The Effect Of Mobile Map With Geospatial Technologies On The Development Of Blind Disabilities’s Spatial Relational Thinking

Muhammad Erwin Amrullah*1, Fatwa Ramdani2, Herman Tolle3, 
123 Brawijaya University, Malang
1m.erwinamrullah@gmail.com, 2fatwaramdani@ub.ac.id, 3emang@ub.ac.id

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Abstract. Abstract—People with visual impairments may have problems traveling from one place to another. One of the common problems they face is that they find it difficult to get used to the places they visit. For the general public, this problem can be solved by using a map. However, the visual impairment solution may not be the best because the maps that can be used by the visually impaired are tactile maps. Tactile maps have many drawbacks, one of which is the difficulty of getting updates when there is a change in the area because tactile maps have not been digitized for mobile applications. Therefore, a map based on a mobile application was made to facilitate the visually impaired along with supporting features for its users. This research focuses on digital maps that can be accessed through a mobile application with an Extreme Programming (XP) approach and a case study conducted using a map of the Universitas Brawijaya area. The digital map developed has been tested for feasibility on respondents and can help improve spatial understanding for the visually impaired.

Keywords: Disability; Blind; Mobile Apps; Maps; Spatial

1. Introduction

The use of mobile apps in today's digital era has grown rapidly. People can easily install and use their desired apps to ease their everyday life. People with special needs, one of which is people with visual impairment, are no exception. People with visual impairment need apps that are specially designed so that they can be used by such users. One of the common apps used by people with visual impairment is a map to ease them locate where they are.

The maps usually used by visually impaired people are tactile maps [1]. Tactile maps have been widely used by visually impaired people for decades [2]. Tactile maps are made for visually impaired people in universities [3]. Nevertheless, tactile maps have disadvantages such as the expensive cost of the production and it is relatively difficult to develop, or update. Tactile maps also have limitations regarding the range of areas and the accessibility of their users [4]. Therefore, a digital map that can overcome the imperfections in tactile maps should be made.

Digital maps have advantages such as their easiness to be updated. Besides, they can explore the earth surface, even the state of space, in three dimensions [5]. Meanwhile, digital maps are not commonly intended for visually impaired people. Thus, this research tries to develop a digital map that can be used by people with visual impairment through a development in accordance with their needs.

Researches related to visual impairment have been done before, and those researches indicated that what people with such disabilities need are vibration and sound. Moreover, those people also need supplementary elements such as audio and
touch response on digital maps that enable them to understand a map [4]. Another research was done by [6] that discussed one on the approaches in developing a digital map, that is by producing an output in the form of audio as the response to an action done by the user. The following research was done to create a digital map that can be used easily by people with visual impairment. This needs supporting components in the map to increase the users’ understanding, such as the use of sounds and vibrations because those are ones of the important aspects to respond and understand things for people with visual impairment [7]. Research conducted [8] developed spatial technology that is used for school students learning to determine the level of spatial relational and divided the questions level into two categories of questions, low and high. The notion of spatial relational thinking is an important way of thinking to analyze and reason [9]. Thought that finds meaning in forms, sizes, orientations, locations, directions or paths, objects, process or phenomena, or relative position in space of many objects, processes or phenomena [10].

Simply put, the problems we can identify and solve to analyze the research of digital map for visually impaired people and to meet the objective of this research is how the result of the development of a digital map application can be used by visually impaired people. Besides, it provides an overview of the results of the analysis of the use of digital maps for visually impaired people which will become a reference in the future for making digital map applications for users of such disabilities. The hypothesis of this study is that there is an increase in the user's knowledge of spatial literacy after using the developed interactive digital map.

2. Method

2.1 Research Design

This research was begun by prior literary study done by collecting references to analyze the needs of the use of apps for visually impaired people as needed. The method used to make the digital map in this research is Extreme Programming (XP). The XP was started by planning, designing, implementing, testing, and validating, as well as deployment as the last step of XP [11]. After all steps in XP have been carried out, the next stage is to test the app on the determined respondents. The results of the testing were then analyzed and concluded.

2.2 Test Scenario

In this research, a test scenario was carried out on respondents to obtain information that was directed at the time the test was carried out. The information extracted is related to spatial knowledge to determine the user's level of spatial literacy after using a digital map application. The series of activities are divided into several agendas that have different durations.

| Agenda of Activities |
|----------------------|
| 1. Introduction to the research plan |
| 2. Introduction to the app and its features |
| 3. Exploration duration (20-minute duration) |
| 4. Execution (20-minute duration) |
| 5. Recording of execution results |

Agenda of Activities

1. Introduction to the research plan
2. Introduction to the app and its features
3. Exploration (10-minute duration)
2.3 Data Collection Technique

The data collection in this research was done through a questionnaire. This was done to gain thorough information related to the respondents. Respondents in this study were used as diggers for information on the spatial literacy level of users related to the digital map application for visually impaired people. The questionnaire had three levels of question which is presented on Table 2.

| Spatial Literacy Class | Test Process                         |
|------------------------|--------------------------------------|
| Low                    | Location identification               |
| Medium                 | Relationship identification between locations |
| High                   | Managing, evaluating, and creating solutions |

Next, Table 3 presents the examples of questions with different level of spatial relation.

| No | List of Questions                                                                 | Spatial Literacy Class | Test Process                                           |
|----|----------------------------------------------------------------------------------|------------------------|--------------------------------------------------------|
| 1  | Can you show me Filkom building?                                                 | Low                    | Identification of location                             |
| 2  | What is the building near the mosque name? If you feel unwell and you want to have a medical checkup around Brawijaya University, where will you go? | Medium                 | Identification of the relatedness between locations     |
| 3  |                                                                                  | High                   | Managing, evaluating, and creating solution             |

The chosen respondents were people who are not familiar with the area of Brawijaya University. The testing technique for respondents involved 12 people consisting of 7 women and 5 men. The test was carried out in groups consisting of 4 people. Furthermore, the respondents were tested on 3 different time durations, namely 20 minutes, 10 minutes and 5 minutes. The total number of questions was 9 questions consisting of 3 different categories: low, medium and high, where each of which had 3 different questions.
The first stage of the experiment was the familiarization of the application used in line with the instructions given. The next stage was the exploration time where the respondents were given time to explore the application and tried the available features. The third stage was the execution where the respondents were given questions to accomplish assignments related to the application and answer questions properly within the time given.

Hypothesis test was done using Anova testing method. If the output was 0.05, the h₀ would be accepted and hₐ would be rejected. If the output was below 0.05, the hₐ would be accepted and h₀ will be rejected [12].

3. Result And Discussion
3.1 Exploratory Analysis

To test the results of the research, the respondents were tested directly to assess the development of the applications that had been made. The results of the analysis of respondents who use digital map applications to test application development are presented in Figures 1 to 3.

Based on the result of the research, all respondents who were given 20 minutes could answer properly the low, medium and high spatial relational level questions. Based on the comparison between 4 respondents with the test duration of 20 minutes, it can be concluded that there was no difference between all respondents because all could answer the questions properly all the questions asked.

All respondents who were given 10 minutes could answer properly the low and medium spatial relational level questions. Nevertheless, on the high spatial relational level questions all respondents could not answer all the 3 questions because all could answer the questions properly all the questions asked.

3.1 Exploratory Analysis

To test the results of the research, the respondents were tested directly to assess the development of the applications that had been made. The results of the analysis of respondents who use digital map applications to test application development are presented in Figures 1 to 3.
All respondents who were tested within a duration of 5 minutes seemed only able to answer the low and medium spatial relational level questions, and no one could answer the high spatial relational level questions properly.

The hypothesis test result using Anova is presented in Table 4.

Table 4. Anova Test Result

| Model       | Sum of Squares | df | Mean Square | F     | Sig. |
|-------------|----------------|----|-------------|-------|------|
| Regression  | 412.482        | 1  | 412.482     | 76.125| .000 |
| Residual    | 54.185         | 10 | 5.419       |       |      |
| Total       | 466.667        | 11 |             |       |      |

a. Dependent Variable: Duration
b. Predictors: (Constant), High

The Anova test result indicated that the hypothesis was accepted because the significance value was 0.000.
4. **Conclusion**

Based on this research, it can be concluded that there is a relatedness between the exploration time and the respondents’ success in answering high level questions; the longer the time given for answering such questions, the higher the level of success, and on the vice versa.

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