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User Experience Design in Mobility Assistant Application for the Physically Disabled Using the Wheel Method

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Abstract-This research was conducted to design a mobility assistant application for persons with physical disability using The Wheel method. This application can assist mobile activities for people with disability. The application called Kuygo was made in four stages: analysis, design, prototype, and evaluation. Analysis of user needs is carried out at Loka Bina Karya (LBK) Bogor through observation and interviews. The interaction design requirements are generated in the form of requirements statements and inventory tasks with three main tasks, namely mobility preparation, mobility comfort, and providing a review of a location. Afterwards, discussions were held in the form of design thinking and ideation sessions, with people who care about people with disabilities and the Senyum Difabel community, which produced sketches, storyboards, and wireframes. Furthermore, the design implementation is carried out by making a prototype of medium-fidelity and the results are tested using cognitive walkthrough techniques. Of the four questions that must be answered with cognitive walkthrough techniques, the average success rate of all the tasks tested is 94.62%. Based on these results, no major usability errors were found in the prototype medium-fidelity and the Kuygo application can be further developed.

Keywords: mobility assistant, disability, mobility, physical disability

1. Introduction

Everyone hopes for a perfect physique with the completeness of the limbs, but not everyone gets a gift from God to get a complete body and mental fitness. There are also those who have physical disabilities or illnesses so there are limitations in their activities. They are known as people with disabilities. Physically disabled person is a person who has a physical/body deficiency or abnormality that causes interference with their personal activities and development [1]. Disabilities has two categories, namely ambulant-disabled and wheelchair-bound disabled. Ambulant-disabled persons are persons with disability who can still move around using tools without using a wheelchair, while wheelchair-bound disabled are those who have limitations in mobilization and are certain to use a wheelchair to carry out daily activities [2].

Data from the Ministry of Health of the Republic of Indonesia states that there are 6,515,500 people with disabilities in Indonesia in 2012 and as many as 10.26% of people experience physical disability [3]. Over time with the increasing number of accidents in Indonesia, it is predicted that people with disabilities in Indonesia will also increase [4]. Indonesia, with a population of around 265 million, should have good enough public services, especially for accessibility. In Law Number 4 of 1997 article 1 (paragraph 1) and Government Regulation Number 43 of 1998 in particular article 1 (paragraph 1) it has been explained that citizens who are both disabled and non-disabled have the right to get equality of position, rights and obligations, and play a role in the society according to his ability. This accessibility is very important to help people with disabilities carry out activities independently. However, often people with disabilities still find it difficult to get services and information about accessibility for people with disabilities. In addition to information, they also sometimes need a companion or assistant in their activities. Trained animals are sometimes used to assist them in order to imrpove independence and carry out social activities [5].

Mobility is the ability to manipulate objects and the ability of an individual to move in their environment. Mobility assistants help people who have difficulty in mobility because of physical impairments or disabilities. This mobility assistant is applied by using technology-based also increasingly developed such as electric powered wheelchairs, prosthetics, functional electrical stimulation, and exoskeleton robots [6]. Mobility assistant can not only be applied in the form of hardware technology, but can also be applied to software, one of which is application technology. This last form can be used more practically by various walks of life because it can run smart gadgets in general which are owned by the majority of the Indonesian population.

This research will design a mobile application that makes it easy for persons with disabilities to obtain information and get appropriate accessibility when doing mobility. This research resulted in a prototype application of mobility assistant for the disabled with visual impairment through the process of designing the user experience of The Wheel [7].

2. Method

This research was conducted using The Wheel [7] cycle method which consists of four stages, namely analysis, design, prototype, and evaluation. The analysis is done by doing contextual inquiry to the user, describing it in the form of a work activity affinity diagram, and modeling it in the form of a hierarchical task inventory (HTI). Based on the HTI produced, the application design is made through a process of design thinking and ideation in groups to produce many possible solutions. The best solution is made in the form of sketches, storyboards, and wireframes. Wireframe is made in the form of a medium-fidelity prototype that will be evaluated by users using cognitive walkthroughs.

a. Analysis

In the first stage of the analysis is to do contextual analysis with direct observation and interviews to three respondents with disabilities. Observation was carried out at Loka Bina Karya (LBK) Bogor by observing the mobility activities carried out by persons with disability and conducting interviews by asking 12 questions related to experiences when mobility to the response to the system to be made. The results of these observations and interviews are made into a label that contains the user's work activity notes.

Activities that have been written in the work activity notes are then combined with work activity affinity diagrams (WAAD) which aim to visualize the contextual data obtained by grouping work activities. WAAD consists of four levels: the first level is the overall scope of the objectives of the research activity, the second level contains questions, the third level (group label) which is the first grouping for work activity, and the fourth level which is the work activity (work activity) of the user.

b. Design

At this stage, design thinking and ideation is carried out with a team from the community concerned with disabilities and the Senyum Difabel community to explore as many solutions as possible from the issues raised. The problem is divided into three main tasks: "getting information to prepare for mobility", "getting information and security while traveling", and "giving a review of a location". This stage produces user persona, sketches, storyboards, and wireframes.

c. Prototype

The results of the design which includes three main tasks are implemented in a medium-fidelity prototype. The medium-fidelity prototype was created to make it easier for users to interact with the system. The medium-fidelity prototype is carried out after the initial design is used for more detailed design purposes and uses validation. This medium-fidelity presents detailed information such as navigation, functionality, content and layout, as well as form estimates [8]

d. Evaluation

At this stage, testing and evaluation of prototypes that have been made in the previous stage are carried out. The prototype was tested using cognitive walkthrough (CW) techniques to get direct feedback from users. CW is one of the testing methods used to test system usability and find the cause of problems that occur in the system usability in a design process [9]. CW assesses the ease of new users in completing tasks with a system. In evaluations using this CW technique relies on a series of detailed questions that must be answered by the user when evaluating specifically through exploration.

Participants in this test will evaluate the interface provided based on the specified task. Input in one walkthrough session includes the design of the system interface, scenarios for each task, and the sequence of actions that must be successfully performed to fulfill each task tested. At each step of the action in a task, the evaluator must observe what the participant is doing and answer the four questions that are the success rate of this evaluation. The questions are as follows: (1) 'Will the user try to achieve the right results?' (2) 'Will the user see that the correct action is available for them?' (3) 'Will the user associate the correct action with their expected results? ', and (4)' If the correct action is taken, will the user see that progress is being made towards the expected results? '[9]. This evaluation was tested on two participants with physical disabilities who used wheelchairs.

3. Results and Discussion

a. Analyst

During the analysis phase interviews were conducted with respondents asking 12 questions to three respondents with disability related to their daily mobility. Several points are obtained based on the results of interviews and observations, including regarding location, transportation, and social information. Respondents often experience difficulties when using transportation are wheelchair user respondents because there are still many transportation facilities that is not so disable-friendly. In addition, information on disability facilities related to a location is needed for persons with disabilities, especially wheelchair users to facilitate their needs. The lack of empathy of non-disabled people is still felt by people with disabilities so they have to struggle alone in carrying out their activities.

Data from interviews and observations in the previous stage were analyzed by making notes of work activities carried out by respondents. The relationship between notes of user work activities on the Kuygo application is interpreted into a work activity affinity diagram (WAAD) that has a research objective, namely the user mobility activity reaches the destination location written at the first level. Each label is coded to make it easier to trace at a later stage. The code is Z for the purpose of research activities (first level), A ... Z for the second level, (AA, AB, ...) for the third level, and (AA1, AB1, ...) for the fourth level. The WAAD diagram can be seen in full in Figure 1. Furthermore, making a requirement document to determine the system interaction design needs based on user work activities. In addition, the feasibility of implementing these needs is also estimated. Full results can be seen in Table 1.

After making the requirements statement, a hierarchical task inventory (HTI) is made which is focused on the user's role, namely the physical disability and can be seen in Figure 2. This HTI is made to show the structure of the user's tasks and actions and guide the overall interaction design. In this HTI, it looks supertask in the form of 'doing mobility activities to the destination location' which is divided into three main tasks. Each main task is divided into smaller tasks.

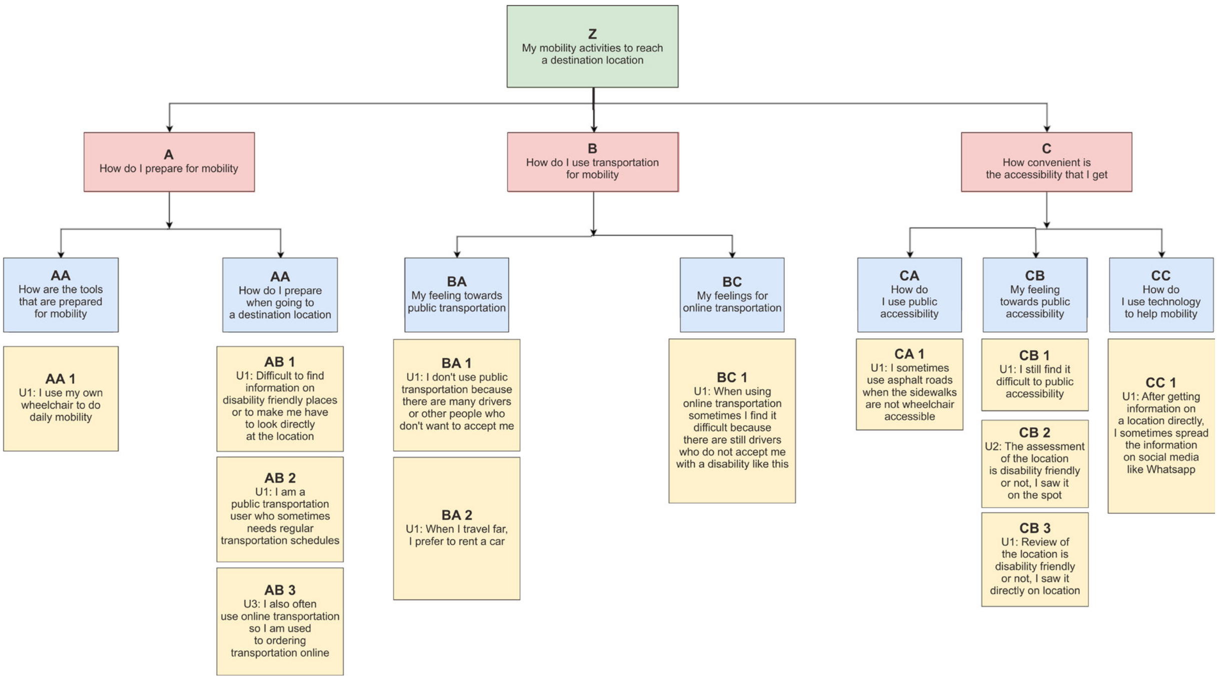

Figure 1. Work activity affinity diagram (WAAD) of the Kuygo application

Table 1. Requirements document for the Kuygo application

ID	Work activity	Requirement statements	Feasibility
AA1	Find out mobility information for wheelchair users	Wheelchair users will receive wheelchair mobility information	√
AB1	Knowing disability friendly location information	Wheelchair users must be able to find disability-friendly location information	√
AB2	Knowing public transportation schedule information	Wheelchair users will receive transportation schedule information to be on time to get transportation	√
AB3	Look for transportation online	Wheelchair users must be able to find transportation information online so they can rent it	√
BA1	Knowing disability-friendly public transportation	Wheelchair users will receive any transportation information that can be used with disabilities	√
BA2	Looking for vehicle rental when traveling far away	Seat users must be able to find a vehicle to rent when going long distance	√

ID	Work activity	Requirement statements	Feasibility
BC1	Knowing disability-friendly online transportation	Wheelchair users will receive disability-friendly online transportation information for convenience	√
CA1	Knowing wheelchair lane information	Wheelchair users must be able to find a route that can be passed by a wheelchair for mobility convenience	√
CB1	Knowing information about disability friendly facilities in a place	Wheelchair users must be able to find disability-friendly location information based on location criteria	√
CB2	Rating a place	Wheelchair users must be able to provide ratings so that other users can find out the location that has been assessed	√
CB3	Write a review somewhere	A wheelchair user must be able to give a reason for a location to be seen by other users for his assessment	√
CC1	Share disability-friendly location information	Wheelchair users must be able to disseminate disability-friendly location information so other users are able to mobility comfortably	√

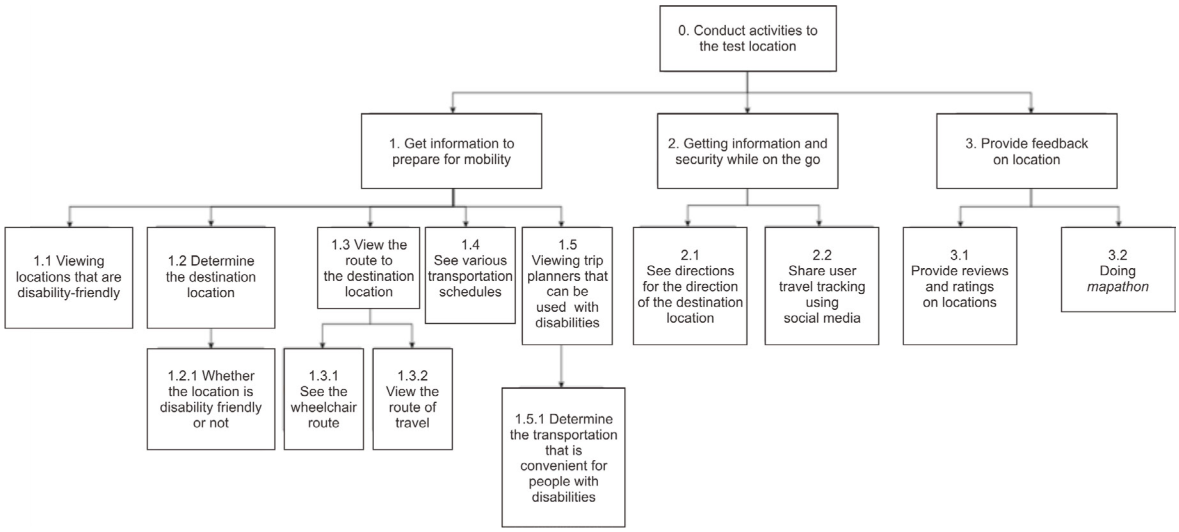

Figure 2. Kuygo's Hierarchical task inventory (HTI) application.

b. Design

In the first stage the design is done by making persona to describe the characteristics of the target user of the application to be developed. Personas are made based on the process of analysis of the results of the interview in the previous stage. User persona for the Kuygo application in Figure 3.

Then the idea was carried out by brainstorming with a team consisting of two people who care about people with disabilities and one of the Senyum Difabel community. In this process of ideation is based on three main tasks on HTI, namely 'getting information to prepare for mobility', 'getting information and security while traveling', and 'giving a review of a location'. The results of the design of ideas and solutions from brainstorming are described in the form of eight sketches (crazy eight) for each main task. The results of eight sketches for the three main tasks can be seen in Figure 4.

After making eight sketches for each of the main tasks, voting is then conducted to determine the best sketch for each task. For the first task, the chosen sketch is a sketch that displays location information, accessibility information to the destination location, as well as information on transportation recommendations that can be accessed by people with disabilities. For the second task, the selected sketch provides information on directions and user safety while traveling by providing emergency calls and can share the user's journey to others through social media. Finally, the selected sketch for the third task is a sketch that provides a place for users to do a review and mapping of a location and its path whether disability friendly or not. All three sketches contain a list of tasks as in Table 2.

After the three sketches have been selected, a storyboard for each sketch will be made. Storyboard is made to know the flow of the use of the system as well as contests of its use from the user's side. One of the storyboards can be seen for the first task, which is mobility preparation in Figure 5, which tells the user who is going to a location but wants to know if the location is disability friendly or not by using the Kuygo application.

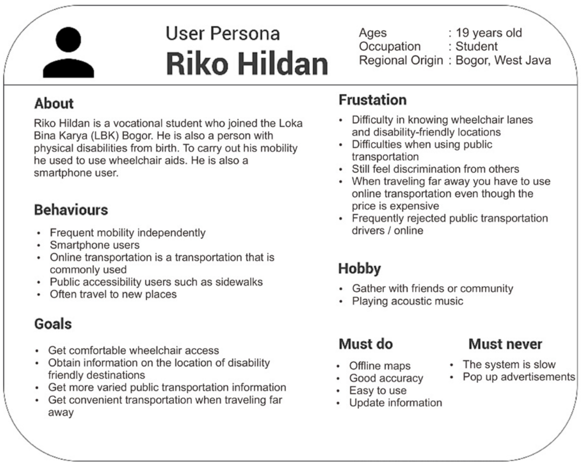

Figure 3. User persona of the Kuygo application.

Figure 4. The results of crazy eight activities for the three main tasks in the Kuygo application.

Based on the storyboard produced, the application design is made in a higher level of fidelity, namely wireframes. This form focuses on the interface that appears in an application and shows more clearly the information displayed along with its layout on the screen. Wireframes are created using Adobe Experience Designer software and follow Google Material Design standards. Wireframes will be increased fidelity into a medium to show more visual elements and interactions that will be felt by users when using this application. An example of a wireframe created can be seen in Figure 6, which is for the task of preparing for mobility.

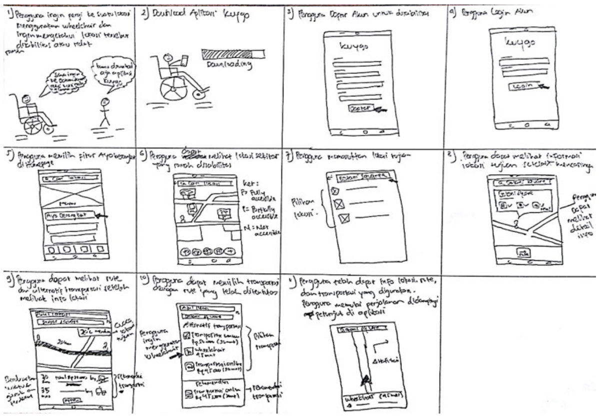

Figure 5. Storyboard for mobility preparation tasks

Figure 6. Kuygo Wireframes application

c. Prototype

The prototype stage is the stage of implementing the results of the previous stage. The current prototype is a feature providing information for preparing user mobility with location and transportation information that can be used. This prototype was made with a medium-fidelity level. The prototype can be accessed at bit.ly/kuygo application and the following sample prototype of the Kuygo application in Figure 7.

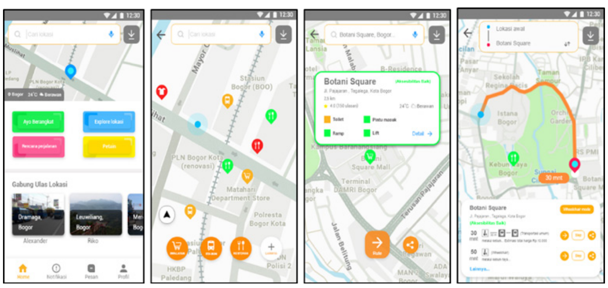

Figure 7. Kuygo application medium-fidelity prototype

d. Evaluation

The overall results of the Kuygo application prototype were evaluated using cognitive walkthrough (CW) techniques. In this study, testing with 16 tasks that must be completed by participants. This evaluation involved two participants who came from Loka Bina Karya (LBK) Bogor who are wheelchair users. This 16 task test is a test based on HTI that has been made.

There are 4 walkthrough questions to evaluate the test results based on the application interface. The first question is to analyze whether the user will try to achieve the right results. This relates to the understanding of users in completing an action. The second question is to analyze whether users will see that the correct actions are available for them. This second question relates to the availability of interface controls. The third question is to analyze whether the user will associate the right action with the results they expect. Relates to labels on available controls. The fourth question is to analyze what if the correct action is taken, will the user see that progress is being made towards the expected results. This relates to the user interface feedback that should be received.

Table 2. Testing tasks

Task
Main Task 1 Get information for mobilization preparation.
1. The user is logged in as a registered user.
2. Users explore locations to see locations that are friendly with disabilities.
3. The user searches for the destination location based on the last search.
4. The user sees destination location information.
5. Users see the recommended wheelchair route.
6. The user searches for the desired transportation alternative along with the travel route.
7. The user saves a trip planner for the user's scheduled trip.
Main Task 2 Get information and security on the way
8. The user starts the trip by looking at the directions.
9. Users share trips for the user's travel security.
10. Users make an emergency button for emergencies when traveling.
11. The user searches for the location of his destination when he is around the location with the Augmented Reality (AR) maps feature.
Main Task 3 Provide feedback on location
12. The user ends the trip by giving a review and rating of the location that has been done.
13. The user does a mapathon / location mapping.
14. Users get mapathon notifications.
15. The user starts the mapathon.
16. The user terminates mapathon.

To measure the success of each action on the task, a representation of the results is carried out, labeled 'Yes' with a weight of 1 if the action was successful and labeled 'No' with a weight of 0 if the action was failed [10]. Every action that is labeled 'No' must be accompanied by a description of the cause of failure for the action (Table 3). Then count the number of successful actions on each task (Table 4). After calculating the number of successful actions, each number of normalized actions by counting the number of successful actions divided by the results of the total actions on a task multiplied by the number of partisans. The results of normalization are summed and the average is taken from each walkthrough question (Table 5). The calculation results obtained success rate based on four questions raised. The success rates for the four questions are 97.25%, 90.87%, 96.18% and 94.18%, respectively.

Based on the average value of the results of the normalization of success there is the lowest average normalized value of each walkhtrough question. In the first question, which is "Will the user try to achieve the right results?" Has the lowest value of 0.80 on task 7 because the user does not understand the save button available so the user fails to save the itinerary.

Task 10 has the lowest value, which is 0.50 for the second question, which is 'Will the user see that the correct action is available for them?'. That is because the user is not too visible with the available text that is too contrasting in color and also the button does not have the word 'emergency' so that users find it difficult to find the 'emergency' button.

In the third question, which is 'Will the user associate the correct action with the results they expect?', There is the lowest value on task 10 which is 0.66. That is because the user feels that there are too many stages for emergency calls so that they cannot contact emergency calls as soon as possible.

The final question, which is 'If the correct action is taken, will the user see that progress is being made towards the expected results?' There is the lowest value on task 7 of 0.80. This is again because the user did not complete the storage because he did not know the save button and also after being notified of the actual action, the user needed a message after the itinerary was saved.

Based on these results, it can be concluded that no major usability errors were found in the prototype medium-fidelity and the Kuygo application can be further developed. However, for the next prototype or product, further testing is needed using the number of participants in the top two people which allows for greater reusability of major problems.

Table 3. Example of cognitive walkthrough test results

Task 15: The user starts the mapathon					
Numb	**Action**	**a¹**	**b²**	**c³**	**d⁴**
1	The user selects the correct navigation ('Petain' on 'Home' navigation)	Y	Y	Y	Y
2	The user selects 'current pet'	Y	Y	Y	Y
3	The user presses the 'Start' button to start mapathon	Y	Y	Y	Y
4	The user added a new location mapathon	Y	Y	Y	Y
5	The user fills in the mapathon form	Y	N	Y	Y
6	The user presses the 'submit' button	Y	Y	Y	N

(1) Will users try to achieve the right results ?;
(2) Will users see that the right action is available for them ?;
(3) Will the user associate the right action with the results they expect ?; and
(4) If the correct action is taken, will the user see that progress is being made towards the expected results?

Table 4. Number of successful actions

	Walkthrough Question							
	1		2		3		4	
Participation	1	2	1	2	1	2	1	2
Task 1	3	3	3	3	3	3	2	3
Task 2	3	3	3	3	3	3	3	3
Task 3	3	3	3	3	3	3	3	3
Task 4	3	3	3	2	3	3	3	3
Task 5	2	2	2	1	2	2	2	2
Task 6	2	2	2	2	2	2	2	2
Task 7	4	4	4	4	4	4	4	4
Task 8	2	2	2	2	2	2	2	1
Task 9	2	2	2	2	2	2	2	2
Task 10	3	2	2	1	2	2	3	3
Task 11	3	3	3	3	3	3	2	3
Task 12	2	2	2	2	2	2	2	2
Task 13	8	7	8	8	8	7	7	7
Task 14	3	3	3	3	3	3	3	3
Task 15	6	6	6	5	6	6	6	5
Task 16	2	2	2	2	2	2	2	2

Table 5. Average results of the normalization of success and success rate

0,83	Walkthrough Question			
	1	2	3	4
Task 1	1,00	1,00	1,00	0,83
Task 2	1,00	1,00	1,00	1,00
Task 3	1,00	1,00	1,00	1,00
Task 4	1,00	0,83	1,00	1,00
Task 5	1,00	0,75	1,00	1,00
Task 6	1,00	1,00	1,00	1,00
Task 7	0,80	0,80	0,80	0,80
Task 8	1,00	0,75	1,00	0,83
Task 9	1,00	1,00	1,00	1,00
Task 10	0,83	0,50	0,66	1,00
Task 11	1,00	1,00	1,00	0,83
Task 12	1,00	1,00	1,00	1,00
Task 13	0,93	1,00	0,93	0,87
Task 14	1,00	1,00	1,00	1,00
Task 15	1,00	0,91	1,00	0,91
Task 16	1,00	1,00	1,00	1,00
Average	0,9725	0,9087	0,9618	0,9418
Succes rate (%)	97,25	90,87	96,18	94,18

4. Conclusion

The conclusion of this study is the needs and desires of respondents have been analyzed based on contextual inquiries that produce work activities, requirements documents, and task inventory. The design stage has resulted in user persona and ideation in the form of ideas, sketches and wireframes for all the main tasks, namely the task of 'getting information to prepare for mobility', the task of 'getting information and security while traveling', and the task of 'giving a review of a location 'based on the results of brainstorming. The results of the analysis and design are implemented as a medium-fidelity prototype. The prototype was tested using cognitive walkthrough (CW) techniques that produce success rates based on four walkthrough questions.

From the calculation results of the average normalization of the success of a task obtained success rate for the question 'Will the user try to achieve the right results?' Obtained a success rate of 97.25%, the question 'whether the user will see that the correct action is available for them?' Is 90.87 %, the question 'Will the user associate the correct action with the expected results?' by 96.18%, and the question 'If the correct action is taken, will the user see that progress is being made towards the expected results?' of 94.18%. Based on these results overall the user has understood and can run this Kuygo application correctly.

Based on these results, it can be concluded that no major usability errors were found in the prototype medium-fidelity and the Kuygo application can be further developed. However, the authors suggest that for the next prototype or product, further testing is needed by using the number of participants in the top two people which allows for greater reusability of major problems..

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