UTM Computing Proceedings
Innovation in Computing Technology and Applications
Volume: 2| Year: 2017 |ISBN: 978-967-0194-95-0

The Development of Multi-Platforms Application for Dengue-Entomological Surveillance System

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Abstract. In Malaysia, entomological surveillance is locally applied to effectively monitor, prevent and control the dengue disease outbreaks. The team of Entomology and Pest Unit (EPU) from the State Health Office of Ministry of Health is the local division that is responsible to perform the dengue monitoring operational tasks. Nevertheless, the EPU team members are currently using the conventional and manual procedures in conducting the entomological surveillance activities. Therefore, there is a critical need to support the EPU team for the development of an automated entomological tool that should reduce the burden in manual interventions for data collection, analysis and reporting the results of entomological surveillance operations. The goal of this project is to develop multi-platforms application for Dengue-Entomological Surveillance (DES) system that will enhance and cost-effectively support the EPU team in their fieldwork especially during dengue surveillance missions. The DES system is expected to be integrated as an interactive mobile and hybrid web applications with three key features, namely: (i) automated real-time data collection for ovitrapping installation operations (ii) automated efficient ovitrapping data analysis, and (iii) automated effective report generation for overall dengue surveillance and control tasks. It is hoped that the proposed DES system shall increase the efficiency of the EPU team in systematically performing the entomological surveillance operations, and contributes to the improvement of early detection and better mechanism to strategically prevent and control the dengue outbreaks.

Keywords: Dengue, entomological, surveillance, multi-platforms application, Ovitrap.

1 Introduction

Dengue remains as global, prolong and daunting disease that spread over the world, especially in the tropical climate countries including Malaysia [1] [2]. This persistent vector not only lead to fatal incidents, unfortunately, the dengue outbreaks also poses a threat to the socio-economy impacts and local tourism industry as a whole [3]. Dengue fever is a viral disease in Malaysia with total of 101,357 reported cases and total of 237 reported deaths in year 2016. As for the first quarter of year 2017, the latest recorded dengue cases has exceeded 30% or 30,079 with 65 deaths, compared to the reported total cases throughout year 2016 (updated on 26th April 2017) [4].

In Malaysia, dengue surveillance is declared as one of the seven initiatives in National Dengue Strategic Plan (2015-2020) to combat the dengue outbreaks by improving the existing detection and response interventions at the state and national levels [5]. Specifically, the entomological surveillance is frequently applied in governing the density changes and distribution of the vector in order to effectively response and control of dengue disease outbreaks [6] [7]. The team of EPU from the State Health Office is the local division that is responsible to perform the dengue monitoring operational tasks. Nevertheless, the EPU team members are currently using the conventional and manual procedures in conducting the entomological surveillance activities. Therefore, there is a critical need to support the public health officers and field workers in EPU team for the development of automated entomological tool [7] that should reduce the burden in manual interventions for data collection, analysis and reporting the results of entomological surveillance operations.

The goal of this project is to develop multi -platforms application for Dengue-Entomological Surveillance (DES) system that will enhance and cost-effectively support the EPU team in their fieldwork especially during dengue surveillance missions. The proposed DES system is reinvented based on the business workflows and current requirements of dengue surveillance procedures, which complies with the local context of Malaysia Ministry of Health practices and guidelines during dengue monitoring operations. The EPU team from the Johor Bahru (JB) Health Office is selected as a pilot case study and the collaborator in providing the stakeholder requirements for the newly proposed DES system.

2 Project Methodology

2.1 Requirement Phase

At the initial phase of DES system development, three techniques namely (i) brainstorming workshop, (ii) closed-interview and (iii) field-observation were conducted during requirements elicitation activity. During brainstorming workshop, the preliminary decisions were made on the proposed features of the DES system by the stakeholders. The prospect users of the DES system are basically from the EPU team. The users will be classified into two categories: officers (public health specialist and entomologist) and field surveyors (public health assistant –PHA and general assistant- GA).

Also, it is decided that the operations of dengue- entomological surveillance procedures should be replicated by field-observation activity to simulate the real-situations and steps performed by the EPU team at the locality (suspected case location). Additionally, the closed-interview sessions were carried out between the developer team and prospect users of the DES system in order to better understand the currents workflows and related business rules in the entomological surveillance procedures.

Figure1 shows the Swimlane diagram that represent the roles played by the stakeholders and the detail workflows for the existing business process of dengue-entomological procedures.

It is observed that most of the data capturing process during ovitrapping installation operations is recorded and updated using the manual forms. (Note: Ovitrap also known as oviposition trap is a technique use to monitor the Aedes mosquito population and distribution in term of the number of larvae and eggs that was directly collected from the field/locality. Ovitrap is a wide-mouth 0.5 liter glass jar painted black with a piece of hardboard paddle submerged into cup).

During the ovitrapping installation, PHA needs to determine the suitable mosquitoes breeding habitats/sites. At least 60 ovitrap cups will be installed approximately within 200 metres radius of the suspected locality. The ovitrap cups will be located at the localities at least 7 days. After 7 days, PHA and GA will collect the cups and calculate the quantity of positive ovitraps. The calculation process is conducted in the laboratory environment. The percentage of positive ovitraps provides the simplest index of density levels. The related data (i.e. cups ids, houses/premises address, markers, outdoor/indoor locations, name & contact no of peoples, GPS coordinates) for each of the installed ovitraps is recorded in the manual forms during the operation.

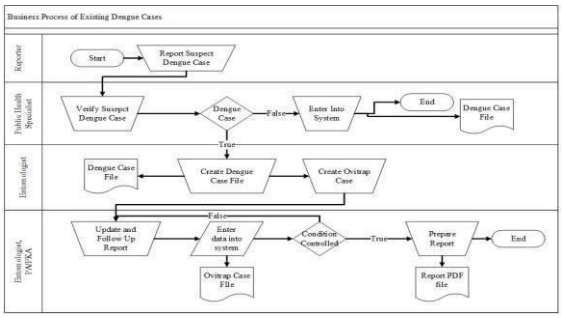

Figure1. Business process for existing dengue-entomological surveillance procedures

When the EPU team complete operation and going back to the Health Office, these recorded data in the manual forms were then transferred to the spreadsheet files using Microsoft Excel. The laboratory results for ovitrap analysis such as number of eggs, and number of larvae for each ovitrap cups as well as the index of density are also updated into the spreadsheet files. Transferring this large amount of data from paper-based filed records is a very time consuming, tedious, and error-prone process.

2.2 Analysis Phase

During analysis phase, a use case diagram is developed to conform the understanding towards user requirements and the capabilities or proposed functionalities that should be provided by the DES system to its prospect users.

Figure3 portrays the use case diagram for the proposed DES system. There are four major roles or end-users namely; health office admin, entomologist, public health assistance and general assistant – that will directly interact with the proposed system. These stakeholders are allowed to access the six main functionalities (represented by use case ID: UC001 until UC006). The health office admin is able to approve the reporter registration. The reporters are basically the verified and registered health practitioners such as government hospitals, private hospitals and the panel clinics. The entomologist has capability to create the ovitrap cases file using the web application from their desktop computers. The field surveyors workers (public health assistant and general assistant) are allow to update the ovitrap data during installation operation and get the ovitrap results using their mobile devices at locality.

2.2 Design Phase

The proposed DES system is designed based on Model-View-Controller (MVC) architecture. The system architecture is basically divided into server-side and client-side as portrayed in Figure4. Client-side will be run on users' device while the server-side will in implemented at the cloud server.

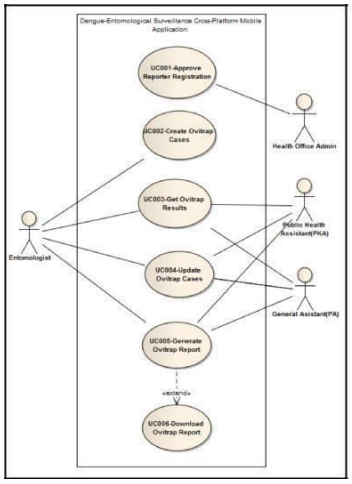

Figure 2. Use case diagram for DES system

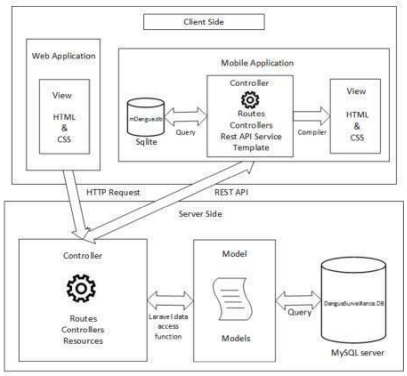

Figure 3 DES system architecture

At the server-side, controller will handle every requests (such as authentication, roles permission verification and function called) going to the server. Models class is defined in controllers to grant access for the model class. Inside model class, Laravel query function used to request data from MySQL server database. Others features of controllers are use for data validation, decisions, calculations and CRUD (Create-Read-Update-Delete) operations. At the client-side for mobile application, REST API will request data to the server's controllers and returned data to mobile application controllers, and then the compiler will compile view display to user. REST API are defined in services file and ready to be called from controllers in web application. In normal web technology, after server returned compiled page to the client, the data cannot update automatically unless using Ajax request. However, since this mobile application using Angular JS as basic framework, two ways data binding allow data and variable to update in real-time.

3 Results & Discussions

The DES system is expected to be integrated as an interactive mobile and hybrid web applications with three key features, namely: (i) automated real- time data collection for ovitrapping installation operations (ii) automated efficient ovitrapping data analysis, and (iii) automated effective report generation for overall dengue surveillance and control tasks.

It is hoped that the proposed DES system shall increase the efficiency of the EPU team in systematically performing the entomological surveillance operations, and contributes to the improvement of early detection and better mechanism to strategically prevent and control the dengue outbreaks.

Figure5 shows the snapshot example of user interface (UI) for data collection of ovitrapping installation procedure using the mobile devices feature in DES system is portrayed in Figure6.

The DES system also provide function that allows the EPU team to automatically generate the ovitrap report analysis and download the specific report based on required format (Satellite-view map, Street-view map, spreadsheet files such as Ms Word, Ms Excel and .pdf) as presented in Figure6.

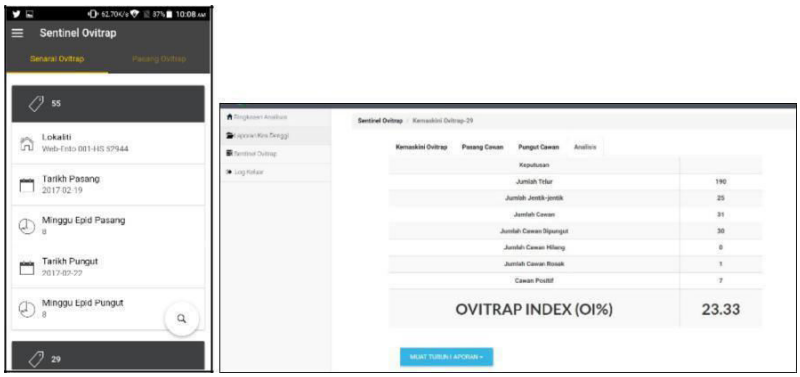

Figure4. An example of data collection and analysis UI screenshot

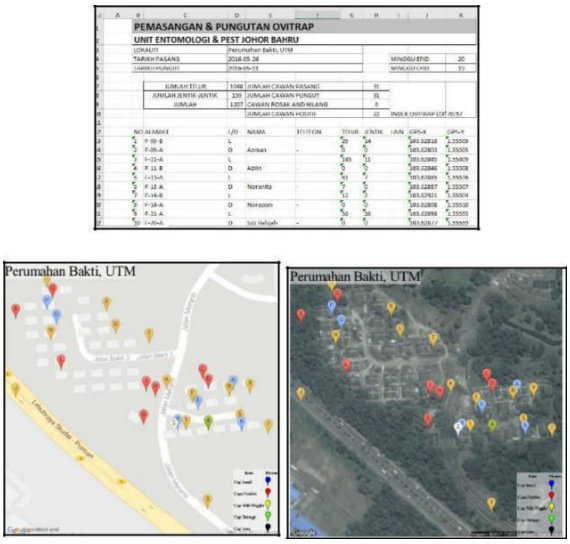

Figure6. An example of report generation screenshots based on various formats

The previous discussion has shown that, with the electronic aid of mobile computing and web technology; the automated data collection, data analysis and report generation of dengue-entomological surveillance missions during field works and laboratory tests- are possible to be achieved in more systematic, strategic and efficient manners.

Similar entomological surveillance systems such as Chaak [8] and TanRaBad [9] has been developed to support the public health community in their country particularly. Chaak is freely downloadable system for Microsoft Windows desktops and Android-based smartphone application, plus Chaak is released under General Public License version 3 (Free Software Foundation 2012). TanRaBad deployment is currently limited to the agencies under the Department of Disease Control (DDC) and has restricted information disclosure as to date.

In contrast, the proposed DES system is tailored-design based on the common ovitrapping method in collecting related data of entomological surveillance at the dengue cases localities and hotspots as discussed in Section 2. Additionally, the DES system is multi-platforms application that support integration of various mobile devices

(smartphones and tablets) platforms such as iOS, Android, Windows, as well as the hybrid web technology for desktop applications.

4 Summary

The proposed DES system is tailored-design based on the stakeholder requirements from the EPU team of Health Office, which complies with Malaysia Ministry of Health practices and guidelines. The DES system is an integrated mobile and hybrid web applications with three key features, namely: (i) real-time data collection (ii) efficient data analysis, and (iii) effective report generation for dengue-entomological surveillance operation. It is hoped that the proposed DES system will increase the efficiency of the EPU team in systematically performing the entomological surveillance operations, as well contributes to the improvement of early detection and better mechanism to strategically prevent and control the dengue outbreaks. As conclusion, it is targeted that the current DES prototype should be evaluated by the EPU team in a near future in order to validate and test the user experiences.

Acknowledgements. This study is partially funded by the Research University Grant (RUG) from Universiti Teknologi Malaysia (UTM) under Cost Centre No. Q.J130000.2528.13H45. In particular, the authors wish to thank the EPU team from Johor Bahru Health Office for their professional collaboration and knowledge sharing in the development of DES system.

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