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# MOBILE LOCATION-BASED APPLICATION AS TOOL TO EASE TOURIST TO LEARN AND EXPLORE HERITAGE SITES

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***Abstract:*** *Cultural heritage is an expression of the ways of living originated by a populace and inherited from one generation to another generation such as Angkor Watt at Cambodia, Palace and Park of Versailles at France and Imperial Palaces of the Ming and Qing Dynasties in China which attracted a lot of tourists to visit each year. In addition, the shift in tourism from relaxation to self-discovery is reflected in the tourism industry and cultural heritage tourism is one of the fastest growing specialty markets in the industry today. The current research aims to show an application that is working on smartphones that can be used for exploration in heritage sites and at the same time is able to develop interaction between user and cultural heritage. A virtual guide application that is Mobile Adaptive Tour of Heritage Sites (MATHS) was developed on iPhone platform to ease the tourists to visit, learn, and explore the tangible (refer to heritage sites) and intangible (refer to festive events and social practices) cultural heritage by integrating the technologies like Global Positioning System (GPS), Geographic Information System (GIS), client-server technology and shortest path algorithm. With these technologies, the administrator can insert or edit the information of cultural heritage easily through the admin interface. Therefore, the content inside MATHS is dynamic and keeps updated. In addition, MATHS also integrated with two modules that are 1) SOS (panic button) to provide emergency support such as clinic and police station to the tourist when the tourists need helps in an emergency and 2) public transportation locator where it helps the tourist to find public transport. In the current research, the field of investigation refers to Georgetown, Penang, Malaysia typically at the core zone. With this*

*application, the user can gain more valuable knowledge such as the content of tangible and intangible of the cultural heritage at Georgetown, Penang, Malaysia.*

***Keywords:*** *Cultural Heritage, Mobile Device, Location-Based Services.*

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**Introduction**

Smartphone had become one of the in demand mobile devices that everybody love to use nowadays. It is because smartphone is able to let the user to make the calling, surf the Internet, and one of the main benefits is to allow the user to install various type of application such as mobile games, social networking, navigation, weather and utilities. Furthermore, user can utilize the cellular data or Internet connection to send free text messages, voice, image and video through Whatsapp, Line, iMessage or WeChat.

According to the latest preliminary release from the International Data Corporation (IDC), vendors of smartphone had shipped a total of 337.2 million smartphones worldwide in the second quarter of 2015, which increase 11.6% from the 302.1 million units in the second quarter of 2014. With this trends in smartphones, many popular destinations such as Spain, Italy and United Kingdom make use of these opportunity to develope various types of travel applications in smartphones especially for the heritage sites [1] to promote their heritage sites.

In general, cultural heritage is an expression of the ways of living developed by a community and passed on from generation to generation including customs, practices, places, objects, artistic expressions and values [1]. So, the concept of cultural heritage is not only manifested through the tangible forms such as artifacts, buildings, historic places, monuments, work of art and natural environment which are considered worthy of preservation for the future, but also through intangible forms. Intangible form refers to the arts, social practices, festive events, storytelling, cuisine, knowledge and traditional craftsmanship. Therefore, cultural heritage is often expressed as either Tangible or Intangible Cultural Heritage.

In the last decades, the nature of tourism has also changed due to the advancements of technology and social media which make tourism more affordable and accessible for millions of people especially in cultural heritage tourism. Cultural heritage tourism involves visiting places that are significant to the past and provides an opportunity for people to experience their culture in depth whether by visiting attractions, historical places or by taking part in cultural activities.

Tha main goal of this research is to ease the tourist to visit the heritage site more systematically and safety by utilizing the location-based services (GPS, GIS) with the shortest path algorithm where it helps to optimize the travel time used to move from one location to another location in three parts which are 1) explore the tangible and intangible cultural heritage, 2) guide the tourist to the nearest location of public transport, and 3) a panic buttion where it can track the exact location and send the distress signal to the local authorities. Therefore, the proposed solution which is Mobile Adaptive Tour of Heritage Sites (MATHS) is a mobile application where it is able to guide the tourists to explore and learn the tangible and intangible cultural heritage by utilizing the

Global Positioning System (GPS) and Google Map API. Besides, the information of the heritage site is dynamic and the tourist can get the latest information through the proposed solution. In this application, MATHS was developed in iOS (Apple) as the mobile platform and the environment was based on Georgetown, Penang, Malaysia.

**Related Works**

For several years, mobile learning has been offering modern ways to support learning process through mobile devices, such as hand-held and dektop computers, smart phones and mobile phones. Mobile learning presents unique attributes compared to conventioanl e-learning such as personal, portable, collaborative, interactive, contextual and situated. Mobile technologies allows contents to be provided to the learner in whatever location, and also allow the location itself to be used as part of interactive learning activities. In a nutshell, the concept of mobile learing is based on mobility of technology (refer to advanced cellular telephones such as smartphones), mobility of learning (refer to transmit the full content of learning materials to user by using the mobile cellular devices), and mobility of learner (refer to the user can perform any learning at any place and at any time). With these new technology, it offers the new forms of educational experience sitated away from the classroom [11]. Several researchers namely [12], [13], [14], [15] have shown that the combination of physical activity with digital activity is able to promote reflection and news ways of assisting childern in learning.

Recent advances in technologies, especially the smart phones and tablets have led to more recent works by using off-the-shelf components with only software required. For example, Mad City Mystery proposed by [16] who used smart phones to present the place by requiring the students to investigate through a mystery-based game. The goals of the simulation are to help students to develop the skills of investigating and observing by relating them to scientific processes. Students are presented with an open-ended problem (a death) and are able to gather location-based evidence by exploring a physical area with a Global Positioning System (GPS) technology from the smart phone. In addition, [17] developed a system Frequency 1550 which uses standard components to provide an environment to explore local history by using a mystery-based game platform similar to Mad City Mystery as proposed by [16].

Several solutions are available and each of these solutions provide different types of information to describe the cultural heritage such as the brief history or provides several graphical information by utilizing the method from virtual reality and augmented reality [3]. In addition, there are several methods such as in the form of storytelling or an artificial agent guides the tourist to view the cultural heritage as shown in [4]. Besides, [5] proposed a GUIDE system which integrated four features such as the technologies from personal computer, wireless communications (refer to WIFI or cellular data), adaptive hypermedia, and context awareness.

In general, a number of mobile applications have been developed in the field of cultural heritage [6,7,10] and can be downloaded from the AppStore (iOS) or Google Play (Android). For an example, [6] presented a number of guidelines for the outdoor cultural heritage sites by utilizing the techniques from images, videos, and an intelligent agent where it uses the Location Based Service (LBS) to interact with the user. Besides, [8] proposed a mobile-based application to guide the tourist to explore the cultural heritage sites. In similar field, [9] presented a tourist guide

application by utilized the context-aware technology such as Global Position System (GPS) from the mobile devices.

In summary, there are many various types of methods and techniques such as LBS, GPS, 3D model, mobile game, virtual reality and augment reality have been deployed in mobile application especially in the area of cultural heritage. However, the applications only cover certain part of the cultural heritage such as the information of tangible sites. Therefore, we can conclude that the idea of combining the tangible and intangible information into one application is the way to help the tourist to explore the content of heritage sites.

**System Overview**

In general, MATHS was implemented in iOS (5.1 version) platform from Apple. Besides, MATHS was designed in server-client architecture in order to solve the static and permanent information inside the application. Figure 1 shows the diagram of server client of MATHS. At the server side, it consists a database where it allows the administrator to manage the information for all the modules from the client side. The administrator can add, delete or update the information remotely through the wireless communication. These three PHP pages which are add.php, delete.php, and update.php are all connected to the database. Therefore, dynamic information of the cultural heritage can be able to synchronize or download the latest information from a server automatically. At the client side, it consists four modules which are 1) Tangible Cultural Heritage, 2) Intangible Cultural Heritage, 3) Public Transportation Locator, and 4) SOS where it communicates with server side through Hypertext Transfer Protocol (HTTP).

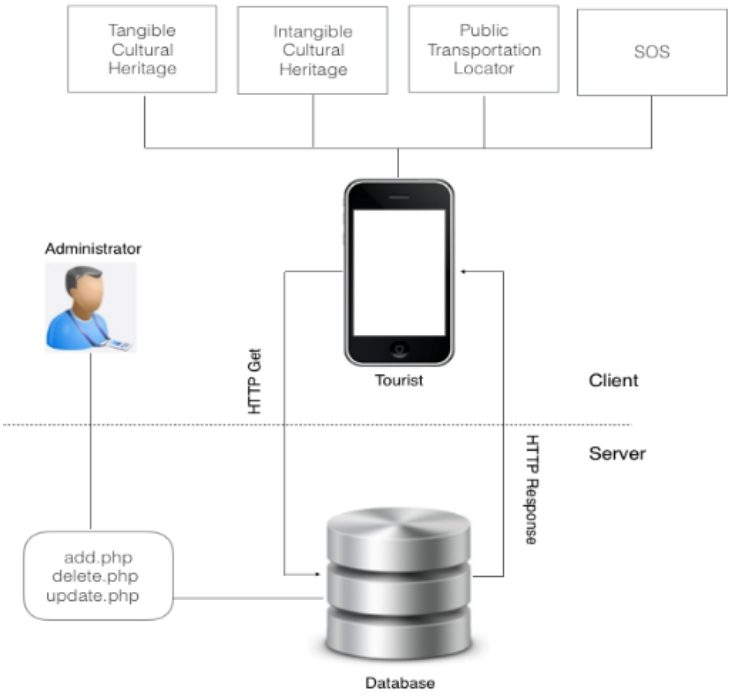


**Figure 1. The Diagram of Server Client of MATHS**

Figure 2 shows the administrator inserts the 1) Coordinate (Global Positioning System), 2) Name,

3) Information and 4) Type. In this example, the administrator enters a new location which the 1) Coordinate: ("5.4166993206383784, 100.33909047022462"), 2) Name: "Songkok Maker", 3) Information: "The experience master weaves the Malay Songkok for discerning customers with an eye for intricacy", Type: "Intangible Cultural Heritage. If the tourists enable to launch MATHS by using the wireless communication, then MATHS still able to function by using the old data records.

Basically, all of the modules utilized the shortest path algorithm from the location-based service (integration the technologies from GPS and GIS). Therefore, MATHS is able to show the route from one heritage place to another heritage place in the minimum time. Figure 3 shows the three proposed destination by Dijkstra's algorithm by the module of Tangible Cultural Heritage. Basically, Tangilble Cultrural Heritage shows the list of unique wonders of the old Georgetown which are "Weld Quay", "Church Street Pier", "War Memorial", "City Hall", "House of Yeap Chor Ee" and etc. In this module, MATHS is able to return a list of result which are 1) "Masjid Melayu Lebuh Acheh", 2) "Dr. Sun Yat Sen Penang Base", and 3) "Khoo Kongsi Clan House" or the tourist can choose by themselves through the menu of "I prefer to choose myself" after the MATHS detected the location of the tourist. Basiaclly, MATHS will show the panoramic view and description of the heritage site after the tourist select the option.

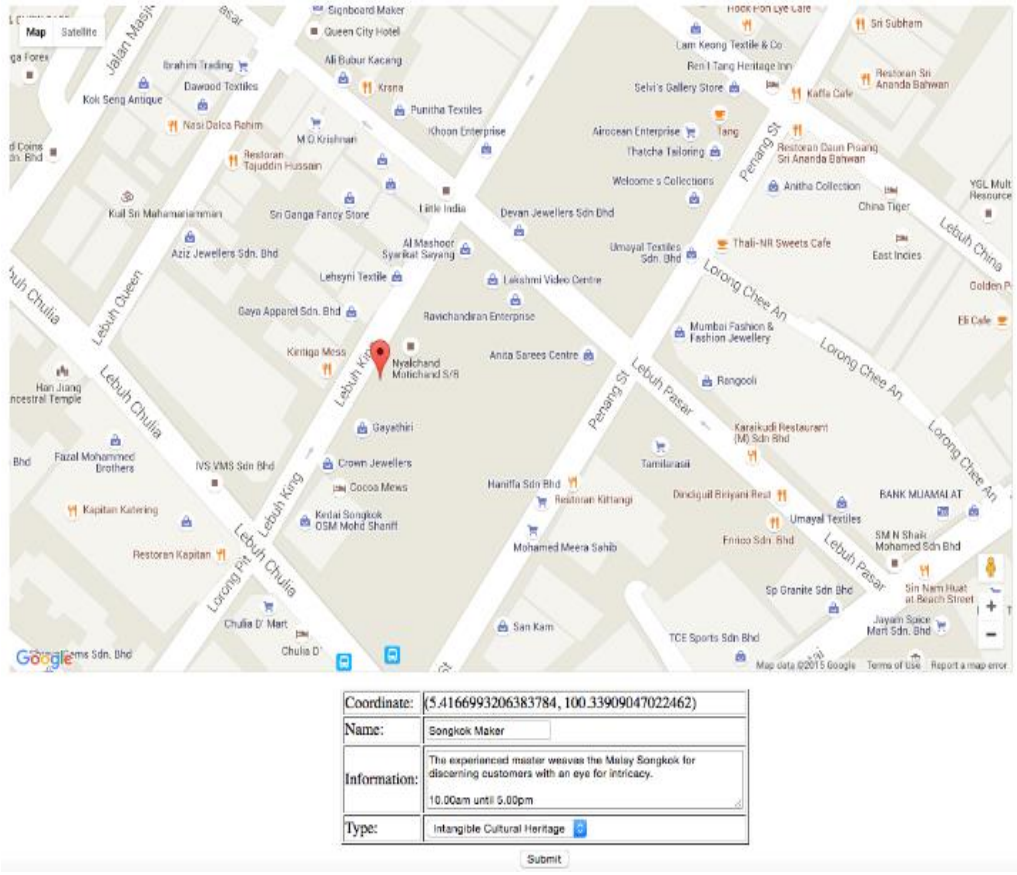


**Figure 2. The Interface for administrator to Insert the Intangible Cultural Heritage**

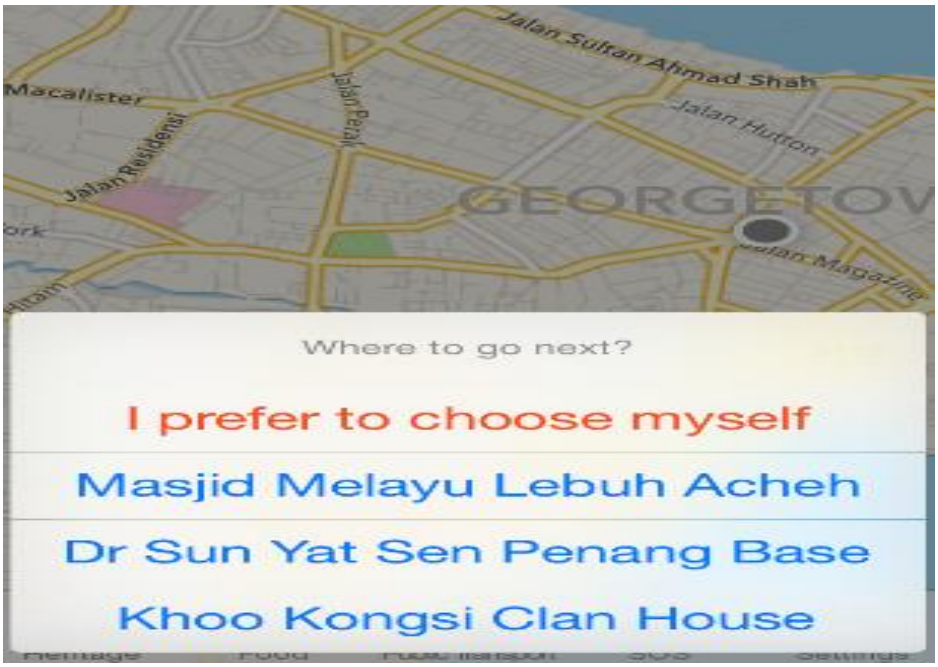


**Figure 3. The Return Result based on Dijkstra's Algorithm**

In this example, the current location for the tourist is at Komtar, Penang where the Latitude is 5.41460259 and Longtitude is 100.32970460. MATHS is utilizing Dijkstra's algorithm to discover the shortest path from one node to another node. The main reason to use Dijkstra's algorithm instead of A* algorithm is because Dijkstra is uninformed algorithm which the tourists have no knowledge on the graph, and the tourists cannot estimate the distance from each node to the target. Besides, Dijkstra's algorithm is able to find path between source (original destination / place of origin) and all other nodes.

Besides, MATHS also covers other modules such as Intangible Cultural Heritage, Public Transportation Locator and SOS. Each of the modules provides different services to the tourist to ease them to explore the heritage sites. Basically, Intangible Cultural Heritage covers the festival events and food trail because both also represent the identity of the nation. For festival events, it shows the events based on Category such as "Dance", "Music", "Workshop", "Exhibition", "Film", "Talks" and "Art" that can be found at Georgetown, Penang, Malaysia. Basically, MATHS allows the user to select the category before it return the list of result based on the nearby location of the user. Food Trail acts as a food stall finder where it shows the available food stall around the heritage site area. Food stall is one of the unique cultures where the tourist only can find in Malaysia. Besides, the food stalls are arranged into several types such as "Malay", "Chinese", "Indian", "Western" or "Others" to ease the tourist to explore and taste the food in heritage area according to their favourite.

Public Transportation Locator provides the information such as the nearest location of the bus station and the timetable for the buses in that particular area as shown in Figure 6 while SOS functions as an emergency channel to the tourists if they need any helps in the area of heritage sites. For an example, MATHS will locate the nearest location of the hospital/clinic or police

station to the tourist in the case of urgency. Figure 6 shows the nearest bus station and other bus station based on the location of the tourist.

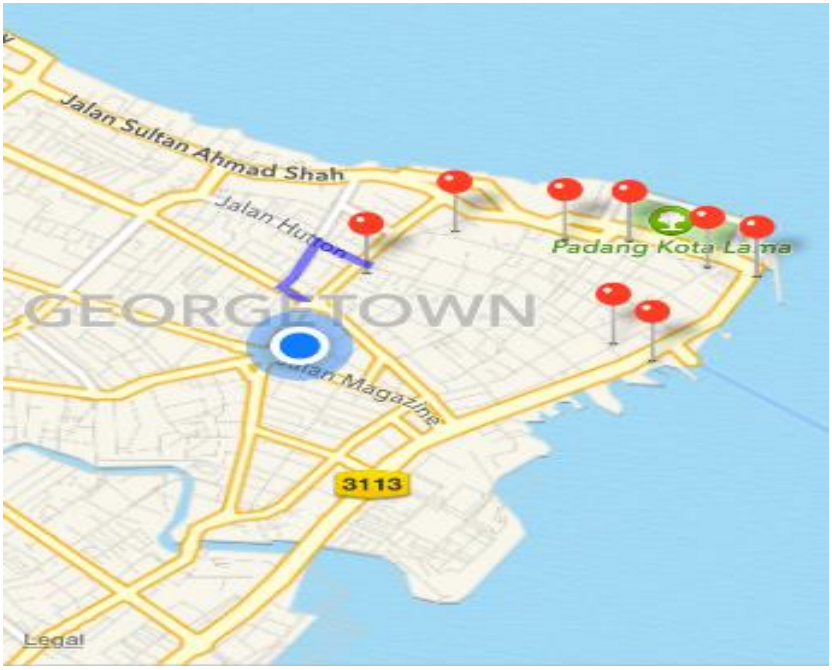


**Figure 6. The Nearest and Others Bus Station (red dot) based on the Location of the Tourist (blue dot)**

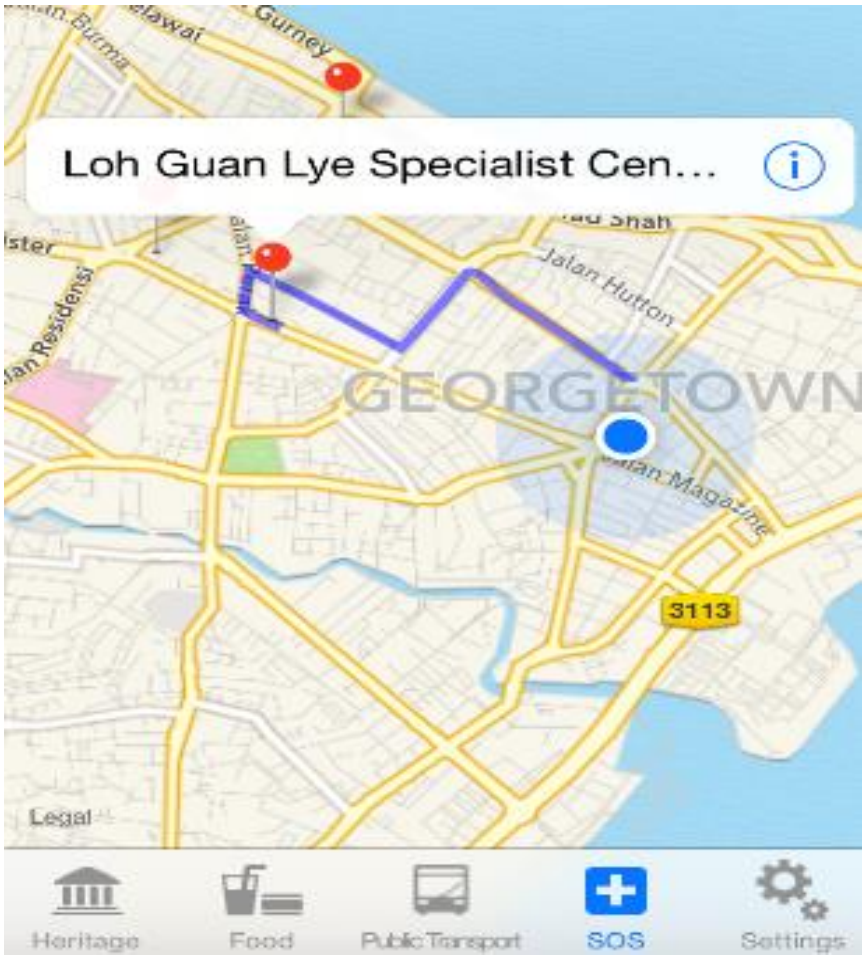


**Figure 7. The Nearest Route from the Current Location (blue dot) to Hospital (red dot)**

Figure 7 shows the nearest emergency support (tourist is able to choose the options which are hospital, clinic or pharmacy) which is the Loh Guan Lye Specialist Center after the tourist choose the option of hospital. Besides, MATHS will show the route from current location of the tourist to the Loh Guan Lye Specialist Center based on the Global Positioning System.

## Evaluation

In order to evaluate the features, usefulness, effectiveness and accessibility of the application, several evaluations were carried out. User-centered and system-centered evaluation were used in this research. The user-centered evaluation that is questionnaire is used to collect the opinions and feedback from the users while system-centered evaluation that is system testing is to collect the performance and efficiency of the application.

### *A. User-Centered Evaluation*

The questionnaire is concerned with the opinions and feedback from the users on the usefulness, effectiveness and accessibility of the application. The respondents were required to rate their satisfaction based on a scale of 1 to 5 where the value of 1 is the strongly disagree, the value of 3 is neutral, and the value of 5 strongly agree. The population is 80 International tourists and the sample size is 50 in this evaluation. The group consisted of 24 males and 26 females with an

average age of 42.40 and fluent in English. Table 1 shows the questionnaire and Figure 8 shows the result of the evaluation of MATHS.

**Table 1. The Questionnaire**

| Questions |
|---|
| 1) Does the application can help to explore and learn tangible cultural heritage? |
| 2) Does the application can help to explore and learn intangible cultural heritage? |
| 3) Does the application can help to guide to the nearest location of Public Transport based on the current location of tourist? |
| 4) Does the Panic Button provide valuable and sufficient information? |
| 5) Is the application useful in exploring and learning the heritage site? |

Based on the Figure 8, majority of the respondents were satisfied that MATHS is able to help them to explore and learn the tangible (43/50 respondents strongly agreed) and intangible (42/50 strongly agreed) cultural heritage. In addition, 70% of the respondents strongly agreed that MATHS is able to guide them to the nearest location of Public Transport based on the current location. Some of the respondents highlighted that is good to integrate other types of public transport such as Uber or Grab (Taxi) into MATHS because of the unavailability and inaccurate during the peak time. Furthermore, 20% of the respondents stayed neutral that the Panic Button provides the valuable and sufficient information (respondents preferred the Panic Button should link with the Police Station or Volunteer Corps when they hit the button instead just provided the contact numbers) while 64% of the respondents agreed that MATHS is able to help them to explore and learn the heritage sites. In addition, respondents also provided valuable information such as the Panic Button should provide the location of the tourist to the rescue team when they hit the Panic Button automatically. In a nutshell, the overall positive result showed that MATHS is able to help the International tourists to explore and learn the cultural heritage at Georgetown, Penang.

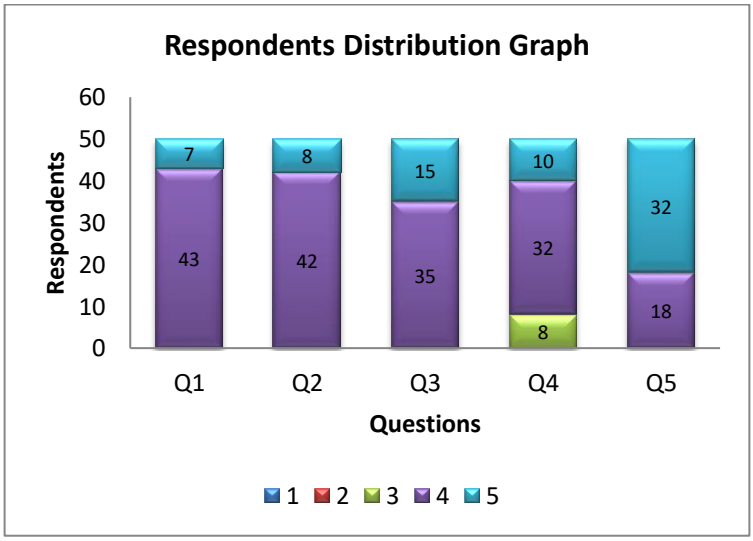


**Figure 8. Result of the Evaluation of MATHS**

*B. System-Centered Evaluation*

System testing of this project is carried out by using two methods which are 1) simulator from Xcode and 2) real device which is iPhone. Since MATHS is a server and client model, both the simulator and real device are needed in the testing phase. The reason to use the simulator is because it allows us to rapidly prototype and test builds the application while real device allows to test almost all the real time scenarios of the application.

Table 1 shows the detailed test case review for both simulator and real device (1 set) based on the test cases which are T1, T2, and T3. Based on the Table 1, some of the test time are faster (less than 1 minutes) while some are slower (more than 1 minutes). This is because the real device needs more time to load the images or a page through the wireless communication where it depends the traffic of the WIFI or cellular data. It is noticeable that T1 Step 10 consumes a longer time (10 minutes) because the tester needs to move from original place to the destination during the testing. In addition, the method used to locate the tourist is region monitoring which it requires the user to move from one place to another place (at least 500m from the last location). Besides, region monitoring works only while the application is running and it helps to conserve the level of the battery of the device. T3 takes a longer time (average 172 second in each step) because MATHS needs to load a page from the server and it really depend the wireless communication. In addition, the time required to upload the image of the heritage site will also affect the time taken to test the test case. Furthermore, T3 Step 4 also takes a longer time (average 300 second) because the administrator may need to take some time to enter the information of the new heritage site.

**Table 2. Review of the Test Case**

| Test Case | Description | Step No. | Test Time |
|---|---|---|---|
| **T1** User visits a heritage site | Launch MATHS and select a heritage location to be visited. Then, choose "Visit" the heritage site | 1 | 10s |
| | | 2 | 30s |
| | | 3 | 10s |
| | | 4 | 10s |
| | | 5 | 10s |
| | | 6 | 10s |
| | | 7 | 10s |
| | | 8 | 30s |
| | | 9 | 10s |
| | | 10 | 10m |
| **T2** User views the image of a heritage site | Select a heritage location to be visited. Then, select the images from the gallery | 1 | 10s |
| | | 2 | 10s |
| | | 3 | 10s |
| | | 4 | 30s |
| **T3** Admin adds new heritage site | Select a new heritage location. Then, insert the new heritage site with appropriate information | 1 | 1m |
| | | 2 | 1m |
| | | 3 | 15s |
| | | 4 | 5m |
| | | 5 | 5m |
| | | 6 | 5m |

## Conclusion and Future Work

In conclusion, this paper has proposed a mobile location-based system to help the tourist to

navigate, learn, and explore the tangible and intangible cultural heritage sites. In addition, MATHS also provides the flexibility for administrator to insert and edit the information of cultural heritage sites remotely through Internet to ensure the information is always updated. In addition, MATHS also provide SOS (panic button) to provide emergency support such as clinic and police station to the tourist when the tourists need helps in an emergency and 2) public transportation locator where it helps the tourist to find public transport. Further research is needed to integrate other types of public transport into the application and enhance the Panic Button to the application since MATHS already utilizing the location-based services.

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