e-ISSN: 2614-8404
p-ISSN:2776-3234

Development of Mobile GIS Based Digital Map Location Marking Application for Navigation Purposes

Alif Ghifari[1*)], Sutarman[2]

[1]Informatics Study Program, Faculty of Science and Technology, University Technology of Yogyakarta
[2]Department of Information Technology, Postgraduate Program, University Technology of Yogyakarta
Email : [1]alif.5210411321@student.uty.ac.id, [2]sutarman@uty.ac.id

Abstrak— In today's digital era, map and navigation applications have become essential tools for users to find locations, obtain the fastest routes, and explore new places. Google Maps is one of the most popular and comprehensive mapping applications that offers various features, such as navigation. However, despite being highly beneficial, Google Maps has several limitations, particularly regarding map markers, personalized, creating individual routes, and offline map usage on navigation. To address these issues, this research develops an innovative application called StellarPath. StellarPath is a mobile-based digital map location marker application that adopts Location Based Service (LBS) methods for more effective navigation. This application focuses on offline usability as a digital map marker and includes features such as offline maps stored indefinitely, offline navigation, manual route creation, and higher personalization, allowing users to save and manage markers with additional information offline. Test results show a success rate of 92.5%, indicating the application's effectiveness. The conclusion drawn is that the application can download and store maps offline, although it has shortcomings in managing downloaded maps. The offline navigation feature allows users to draw, save, and manage manual routes on the map. Users can create and save location markers with additional information offline. Navigation is flexible, with the option to start navigation by tapping on the map and features that can be enabled or disabled. This research aims to provide a more flexible and personalized navigation solution compared to existing standard map and navigation applications, such as Google Maps.

Keywords: Location Markers, StellarPath, Mobile GIS, Location Based Service, Kotlin, Android.

I. INTRODUCTION

The internet is one of the media increasingly utilized by the wider community, both through desktops and mobile devices. With the growing development of internet technology, it significantly aids in the development of Geographic Information Systems [1]. Location-based services are location-based services or a common term used to describe the technology used to find the location of the user's device. This service utilizes Global Positioning System (GPS) technology and cell-based location from Google [2]. A previous GIS application built by [3] facilitates tourist access to tourism information, increases visitor interest, and simplifies location searches. The development of more sophisticated and efficient navigation applications becomes relevant. Furthermore, in previous research conducted by [4], an application was developed to assist people in providing travel routes, estimated travel time, and distance. In previous research titled "Development of an Application as a Marker Regarding Thematic Creative Villages in Bogor City Smart Branding Based on Android" by [5], to deepen knowledge of navigation, techniques, and knowledge of assistive tools such as compasses, Global Positioning Systems (GPS), altimeters, and maps are crucial to learn. In addition, another important aspect to understand is reading the terrain and natural or man-made landmarks for direction. In navigation, the accuracy of location markers is essential. In previous research conducted by [6], Mobile GIS-based location mapping is an integrated technology mobile devices. By utilizing GPS and LBS technology, navigation applications can provide more precise and accurate location markers, minimizing the risk of navigation errors. In previous research, the application built by [7] used Location Based Services (LBS), utilizing the Global Positioning System (GPS).

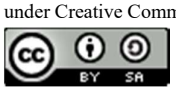
In today's digital era, map and navigation applications have become essential tools for users to find locations, obtain the fastest routes, and explore new places. Google Maps is one of the most popular and comprehensive map applications, offering various features such as navigation. However, despite its usefulness, Google Maps has some limitations. Google Maps locks applications into the Web Mercator projection, a small set of color palettes, and a limited number of points on each map [8]. For example map markers, personalized, and creating individual routes. Google Maps automatically takes over most of the tasks, it is still a subjective requirement for them to be able to actively participate. For example, respondents state that they would like to be able to choose their own favourites from the routes presented and additionally adapt them to their own needs. In

e-ISSN: 2614-8404
p-ISSN:2776-3234

terms of agency, options like creating individual routes and saving favourite places are very much appreciated. This gives users the opportunity to have a say in which places could be found on the app and to actively participate in its design [9]. The visualization of route in the maps requires path information from Google server for path and GPS position from GPS system (in-built) for locations. Hence there is a need of path information for visualization which is to be fetched from the internet. However the facility of fetching path information through internet is not available in every region, especially at remote forest. In such cases, offline based navigation systems will be very helpful [10]. People often experience difficulties when there is no network connection or when encountering routes such as unmapped small roads. Mapping digital maps is challenging due to limitations in offline usage in the navigation applications used. The application like google maps, imaps provides location based service of the current location by GPS positioning or network positioning. With the combination of GPS and using Google Map API, the navigation system provides functions such as current location, get the navigation route, address query and view historical location records. However the facility of getting path information through online navigation system is insufficient in these regions as it is remote areas. It is hard to load google maps to locate in the Sathuragiri forest due to absence of network services. Thus, in this region the offline based navigation system will be suitable[11]. Google Maps is designed more for highway and city use, making it less optimal for outdoor activities in remote areas with limited internet connectivity. In this context, the proposed solution is the development of StellarPath, a mobile GIS-based application that can run on the Android platform. StellarPath offers various additional features that not only add functionality but also provide flexibility and personalization. Key features such as digital map markers and other features like unlimited offline map storage, offline navigation, manual route creation, and higher personalization. In its implementation, the StellarPath application uses OpenStreetMap. When downloading, extracting and symbolizing the data can be successful if the map on OpenStreetMap is enlarged to a large scale, scale 1: 2000 or greater for areas of heavy building or up to a scale of 1: 10,000 for rural areas with less number of buildings [12]. With a base map using free OpenStreetMap this application is ideal for users who frequently engage in outdoor activities involving routes not mapped by Google Maps or travel to areas with limited internet connectivity. This solution is expected to provide a better experience for users in mapping and managing location information in their daily lives. Based on the above problems, the researcher created a mobile GIS-based application that runs on the Android platform and developed it as a Final Project for the Informatics Department at Yogyakarta Technology University.

1.1. Theoretical Foundation

Android is an operating system widely used on mobile devices that is currently very well-known and popular on smartphones. Android is also a programming platform developed by Google for smartphones and other mobile devices [13]. Android provides tools and development environments such as Android Studio, SDK, Open Street Maps Library, Location Services, SQLite Database, and Google Play Services. Android Studio is a native mobile development environment that is easy to understand and use. Google launched Android Studio as a new integrated development environment (IDE) for Android based on IntelliJ IDEA [14]. Android Studio is used to build mobile GIS-based digital map location marker applications that can be used with devices equipped with Global Positioning System (GPS) technology. The Global Positioning System (GPS) is a satellite-based navigation system consisting of interconnected satellites in orbit. With 24 satellites in use. To determine a person's position, a device called a GPS receiver is needed, which functions to receive signals sent from GPS satellites [15]. The key to developing a application for navigation using Location Based Services is a service that functions to search using Global Positioning Service (GPS) technology and Google's Cell-based Location. Maps and location-based services use latitude and longitude to determine geographic locations [16]. Mobile GIS is an integration of mobile device technology, the Global Positioning System (GPS), and wireless communication to access GIS on the internet. The combination of these technologies allows mobile GIS to capture, store, update, manipulate, analyze, and display geographic information accurately. Thus, through this technology, a database can be created that is accessed directly by personnel in the field at any place and time [17]. This system accelerates access and decision-making based on geospatial data, which is very useful in various navigation and mapping applications. Based on maps using OpenStreetMap, OpenStreetMap



e-ISSN: 2614-8404
p-ISSN:2776-3234

(OSM) is an open-source mapping project that provides free and editable map data to the public. Unlike proprietary mapping platforms such as Google Maps and Mapbox, OpenStreetMap allows developers to access, use, and contribute to map data freely without restrictions. To integrate OpenStreetMap into your Android app, you can use third-party libraries such as osmdroid or Mapsforge, which provide APIs for displaying OSM tiles, adding markers, overlays, and annotations, and interacting with map features [18]. SQLite is a lightweight relational database management system that is integrated in the form of a library. Unlike other relational database management systems such as MySQL or PostgreSQL, SQLite does not use a server to manage connections and data storage [19]. SQLite can be used to store data such as locations, routes, and other information related to location-based applications. Additionally, use of Unified Modeling Language (UML) in system application design allows visual language for modeling object-oriented languages, all elements and diagrams are based on the object-oriented paradigm [20]. Diagrams such as use case diagrams are used to illustrate the system's functionality from the perspective of users or actors [21], activity diagrams serve as a graphical representation of the workflow sequence from the beginning to the end of a system or part of a system [22], and sequence diagrams represent interactions. These interactions can take the form of functions, procedures, or variables [23].

II. RESEARCH METHOD

In this research, researchers analyzed the need for an Android application that can create digital map markers and can be used offline and makes it possible to navigate offline and create manual routes.

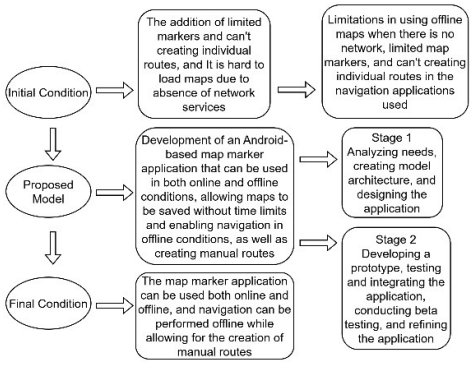


Figure 1 Research Method

A. Initial Condition

The use of the Google Maps application on mobile devices connected to the internet and GPS satellites for navigation. Users utilize mobile devices, such as smartphones or tablets, to access the navigation application. These mobile devices are connected to GPS satellites to accurately determine the user's location. Users open the Google Maps application on their mobile device to search for locations to visit, or they can use markers that have limitations to navigate to already known locations. The mobile device must be connected to the internet to access all features of Google Maps, including obtaining directions. After finding the destination, users utilize the navigation feature in Google Maps. Routes are provided from Google's servers, so users cannot create their own routes. If the mobile device loses internet connectivity, users cannot use the real-time navigation feature because Google Maps requires an internet connection to update maps and provide directions live.

B. Proposal

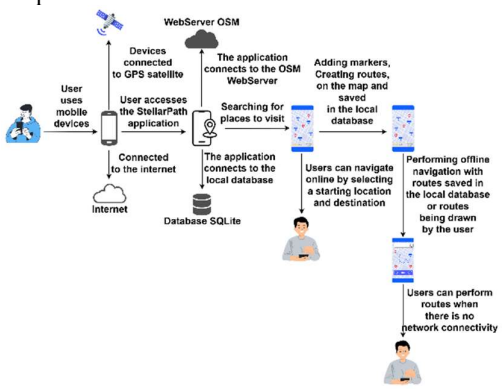


Figure 2 Architecture Model

The use of the StellarPath application on mobile devices connected to the internet and GPS satellites for navigation, with the added capability of offline navigation. Users utilize mobile devices, such as smartphones or tablets, connected to GPS satellites to accurately determine their location. Users open the StellarPath application on their mobile device to mark locations they have visited or wish to visit, and these markers are saved, allowing users to manage them; the markers are stored in the device's local storage. The mobile device must be connected to the internet for the StellarPath application to access the web server, which is necessary for logging in and registering on the app, as well as downloading maps for offline use, while the

e-ISSN: 2614-8404
p-ISSN:2776-3234

local SQLite database does not require internet access. The application allows users to add and manage markers, create manual routes, and save downloaded maps to local storage indefinitely, enabling users to navigate even without an internet connection based on previously drawn routes. Thus, users can continue to navigate and proceed with their journey without relying on an internet connection.

C. Proposed stage
    1. User needs analysis, This stage begins with understanding the features and experiences required in the application, both online and offline. The goal of this analysis is to ensure that the application will meet user needs under various conditions.
    2. Designing the application model architecture, After the needs have been identified, an architectural model design is created to support features such as offline map marker storage, offline navigation, and manual route creation. This design determines how each feature will work together within a single application system.
    3. Defining the application structure, At this stage, the main components of the application are established, including the integration of SQLite for local data storage, the implementation of OSM Maps, and the use of CacheManager for downloading offline maps. This is crucial to support the use of the application without an internet connection.
    4. User interface (UI/UX) design, The UI/UX is designed to make the application easy to use in various conditions, both online and offline. This design considers ease of navigation and feature usage to ensure that users remain comfortable while using the application without internet access.
    5. Developing the application prototype, Based on the design that has been created, the application prototype is developed. This prototype includes the implementation of features such as displaying maps, downloading maps, adding markers, creating manual routes, and offline as well as online navigation.
    6. Testing and integrating the application, After the prototype is completed, functional testing is conducted to ensure all features work well, especially when used without an internet connection. Integration between components is tested to minimize bugs and ensure the stability of the application.
    7. Beta testing by end users, This testing involves end users who test the application on a larger scale to gather feedback. The main goal is to ensure the application's performance and ease of use.
    8. Refining the application, Based on feedback from beta testing, the application is improved and refined. This includes fixing identified bugs, as well as adding features that users need to enhance their experience and satisfaction.

III. RESULT AND DISCUSSION

3.1. Analysis and Design

1. Functioal Requirements

    A functional mobile GIS-based digital map application requires various crucial inputs to operate. Key inputs include downloadable map data for offline use, start and end points for navigation from user-added map markers, and marker coordinates (latitude and longitude) to pinpoint marker locations on the map. Users must also input customizable route information and additional details such as name, address, category, and notes for markers. Core processes include downloading and storing maps for offline access, calculating optimal routes using a navigation algorithm, and creating manual routes. The application also manages markers with additional information. Outputs include offline maps accessible without internet connection, manual routes enabling offline navigation, and personally accessible and manageable markers with additional information, all available offline.
2. Non-functional Requirements
    a. Hardware Requirements
        1. Laptop Asus TUF Gaming F15 with Intel(R) Core(TM) i5- 10300H

e-ISSN: 2614-8404
p-ISSN:2776-3234

CPU @ 2.50GHz, SSD 500 GB, RAM 8.00 GB
2. Xiaomi Redmi Note 8 Android Smartphone MIUI Global 12.0.1 Android Version 10

b. Software Requirements
1. Microsoft Office
2. Google Chrome
3. Android Studio Hedgehog | 2023.1.1 Patch 2
4. XAMPP version 3.3.0
5. Android Software Development Kit (SDK)
6. Android Development Tools

3.2. Conceptual Design

1. Use Case Diagrams

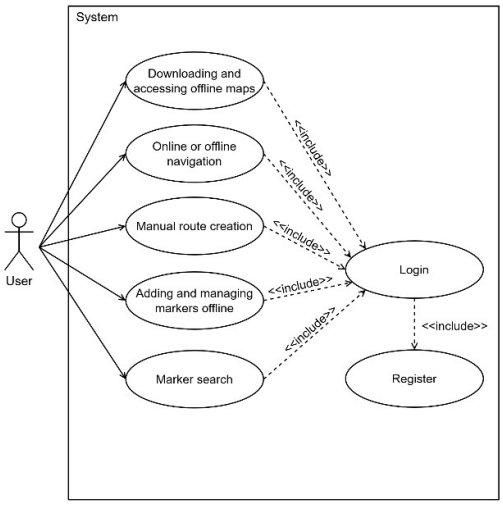


Figure 3 Use Case Diagrams

Users must register first then log in to be able to use the application. Users download maps for offline use. After the map is saved, users can open and view the map without requiring an internet connection. The user determines the starting point and destination from the saved map markers. The application provides directions from the user's location to the destination without requiring an internet connection, using previously downloaded maps. Users can draw routes manually on the map by marking the desired points. Drawn routes can be saved for later use. Users can add markers at desired locations on the map by providing details such as place name, address, category and notes. These markers can be viewed, edited, or deleted at any time. Users can search for map markers using the search feature available in the application.

2. Sequence Diagrams

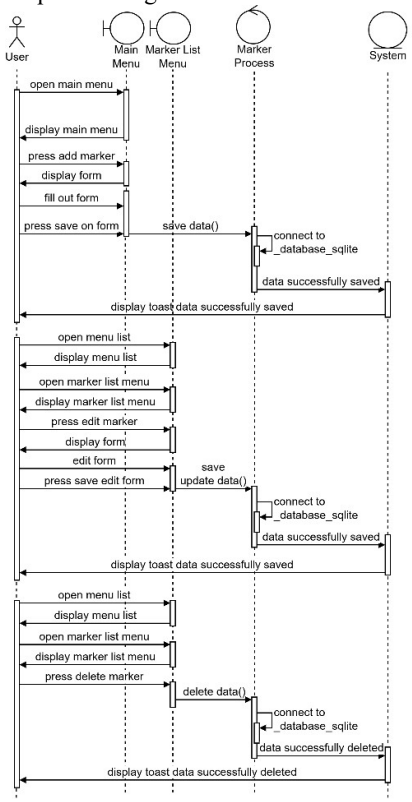


Figure 4 Sequence Diagram Adding and Managing Markers

e-ISSN: 2614-8404
p-ISSN:2776-3234

The user opens the main menu, and the system presents it. The user selects "Add Marker," prompting a form to appear, which the user fills out before pressing "Save." The marker data is then saved in the SQLite database, and upon successful saving, a toast notification appears. The user opens the menu list, and the system displays it. The user accesses the marker list menu, and the system shows the marker list. The user presses "Edit Marker," and the form for the marker to be edited appears. After completing the edits, the user presses "Save," and the changes to the stored data in the SQLite database are updated. If successful, a toast notification will appear. The user opens the menu list again, and the system displays it. The user accesses the marker list menu, and the system shows the marker list. The user presses "Delete Marker," and the corresponding data in the SQLite database is deleted. Upon successful deletion, a toast notification appears.

3. Activity Diagram

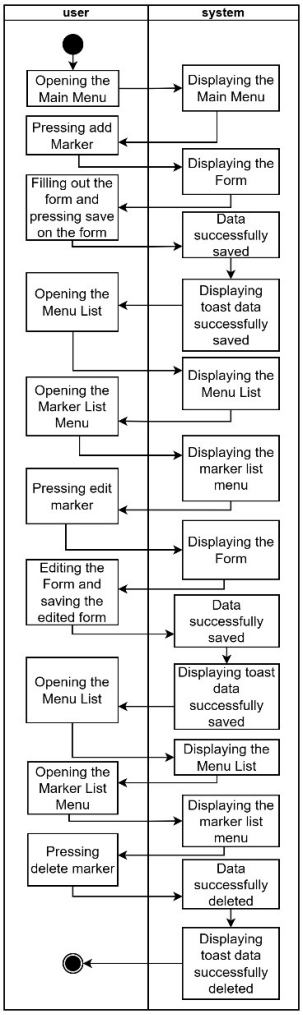


Figure 5 Activity Diagram Add and manage Markers

The user opens the main menu, and the system presents it. The user presses "Add Marker," prompting the system to show a form. The user fills in the form and presses "Save," after which the system saves the data and displays a toast indicating successful saving. The user opens the menu list, and the system displays it. The user then opens the marker list, and the system shows the marker list menu. The user presses "Edit Marker," leading the system to display the form. The user edits the form and saves the data, and the system saves it, displaying a toast that the data has been saved successfully. The user opens the menu list again, and the system displays it. The user opens the marker list, and the system shows the marker list menu. The

e-ISSN: 2614-8404
p-ISSN:2776-3234

user presses "Delete Marker," and the system deletes the data, displaying a toast confirming that the data has been successfully deleted.

3.3. Table Structure

This section will explain how data is stored, managed and accessed. This table structure section will make it easier to manage existing data in the system, increase efficiency in data searches, and maintain data integrity between tables. With clear primary keys, foreign keys and data types. The following are details of each table used in the system.

Table 1 User

Column	Data Type	Information
Id_name	INT (10)	Primary key, autoincrement
username	VARCHAR (255)	Unique username for users
email	VARCHAR (255)	Unique email for users
password	VARCHAR (255)	Password for users
created_at	TIMESTAMP	The time when the user was created
updated_at	TIMESTAMP	The time when the user was created

The StellarPath application's User table stores crucial user data. The `id_name` column is a unique, auto-incrementing primary key. The `username` column serves as a unique identifier for login, while the `email` column stores a unique email address for each user, usable as an alternative identifier and for communication or account recovery purposes. The `password` column stores the user's encrypted password for security. The `created_at` column records the account creation time, and `updated_at` records the last time user data was updated, helping track changes within the StellarPath application.

Table 2 Markers

Column	Data Type	Information
Id_name	INT (10)	Primary key, autoincrement
User_id	INT (10)	Foreign key to table users
title	VARCHAR (255)	Marker title
address	VARCHAR (255)	Marker address
category	VARCHAR (255)	Marker category
note	TEXT (500)	Additional notes for markers
latitude	DOUBLE	Latitude of marker
longitude	DOUBLE	Longitude of marker
created_at	TIMESTAMP	Time moment markers made
updated_at	TIMESTAMP	Time moment markers last updated

Tabel Routes in application StellarPath Stores location information marked by the user. The `id_name` column is a unique primary key, and `user_id` links the marker to the user in the `User` table. The `title` and `address` columns contain the marker's title and address, while `category` stores the location category, such as "Tourism" or "Restaurant". `note` is used for additional notes. The `latitude` and `longitude` columns store the location coordinates, while `created_at` and `updated_at` record the creation and update times of the marker.

Table 3 Routes

Column	Data Type	Information
Id_name	INT (10)	Primary key, autoincrement
User_id	INT (10)	Foreign key to table users
route_name	VARCHAR(255)	Route
route_data	TEXT	Route data in compressed format (for example, encoded)
created_at	TIMESTAMP	Time moment markers made
updated_at	TIMESTAMP	Time moment markers last updated

Tabel Routes in application StellarPath Storing user route data, with the `id_name` column as a unique, auto-incrementing primary key, and `user_id` as a foreign key linking the route to the user in the `User` table. The `route_name` column stores the route name, while `route_data` stores the route data in a compressed format (e.g., encoded). The `created_at` column records the route creation time, and `updated_at` records the

e-ISSN: 2614-8404
p-ISSN:2776-3234

last time the route was updated, useful for tracking data changes.

3.4. IMPLEMENTATION

1. Main Menu

Figure 6 Main Menu

The Main Menu page of the StellarPath application is designed simply to create a cleaner appearance because the main page displays a map. In the upper left corner there is a "three line" which will go to the menu list page, at the top there is also the name of the StellarPath application as a sign that the maps application used is called StellarPath, in the lower right corner there is a logo like "paper plane" and also a logo like "circle with a dot in the middle", this logo is a navigation feature and a feature for following users in the StellarPath application. At the bottom there is a column for searching for markers. In the top right corner there is a feature for adding markers, to make it clearer and easier for users, the display uses "+" which means to add and also says "Add Marker", the appearance of this main menu will make it simpler for users to utilize the StellarPath service.

2. Marker List Page

Figure 7 List Marker

The List Markers page is designed to make it easier for users to manage markers. In the top left corner there is a very clear word "List Markers" to inform that the user is now in the list markers menu. And also at the bottom of the list of markers there is the text "Last added" to notify the user of the last markers added. In the list of markers there is the name of the marker and also the address. The design is also made simple to make it easier for users, then at the bottom of each of these markers there are symbols such as "pencil" and also "trash can". These symbols are functions for editing and deleting markers, the design is made to make it simpler

e-ISSN: 2614-8404
p-ISSN:2776-3234

for users to utilize the StellarPath application services.

3. Download Maps Page

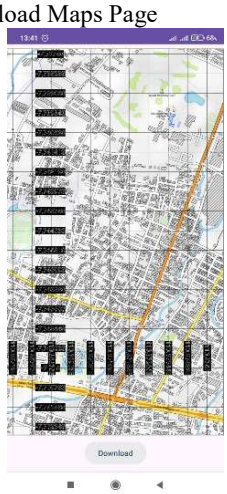


Figure 8 Download Maps

The Download Maps page is designed cleanly, in the top left corner there is a symbol to return to the previous page, at the bottom there is a button that says "download" which functions to start the download, the appearance of this page is quite small, not much is added.

3.5. TESTING

This process aims to evaluate and verify that a software or system works as expected. Testing is carried out to ensure that the StellarPath application is free from bugs, has good performance, and meets user needs and specifications.

Table 4 Blackbox Main Menu

No	Testing Scenario	Expected Result	Test Results	Test Results
1.	Adding Markers	Successfully added a marker to the map	Marker can added And appears on the map as well as in	Valid
2.	Displaying Marker Name	Displays marker names when the marker is tapped	The marker successfully appears when tapped	Valid
3.	Displaying Marker Details	Displays marker details when tapped	Detail from marker appears when tapped	Valid
4.	Opens Menu List	Displays a list menu application	List Menu appeared successfully	Valid
5.	Close the Menu List	The menu list is successfully closed when pressing the back button	The Menu List closes when pressing the back button	Valid
6.	Open a Manage Route option in the List Menu	Successfully opened the Manage Route option	The Manage Route option opens when tapped	Valid
7.	Open a New Route Manual option in the List Menu	Successfully opened the New Route Manual option	Option New Manual Route opens when tapped	Valid
8.	Open a Download Maps option in the List Menu	Successfully opened the Download Maps option	The Download Maps option opens when tapped	Valid
9.	Open a Manage Maps option in the List Menu	Successfully opened the Manage Maps option	The Manage Maps option opens when tapped	Valid
10.	Open a Marker List option in the List Menu	Successfully opened the Marker List option	The Marker List option opens when tapped	Valid
11.	Activate Follow Location	The map display will automatically track the user's current location.	The map display tracks the user's current location.	Valid
12.	Deactivate Following Location	The map display does not track the user's current location.	The map display does not track the user's current location.	Valid
13.	Press search marker and enter the	Successfully displays the name of the marker you	The marker name successfully appears	Valid

e-ISSN: 2614-8404
p-ISSN:2776-3234

	marker name registered	are looking for	when searched	
14.	Reset Map to Default View	Successfully reset the map to default view	Resetting the default view on the map was successful	Valid
15.	Open map in condition offline	Map will is displayed on application	Map succeed come on stage on application	Valid
16.	Zoom In and Zoom Out	Map zoom in and out works without errors	Zoom functionality works as expected	Valid
17.	Activate the navigation feature	Displays n toast notifications when the feature is active	A toast notification appears when the feature is activated	Valid
18.	Disable navigation features	Displays a toast notification when the feature is deactivated and the navigation route disappears	A toast notification appears when the feature is activated and the navigation route on the map is lost	
19.	Navigate the user's location to the marker	Displays user location toast notifications and marker name toasts	The user location toast notification and marker name toast successfully appear	Valid
20.	Navigate the user's location to a random destination location	Displays user location toast notifications and destination location toasts	The user location toast notification and the destination location toast notification successfully appear	Valid
21.	Marker navigation to the user's location a	Displays marker name toast notifications and user location toasts	The marker name toast notification and user location toast notification successfully appeared	Valid
22.	Marker navigation to the user's location	Displays marker name toast notifications and user location toasts	The marker name toast notification and user location toast notification successfully appeared	Valid
23.	Marker navigation to the marker	Displays notifications toasting the name of the initial marker and toasting the name of the destination marker	The initial marker name toast notification and the target marker name toast notification have successfully appeared	Valid
24.	Marker navigation to a random destination location	Displays toast notifications for marker names and destination location toasts	The marker name toast notification and destination location toast successfully appeared	Valid
25.	Navigate random starting location to marker	Displays initial location toast notification and marker name toast	The initial location toast notification and marker name toast successfully appeared	Valid
26.	Navigate from a random start location to a random destination location	Displays initial location toast notifications and destination location toasts	The initial location toast and destination location toast notifications successfully appeared	Valid

The Blackbox Main Menu table in the StellarPath application is a test of the main menu features

e-ISSN: 2614-8404
p-ISSN:2776-3234

including adding markers, menu list, navigation, zoom, and offline conditions.

Table 5 Blackbox Download Maps

No	Testing Scenario	Expected Result	Test Results	Test Results
1.	Downloading the Map	Map success downloaded and can be saved	Map succeed downloaded And saved successfully	Valid
2.	Zoom in dan Zoom out pada peta	Map zoom in and out works without errors	Zoom functionality works as expected	Valid
3.	Resume Map Download after Disconnect	Can continue downloading maps when the network is not connected	Downloading maps cannot continue when not connected to a network	Invalid
4.	Notifications and toast when the maps are successfully downloaded d	Displays notifications toast when maps successfully download and displays the number of tiles downloaded	Displayed successfully the toast notification and number of tiles downloaded	Valid

The Blackbox Download Maps table in the StellarPath application is a feature test when downloading Maps, including notifications and whether it is possible to continue downloading when not connected to the internet.

Table 6 Blackbox Marker List

No	Testing Scenario	Expected Result	Test Results	Test Results
1.	Editing Markers	Successfully changed the marker information in the marker list	Displays the form And users Can edit And save	Valid
2.	Edit Latitude dan Longitude	Cannot edit Latitude and Langitude	When editing Latitude and Longitude cannot be edited	Valid
3.	Deleting Markers	The success marker is deleted and does not exist on the map or marker list	The marker has been successfully deleted from the marker list or map	Valid

The Blackbox Marker List table for the StellarPath application is a test of the Marker List feature for editing and deleting markers.

Table 7 Blackbox New Route Manual

No	Testing Scenario	Expected Result	Test Results	Test Results
1.	Draw a Polyline on the map	Successfully draw a Polyline on the map	The polyline is successfully drawn by tapping on the map	Valid
2.	Save the drawn Polyline pan	Successfully save and name the polyline that has been drawn	The polyline was successfully saved and named	Valid
3.	Zoom in dan Zoom out pada peta	Map zoom in and out works without errors	Zoom functionality works as expected	Valid

The Blackbox New Route Manual table in the StellarPath application is a feature test when drawing Manual Routes with Polylines.

Table 8 Blackbox Manage Maps

No	Testing Scenario	Expected Result	Test Results	Test Results
1.	Displays a list of Maps that have been downloaded d	Displays the size and list of Maps that have been downloaded	Maps list and sizes do not appear	Invalid
2.	Delete us Maps that have been downloaded d	Successfully deleted the downloaded Maps	The downloaded maps were not successfully deleted	Invalid

e-ISSN: 2614-8404
p-ISSN:2776-3234

The Blackbox Manage Maps table in the StellarPath application is a feature test when managing downloaded Maps.

Table 9 Blackbox Manage Route

No	Testing Scenario	Expected Result	Test Results	Test Results
1.	Displays a list of routes that have been drawn	Successfully displays n list of drawn routes	The list of routes Drawn successfully is displayed	Valid
2.	Delete the route that has been drawn	Successfully deleted the drawn route	Route which already drawn successfully deleted	Valid

The Blackbox Manage Route table in the StellarPath application is a feature test when managing pre-drawn Routes.

IV. CONCLUSION

Based on the research on the Development of a Mobile GIS-Based Digital Map Location Marker Application for Navigational Purposes Using the Location Based Service Method. With a focus on offline capabilities, this application provides a more flexible and personalized solution for users' navigation needs. The testing of the application's features was conducted by calculating the success rate $= \left(\frac{\text{Number of Passed Tests}}{\text{Total Tests}}\right) \times 100\%$, resulting in a success rate $= \left(\frac{37}{40}\right) \times 100\% = 92.5\%$. Thus, the following conclusions can be drawn:

a. This application enables users to download maps and save them for offline use, allowing access without an internet connection. Users can also manually create their own routes and save them for offline use, however, it has drawbacks such as the inability to resume downloads when the connection is interrupted and challenges in managing downloaded maps, which can lead to the application size increasing significantly with the number of maps downloaded.
b. The application provides features that enable offline navigation with routes that can be drawn on the map, allowing users to manage those routes.
c. The application offers marker features that can be created and saved with various additional information; these markers can be stored and managed offline, making it easier for users to locate marked locations.
d. The application provides flexible navigation; users can navigate by tapping on the map, and this navigation feature can be activated and deactivated.

REFERENCES

[1] R. S. Amri, Soelarno, and Zulfahmi, "Pembuatan Aplikasi Mobile GIS Berbasis Android Untuk Informasi Pariwisata Di Kota Pariaman," *J. Sains dan Teknol.*, vol. 1, no. 1, pp. 21–26, 2021.

[2] R. M. Abi, S. Achmadi, and F. X. Ariwibisono, "Aplikasi Location Based Service Pencarian Tempat Wisata Dan Hotel Pada Wilayah Kabupaten Timor Tengah Utara Berbasis Android," *JATI (Jurnal Mhs. Tek. Inform.*, vol. 4, no. 2, pp. 283–291, 2020, doi: 10.36040/jati.v4i2.2669.

[3] Z. Zaliyanti, L. Fujiyanti, and A. Josi, "Meningkatkan Aksebilitas dan Navigasi Wisatawan melalui Aplikasi Mobile dan Web Berbasis GIS di Provinsi Kepulauan Bangka Belitung," vol. 02, no. 2, 2024.

[4] A. Almunawar, "Aplikasi Bogor Ngawas Untuk Sistem Navigasi Perjalanan Warga Kota Bogor Berbasis Android," *JATI (Jurnal Mhs. Tek. Inform.*, vol. 8, no. 2, pp. 1941–1948, 2024, doi: 10.36040/jati.v8i2.9260.

[5] R. A. P. Rusdian and A. B. Prasetyo, "Pembuatan Aplikasi Sebagai Penanda Mengenai Kampung Kreatif Tematik Pada Smart Branding Kota Bogor Berbasis Android," *J. Multi Media dan IT*, vol. 4, no. 2, pp. 1–9, 2020, doi: 10.46961/jommit.v4i2.332.

[6] S. Herlambang and A. Al Mawy, "Pengembangan Aplikasi Mobile Untuk Informasi Service Kerusakan Handphone Menggunakan Platform Android," *Teknologipintar.org*, vol. 2, no. 11, pp. 1–12, 2022, [Online]. Available: http://teknologipintar.org/index.php/teknologipintar/article/view/443

e-ISSN: 2614-8404
p-ISSN:2776-3234

[7] Gladian Dzaky Dirga Ananda, "Perancangan Aplikasi Pengenalan Pariwisata Danau Toba Berbasis Android Menggunakan Layanan Location Based Service (LBS)," *J. Komput. Teknol. Inf. dan Sist. Inf.*, vol. 2, no. 2, pp. 315–325, 2023, doi: 10.62712/juktisi.v2i2.74.

[8] C. M. Dalton, "For fun and profit: the limits and possibilities of Google-Maps-based geoweb applications," *Environ. Plan. A*, vol. 47, no. 5, pp. 1029–1046, 2015, doi: 10.1177/0308518X15592302.

[9] P. Gentzel and J. Wimmer, "Restricted but satisfied: Google Maps and agency in the mundane life," *Convergence*, vol. 30, no. 3, pp. 1041–1057, 2024, doi: 10.1177/13548565231205869.

[10] P. R. Nagarajan, V. M. Vinod, V. Mekala, and M. Manimegalai, "A fast and energy efficient path planning algorithm for offline navigation using Svm classifier," *Int. J. Sci. Technol. Res.*, vol. 9, no. 1, pp. 2082–2086, 2020.

[11] N. P. Ram, K. Sandhiya, V. M. Vinod, and V. Mekala, "Offline navigation:GPS based assisting system in Sathuragiri forests using Machine Learning," *Proc. IEEE Int. Conf. Intell. Comput. Commun. Smart World, I2C2SW 2018*, pp. 326–331, 2018, doi: 10.1109/I2C2SW45816.2018.8997523.

[12] I. Marsudi, "Extraction of Open Street Map to Produce Digital Maps," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 366, no. 1, 2019, doi: 10.1088/1755-1315/366/1/012025.

[13] Herlinah and Musliadi, *Pemrograman Aplikasi Android dengan Android Studio, Photoshop, dan Audition*. Jakarta: PT Elex Media Komputindo, 2019. [Online]. Available: https://books.google.co.id/books?id=pEyrDwAAQBAJ&printsec=frontcover&hl=id#v=onepage&q&f=false

[14] D. Darmawan *et al.*, *Wirausaha Bidang Teknologi*. Jambi: PT. Sonpedia Publishing Indonesia, 2023. [Online]. Available: https://www.google.co.id/books/edition/Wirausaha_Bidang_Teknologi_Peluang_dan_I/hsmlEAAAQBAJ?hl=id&gbpv=1

[15] S. Munari, Aip, H. Setyawan, Muhammad, Yusril, and N. Fauzan, M., *Panduan Lengkap Algoritma Haversine Formula Pada Sistem Monitoring Mahasiswa Internship Berbasis GPS*. Bandung: Kreatif Industri Nusantara, 2020. [Online]. Available: https://books.google.co.id/books?id=H3T9DwAAQBAJ&printsec=frontcover&hl=id#v=onepage&q&f=false

[16] H. Kurniawan *et al.*, *BELAJAR WEB PROGRAMMING : Referensi Pengenalan Dasar Tahapan Belajar Pemrograman Web Untuk Pemula*. Jambi: PT. Sonpedia Publishing Indonesia, 2023. [Online]. Available: https://www.google.co.id/books/edition/BELAJAR_WEB_PROGRAMMING_Referensi_Pengen/gs3OEAAAQBAJ?hl=id&gbpv=1

[17] P. Sari, Ira and Z. Indra, *SISTEM MONITORING KEBAKARAN HUTAN BERBASIS ANDROID*. Ponorogo: Gracias Logis Kreatif, 2021. [Online]. Available: https://www.google.co.id/books/edition/SISTEM_MONITORING_KEBAKARAN_HUTAN_BERBAS/beVVEAAAQBAJ?hl=id&gbpv=1

[18] R. Botwright, *Android Studio Masterclass*. Pastor Publishing Limited, 2024. [Online]. Available: https://www.google.co.id/books/edition/Android_Studio_Masterclass/8AcCEQAAQBAJ?hl=id&gbpv=0

[19] B. Hudaya, *Pemrograman Java Dasar*. Tasikmalaya: EDU PUBLISHER, 2024. [Online]. Available: https://www.google.co.id/books/edition/Pemrograman_Java_Dasar/xlMnEQAAQBAJ?hl=id&gbpv=1

[20] P. Nugroho, Ilham, Dwi and N. Fatonah, Siti, *Penerapan User Centered Design Untuk Penentuan Sistem Contingency Plan*. Penerbit Buku Pedia, 2022. [Online]. Available: https://www.google.co.id/books/edition/Penerapan_User_Centered_Design_Untuk_Pen/vqKaEAAAQBAJ?hl=id&gbpv=1

[21] N. Suryantara, I, Gusti, *TEKNOLOGI IMERSIF: Membangun Teknologi Interaktif dan Kreatif dalam Era Industri 5.0 dan Society 5.0*. Jakarta: Elex Media Komputindo, 2024. [Online]. Available: https://www.google.co.id/books/edition/TEKNOLOGI_IMERSIF_Membangun_Teknologi_In/BuINEQAAQBAJ?hl=id&gbpv=1

[22] B. Hadiprakoso, Raden, *Pemrograman Berorientasi Objek*. RBH, 2021. [Online]. Available: https://www.google.co.id/books/edition/Pemrograman_Berorientasi_Objek/o_kdEAAAQBAJ?hl=id&gbpv=1

e-ISSN: 2614-8404
p-ISSN:2776-3234

[23] E. Sutanto, *Pemrograman Android Dengan Menggunakan Eclipse & StarUML*. Surabaya: Airlangga University Press, 2020. [Online]. Available: https://www.google.co.id/books/edition/Pemrograman_Android_Dengan_Menggunakan_E/UGvIDwAAQBAJ?hl=id&gbpv=1