car/motorbike online transportation easily through the grab application Get easy access to location information when ordering transportation online Get a notification/reminder from the system when the driver has approached the pickup location and destination Can communicate with drivers via calls conveniently Can save and rebook transportation with saved drivers
Pain Point	The location information on the screen when booking transportation is not read by Talkback When choosing a pickup location there are too many steps so it takes a long time to determine the location Users feel uncomfortable when the driver sends a text message while communicating, according to the user it will take a long time Users have difficulty giving 5-star ratings to drivers Users feel uncomfortable taking long trips without knowing their current location When ordering transportation online, users feel uncomfortable with image ads that are displayed too often When ordering transportation online, the user is uncomfortable and doesn't feel the need to access the map displayed on the screen to find out the driver's location and position Users feel a waste of time when choosing car or motorcycle transportation because there are 2 separate menus, the user wants to determine the location first and then determine the transportation needed

3.2 Specify Requirements

At this stage, the process identifies user needs, create user mental models and perform analysis task using Hierarchical Task Analysis (HTA).

3.2.1 Identification of User Needs

At this stage, the identification of user needs that have been made in the previous persona is carried out on 5 respondents aged 42-52 years. The results of this identification will be used to find out what the needs of users with visual impairments are in using the grab application when ordering online transportation.

Table 2. User Needs

User	Need	Requirements
Visual-impaired user	Can order car/motorbike online transportation easily through the application	The prototype was built by increasing accessibility on the android operating system by maximizing the use of Talkback and Haptic
Visual-impaired user	Can communicate with drivers via calls	A sign of the passenger's status as visually impaired so the driver can know it so that they can immediately make calls when communicating

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User	Need	Requirements
Visual-impaired user	Get notified of gesture prompts on the feedback page	There is a description to notify the gesture on the feedback page
Visual-impaired user	Get a notification/reminder from the system when the driver has approached the pickup location and destination	The reminder feature is accompanied by vibration so that users can know when the driver is approaching the pickup location and destination location
Visual-impaired user	Can save and rebook transportation with saved drivers	The feature of saving and retracing trips with saved drivers

3.2.2 Mental Model

Mental models describe an in-depth understanding of people's motivations and thought processes. The resulting mental model is a diagram of how a particular segment of people is likely to achieve something. Mental models are made based on an understanding of the characteristics, behaviors, and philosophies that have been obtained from interviews and observations, so that they can imagine what it would be like to be them, to achieve a certain goal. Mental models are needed to make a task analysis which will later be implemented in the form of a prototype. The following is a mental model that has been created.

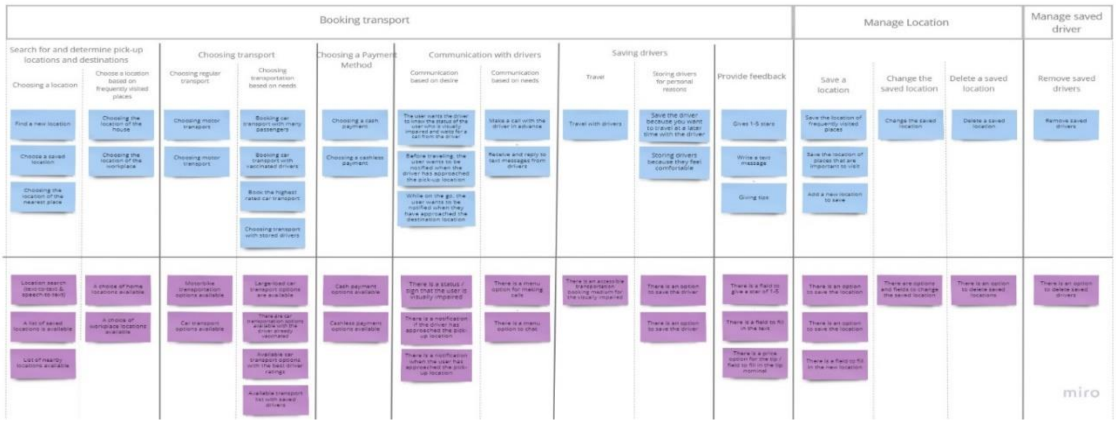

Figure 3. User's Mental Model

3.2.3 Task Analysis

In this study, Hierarchical Task Analysis (HTA) was used for task analysis. HTA is created by identifying and describing features into tasks and sub-tasks that are more organized to make it easier to develop interface designs because they contain content and flow to be built [26]. From the research data, you will get the user persona that was previously created, then the data will be analyzed for tasks and subtasks using HTA. This analysis can form a design that fits the user's data more easily. Here is the HTA that has been made.

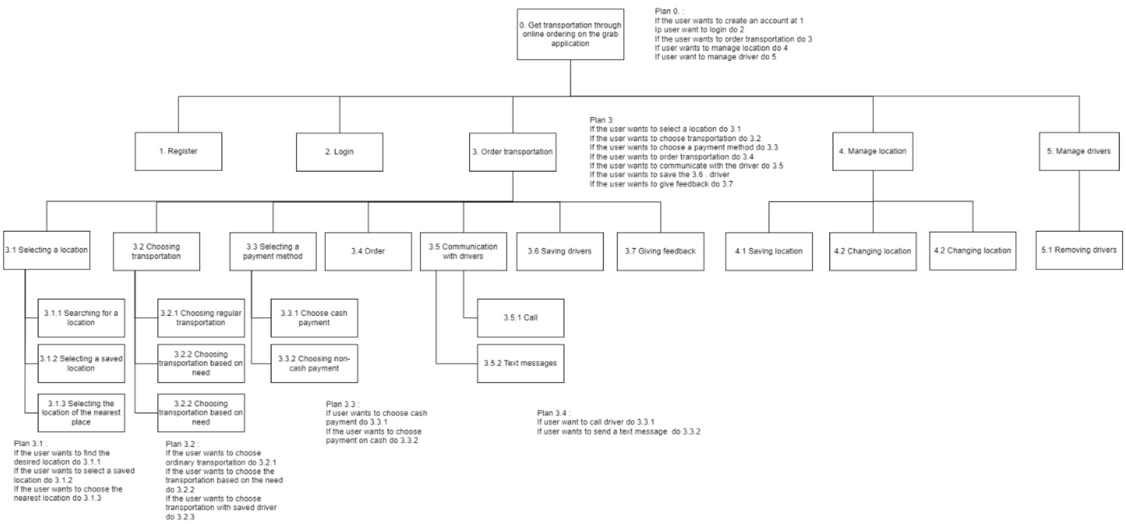

Figure 4. Task Analysis (HTA)

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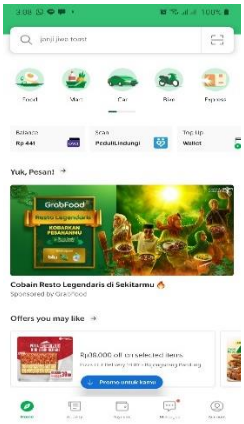
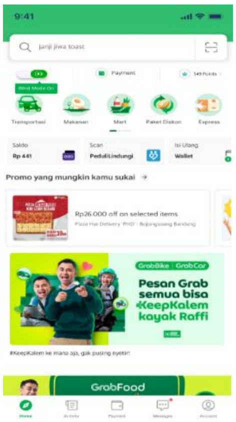
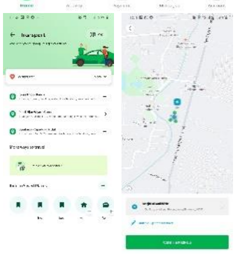
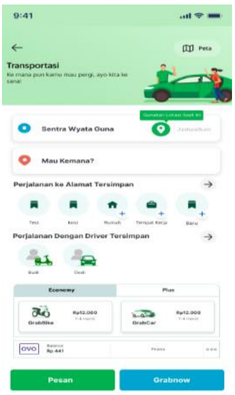
3.3 Create Design

At this stage, the result of the designed interaction design is a prototype. The design of the prototype is carried out based on the data that has been obtained previously by taking into account the element of accessibility. The interaction design is made by maximizing the talkback and haptic features. Users who are blind or visually handicapped can be stimulated by haptic feedback in a variety of situations when navigating. The system can be designed to provide a variety of vibrational stimuli in a variety of instances. The majority of vibrotactile stimuli utilized in smartphones carry extremely basic information, such as alerts [27]. Furthermore, smartphones with complex vibrotactile stimuli offer improved communication by employing touch to make up for or even compensate for limitations in other senses [27][28]. When auditory modalities cannot be used, such as in a noisy location or while the user is on the go and has to be alerted when approaching the destination, this feature might be valuable in the design of navigation aids.

3.3.1 Mockups

At this stage, the final view of the wireframe design is produced that uses color and has a more detailed and concrete appearance. Mockup is made using the software Figma. Here is a mockup that has been created.

Table 3. Mockup

Existing Design	New Design	Information
-		This page is the starting page after logging in for the first time in the application. This page contains information only if the Talkback mode on the smartphone is active, the user is recommended to turn on the blind mode. When the blind mode is activated, the user pain points previously described become the recommended solution designed. The condition that blind mode can be used is that the talkback feature is active.
		This page is the home page that contains the services that can be used. To order car or motorbike transportation, users can choose transportation services. On this page, there is also a toggle button and information on whether the blind mode is active or not. In the existing design, the car and motorcycle service options are separate, while both have the same function. In ordering motorbikes, there are also types of transportation that can be ordered, making users need time if they want to select the button to order. From this, a solution was designed wherein ordering motorbike or car transportation became a menu of choice on the home page.
		This page is a transportation booking page. The user can enter the location in the field provided. In determining the pick-up location, the user can do this only by using the location icon. In the existing design, it takes respondents a long time to determine the pick-up location because they need to confirm the pick-up on the map first. The solution designed is that the user can enter the location of the pick-up point in just one click via the icon provided. The user can then proceed to choose the final destination. The solution designed for users to easily choose the type of transportation is to provide the transportation options that the user needs on one order page. Users can also travel by selecting locations and drivers that have been saved. Users

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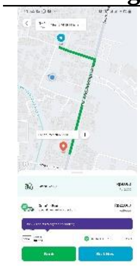
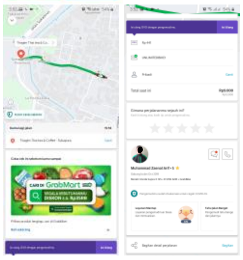
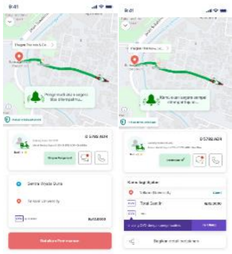
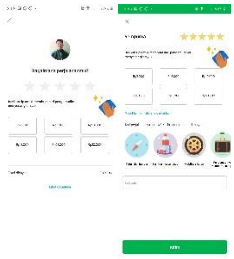
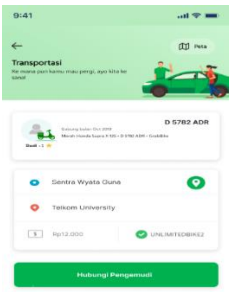
Existing Design	New Design	Information
		can also choose the economy/plus services and payment methods provided.
		This page is the page when the user has made an online transportation order. To overcome user pain points, with blind mode activated, the map feature on the screen cannot be accessed due to user limitations, only as a preview because the user does not need access to the map. In addition, image ads are hidden because users don't need them. Giving feedback is done after the user arrives at the destination because the user wants a simple display so that it can be understood. On this page, there is the option of communicating with the driver via call/text message. After placing an order, the driver will see the user's status as a blind person (Blind mode activated). Then the driver will immediately make phone calls and not send text messages. If the driver is close to the pick-up point, there will be reminder notifications and vibrations on the user's smartphone, as well as when the user is almost at their destination. The haptic feature in the form of vibration here is very necessary when the user is in an external environment and cannot rely on sound modalities. On this page also users can save drivers to travel back with the same driver.
		This page is the page when the user has finished ordering online transportation. On this page, there are feedback options that users can make, such as giving 1-5 stars. For gestures, feedback is also notified in advance to users so that users can provide feedback. Another option for providing feedback is that users can give tips and choose the driver's travel experience on one page.
-		This page is the page where the user wants to travel with the saved driver. Users can determine the pick-up location and destination, then find out how much the trip will cost.

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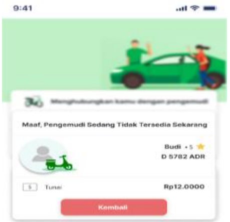
Existing Design	New Design	Information
-		This page is the page when the driver is not willing to travel. The user can return to the previous page.

3.3.2 Prototype

After making a mockup, at this stage, a prototype is built so that it can run on the Android operating system. Several things need to be considered in designing a prototype using Talkback, including:

a. Labeling all interface elements including images and icons so that Talkback can provide feedback in the form of sound related to the touched element so that it can meet the needs of visually impaired users.
b. The use of color combinations in the interface can help visually impaired users in the low vision category to distinguish between different elements.
c. Simplify the navigation of elements that have the same function so that users can interact efficiently and easily find the information on the screen.
d. Enlarges the touch target on an existing element on the screen so the user can see which interface element is being touched.

Here's an example of a touch target on an app element to watch out for.

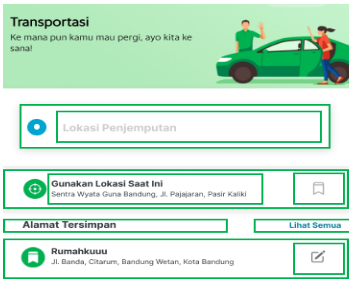


Figure 5. Touch target app page

3.4 Evaluate Design

Studying the system to be tested, identifying respondents, assembling scenarios of tasks that respondents must do, and transforming the task scenarios that have been defined into phases that are in process are all done during the preparation stage. Next is the execution stage, which is a sequence of walkthrough actions carried out by respondents and recording problems [24]. The degree of task scenario completion, the number of errors made, specifically the number of errors resulting from actions that did not follow what was intended when the activity took place, and the length of time necessary, specifically the amount of time the responder needed to complete the task scenario, are metrics that can be used from the test results [30]. Each task scenario is recorded at this point, whether it is successful or unsuccessful, depending on when it is completed. In this study, the amount of time required for each respondent was not included in the calculation in the analysis of the results. This was chosen to avoid bias in the calculation of the completion time because the conditions of the smartphone and internet network used by each respondent were different.

3.4.1 Respondent

An evaluation was carried out on 5 people according to the initial evaluation to compare the usability value of the initial design and the design after it was repaired. The usability test only requires the number of respondents not more than five people. Three respondents who did the usability test could show usability problems up to 67%[31]. The following are the criteria for the selected respondents.

Table 4. Respondent Criteria

No.	Criteria for Testing Respondents
1	Blind people who have ordered online transportation via the Grab application
2	Understand using mobile applications

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No.	Criteria for Testing Respondents
3	Understand and be able to use a smartphone

3.4.2 Task Scenario

The task scenario is a set of actions that the respondent must take when reserving online transportation using the Grab app. This study makes use of three task situations that are pertinent to the Grab application's menu when a user orders transportation online. The tasks that respondents must do are listed in the scenario below.

Table 5. Task Scenario

No.	Task Scenario	Existing Number of Stages	Expected Number of Stages
1	Order motorbike transportation to the desired place	13	10
2	Book a car transfer to the desired place	14	10
3	Give 5-star feedback to drivers	6	6

The Grab app has recently been updated with additional functionality. The tasks that respondents must do are listed in the scenario below.

Table 6. New Feature Task Scenario

Scenarios of ordering transportation with saved drivers	
Goals	Making online transportation bookings with saved drivers
Scenario	You want to travel back with the drivers that were previously saved on the app. You have to book transportation with the saved driver. You can enter the location of the pick-up point and destination, then choose a payment method. After that, you will contact the driver.

3.5 Analysis of Test Results

Analysis of the test results is done by comparing the results of the early stages of research and the final results after making improvements to the new interaction design. The following is a comparison of the results of the tests carried out.

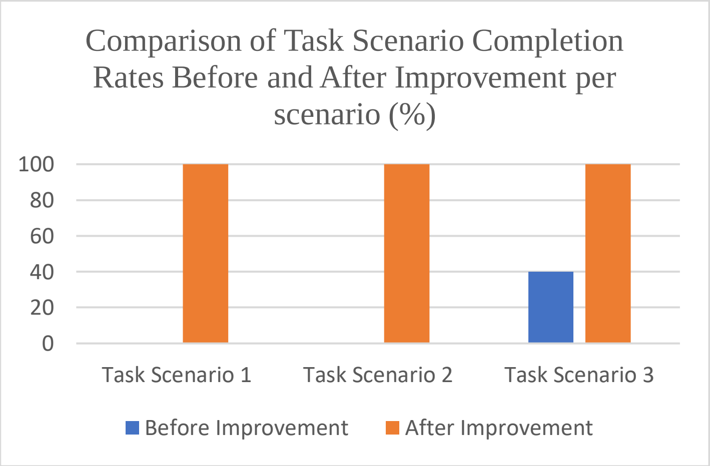

Figure 6. Comparison Chart of Task Scenario Completion Rates

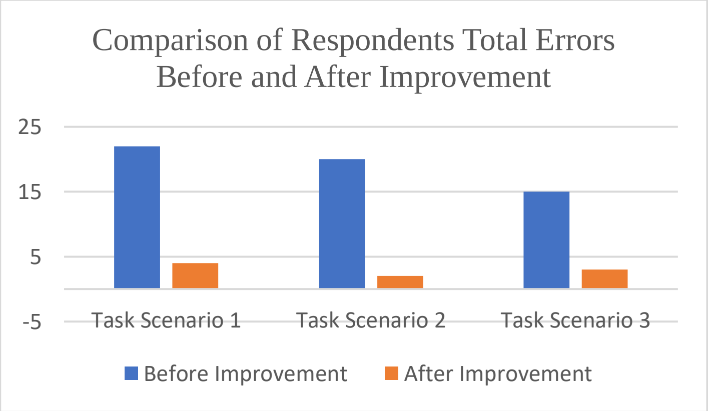

Figure 7. Comparison Chart of Respondents' Total Error

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Based on the table of comparison results above, shows that after repairs were made, the completion rate of the task scenario reached 100%, which was initially 0%. The number of errors made after the repair has also decreased. In all task scenarios there are still errors, but still better than before the fix. The results of testing the scenario of ordering transportation with a stored driver are that the respondents completed the scenario and did not make mistakes when working on the task scenario.

4. CONCLUSION

Based on the findings of previous research, user needs in ordering online transportation through the grab application include the user being able to determine the pick-up location and destination easily, the user wanting to get a notification when the driver approaches the pick-up location and destination location. In addition, the user also wants to save the driver and travel back with the saved driver and the user wants the driver to know the user's status as a blind person. The author provides interaction design recommendations so that users can determine the pick-up location and destination easily, and provide notifications in the form of reminders when the driver has approached the location. The author also creates a feature that allows users to save and return saved drivers. The preliminary evaluation's findings indicate that the grab application's usability testing is bad, as evidenced by the user's inability to accomplish the task scenario and the sheer volume of mistakes they commit. Users were able to complete task scenarios and fewer errors were made after the application was designed utilizing the UCD method, improving the program's usability evaluation findings. Suggestions in this study are to evaluate using other methods to find other things that are obstacles for users in accessing the application. Hopefully, in the future, there is research that explores and studies more deeply and implements haptic features so that users with visual impairments can distinguish between interface elements on the screen only through the smartphone they are using.

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