Smart Campus Geographic Information System (GIS) Mobile Application Reporting System

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Abstract. The Geographical Information System (GIS) mobile application helps the communities in a specific area, the agency related to the maintenance and solving problems related to infrastructure. The purpose of this study is to enhance the location and visualization of the current reporting system. The methodology used in this study starts with a preliminary study to understand the issue, data collection, data processing, and system design using ArcGIS for Desktop, ArcGIS App Studio to design the application, ArcGIS Online to create the computer dashboard, and finished by testing the system. As a result, a mobile geographical information system based on the maintenance and solving problems related to infrastructure was created as a mobile application. Some people tested the Smart Campus GIS Mobile Application Reporting System in the specified area to verify the capabilities. In conclusion, the positive feedback received from the respondent is used to validate the mobile application and is ready to be used by the people in the target area.

1. Introduction

"Smart campuses" are places where efficient technology and infrastructure are available to aid the teaching process, research efforts, and student experience. Students, stakeholders, and the environment interact intelligently on a smart campus [1]. The smart campus has recently been adopted at several universities around the world. However, each university has its own set of objectives to accomplish via various initiatives [2]. Due to infrastructure issues, the higher education community faces a variety of challenges.

This case study was conducted out at the Universiti Pertahanan Nasional Malaysia (UPNM). In most cases, they affect the roads, pipes, buildings, and electricity supply. Natural disasters such as landslides and tree collapses are also a problem, as can the invasion of ferocious animals. These problems cause people to feel very uncomfortable, especially in teaching and learning at UPNM. The communities may know some problems, but they do not know how to report them efficiently to the correct agency. The agencies also face a problem where some of the complaints do not accurately locate the problems.

UPNM's present reporting method comprises filling out a damage report form, writing a report letter, and using a computer system that only a few people at the institution are familiar with that
system. To assist the communities in a particular region and the agency responsible for infrastructure maintenance, a Geographical Information System (GIS) mobile application reporting system was developed. With the help of this project, the existing reporting method will be more accurate and easier to navigate than it is now.

2. Literature Review

Geographic Information Systems (GIS) are designed to capture, store, control, analyze, manage, and display a broad variety of spatial or geographical information [3]. According to Restrepo [4], the GIS is a tool for managing, analyzing, and visualizing geographic knowledge organized in different information, including interactive maps, geographic data, and geoprocessing data models. This application's systems operate by capturing data from previous occurrences and the precise place where the event occurred. The data is subsequently saved in the form of coordinates for map maintenance. The "World Standard System," WGS-84, will be a particular control system that will assist arrange the information into geographical locations.

Hrizi et al. [5] describe the Mobile Application Geographical Information System as an emerging technology that combines GIS with the capacity to communicate via a mobile to access, retrieve, fusion, and remotely altered data. It enables data collection and storage from the mobile GIS application to remote the database, allowing remote access to more extensive or more significant databases. The attachment created will assist in providing a more precise coordinate to the mobile GIS to assess the risk of collision effectively.

In addition, Sharavanan [6] explains that Android applications made for smartphones mainly give the user more flexibility and convince them. It enables the user to access the data and resources in mobile directly after installment by giving the user the privilege. The smartphones that apply Android OS can supply many resources like Wi-fi connection, mobile internet support such as 3G and 4G, optimized camera, cloud storage, a stack of sensors, and synchronized support to external devices and environment. Meanwhile, the Linux kernel can constantly supply and provide better protection than other kernels, which is why it is taken as the base for the development of Android OS. It is crucial to identify the device's exact location as the device's content is restriction-based. The measurement's accuracy in predicting the device's location depends on the number of towers surrounding it.

The phrase "smart campus" itself differs from the traditional campus. The smart campus is a widespread application on the Internet of Things (IoT) environment that connects campus teaching, research and management, and campus resources [7]. IoT is a framework in which things and people are supplied with updated identities and data moving capability via a network without humans themselves or humans and computers. The idea of creating a smart campus implies that the institution would automatically adopt sophisticated ICTs to monitor and manage every campus infrastructure. The smart campus's design and execution are determined by on-campus demand, and installing that system will increase the effectiveness and efficiency of all operations. Mobile phones and other devices may be used to access campus information [8].

According to Bassil [9], the software development methodology is the Software Development Life Cycle (SDLC). This method is extensively used in mechanical engineering, system engineering, software engineering, applied engineering, computational sciences, and computer science, among other fields. According to the findings, many SDLC models have been suggested all around the world. Each model has advantages and disadvantages. Waterfall, spiral, incremental, rational unified process (RUP), fast application development, and rapid prototyping are the models found in the study. Currently, SDLC models can only exchange essential attributes. The models comprise chains or sequences of phases or stages that must be respected and followed by the system designers and developers to achieve the desired outcomes and produce the final product.

In addition, the reporting system is created because mainly, the people such as managers, accountants, and clerks always experience many problems in gaining information or data in the form that can help them understand it straight away. In this context, the end-user is the person who benefits from manipulating the data and the performance of processing services. The reporting system gives
computing facilities to the end-user, which is specialized for every quick report from them. Next, the reporting system also helps users easily search and gain information in the form of distributed reports brought out from a combined database for all classes of users due to their past acknowledgment to the computing system [10].

3. Methodology
System Development Life Cycle (SDLC) phases are the general methodology that shows how to obtain the research objective, as shown in Figure 1.

![Figure 1: Methodology of Smart Campus GIS Mobile Application Reporting System and Smart Campus Monitoring Dashboard](image)

3.1. Preliminary Study
A preliminary study is an early exploration of content related to the proposed project. Preliminary studies may identify the key features to be addressed in a quality process but do not happen in all systems. Identifying and understanding the research topic is crucial as it is the main requirement before developing the desired system. This assessment will include developing the system, a user requirement, and the association of the data collected. Reviewing the current reporting system will lead to knowing about UPNM that currently have a few methods of reporting any damage. Generally, the client may use three methods: the WhatsApp application, the 'E-Aduan' system, and a physical form. These methods have their advantages and disadvantages, which depend on the problems faced by the client. The disadvantages of the three methods can be analyzed to create a better-desired system for the users. A product developed by ESRI is chosen in this step as the client widely uses it with massive numbers of analysts worldwide. The desktop application, which is the software, is used to handle information and separate the data. For software assessment, ArcGIS 10.6.1, ArcGIS Online,
AppStudio for ArcGIS Online, and AppStudio for ArcGIS Desktop Version are chosen to design and develop Smart Campus GIS Mobile Application Reporting System. At the same time, ArcGIS Web App Builder is used to design and develop Smart Campus Monitoring Dashboard.

3.2. Data Collection
There are few techniques in conducting the process of data collection used in the development of this application. Data collection is the process of compiling and measuring information in various ways to attract interest and establish a systematic data collecting system to gather as much information from the client. There are two types of data collecting techniques for the development: interview methods and questionnaire surveys. The face-to-face interview is one of the methods used in this research. In this method, the collection of data was made from a target respondent. The target respondents for this research are the people involved in using the current infrastructure in UPNM, such as the lecturer, student, and staff. This survey will be conducted mainly in UPNM, which is the target side of this research. This survey is used to get the perception of people who are recently using the reporting system on UPNM's Web. The interview will be consisting of multiple sections of the question that will be asked. All the questions in the interview for all respondents will be the same, such as the respondent's detail, perception, and feedback about the current reporting system. In addition, the survey will also ask about the problem that frequently happens in UPNM based on the current reporting system and their opinion on how to improve the mobile application.

3.3. Data Processing
Data Processing is divided into two steps: managing the attribute and spatial data and analyzing interview and questionnaire surveys. Managing the attributes and spatial data is essential in recognizing the target respondent, giving detailed information related to name, identification card number, phone number, and others. Meanwhile, the analysis of interview and questionnaire survey is another crucial step to understand and help answer the problems studied easily. In the interview method, all the recording interviews will be collected and gathered in softcopy. The data which have essential information will then be analyzed. In the questionnaire method, the respondent's perception of the current reporting system in UPNM will be divided into a few sections that will determine whether the system is good, moderate, or bad depending on the client's statement. Lastly, the percentage of the results for a new application to be created will be interpreted by the agreement based on the survey results.

3.4. Design Phase and Development
Design phase in which the mobile app's preliminary storyboard with the desired function is created. The final output is created on a storyboard basis (e.g., Figure 2) with multiple software and platforms such as ArcGIS 10.6.1, ArcGIS Online (AGOL), and AppStudio for ArcGIS to build Smart Campus GIS Mobile Application Reporting System. App coding system and app data attachment were the responsibilities for system development.

![Figure 2: Storyboard of Desired App](image-url)
3.5. Testing and Implementation
The application will be tested first to ensure the condition of the finalized application whether it can put it into operation without facing any obstacle or not. By attempting to make a request, the selected audience is invited to the test phase. If the web map application received and displayed the request, the details were the user's current location, identity, and damage category.

3.6. Evolution
At this stage, the developer in charge will gather all suggestions, modifications, or even acknowledge the problems or errors that bugs could cause. Before it can be re-released to desired platforms, the application will be treated and improvised.

4. Results and Discussion
This project aims to produce an Android application to help those UPNM communities to lodge report damage in UPNM so that their response context welfare is secured and the outcome or feedback from users can be used for further analysis. The result is developing an Android mobile app called Smart Campus GIS Mobile Application Reporting System and a web app called the Smart Campus Monitoring System Dashboard.

4.1. To Study the User Requirement of the Proposed System
Figure 3 shows the questionnaire among the UPNM community's conduct. 96% of them agreed to create Smart Campus GIS Mobile Application Reporting System with such features as user's name, identification number, phone number, damages description, and current location and base map to be installed on this app, equipped with ten main types of damages.

![Figure 3: Respondent Who Agree if Smart Campus GIS Mobile Application Reporting System for to be Developed](image)

4.2. To Design and Develop the Proposed System
The final output of the Smart Campus GIS Mobile Application Reporting System with its flowchart of the function is shown in Figure 4. This app contains several pages such as the Homepage, Select Report Type page, Add Location page, Add Photo page and Add Details page. On the Select Report Type page, the user can select ten types of damage. If the user is on their location on a smartphone, the location was auto-detected on page Add Location. Users also add media such as capturing the image, selecting the image from the album, and uploading the video and audio for reporting the proven
damage. To control the fake reporting and easy to contact the person in charge makes the report, the user must add their details such as Name, Identity Card number, phone number, specific location, and damage description.

Figure 4: Interface Smart Campus GIS Mobile Application Reporting System

A home page of the Smart Campus Monitoring System Dashboard web app created to be used by the agency team is shown in Figure 5. Using both "Distance and Near Me" widgets, the team can perform the shortest path analysis and buffer analysis. Several widgets, such as Add Data, Attribute Table, Legend, and Layer List, can also be used for monitoring and display purposes.
4.3. Verification capabilities of the Mobile Application for Reporting Damaged Infrastructure and Casualties that Occurred in UPNM

Figure 6 shows scenarios created to test and verify the mobile application function, such as choosing to report various types of damages using this application, such as electronic problems, public facilities, toilets, pipes, and drainage. This application could also choose other benefits features, such as sending photographs, audio, and videos for visualization. In addition, the symbol types of reporting damage appeared on this dashboard, and it was easy for the agency to know where the exact location of damage occurred.

![Figure 6: Some scenarios of Smart Campus Monitoring System Dashboard](image-url)
Figure 7 shows the direction widgets that allow the agency's team to analyze the shortest path and provide the best direction from one location to another location. There are few options to choose a direction, such as Driving Time and Driving Distance.

![Direction widgets](image)

**Figure 7: Direction widgets to analyze the best direction from one location to another location**

5. Conclusion

The Smart Campus GIS Mobile Application Reporting System was developed explicitly to use UPNM communities to report any problem or damages in UPNM. Considering the physical and environmental barrier facing nearly UPNM communities when reporting any problem and damages in UPNM, the ten options service was offered. Smart Campus Monitoring System Dashboard was subsequently developed as a web map application to enable the agency team to manage all user requests and meet their needs. This project has achieved all this project's goals. The first goal is to study the user requirement on the proposed system, and in two different ways, the information needed was carried out. The first is an interview session with Deputy Officer UPNM Development and Maintenance Department to gain a deeper understanding of the reporting system in UPNM and discuss which feature should be placed on the system proposed. By using the questionnaire, the second option conducted a survey and distributed it to 50 respondents. The survey shows that 96% of 50 respondents agreed that mobile application is made specifically for the Smart Campus GIS Mobile Application Reporting System without facing physical and environmental barriers. AppStudio developed an android application named Smart Campus GIS Mobile Application Reporting System to help UPNM communities to make a report on damages and problems. The advantage of using this product is that it allows developers to build a system that matches all platforms to deliver their system and benefit others. However, the limitation of ESRI products is due to the type of license applied for using this platform.

In addition, following the creation of the Smart Campus GIS Mobile Application Reporting System, Smart Campus Monitoring System Dashboard was developed as a web map application. Smart Campus Monitoring System Dashboard plays its role in monitoring or viewing the user's request, whether they select any problems and damages at the current locations. The agency team that handles any damages in UPNM can manipulate Smart Campus Monitoring System Dashboard to...
perform few analyses such as shortest path analysis and nearby analysis to enhance their efficiency level in assisting users and meeting their needs. The testing and implementation process has been carried out systematically as the developer wants to integrate and finally work out both Android and web map applications. The developer has interfered with some of the unprogressive results of both apps, so it needs modification to fix a few errors. Finally, Smart Campus GIS Mobile Application and Smart Campus Monitoring System Dashboard work together as both apps host layer feature is the exact URL service and has been fixed.

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