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Mobile Application Of Searching And Mapping Temporary Waste Disposal Site In Fakfak Regency

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ABSTRACT

Nowadays, humans live in technological era. Smartphone is a kind of technology that has function to access information including services or public facilities. one of the information that public needs to know is temporary waste disposal site (TPS). The lack of information about the TPS location triggers irresponsible behavior including littering and the emergence of illegal dumpsters and garbage piles in waterways which can lead to flood. Geographic Information System (GIS) can be used to find the location of TPS as well as the route and information to the desired TPS. This study aims to build a Mobile Application for Mapping and Searching for Temporary Waste Disposal Site (TPS) with Case Study in Fakfak Regency, West Papua Province. This system is built through combination of web application as a backend and mobile application as a frontend by utilizing features from Google Maps. This research generally uses the Waterfall method, where the implementation is systematic with several stages, namely; system requirements analysis, system design, system making, system testing and repair, and maintenance and repair. Based on the test results using Black Box method, it shows the application is functionally running well. Meanwhile, the testing result by users using a questionnaire reveals that there are >84% of users gave a good and very good assessment of the built application. The findings of this study assist users in finding the location of TPS in Fakfak Regency and reduce the number of illegal dumpsters which directly improves the quality of cleanliness and healthy environment.

1. Introduction

Nowadays, humans cannot be separated from the existence of technology that supports whole life aspects. today's life is colored by rapid technological developments so that humans reach at a level called modern [1]. One of the evidences of technological developments is the existence of the internet with various advantages and conveniences [2]. Technology is basically used by humans as a tool to meet their needs, where one part of the technology is smartphone. One of the main functions of smartphones is to make it easier for humans to access information [3]. Through a combination of smartphones and the internet, it can help the public to be able to access information easily, quickly and efficiently [4], one of them is information about services or public facilities.

One of the public facilities that the public needs to know about is the location of a temporary waste disposal site (TPS). In Indonesia, this is important because garbage dumps are difficult to find in public places. Then, it may has a negatibe impact on the community's irresponsible behavior in treating the waste to be disposed of [5]. These irresponsible behaviors include littering, the emergence of illegal dumpsters, and the emergence of piles of garbage in waterways that can lead to flood [6].

One of the problems faced in handling waste by the community in Fakfak regency is the public's ignorance about the location of the garbage dumps. This is reflected by the large number of garbage piles that are not in the legal waste disposal site that have been prepared by the local government through the relevant

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agencies. The location of this legal dumpsters is very important to be known by the community to prevent people from making garbage piles in any place that can damage the environment.

A technology that can be used to help the public know the location of TPS is through digital mapping using Geographic Information System (GIS. Through this GIS, it can provide an overview to the community regarding to the location of the available waste disposal sites and also the closest to where the community is located. In addition, it also provides information to the public about the route to the desired TPS location.

Several studies have been conducted related to the application of Geographic Information Systems, including Yuliani, et al (2016) who conducted a research on mapping traditional markets in the city of Semarang based on the Web. The result of this research is a web-based application which in its mapping describes the existence of traditional markets in the scope of Semarang city. In this web-based application, users will be given a route to the selected traditional market location [7]. Another study was carried out by Darwis, et al (2020) who conducted research on the development of geographic information system applications for searching puskesmas in East Lampung Regency. This research produces an Android application that maps the location of puskesmas in East Lampung Regency. In its application, the system built can show the nearest puskesmas from the user's location [8]. Further, research conducted by Yuswardi, Y., & Zuhri, M. (2021), regarding the mapping of landfills in the city of Sigli using WebGIS, where in this study a webGIS application was built to map the location of landfills based in the city of Sigli [9] . Another study was carried out by Siswandi, E., & Wahyuddin, W. (2021), regarding the mapping of illegal waste collection sites using GIS in the Mataram sub-district, Mataram City, where in this study a web-based GIS application was built using ArcMap, where in its application the distribution of illegal dumpsters was mapped in Mataram sub-district.[10]. The writers' previous research, entitled Android-based Geographic Information System of Tourism Object Locations (A case study: Fakfak Regency, West Papua Province), where in this study, we developed a mapping application for the location of tourist objects in Fakfak district based on the Android operating system. In the application developed the user is shown the route to the location of the selected tourist attraction. [11]. Another the writers' research is Android-based Geographic Information System for Worship Places in Fakfak Regency, in which the research carried out mapping and knowledge related to the location and history of mosques in Fakfak Regency [12].

Based on the background and previous research results regarding to the development of mapping applications, both web-based and mobile, the authors develop research that utilizes geographic information system technology in the field of searching and mapping Temporary Waste Disposal Sites (TPS) based on mobile phone with a case study in Fakfak Regency, West Papua Province. In designing this application, a web-based back-end application was developed to handle the temporary shelter data input by the admin, and an Android-based front-end application to interact with users. The application that was built mapped the location of permanent and legal waste disposal site (TPS) in the scope of the Fakfak Regency accompanied by route instructions to the location selected by the user. In addition, it can also show the location of the nearest temporary dumpsters along with the route from the user's current location point. The results of this study are expected to provide benefits for Fakfak society in finding the nearest waste disposal site from their residence. In addition, it is also expected to minimize the number of illegal landfills that have a bad impact on the environment. Thus, natural conditions and the environment can be kept clean and healthy.

2. Method

2.1 Android

Android is an operating system developed by Google based on Linux kernel that supports the performance of touch screen electronic devices, such as tablets or smartphones. So, in the operation process, Android uses touch, swipe or tap on the smartphone screen. Android is open source, it means that it is free to be used, modified, improved and distributed by software developers. Since it is open source, technology companies can freely use this operating system on their devices for free. Likewise with application developers who are free to build applications using source codes issued by Google. This causes Android to have a lot of free and paid application support that can be accessed via Google Play [13].

2.2 Geographic Information System (GIS)

GIS is a special information system used to process spatial data (spatial reference) [14]. In other words, GIS is a computer system that has the ability to build, store, manage, and display geographic reference information as well as data that is identified based on its location in a database [15]. Thus, GIS is a series of

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activities for collecting, structuring, processing and analyzing spatial data/facts so that spatial information is btained to be able to answer or solve a problem in a certain earth surface space [16]. In this study, using Google Maps in mapping the location of the temporary waste location site which will be presented to users.

2.3 API Google Maps

Google Maps API is a technology developed by Google to embed Google Maps in an application that is not developed by Google. Google Maps API is a javascript-based library which is useful for modifying maps on Google Maps as needed for later display. In its development, the Google Maps API has a feature that can take static map images, perform geocoding and provide directions. The Google Maps API is free to the public [17]. To perform Android-based mapping using Google Maps, in this study the Google Maps API was used as a bridge to access Google Maps features.

2.4 Temporary waste disposal site (TPS)

TPS is a temporary waste dumps before it is transported to the Final Processing Site (TPA) [18]. TPS is a container used to accommodate the waste in the community, so that both the amount or location and capacity adjust to the amount of potential waste of the community. The existence of TPS is very important for the community and the government because it helps in maintaining the cleanliness of the environment before the waste is transported to the TPA. The manufacture and construction of TPS are generally in the form of concrete or brick tubs which are open at the top and equipped with door holes. The sizes of TPS is varied, depending on waste productivity volume in the surrounding area, but in general TPS can usually accommodate more than 4 m3 of waste [19].

2.5 Waterfall Model

Overall, system development is carried out through several stages. The software development method is also known as the Software Development Life Cycle. The Waterfall method is the oldest software development method because it is natural. The waterfall method provides a systematic and structured approach to application development, starting at the requirements analysis, design, coding, testing and maintenance phases [20][21]. The waterfall model as shown in Figure 1 [21].

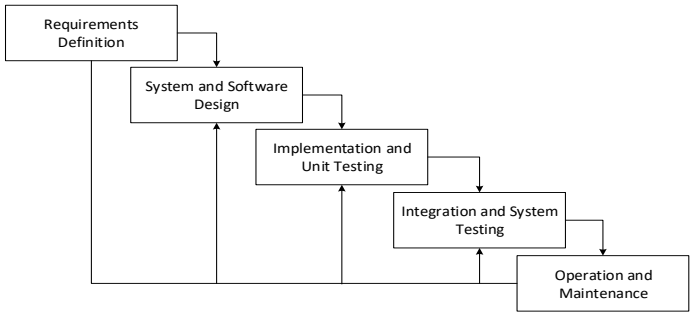

Figure 1. Waterfall Model

The Waterfall method is a sequential software development process, where the process continues to flow from top to bottom (like a waterfall) through the phases of Requirements Definition, System and Software Design, Implementation and Unit Testing, Integration and System Testing, and Operation and Maintenance [22][23].

2.6 System and Software Design

a. Application Scheme

In the Figure 2, it can be seen that there are 2 applications to be built, namely a web-based backend and an Android-based frontend. The backend application will be used by the Admin to manage TPS data which is stored in the database and can be accessed using a web page. Meanwhile, the frontend application is used by users to access mapping data and TPS locations which are described using API Google Maps. To be able to use, the application on the user must be connected to the internet.

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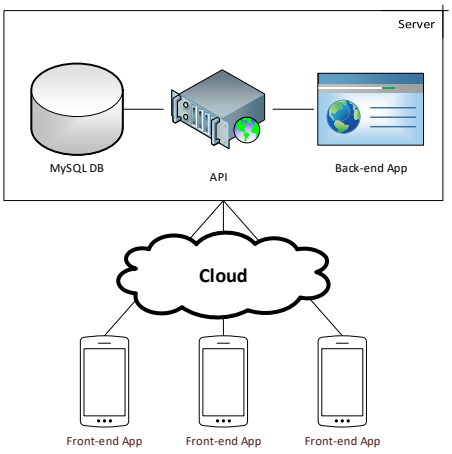

Figure 2. Application Scheme

b. System Functional Design

Figure 3 shows the functional design of the built system. In Figure 3, it can be seen that for the initial design, the built system has 5 main functions, namely 1) a function to open Maps in general through the Open Maps menu, 2) a function to view TPS location points around the user through the Available Location menu which can be selected by the user and a route to the location that will be displayed, 3) a function to view TPS in the form of a photo and if one of them is selected, it will show the route to the location, 4) a function to create a route to the nearest TPS location directly through the Create Routes menu, and lastly, 5) the function to view the application subject via About menu.

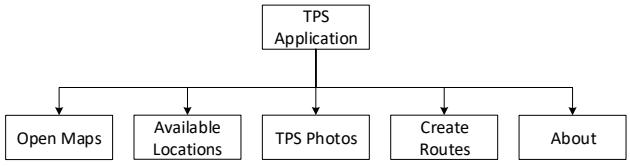

Figure 3. System Functional Design

c. Diagram Context

Figure 4 displays the Data Flow Diagram (DFD) design of the built system. Based on the DFD, it can be seen that there are two actors involved in this system, namely admin and user. Admin will play a role in TPS data management in the backend app, while the user acts as a user who takes advantage of the functions of the system built on the frontend app. information.

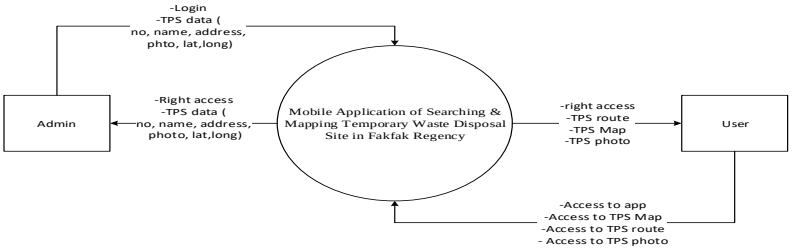

Figure 4. Diagram Context

d. Data Flow Diagram (DFD)

Figure 5 shows the Data Flow Diagram (DFD) of the built application. In the DFD, it can be seen that the admin can manage the data of the Temporary Waste Disposal Site (TPS) by logging in the first. For users, to be able to take advantage of the applications built, they do not need to go through

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the login process. All data regarding the dumpsters is stored in d_tpsu. In providing a map display that suits user needs, the Google Maps API is used to visualize the stored latitude and longitude data.

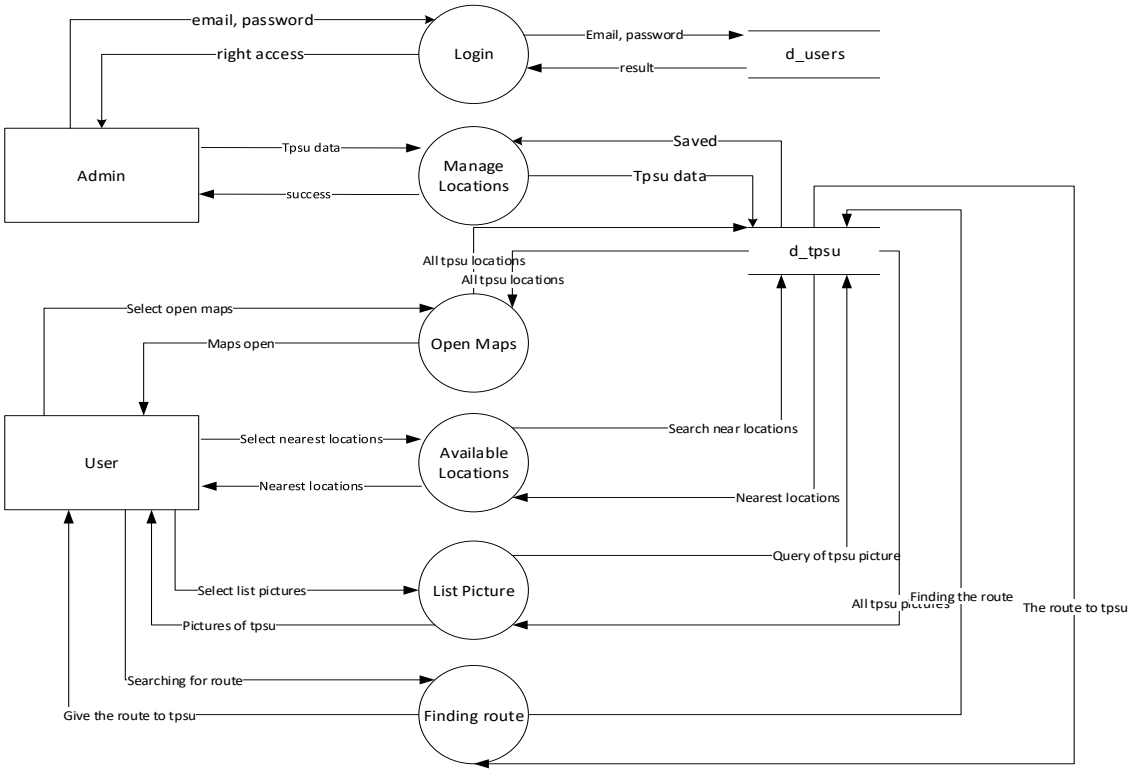

Figure 5. Data Flow Diagram

e. Database Design

In table 1, it can be seen that there are 6 main data needed in building the system, namely id, TPS name, TPS address, TPS image, TPS latitude and TPS longitude. Meanwhile, other secondary data is still needed to complete the built system.

Table 1
Database Design

No	Data	Description
1	Id	To save ID from TPS, it should be unique
2	TPS Name	Name for TPS, can be a term/ plece/addressof TPS location
3	TPS Address	Address of TPS locatiom
4	TPS Pictures	TPS Photos
5	TPS Latitude	The latitude of the TPS location
6	TPS Longitude	Longitude point of TPS location

3. Result And Discussion

3.1 Result

Based on the application design that has been made, the next stage is the implementation and coding. The implementation and coding stages use Java programming language. The Integrated Development Environment (IDE) used is Android Studio, with minimal API settings for Android version 4.2.2 Marshmellow. The following are the results of the system implementation that has been built:

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a. Main Menu Display

The main page is displayed as shown in Figure 6. On the main menu page, there are 5 (five) menu options, namely; open maps, available locations, list of location images, create routes, and about. Each menu will take the user to a different page.

b. Open Maps Display

On the open maps menu, it will display user's location in Fakfak city. Map display based on Google Maps API. The display of Open Maps menu as shown in Figure 7.

c. Available Location Display

On the Available Locations menu, the user can see all the locations of the TPS in Fakfak city. On this page, the user can directly select the location of the desired waste disposal site. The display of this menu is as shown in figure 8.

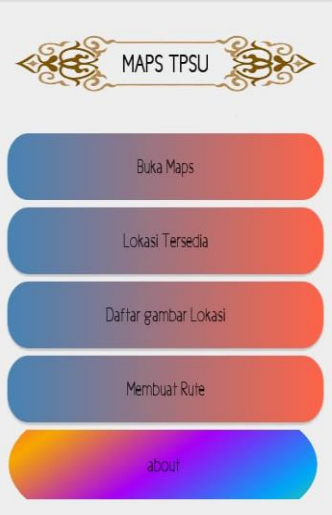

Figure 6. Main Menu Display

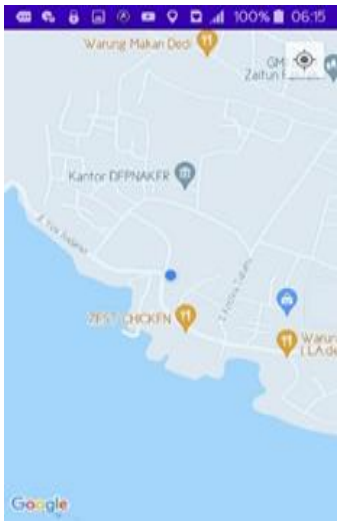

Figure 7. Open Maps Display

Figure 8. Available Location

d. Display of Image Location List

In the image location list menu, all photos from the locations of the Temporary Disposal Sites (TPS) that have been stored will be displayed. This aims to make it easier for users to identify the exact location of the TPS. Figure 9 shows the contents of the image location list menu.

Users can also select the TPS location they want to go to from the image displayed on this menu. The application will then display the location of the TPS on the map. Figure 10 shows the location of the TPS selected by the user via the image. Creating Routes Display. The menu for making routes is a menu that will display the route to the nearest TPS location from the user's current location. The menu display creates a route as shown in figure 11.

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Figure 9. Image Location List Menu

Figure 10. Location of selected TPS

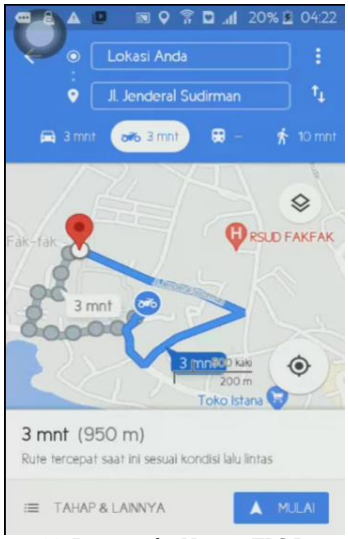

Figure 11. Route to the Nearest TPS Location

3.2 Application Testing

The last stage in making the Application for Public Waste Disposal Site in Fakfak Regency is system testing. In this test, the writers use the Black Box method. Black Box is a testing method that tests the functionality of the system without looking at the program code. The test only assesses the input given whether it gives the desired output [24][25]. The test was carried out using Samsung J1 Ace smartphone with the Android operating system with the results in table 2.

Table 2
Black Box Testing Result

Input	Process	Output	Results
Click Application icon	Login process on application	Display the splansh screen	Success
Click Application menu	View application menu options	Display the open maps menu, available locations, a list of location images, create routes, about	Success
Click Applications open maps	View open maps	Display a map of the trash can location	Success
Click Location application available	View login on available location	Display the location along with the name and address of the public trash can	Success
Click Application list image location	View the list of location images	Displaying the image along with the location that matches the image	Success
Click Application create route	View open on create route	Displays the closest location to the user's location	Success
Click App about	Login process on about	Display app name and version information	Success

Based on the testing process, it can be seen that the built application is able to go through the test scenarios which carried out using the Black Box method. Some of the implemeneted scenarios were accessing the application and accessing the menu, testing the map open function, location function, location image list function, route creation function, and opening the about page showing this application producing the expected output. This shows that the application that has been built in terms of functionality is running well.

Meanwhile, based on the survey of user satisfaction levels (user testing) conducted using a questionnaire, it shows that users choose strongly agree and agree (>84%) to various positive questions about the application. The followings are the results of using the Android-based application of geographic information system for the location of temporary waste disposal site (TPS) in Fakfak Regency.

a. 50% respondents agreed that the use of the menu or features of this application is very easy to use and 30% respondents said that it is easy.

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b. The application has capabilities and functions as expected, 60% respondents agreed and 30% strongly agreed.
c. This application is comfortable to use, around 50% respondents thought it is comfortable to use and 40% agreed that its is very comfortable to use.
d. The application is easy to operate, 70% respondents answered very easy and easy (20%).
e. The application is easy to learn, 30% respondents said it is very easy and easy (50%).
f. The application is useful for users, the respondents said it is very useful (80%) and useful (10%).
g. The menu display in the application is easy to recognize, 50% repondents thought it is very easy to recognize and 30% is easy to recognize.
h. The information provided by this application is easy to understand, very easy to understand (50%) and 30% is easy to understand.
i. Overall, this application is easy to use (80% respondents).

3.3 Discussion

The Geographic Information System Application for the Temporary Waste Disposal Sites (TPS) is an application built to detect and find out the location of dumpsters in Fakfak Regency. This application aims to make it easier for people to dispose of waste, so that people have no difficulty in finding legal and official temporary disposal sites (TPS). The existence of this application can reduce the incidence of illegal waste dumps scattered in every corners in Fakfak city. This application also increases the knowledge of the community regarding to the location of legal TPS scattered around Fakfak Regency. In general, this application can still be developed further. For example, through integration with Internet of Things (IoT) technology, smart dumpsters applications can be developed, so users can find out where the waste dump is full or not. This can also be used by the local Sanitation Office to monitor garbage piles in temporary disposal sites (TPS).

4. Conclusion

The designing process of a mobile application for finding temporary waste disposal site (TPS) based on Android is built using the waterfall model which includes needs analysis, system design, system development, testing, and repair and maintenance. In the development process, a backend application is built that functions as a database for TPS information, while the frontend is built based on an Android application. The Google Maps API is used for the process of visualizing the coordinates on a digital map and also to provide directions to the intended location. The application built consists of several main features namely the open map feature which will direct the user to the map view, the available location feature which will direct the user to the location points of the existing waste disposal site, and the location image list feature which displays a list of TPS in the form of images/photos which can be clicked to display the route to that location, the feature creates a route that directs the user to the nearest TPS location.

Furthermore, the testing method used is the Black Box method and user satisfaction. In the process of testing Black Box method that has been carried out, it is concluded that the application built functions well according to the input given and expected output. In user satisfaction testing, a questionnaire method is used which provides several questions to the user. The results of this test show that the majority of users (> 84%) choose strongly agree and agree to the questions given regarding the ease of menus and application features, functions as expected, application comfort level, ease of operation, ease of learning, benefits for users, ease of identification, the information is easy to understand and the overall ease of use, which shows the application is running well according to user assessment tests. One of the limitations of the results of this study is that the built application requires internet access to operate because the application requires direct access to the Google Maps API. The use of Digital Offline Map module can help solve this problem but will have an impact on large application capacity.

The results of this study will provide convenience to users in providing an overview of the location of the nearest TPS from the user's location. Users are also given information about pictures/photos from a TPS and the route to the TPS location. This certainly contributes to reduce the number of illegal landfills because people do not know the location of the nearest TPS. This will have a direct impact on the condition of the surrounding environment related to improving the quality of cleanliness and environmental health.

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