

# M-DENGUE: UTILIZING CROWDSOURCING AND TELECONSULTATION FOR LOCATION-BASED DENGUE MONITORING AND REPORTING SYSTEM

Wahidah Husain\*, Fatin Syazana Abdul Aziz, Nur' Aini Abdul Rashid, Neesha Jothi

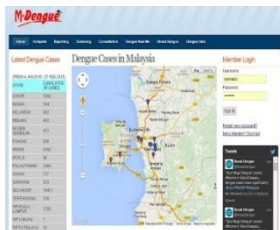
School of Computer Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

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\*Corresponding author  
wahidah@usm.my

## Graphical abstract



## Abstract

Dengue fever has become a major public health concern in recent years. The number of deaths caused by dengue is increasing over the years thus putting it in an alarming state. Public should be informed about the latest dengue cases around them. Most of them have to access various source of information to get this updates. M-Dengue, a web-based system has been proposed as a location-based platform for monitoring and reporting dengue cases, which allows information sharing in real time. It also includes dashboard that represent the data and act as a tool for analyzing, visualizing, classifying and geo-referencing dengue reports. The dashboard will helps the health staff to monitor this disease and make quick decisions. The system is proposed to benefit the community and to improve their health as well as the health of those around them. It is also aimed to engage the public as participants in the public health process as they could issue reports and share information regarding this threatening disease. The system is developed for the health staff and general public. Users are expected to be able to monitor dengue disease and gain the latest information regarding dengue cases in the country.

*Keywords:* Dengue, public health, crowdsourcing, data visualization, dash-board

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## 1.0 INTRODUCTION

In public health structures, information often travels slowly because it has to go through different level of providers. The providers need to communicate with the public in the process of information dissemination. Internet-based collaborative systems can be used in information sharing process to improve coverage and accessibility [1]. Participatory systems involved gathering of data from the population have also been used to gain knowledge on diseases, especially life threatening disease such as dengue. Furthermore, mobile computing is another device that can be utilized in healthcare [2]. The key problem with the current system is that there are no proper platforms to report new dengue cases despite number of reported dengue cases are increasing [3]. The systems we have nowadays

basically acts as informative platforms, which focus on educating the public about dengue disease.

There are no specific platforms for the public to report new dengue cases near them. Furthermore, the public does not have any channel to issue reports that allow them to share real-time information. The second problem is that the information travels slowly, despite providing all the important information about dengue. Moreover, the information provided is not up-to-date. This is not good as the public should be informed as soon as possible concerning this lethal disease. There are also no platforms to broadcast critical issues. The public are less likely to share information concerning dengue near them because there might be no proper channel for them to do so. Therefore, M-Dengue is proposed to solve the problems and reduce the limitations of health system to provide a

useful platform for monitoring and reporting the disease. Furthermore, this system could allow the public to report dengue issues near them, thus helping in the early detection of dengue disease to save peoples' lives. Seeing how fast the dengue continues to spread and the increasing number of deaths, this system would at least educate the public about the dangerous of this disease. Furthermore, this system would allow the public in remote areas to make reports and directly share their inquiries and problems to health workers. This would leads to a collaborative community and at the same time aiding in the enhancement of their health. The objectives of this system are:

- To develop a one-stop platform that provides real-time dengue information via web and mobile phones.
- To provide visual geographical mapping and dashboard interfaces system for better visibility and quick references for effective decision making.

## 2.0 LITERATURE REVIEW

In the new internet community-based systems, Internet has provided additional opportunities in crowdsourcing, which refers to the engagement of large groups of people in performing a task [4]. Mobile phones hold a particular promise in crowdsourcing as they could be used as point-of-care devices, function in remote locations, and are handy as well as being used at any time [5], [6] and [7]. Besides crowdsourcing, teleconsultation is an important element in designing this system.

### A. Crowdsourcing in Healthcare

Crowdsourcing is known as an approach to outsource the online tasks performed by a group of people responding to an open call [8]. Crowdsourcing is gaining its popularity since it is being extending in various industries. Among the industry its being used widely now is the healthcare industry. The crowdsourcing is used in the healthcare industry for disaster response [9] and reporting disease outbreak [2][10][11]. A system such as Distribute ISID, 2014 project of the International Society for Disease Surveillance and the Automated Epidemiologic Geotemporal Integrated Surveillance System (AEGIS) both currently integrate emergency department visit records from a range of hospitals to provide real-time disease and syndromic surveillance [11]. For emergency planning and response, the Ushahidi project has been seen as a success in engaging users to provide fast respond during emergency situation [12].

Having studied from these literatures, we have decided to use the crowdsourcing method to design our M-Dengue to monitor dengue cases in Malaysia since it involves the contribution from the public to disseminate information regarding dengue.

Three functions of the M-Dengue system, the real-time data collection, M-Dengue public participatory and dengue near me functions are using the crowdsourcing technology. The function real-time data collection is using crowdsourcing to gather information from users on the based on the report made; upon verification admin will update the case. From there users of the M-Dengue system will be able to view the cases based on the M-Dengue public participatory and dengue near me functions. The functions details are discussion in the proposed subsections.

### B. Teleconsultation

A teleconsultation is a generic term for linking people between two or more locations by technology. The advantage of video conferencing is the capability to display moving images in which the participants can see motion images of each other without the restriction of geographical location [13]. Hence, the consultation can be carried out with face to face interaction among doctor from the city and patient in rural area. It is very cost effective too especially for rural area which lack of medical facilities. Three popular and widely used teleconference software's for review are Skype, Google Hangouts and AnyMeeting.

Skype is free teleconferencing software that provides video calling, voice calling, instant messaging and file sharing via computers, tablet and mobile devices through internet. The advantage of Skype is its high usability which is easy to install and use. It supports video chat up to 10 people. With extra fee, Skype enables SMS or calling to mobile and landlines worldwide at low rates [14].

Google Hangouts is an instant messaging and video chatting platform provided by Google that works on almost all computer and mobile devices. It is easy and free to use [15]. Google Hangouts supports group chat up to 10 people at the same time, and it enable users to send Emoji, photos or text messages anytime even when they are offline [15]. Besides that, Google Hangouts also provide Live-Stream features that enable users to go live in front of a global audience.

The third popular tool is AnyMeeting is a web conferencing recommended for small business uses. It is easy to use and is free of charge. AnyMeeting is browser based. Hence, no installation is needed. It can support meeting size up to 200 participants and video conferencing up to 6 people at once. Users can join via phones or computer with the conference call number and PIN code provided by the account [15]. AnyMeeting enable users to share their screen with others upload and present power point slides.

Based on the review, it can be concluded that Skype is the most suitable software for teleconsultation services [16]. It provides all the features required for a physician to carry out face-to-face diagnosis. It is a voiceover-internet-protocol (VOIP) service that allows users to communicate with

peers by voice, video, and instant messages over the Internet. Skype could ease to facilitate remote consultation to the patient at no cost using the simple interface it provides at no cost. Due to its popularity and user friendly interfaces [16], it would be easier for the patients to use it even without having technical knowledge. Skype is chosen for teleconsultation technique of M-Dengue because it has the benefit of being popular among any other system [16]. Additionally, Skype is available for almost any device that allows internet connection with cross-platform functionality in place. In terms of cost, it is much convenient as two-way Skype video calls are free.

### 3.0 DEVELOPMENT METHODOLOGY

The methodology used to develop M-Dengue is Rapid Application Development (RAD). This approach is suitable for M-Dengue where the objectives are well defined and narrow, thus decisions can be made easily. It uses minimal planning in favor of rapid prototyping, allowing software to be written faster and makes it easy to change the requirement at first stage which is requirement planning, the functions, the system's scope and the data subject areas that the system will support are defined [17]. Next, at the user design stage, the system's data and processes are designed and a working prototype of M-Dengue system components is built [17]. The system procedures are designed and preliminary layouts of screens are developed. The next stage which is the construction stage consists of a series of "design-and-build" steps in which the users have the opportunity to fine-tune the requirements and review the resulting software implementation. Then we implement the new system and manage the change from the old system environment to the new one.

The RAD methodology is chosen as it was developed to respond to the need to deliver systems very fast [17]. Moreover, the system will be developed in early visibility as it is more focused on prototyping. This methodology is also used to develop the system to save development time, possibly at the expense of economy or product quality.

### 4.0 PROPOSED SYSTEM

The proposed system is designed based on studying the strength and weakness of the systems discussed in the literature. Since crowdsourcing is widely used in reporting the disease outbreak [2], [10], [11]. We have used this idea to design our M-Dengue to monitor and report dengue cases in Malaysia.

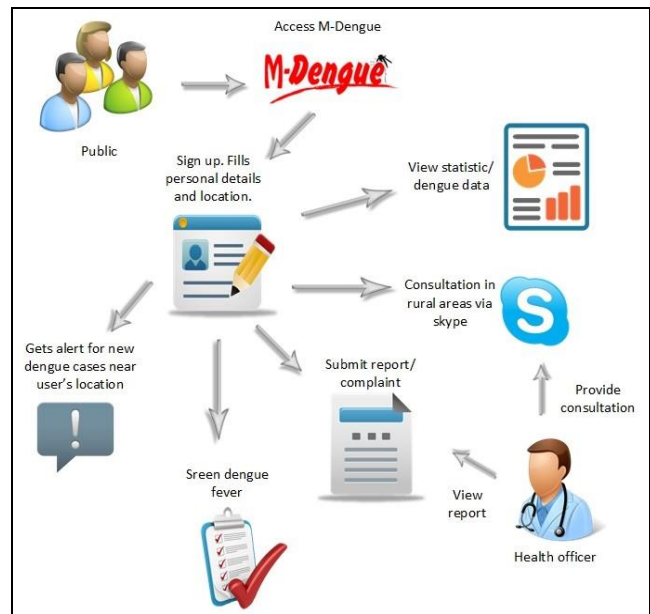


Figure 1 Overall System Flow of M-Dengue

Figure 1 shows the flow of M-Dengue system. The public and health officers can access the system using laptop or mobile phones with internet connection. Users are encouraged to sign up in order for them to fully benefit the system. When user is logged in, they can use many components of the system such as submit report, gets alert for new dengue cases, view statistics and data, get consultation from health officers and screen dengue fever. For the admin/health officer site, the system allows admin to view the reports and verify them by changing their status. For example, from 'pending' to 'in progress', and lastly to 'solved'. Admin is also responsible to confirm the slot chosen by user for consultation via Skype.

The M-Dengue main functions are as below:

#### A. M-Dengue Map Data Visualization and Dissemination

The information and reports regarding dengue is presented on a map-based interface. The map-based interface is used because it is well-defined and more user friendly than tables or lists. The information provided in the map includes:

- The number of dengue cases in respective states daily.
- The total number of latest dengue cases based on states and regions.
- Disease cluster areas.
- Hotspot areas.
- Statistics of dengue cases based on states.

## B. Real-time Data Collection

Real-time data denotes information that is delivered immediately after collection. There is no delay in the timeliness of information provided. This system allows the users to make reports and share information on the website in real-time. Information regarding dengue can be sent through the system. Admin will view the reports and take necessary actions. If a new dengue case is confirmed, the admin will then update it in the system as soon as possible. This step is taken to ensure that all the information provided in the system is always updated.

## C. M-Dengue Public Participatory

Public are allowed to register as an M-Dengue member. The benefit of being a member is that they will be informed about the latest dengue reports based on their location via email. Thus, this is the fastest way to keep them updated with dengue cases. Moreover, the public could issue reports to the system via website. They are allowed to send reports with attached pictures, GPS locations (coordinate) and addresses.

## D. Dengue Near Me

Members of M-dengue will be notified about any new dengue cases near them based on their location. The system will broadcast the information via email in real-time.

## E. Dengue Fever Screening

This test helps users to determine whether or not a person with symptoms and recent potential exposures to dengue has been infected. Dengue infection is difficult to be diagnosed without laboratory tests because its symptoms may initially resemble other diseases. Users need to answer several questions to receive information, symptoms of dengue and suggested treatment. Some of the questions include:-

- What is the patient's current temperature?
- Does the patient experiences severe headache or pain behind the eyes?
- Does patient's gum and nose bleeds?

The result from the test is determined using rule based reasoning. It is a way to store and manipulate knowledge to interpret information in a useful way.

## F. Consultancy in Rural Areas

This system provides consultancy for the people who stayed in rural areas. The platform used for the consultancy is via Skype as shown in Figure 2. Skype specializes in providing video chat and voice calls from computers, tablets and mobile devices via the Internet to other devices. Users that require consultancy have to register in the system and make

Skype appointment with health officers. Another way is by going to the nearest health center and set a Skype appointment from there. This consultancy helps those who live in rural areas far from clinics or hospitals.

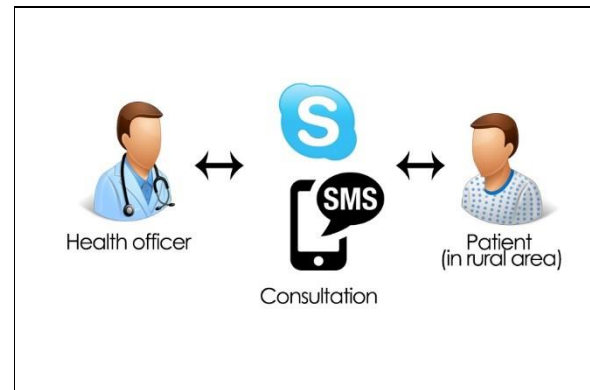


Figure 2 Consultation methods for rural area patients

## 5.0 SYSTEM DESIGN AND IMPLEMENTATION

### A. Architecture Diagram of the Proposed System

M-Dengue is developed for the use of public and health officers in Malaysia to keep themselves updated with dengue cases. To use M-Dengue, the public and health officers need to register into the system. After the registration, users can fully use the system and allows them to issue a dengue case report, receive alerts on dengue cases near them, do a dengue fever screening and receive consultancy from health officers. Briefly, the system provides the latest dengue reports by using real-time information reported by users and health officers on a map-based interface. The information regarding dengue can be sent through email and SMS. The aim of this project is to transform users from passive recipients of information to active participants in a collaborative community.

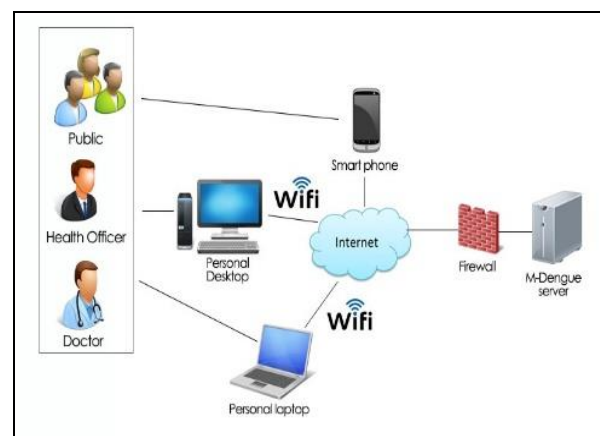


Figure 3 Architecture Diagram for M-Dengue



As illustrated in Figure 3 above, there are three types of M-Dengue user, first, the public, second, the health officer or admin, and third, the doctors. They could access the system if they are connected to the internet by using personal computers, tablets or smart phones. Moreover, it is easier for the public to submit their reports or any complaints using smart phones in real time and on specific locations. There is a firewall that controls the flow of traffic to meet security requirements. It is crucial to ensure the security of M-Dengue system. M-Dengue has a server that is responsible to run the system as well as providing database services.

B. User Interface Design

This user interface for M-Dengue is shown in Figure 4. The main modules consist of reporting, screening, consultation, dengue near me and dengue data.

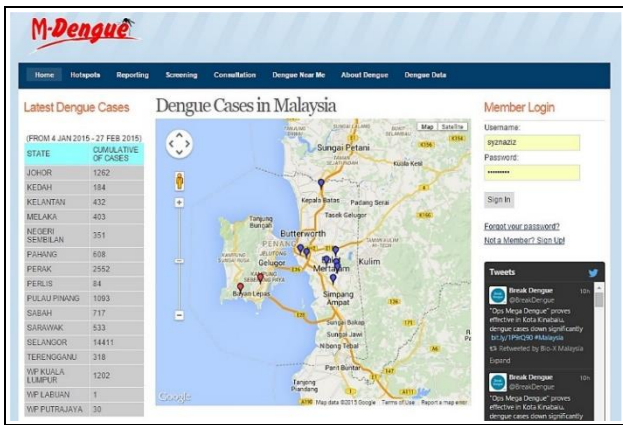


Figure 4 Home page of M-Dengue

Figure 5 shows the reporting page, which allows users to submit reports or make complaints. Users must initially log in before they could submit a report. Users are also allowed to upload a picture along with the report if necessary.

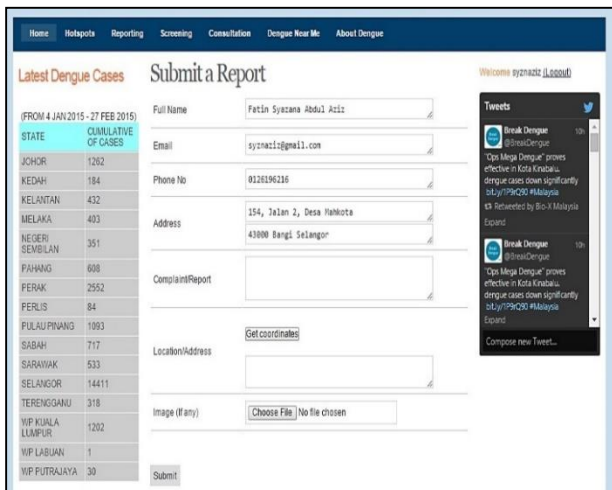


Figure 4 Reporting page for user to submit a report/complaint

The interface for dengue fever screening shown in Figure 6 below demonstrates the symptoms that dengue patients usually experience. Users need to choose which symptoms they are experiencing to get the result from screening. The result will be either "suspected dengue" or "normal fever" followed by an advice to patient for follow up action.

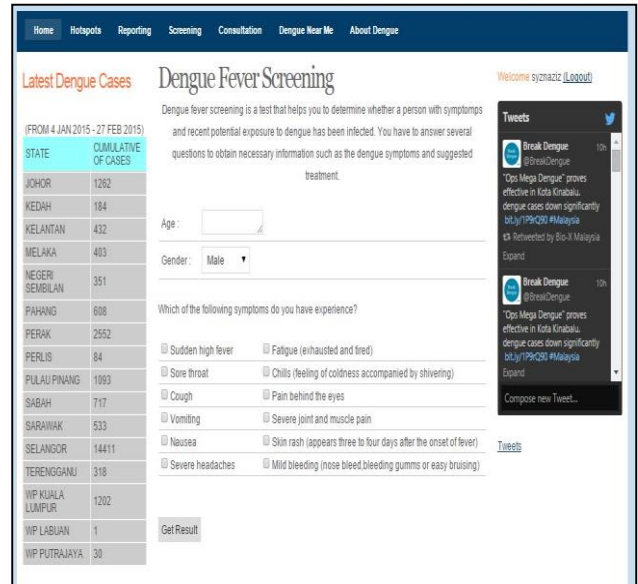


Figure 6 Screening page which allows user to screen dengue fever

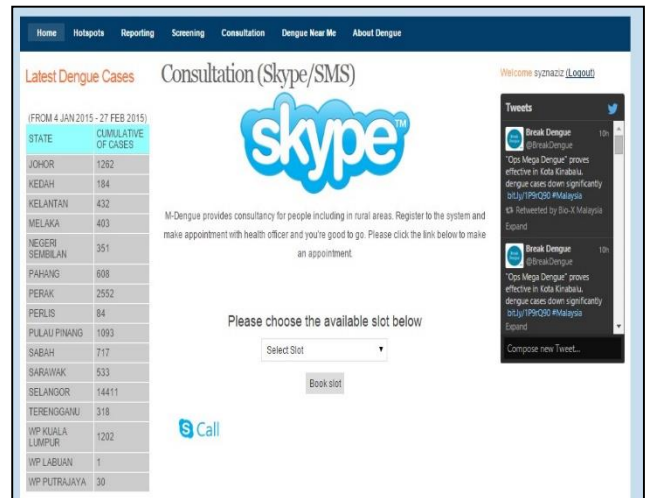


Figure 7 Consultation page for user to make appointment

Consultation page shown in Figure 7 allows the users to choose available slots for a Skype appointment. Users will receive an email notification after the slot is booked and confirmed. They must also aware of the time slot and be ready for their Skype video consultation.



Figure 8 Admin page to view and take actions of the submitted reports

As shown in Figure 8, admin could view the submitted reports in a table form. Admin could also view the full report by clicking at the View Report link. The admin could always change the report status after necessary actions have been taken. Figure 9 shows a page for users to know basic knowledge about dengue disease.

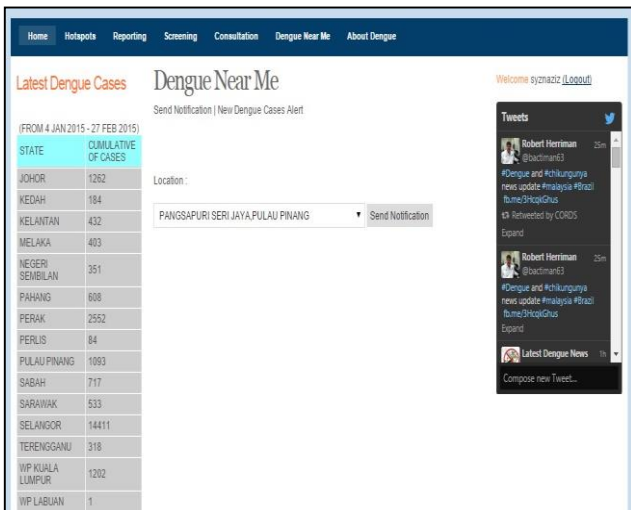


Figure 9 Admin page for Dengue Near Me function

Figure 10 demonstrates the manner used by the admin to send notification if there is any new cases nearby user's location. Users will receive an email relating to this matter. Email screenshot of Dengue Near Me notification that was sent by M-Dengue system. Figure 11 illustrates the embedded twitter feeds for real time updates for the keyword "Dengue case Malaysia".

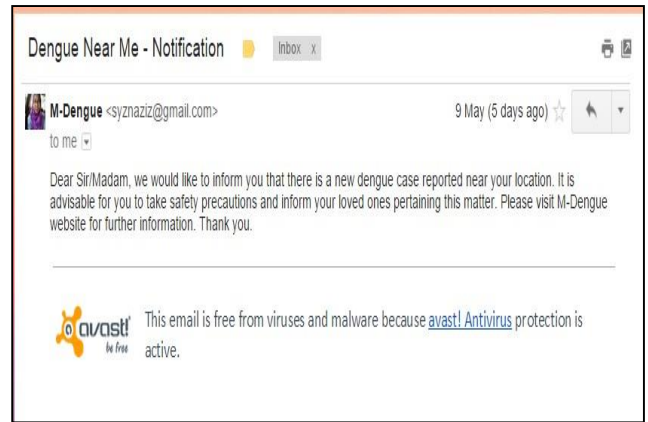


Figure 10 Admin page for Dengue Near Me function



Figure 11 The embed twitter feeds for real-time updates using "Dengue case Malaysia" as the key words

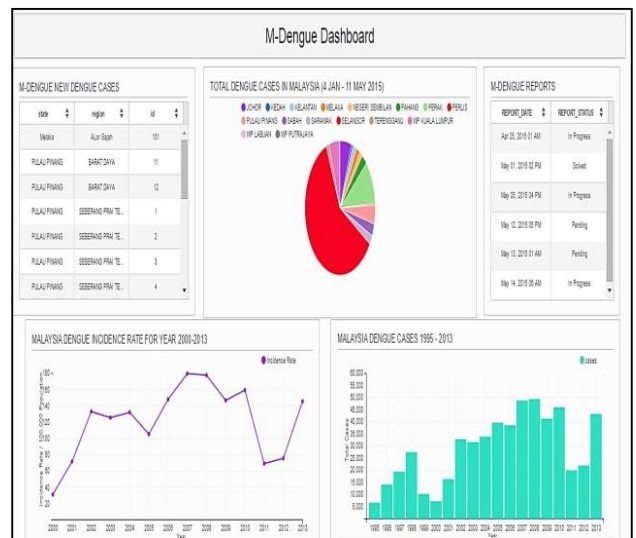


Figure 12 M-Dengue dashboard with data visualizations

M-Dengue also provide a dashboard functionality that can be viewed by admin and also the public as shown in Figure 12. The dashboard represents dengue data such as new dengue cases, total cases in Malaysia, submitted reports' status, the incidence rate and total dengue cases over the years. The data are represented using charts such as pie charts, line and bar graphs. The system also provides dynamic plot graphs. The dynamic plot graph is used to instantly retrieve the data from database and plot on the graph. Google Chart is used to represents collected data in various types of charts. The data have to be stored in an array to plot the graph. To display a chart, a page needs to load at least three libraries, which is Google AJAX API, Google Visualization library and Individual chart libraries.

## 6.0 CONCLUSION

The evolving of technology used in the medical service has encouraged us to design the proposed system, M-Dengue. The M-Dengue is designed as a one stop platform which provides real-time dengue information via web and mobile phones by utilizing the crowdsourcing technology. This technology allows public to share information and get the most recent information on dengue. This will allow the information on dengue to be to be disseminated fast and allows data sharing. The gathered information from public are then displayed in visual graphical mapping and in dashboard interfaces system for better visualization and it also helps the involved parties in make fast decisions related to dengue outbreaks in Malaysia.

The system could be further improved in the future work by developing a mobile application specifically for M-Dengue. Since smart phones are widely being used. It would be beneficial to develop a mobile application that could inform and notify users through their mobile phones about dengue. M-Dengue can also be enhanced by expanding the range of dengue cases study for not only in Malaysia, but around the globe. A system that shares real-time information about dengue cases and issues that is happening in the world to the public might help in decreasing the number of dengue cases worldwide.

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