



Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage:
https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943



Geolocation Based Mobile Application for the Underserved Community

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ARTICLE INFO

Article history:

Received 20 July 2023
Received in revised form 25 October 2023
Accepted 6 November 2023
Available online 21 November 2023

Keywords:

Underserved community; *Orang Asli*;
Geolocation; Navigation; Mobile
application

ABSTRACT

Underserved community is described as underserved, vulnerable and special needs populations that include members of minority populations or individuals who have experienced health issues. Other terms that are used to describe underserved community are people with low income that is below 200% of the federal poverty level and those who are residing in a geographically isolated region or those who are confined to a residential setting. The problem that leads to this research is little publicity and awareness about the society or departments that can help the underserved community. Therefore, this research is proposing a mobile application that can locate and help underserved community. The objectives of this research are to identify the requirements of Ledang ResQ mobile application, to design and also to develop Ledang ResQ mobile application. The scope of this research is this research is intended for Non-Government Organization (NGO) and the application will cover only Gunung Ledang area in Johor, Malaysia and available for Android user only. The features of Ledang ResQ mobile application are to detect user current location, to add marker and to save the location, to view and to search information of underserved community around Gunung Ledang. This research is using MADLC as the methodology approach to the development of Ledang ResQ mobile application. MADLC is divided into seven phases which are identification, design, development, prototyping, testing, deployment and maintenance but this research only covered five phases from identification until testing. Based on the user testing results, it shows positive responses from the users. Ledang ResQ mobile application may help the NGOs and the general public to locate and help underserved community.

1. Introduction

Underserved community is described as underserved, vulnerable and special needs populations as communities that include members of minority populations or individuals who have experienced health issues [1]. Mendoza-Vasconez *et al.*, [1] also describe underserved community are people with low income that is below 200% of the federal poverty level and those who are residing in a geographically isolated region or those who are confined to a residential setting.

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<https://doi.org/10.37934/araset.33.3.351363>

Based on a preliminary investigation that has been conducted, the current problems are little publicity and awareness about the facilities or departments that can help the underserved community.

Underserved community usually live in a place that have lack of infrastructure and facilities so the information about their location is not known by the society [2,3]. With current pandemic issue of COVID-19, underserved community are more vulnerable to infection of COVID-19 since the health services are limited. The main purpose of this research is to assist non-government organizations (NGOs) or community services in locating and helping underserved communities by developing a mobile application that is named as Ledang ResQ that can locate the underserved community. The objectives of this research are firstly to identify the requirements of the Ledang ResQ mobile application, secondly to design the Ledang ResQ mobile application and thirdly, to develop the Ledang ResQ mobile application.

1.1 Underserved Community in Malaysia

Department of *Orang Asli* Development (JAKOA) reported a statistic of 209,575 *Orang Asli* (indigenous people) was found in Malaysia in 2022 [4]. The two (2) most population of *Orang Asli* was located in Pahang and Perak [3] meanwhile the least population was located in Perlis and Pulau Pinang [5] whereas a total of 15,825 *Orang Asli* was found in Johor [4]. The numbers were divided into nine (9) different district in Johor which is Mersing, Kluang, Johor Bahru, Segamat, Batu Pahat, Pontian, Kota Tinggi, Muar and Tangkak. Gunung Ledang is located in Tangkak with a population of 616 *Orang Asli* lives in the area. The selected study place for Ledang ResQ is around Gunung Ledang, Johor.

Gunung Ledang is also known as Mount Ophir, is located inside Johor's border with Melaka state, about 30 km from Muar town. According to Mahmud, Baharudin and Isa [6], *Orang Asli* are the underserved community in Malaysia. Over the years, under the government-sanctioned relocation programme, many *Orang Asli* groups were moved to a more developed and urban area [7], with essential services provided by the government sector such as healthcare, police security, communication and education [8]. However, there are still a major issue within each of the organization where government are facing difficulties when visiting the village as they are not well organized and many data were not shared which leads to inaccurate population besides they often ignoring their healthcare and essential needs such proper clothing and nutritious diets for the whole family. Figure 1 shows the population of *Orang Asli* in Malaysia in 2022 from www.jakoa.gov.my. Figure 2 shows the map of *Orang Asli* distribution in Malaysia.

JUMLAH PENDUDUK ORANG ASLI MENGIKUT KUMPULAN ETNIK DAN NEGERI TAHUN 2022				
NEGERI	SENOI	MELAYU PROTO	NEGRITO	JUMLAH
JOHOR	49	15,773	3	15,825
KEDAH	30	10	296	336
KELANTAN	15,382	73	2,032	17,487
MELAKA	23	1,809	1	1,833
NEGERI SEMBILAN	110	12,107	4	12,221
PAHANG	36,002	41,485	1,128	78,615
PERAK	57,747	667	2,811	61,225
SELANGOR	5,425	15,532	4	20,961
TERENGGANU	944	85	43	1,072
JUMLAH	115,712	87,541	6,322	209,575

Fig. 1. Population of *Orang Asli* in Malaysia until 2022

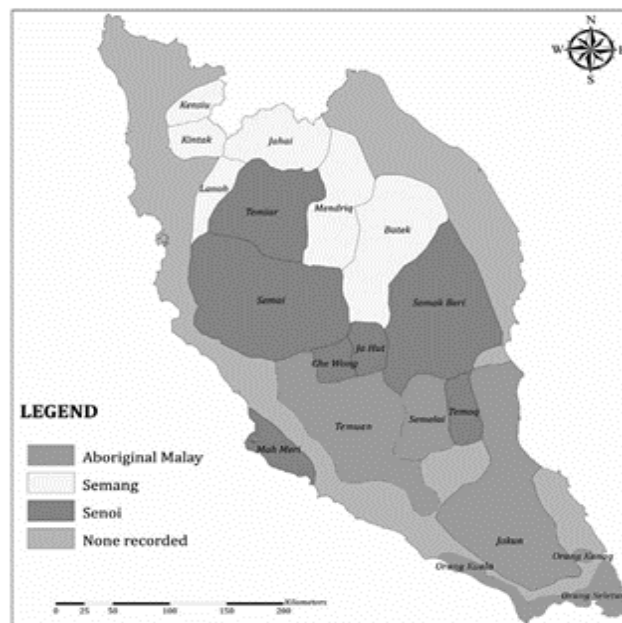


Fig. 2. Map of *Orang Asli* distribution

Poverty is one of the issues faced by the underserved community. According to Jabatan Kemajuan Orang Asli (JAKOA) [4] has discovered that 80% of *Orang Asli* live below the poverty line compared to 8.5% nationally. *Orang Asli* has been identified as the one of the poorest groups with higher incidence of poverty (50.9%) and hard core poverty (15.4) compared to the national figures of 7.5% and 1.4% respectively [4].

They also have a lower health status compared to general population [6-8]. The life expectancy of females' *Orang Asli* was estimated to be 52 years old while 54 years old for males' *Orang Asli* population [9]. This is because higher maternal death rates resulting from childbirth and poor maternal health. Geographical population of *Orang Asli* mostly in land forests and rivers because of their source of livelihood [10]. Traditionally, the indigenous belief holds that land is not a product and consequently cannot be bought or sold [11]. Therefore, land has spiritual and cultural values

attached to it. These beliefs function to cultivate the natural environment and thus reserve the biodiversity of the forest.

1.2 Navigation Techniques and Methods

To overcome the issue, this research is going to develop a geolocation based mobile application to assist the Non-Government Organization (NGO) to locate and help underserved community in Gunung Ledang area. With advanced technology nowadays, Freedman [12] described location-based technology is one of the techniques used to solve the problem. According to Qu *et al.*, [13], location-based technology uses real-time geo-data from mobile phone to provide information. Freedman [12] also added the main function of geolocation is identifying a device's location, providing driving directions and integrating with a mapping software. Many companies use geolocation application track their employee, vehicle, and other resources [14-15]. The mobile application will provide push notification as a push notification have been generally used in many platforms like Code Division Multiple Access (CDMA) and Global Positioning System (GPS) [16], and a marker is use to identify a location on a map. Markers can display custom images, in which case they are usually referred to as "icons".

1.3 Mobile Application Development

Mobile application is of the mobile technology produced to enhance the current technology as it running on a small hand hold mobile device which is moveable, easy to use and accessible from anywhere and any place [17-18]. This is supported by Patil *et al.*, [19] in their research where they described the mobile technology have been growing rapidly across the world while technology goes evolution from the big one such as computer into tiny one such as mobile cellular.

A native is a smartphone application that is coded in a specific programming language, such as Objective C for iOS or Java for Android operating system [20]. The development for this application requires time consuming compared to hybrid and web application, whereas the web application authorize the processing function of information to be controlled and monitored remotely on web server [21]. The only different with a web application when referring to the mobile space is that the web application is just a designed and developed to work well on a small screen whether it be a phone or a tablet. Meanwhile the hybrid application is a combination of native development and web technology development [20]. According to Malavolta *et al.*, [22], companies build hybrid application as wrappers for an existing web page; in that way, they hope to get a presence in the application store, without spending significant effort of developing a different application. Hybrid applications are also popular because they allow cross-platform development and thus significantly reduce development costs.

1.4 Mobile Application Platform

The mobile application Ledang ResQ is developed using Android as Android is one of the most widely used mobile operating system these days. This is supported by past research conducted by Almisreb *et al.*, [23] which stated Android enables applications to make use of the hardware features through abstraction and provide a defined environment for applications. Research by Datta [24] also added that Android grows very success and rapidly in term of application development, profit-making and economy contribution.

To understand the function and features that should be implemented in Ledang ResQ mobile application development, a study of existing applications is required to avoid a similar error in the existing developed application. To summarize the existing features in mobile application, Table 1 shows the comparison of the implemented design features in selected mobile application.

Table 1
 Summary of the design features of existing mobile application

Existing mobile application	Design Features and Function						
	Map view	Alert notification	Store information (address, coordinate)	Tagging	Marker	GPS	Location sharing
Map Marker (Google Store)	✓	✓		✓	✓	✓	✓
Save Location GPS (Google Store)	✓	✓	✓			✓	✓
InfraMaker (Google Store)	✓	✓		✓	✓	✓	✓
Location Marker (Google Store)	✓		✓		✓	✓	
Place Marker (Google Store)	✓		✓		✓	✓	✓
Nearby Places – Everything (Google Store)	✓	✓	✓	✓	✓	✓	✓
GPS Measurer (Google Store)	✓				✓	✓	
Send My Location Map (Google Store)	✓			✓	✓	✓	✓
Waze (Google Store)	✓	✓	✓	✓	✓	✓	✓
MAPS.ME (Google Store)	✓	✓	✓	✓	✓	✓	✓

Table 1 shows nine (9) existing mobile application compared with seven (7) design features. As developing Ledang ResQ mobile application, there are some features chosen for the mobile application. The main feature is the map view with detection of current user location as it will provide an address of current location of the user. User has choice to help the poor with navigation features which provide a direction to the location of *Orang Asli* and save the location features by adding a marker on the map for future perusal for another user. To do so, user have to fill a form regarding the people on the exact location.

In order to develop a software product, a framework or structure is required [25]. It is a type of process called software development lifecycle [26]. There are many types of lifecycle models and each type may differ in term of activities or development step but usually all of it will include planning, requirement, analysis, design and others [25-26]. Thus, Mobile Application Development Lifecycle (MADLC) is proposed in order to standardize the approach in the development as contains more detailed explanation and more specific about each phase and its outcomes. MADLC enable a more systematic approach in development of mobile applications and provides specific details on what need to be done in ensuring each step are carried out successfully.

As highlighted before, the current problems are little publicity and awareness about the facilities or departments that can help the underserved community. Therefore, in order to minimise this gap

this research is to assist non-government organizations (NGOs) or community services in locating and helping underserved communities by developing a mobile application that can locate the underserved community.

2. Methodology

Mobile Application Development Lifecycle (MADLC) contains 7 phases used to model and plan the research. Figure 3 shows the phases of MADLC.

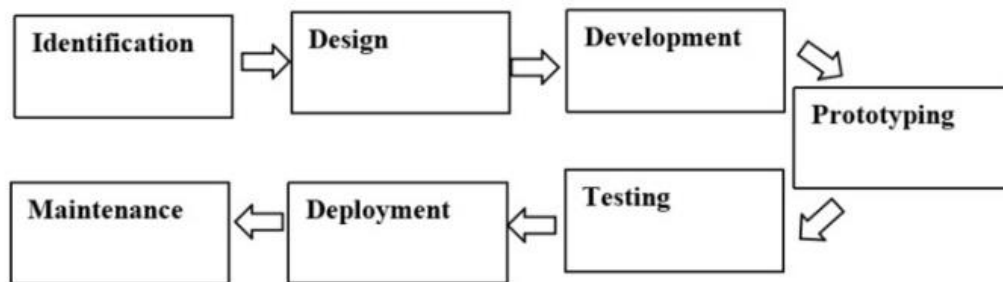


Fig. 3. Methodology phases of MADLC

Yet, this research will only adopt five phases which are Identification phase, Design phase, Development phase, Prototyping phase and Testing phase and 2 more phases excluded were recommended for future works.

2.1 Five Phases Adopted from MADLC

2.1.1 Identification phase

The first phase of MADLC is to gather ideas and requirement. The purpose of this phase is to come out with a new idea or improvements from the existing applications. The existing application from any platforms is reviewed to create and invent something new from the existing application.

2.1.2 Design phase

The second phase of MADLC is design. In this phase, the information received from identification phase is delivered to preliminary design phase. The design of the mobile application will take place according to their flow and suitable platform to deliver the application, Android platform is more suitable to deploy for newcomer application. Storyboard are one of the requirement in the design phase because it describe the flow of the mobile application.

2.1.3. Development phase

The application is coded in this phase using Android Studio. It consists two coding stages to develop which are coding for functional requirements and coding for user interface (UI) requirements. The code is developed first for the core functionalities. Next, UI is designed in order to be supported on operating system platform. The next step is the development of user interface through Android Studio by using HTML5, CSS3, JavaScript and PHP. Finally, the documentation of the development phase will be forwarded to the prototyping phase.

2.1.4 Prototyping phase

The fourth phase of MADLC is prototyping. A high-fidelity prototype will develop based on the functional requirements and then will be given to stakeholders to receive their feedback. The process is repeated until the user is satisfied with the functionalities and the design of the prototype. This phase is to make sure it meets all the requirements. The result in this prototyping phase is documented and will be bring forward to the Testing phase.

2.1.5 Testing phase

The fifth phase of MADLC is testing phase. There are two set of activities that required for the testing of Ledang ResQ mobile application. The first set of activities consist of functional testing of Ledang ResQ through list of activities as shown in Table 2.

Table 2
 Description of user testing procedure

Activity Task	Description
Open Ledang ResQ mobile application	User open Ledang ResQ mobile application.
Go to Main Menu	User is directed to the main menu that contains submenu.
View Gunung Ledang map	User can open and view Gunung Ledang map.
View any location of underserved community on the map	User can see a marker on the map indicates the location of underserved community.
Find specific location of underserved community	User can enter the name of the community
View information of the underserved community	User can see the information of the underserved community
Go to Marker screen	User is directed to Marker screen
View current position on the map	The current position of the user is shown on the map
Adding a marker on the map	User fill up a form to add and save location of the underserved community
Exit from the application	User close the application when finished using it.

The second set of activities consist of list of interview question for user feedback and recommendations after conducting the first functional testing of the system in order to understand their perception and experience on mobile application as shown in Table 3.

Table 3
 Interview question for user feedback

Questions
What did you expect when using this application?
What do you think about the user interface design of this application?
Do you understand the text, icons and buttons in this mobile application?
Is it easy for you to navigate through this application?
Does this application help you to view, find and save the location of underserved community?
What is your overall rating regarding this mobile application?
Do you have any suggestion that can be improved from this application?

Table 4 show the summary of MADLC phases which include the activities and techniques and the outcomes of the objectives.

Table 4
 Summary of MADLC phases

Objectives	Phase	Activity	Techniques	Deliverables
To identify the requirement for Ledang ResQ mobile application	Identification	Identify problem statement, objective, scope and project significant. Identify system requirement. Set up project title Identify the user of the mobile application.	Conducting interview with an experience organization or volunteer. Reading articles and journals Review existing similar mobile application or system.	Problem statement, objective, scope and project significant are identified List of the design features.
To design the Ledang ResQ mobile application	Design	Choosing suitable platform for the application Design user interface. Design Use Case diagram, ERD and flowchart. Sketch storyboard for the flow of the application	User interface storyboard Paper prototyping JustInMinds StarUML	Application platform has been identified. Storyboard for Ledang ResQ application is designed. Use Case diagram and Use Case description.
To develop the Ledang ResQ mobile application	Development	Convert the designed plan to development.	<u>SOFTWARE</u> Android Studio by using Java programming language and XML for UI Firebase for database <u>HARDWARE</u> Using PC and laptop with installed software Mobile phone/Smartphone to run the mobile application.	<ul style="list-style-type: none"> • Ledang ResQ mobile application is developed • Databases. • Interface. • Function and features of the application.
	Prototyping	Develop prototype based on designed system Analyze the prototype Get feedback from the user Implement requirement changes	Android Studio JustInMinds Microsoft Powerpoint	High-fidelity prototype for Ledang ResQ mobile application
	Testing	Test the prototype with user	Android devices	Ledang ResQ mobile application

3. Results

Several surveys are done throughout the research to properly target the scope of the research. The requirements were conducted and collected by using online forms and send throughout various communities. Furthermore, the requirements are also gathered through a review of existing mobile application that related to geolocation function as well as literature review that has been discussed.

3.1 Survey

The preliminary study has been done by conducting a survey. The survey has been distributed to NGOs that conduct community service towards underserved community and others. The purpose of this survey is to identify the problem occurred while conducting charity activities.

3.2 Mobile Application Identification

In this phase the ideas and requirement for the mobile application development is gathered. Based on the survey that has been conducted, the problem occurred that NGOs facing while doing community service is identified and other information related to the underserved community are also gathered. The main problem that faced by them is lack of publicity and awareness about the facilities or departments that can help the underserved community which is hard for them to locate accurately. Hence, this research focuses on locating the underserved community and save the location.

Table 5

Summary of the identification phase

Analysis	Descriptions
Problem statement	Difficulty to locate the underserved community
Module	Location of where underserved community lives. Save location and information of the underserved community.
Focus of the project	Provide location of where the underserved community. Add a marker by save the location. View the information of the underserved community.

3.3 Mobile Application Design and Development

Several features for this mobile application have been outlined as a guideline for the development of Ledang ResQ mobile application.

Table 6

Design features for Ledang ResQ mobile application


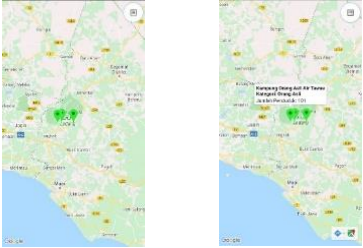
Design Features and Functions	Description
Map view	Allow user to view the location of underserved community on the map.
Detect current location	When the user is on the map, they will get their current location through GPS.
Mark location and fill up information about the location	Allow user to add a pin or marker on the map and write the details such as name, address and category so that other user can refer.
View marker and information	Allow user to view location and the details of the location
Filter information	Allow user to search specific information of the location

Developing the mobile application is important to ensure it follows all the requirements that have been explained. User interface for Ledang ResQ mobile application is very simple and consistency. Crucial part involved when designing user interface to ensure the system can communicate with user. Firebase is used as database to store location, name, address, and other information. When the system has been developed, it will be tested to ensure all the features works and no defects happened when using the system before being deployed. Five users have been selected to run the

system from opening the application until exit from the application and to test whether is there any bugs or error during run time of the system.

The system has been designed for mobile application which only can be accessed on mobile devices. Table 7 briefly shows the interfaces of Ledang ResQ mobile application and its description.

Table 7
 Interface of Ledang ResQ mobile application

Interface	Description
	<p>This is the main menu of Ledang ResQ mobile application. It consist five (5) submenu which is Map, Marker, Help, Info and Exit.</p>
	<p>This Map screen will show all location of underserved community around Gunung Ledang. Green marker indicates where underserved community is currently stay. When user click on the marker, a small info window will appear to show name, category and population of the underserved community. There is small circle button at top right of the screen will indicates to list view of the underserved community in Gunung Ledang.</p>

3.4 Mobile Application Testing

In this phase, the application is tested with users which is the NGO user. The mobile application is being tested by five (5) users from NGO. The function of the system starts from opening the mobile application until closing the system is tested to ensure no errors or bugs encountered during the testing.

The selected users were identified numerically from User #1 to User #5. There are 13 activity tasks to be performed in order to test the mobile application. The check mark '✓' indicates that the user has performed the specific activity task while the 'X' mark shows that the user unable to perform the task. The testing shows that User #1, User #2 and User #5 performed all the activity without encountered any errors, while User #3 and User #4 encountered minor errors at 'View current position and address' and 'Fill up the details and save' task respectively. As a result, it can be concluded that the mobile application Ledang ResQ has works properly without major errors occurred during the testing.

3.5 Discussion

In short, this research has achieved all three of the objectives by identifying the requirements, design and develop the mobile application Ledang ResQ. The mobile application has successfully been tested by the selected users without encounter major errors that will fail the performance of the mobile application. The development of Ledang ResQ will help the NGOs to find the location marked by other user or mark the location the encountered to help and serve the underserve communities. This is supported by past research from Ahmadzadegan *et al.*, [27] in their paper where they studied the importance of mobile applications and their technical aspect. This proved the needs and importance of mobile applications at the present time considering the rapid evolution of mobile

technology [28, 29] and the use of smartphones, the importance of mobile applications is clear [26]. Similarly, this research also benefitted the mobile application developer as it helps the developers to understand the current issue related to technologies and people. Also, the development of Ledang ResQ will become a model to give idea for future works in order to improve or enhance the new or existing mobile application for better user experience.

4. Conclusions

The implementation of Ledang ResQ mobile application may create a significance value towards the non-government organizations (NGOs) in helping the underserved communities. Perhaps, Ledang ResQ mobile application may assist them to improve their daily community service life. With emerging of mobile technology, hopefully it will increase the interest and motivate other users to help underserved communities including the poor. Helping without getting paid and be sincerely is what mobile application is developed for. Creating a community which love to help less fortunate people is the most significant value in the contribution of Ledang ResQ mobile application.

Although this research is considered successful and has achieved all the three objectives, yet there are few limitations found out throughout this mobile application. The system is only available in Gunung Ledang area, the focus of this research is to help and locate underserved community in Gunung Ledang area. Area outside of Gunung Ledang area will not work in this system. While developing in Android Studio, the system is only available for Android devices. iOS or any other platform would not be available to use the system. The system also only used basic features provided by Google Cloud Platform since advanced features requires to be subscribed to their cloud services.

It is recommended to improve and enhance the system. After Ledang ResQ mobile application has been deployed, there are several future enhancements that can be done based on user testing evaluation. The main features that can be added into the system is user authentication. Security is important while using the mobile application to avoid misleading information, misuse of the data to gain for their own personal use. Furthermore, the system is depending on third party application for navigation. Self-navigation could be useful in the system so that user does not have to rely on third party application.

Acknowledgement

This research was funded by a grant from Universiti Teknologi MARA (UiTM) (LESTARI SDG-T Grant Ref: 600-RMC/LESTARI SDG-T 5/3 (143/2019)). We would also like to thank the College of Computing, Informatics and Mathematics, Universiti Teknologi MARA (UiTM), Shah Alam, Selangor, Malaysia for the support given to this research.

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