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# An Evaluation Study on Dengue-Entomological Surveillance System Using Alpha Acceptance Test

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***Abstract*— Regular practice of an alpha test in system acceptance test is to involve users, who are internal to the organization, which takes place at the developers' site. The aim of an alpha test is to get early feedback from users and to identify bugs in order for improvements to be made. Instead of carrying out regular alpha test activities, System Usability Scale (SUS) method is used in the alpha test. The main aim of this paper is to report on how the SUS is applied as a part of an acceptance test for a newly built multi-platforms application, known as Dengue-Entomological Surveillance (DES) system. The DES system is built both as an interactive mobile application and a hybrid web application that allows its end-users; Entomology and Pest Unit (EPU) team from State Health Office of Ministry of Health of Malaysia, to collect real-time data encompassing data from ovitraps installation, automatized data analysis, as well as, entomological surveillance operations' reports concerning dengue outbreaks. Experimental design and procedures of the alpha test were carefully planned and successfully implemented. Participants' (EPU team) demographic data, execution and completion time for given tasks, and user experience on DES system comprising usability, as well as, general comments and feedback from users were collected and analysed. The findings of the alpha test reveal a higher percentage total of SUS score usability of the web-based application with 72.75%, as compared to 68.75% for the mobile-based application.**

***Keywords*— alpha testing; usability; user acceptance testing; dengue surveillance; entomological; health application**

## I. INTRODUCTION

Alpha testing is a type of acceptance test, which involves users' participation at developer's site in order to obtain early feedbacks and identify software bugs. Regular practice of an alpha testing is to consider users who are internal to the organization itself [1]. The practice of an alpha testing normally involves black box and white box techniques [2].

Usability testing or evaluation, meanwhile, focuses on usability aspects and sometimes the experience of users, in order to obtain early feedback from the users. By doing so, the design of the systems could be improved. Usability evaluation is a common practice in any kind of projects that adopt a user-centered design approach or interaction design approach [3].

Currently, reported usability evaluation of health-based information systems is scarce [4]. Researchers are prone to introducing new tools in this domain without any mentioning of the evaluation done by the tools that involve real stakeholders [5], [6], [7]. Therefore, there is a need to highlight an experimental design involving this evaluation, specifically, the outcome of the evaluation in order to promote the importance of quality for products or tools developed for this health-based domain.

Consequently, the objective of this paper is to present the designed procedures of alpha acceptance testing and its finding results in validating the developed Dengue-Entomological Surveillance (DES) system. DES prototype is basically a multi-platforms application system that is developed to help the team of Entomology and Pest Unit (EPU) from the State Health Office of Ministry of Health in data collection, analysis and reporting the results of entomological surveillance operations to combat dengue outbreaks [8]. The EPU team from the Johor Bahru (JB) Health Office is chosen to become participants in the experimentation in order to validate and test the user experiences towards the DES system.

This paper will first briefly describe the developed DES system, followed by a related work with regard to this topic. It will also include some related works on the current technologies that support entomology-dengue activities and processes. Subsequent section then presents the design procedures of an alpha testing performed in the built application. Analysis of results is discussed in the next section. The paper ends with a conclusion and future work.

## II. Material and Method

### A. *Dengue Entomological-Surveillance System*

DES system is basically an interactive mobile and hybrid web applications with three key features: (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 [8]. This automated entomological surveillance tool has been developed using both Model-Controller-View and Model-Controller-Controller-View (MVC and MC-CV) approaches. In brief, the DES system architecture is divided into server-side and client-side as shown in Fig. 1.

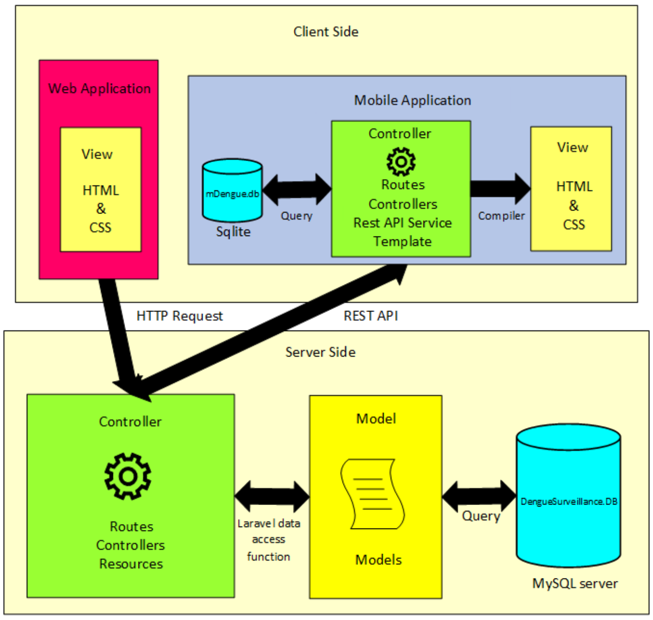


Fig.. 1 Architecture of DES system

In server-side, the controller acts as the mediator between Model and client-side View. It handles requests from users (i.e., authentication, role permission, verification, and function calls) with the help of a Middleware module. Other features of controllers comprise data validation, decisions, and calculation operations. Models are associated with database tables. Models handle the relations and operations from controllers. In the DES application, a Laravel query function is used to request data from MySQL database. Client-side interacts with the server through a Hypertext Transfer Protocol (HTTP) request.

For mobile application, Representation State Transfer (REST) APIs are created to interact the users with the cloud server. REST requests are defined in services file and called from controllers in a mobile application. In a mobile application, only data are transmitted between clients and server through REST requests. Partial Hypertext Markup Language (HTML) view is transmitted between server and clients by Asynchronous JavaScript and XML (AJAX) technique in web application [8].

### B. *Related Works*

Most software houses have already made testing as a practice in their respective organizations, or a part of regular activities in their software development process. The common tests performed are unit, integration, system, and acceptance tests. Focusing further on acceptance test, the most common practice is the execution of a user acceptance test, which frequently excludes alpha, beta, and usability tests [9], [10]. Measuring and assessing the technology readiness for the application of the domain-specific is vital to ensure the built applications met the user's expectation [11]. In addition, Salim *et al.* [12] for example, performed testing to validate the user acceptance of technology specifically for the healthcare related mobile application that embeds persuasive design principles.

The success of adopting and applying usability testing as a part of a software development process can be seen in many reported projects [13]. Researchers highlighted that in cases where instead of practicing regular alpha/beta testing in a developed software, it is found that usability testing is able to discover more than just functionality issues, which has helped to improve the quality of the software tremendously.

In this study, the usability of mobile and web applications is evaluated based during and on post questionnaires filled in by participants, which adopts a System Usability Scale (SUS) questionnaire [14], [15]. In a systematic literature review performed by Zapata *et al.* [16], it was revealed that questionnaire was highly preferred among researchers to assess usability. The findings revealed that 82% of participants that are involved in usability evaluation of health-related mobile applications had utilized SUS, which involved real stakeholders of the system. Most researchers assessed efficiency, effectiveness, and satisfaction of users when evaluating usability for health-related applications [17]. Effectiveness and efficiency deal directly with the implementation and system design; therefore, they are frequently assessed during usability testing. Satisfaction deals with the extent of user's attitudes towards tasks that can be achieved via tested mobile applications [17].

In SUS, there are ten perceived usability criteria required to be rated by a participant. Each criterion would have a Likert scale starting from the highest scale-"strongly disagree (scale score=5), and ending with the lowest scale-"strongly agree (scale score=1) [15]. Brooke highlighted the importance of observing total SUS score, instead of individual scale score [15]. In order to obtain total SUS score, Brooke split score calculation strategies into two. First, for SUS criteria in odd number position-1, 3, 5, 7, 9, each respective scale score rated by the participant would be calculated by subtracting it by one (scale score – 1) in order to obtain respective SUS contribution score. Second, for SUS criteria in even number position-2, 4, 6, 8, 10, five would be subtracted by each respective scale score rated by the participant (5 – scale score) in order to obtain respective SUS contribution score [15].

A quick look at the current technologies in facilitating the activities of entomologists in dengue prevention process shows that software alpha/beta testing is an essential step for health-related applications. Chaak [17] for example, is a similar entomological surveillance tool to DES system. In contrast, Chaak is a Window-based system and currently support only Android version for mobile application. It is reported that Chaak's developer has already conducted the beta field-testing concurrently with a pen-and-paper-based method to measure its performance in real environment settings [17].

### C. Experimental Design

In this study, the procedures of the alpha test which considers usability evaluation were divided into four sessions. The activities in session one involved meeting's introduction and participants' demographic data collection. The activities in session two involved alpha testing on web application and distribution of questionnaires to participants. The activities in session three involved alpha testing on mobile application and distribution of questionnaires to participants. The activity in session four involved recording feedbacks from participants concerning both mobile and web platforms. Each alpha testing task was allocated a duration of 35 minutes, while the post-testing questionnaire was allocated a duration of 10 minutes. The remaining tasks were allocated 5-10 minutes each. For mobile application testing, participants were divided into two different time slots. The sessions, their respective tasks and the detailed agenda of the alpha testing are listed in Table 1.

In addition to that, each participant was required to perform both mobile and web application activities. The tasks involving these activities were guided, in which steps are provided to participants. The steps are there for them, to begin with, the tasks and for their references, as they need to. Based on Table 2, an entomologist will have 12 steps to be carried out on a web application, while 12 steps to be carried out on task for mobile application. Meanwhile, public health assistant and general assistant will have 11 steps to be carried out on task for web application and 11 steps to be carried out on task for mobile application. There are differences in terms of a number of steps for different stakeholders' roles due to the limited access and interactions toward the DES system as reported in [8].

The alpha testing was carried out in Project Management Office, Faculty of Computing, Universiti Teknologi Malaysia, for one-day. All participants were seated in one table, grouped according to their respective roles. Fig. 2 shows the location setup for the alpha testing's participants.

Six documents were prepared for alpha testing comprising: user guideline for a web application, user guideline for mobile application, demographic questionnaires, post-test questionnaires, data sheet, and time record document. User guideline document records detailed steps to be carried out for alpha testing. The demographic questionnaire is collected to help to determine factors that could influence a participant's response towards the both web and mobile applications of DES system. Post-test questionnaires comprise a list of questions given to participants after the completion of system testing. The post-test questionnaires concern with participants' responses to the system from the aspect of usability of the system.

TABLE I
EXPERIMENTATION PROCEDURES AND AGENDA

| Activities | Time slots | Duration |
|---|---|---|
| **Session 1** | | |
| 1. Briefing on alpha testing flow | 0900 - 0905 | 5 minutes |
| 2. Fill-in demographic questionnaire | 0905 -0915 | 10 minutes |
| **Session 2** | | |
| 3. Alpha testing on web application | 0915 - 0950 | 35 minutes |
| 4. Fill-in post-testing questionnaire for web application | 0950 - 1000 | 10 minutes |
| **Break** – 5 minutes | | |
| **Session 3** | | |
| 5. Alpha testing on mobile application (Part 1) | 1005 - 1040 | 35 minutes |
| 5. Alpha testing on mobile application (Part 2) | 1040 - 1115 | 35 minutes |
| 6. Fill-in post-testing questionnaire for mobile application | 1115 - 1125 | 10 minutes |
| **Session 4** | | |
| 7. Feedback session | 1125 - 1135 | 10 minutes |

TABLE II
STEPS QUANTITY FOR EACH ROLE

| SESSIONS | Steps | |
|---|---|---|
| | **Web** | **Mobile** |
| Entomologist | 12 | 12 |
| Public Health Assistant | 11 | 11 |
| General Assistant | 11 | 11 |

Fig. 2 Location set-up of alpha testing

The data sheet contains document to record the input data that is entered by participants into the application during alpha testing. Time record document allows the user to comment and record their tasks' execution time. The Camtasia Studio software was also installed in each participant's laptop and being used during the testing sessions to record the time taken.

Software environments for alpha testing comprised two platforms including mobile platform and computer (web) platform. For the mobile platform, there were two mobile operating systems involved, which include Android and iOS. Meanwhile, for the computer platform, there were two computer operating systems involved; Windows and Apple OSX. A total of five Windows laptops and five Apple OSX MacBook laptops were provided to participants, while four Android phones and two iOS phones were provided to participants for mobile platform testing. Prior to the alpha testing day, both DES system web page and mobile application were installed and bookmarked in every device that was going to be used. During the alpha testing day, entomologist participants used MacBook laptops for web application alpha testing, while public health assistant and general assistant participants utilized remaining MacBook laptops and Windows laptops according to their preferences. The details of laptops distributed to participants for web application testing are shown in Table 3.

TABLE III
LAPTOPS DISTRIBUTION FOR WEB APPLICATION TESTING

| Role | Device | Quantity |
|---|---|---|
| Entomologist | MacBook | 3 |
| | Dell Laptop | 0 |
| Public Health Assistant | MacBook | 1 |
| | Dell Laptop | 2 |
| General Assistant | MacBook | 1 |
| | Dell Laptop | 3 |

According to the experiment's activities time slots in Table 1, web application testing comprises one part, while mobile application testing comprises two parts. Mobile devices distribution is shown in Table 4. The first part of mobile application testing involved six participants while four participants were involved in the second part of alpha testing.

### *D. Demographic Data*

Table 5 shows participants' roles with their working experience as members of a dengue surveillance team. Overall, from ten participants, only one participant is an entomologist with grade C44, while the remaining participants comprise two-grade C41 entomologists, three grade U19 public health assistants, and four grade H11 general assistants. From Table 5, it is evident that 80% of participants involved in this alpha testing have acquired more than two years working experience in dengue surveillance related works. In entomologist role, none of the participants are in the role with less than two years working experience. However, one participant who holds a public health assistant role and one participant who holds a general assistant role is relatively new in the dengue surveillance team.

TABLE IV
DEVICES DISTRIBUTION FOR MOBILE APPLICATION TESTING

| Part | Role | Device | Quantity |
|---|---|---|---|
| I | Entomologist | Android | 2 |
| | | iOS | 0 |
| | Public Health Assistant | Android | 1 |
| | | iOS | 1 |
| | General Assistant | Android | 1 |
| | | iOS | 1 |
| II | Entomologist | Android | 1 |
| | | iOS | 0 |
| | Public Health Assistant | Android | 1 |
| | | iOS | 0 |
| | General Assistant | Android | 2 |
| | | iOS | 0 |

TABLE V
PARTICIPANTS' WORKING BACKGROUND

| Role | Frequency (N=10) | Experience(Years) | | | |
|---|---|---|---|---|---|
| | | <2 | 2-5 | 5-10 | >10 |
| Entomologist C44 | 1 | 0 | 0 | 1 | 0 |
| Entomologist C41 | 2 | 0 | 2 | 0 | 0 |
| Public Health Assistant U19 | 3 | 1 | 0 | 1 | 0 |
| General Assistant H11 | 4 | 1 | 0 | 1 | 0 |

With regard to participants' background on technological devices usage, seven participants are Android device users, two participants are iOS device users, while one participant does not own a mobile device. Mobile device is a basic communication tool in today's life, but despite this fact, there is one participant who claimed to have zero years of experience on using a mobile device while others have more than three years of mobile device user experience. 10% of participants have little experience on using a mobile device.

Little experience in mobile device usage refers to basic usage mobile device functions including Short Message Service (SMS) and making and receiving calls. Four out of ten participants claimed that they have average skills in using mobile devices. Average skill refers to participants' ability to use mobile device's applications (i.e., social media and entertainment applications), other than SMS, and making and receiving calls. Meanwhile, another 40% of participants claimed that they have substantial and professional skills on using mobile devices. Professional skills on using mobile devices refer to participants' ability to use mobile devices to perform other than general purpose tasks like composing and sending e-mails. The details of the experience of participants on using mobile devices are shown in Table 6.

TABLE VI
PARTICIPANTS' EXPERIENCE ON USING MOBILE DEVICE

| Role | Year | | OS | | Range | Frequency-% |
|---|---|---|---|---|---|---|
| | 0 | >3 | Android | iOS | | |
| Entomologist | 0 | 3 | 3 | 0 | None | 0 |
| | | | | | Little | 0 |
| | | | | | Average | 1-10 |
| | | | | | Substantial | 2-20 |
| | | | | | Professional | 0 |
| Public Health Assistant | 0 | 3 | 2 | 1 | None | 0 |
| | | | | | Little | 0 |
| | | | | | Average | 1-10 |
| | | | | | Substantial | 1-10 |
| | | | | | Professional | 1-10 |
| General Assistant | 1 | 3 | 2 | 1 | None | 1-10 |
| | | | | | Little | 1-10 |
| | | | | | Average | 2-20 |
| | | | | | Substantial | 0 |
| | | | | | Professional | 0 |

## III. RESULTS AND DISCUSSION

In this section, two important results of the alpha testing namely (i) the efficiency analysis on the steps execution time and (ii) user experience usability on the system based on SUS criteria are discussed in details.

With regard to the time taken for tasks completion, this study highlights on the average execution time for 12 steps performed by the entomologist, as mentioned in Section III experimentation procedure; Table 3. Fig. 3 shows steps execution on the web and mobile platform by entomologist and their respective average time. The average execution time of a step is directly proportional to a complexity of the step. Each execution time in step 6, 7, and 8 of the web application is higher than other steps, as these steps involved data entering the action. Participants required more time to enter ovitrap data and cups data into the system. For mobile application, the execution time of steps 7 and 11 are significantly higher than others task. Step 7 and 11 are steps which involved inserting input of ovitraps data and cups data through mobile devices. Since virtual keyboard on mobile devices is smaller, the average time it took to complete inserting input through mobile phone is clearly higher. However, when creating ovitraps case file, participants were able to automatically retrieve participants' current address to be used as an input data. This automatic retrieval of current address feature in the DES mobile application enabled the participants on a mobile application to consume less time to perform step 7 compared to the web application.

Table 7 and Fig. 4 show post-questionnaires' results, after the completion of alpha testing on web application and mobile application, respectively. The SUS was utilized, which helped to measure system satisfaction and sub-scales of usability and learnability. Questions 4 and 10 address the learnability dimension while the remaining eight questions address the usability dimension [19].

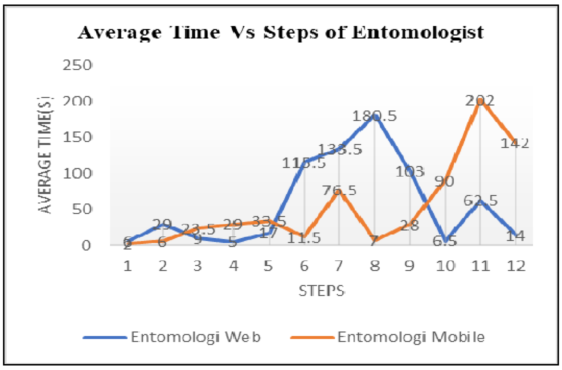


Fig. 3 Average time of step execution of entomologist on web and mobile applications

TABLE VII
POST QUESTIONNAIRE RESULTS

| SUS Questions | Web | | Mobile | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| 1. I think that I would like to use this system frequently | 3.8 | 1.38 | 3.5 | 1.46 |
| 2. I found the system unnecessarily complex | 1.9 | 0.54 | 2.3 | 0.64 |
| 3. I thought the system was easy to use | 3.9 | 1.14 | 3.8 | 0.31 |
| 4. I think that I would need the support to be able to use this system | 2.9 | 1.14 | 3.7 | 0.78 |
| 5. I found the various functions in this system were well integrated | 3.8 | 0.87 | 3.8 | 1.08 |
| 6. I thought there was too much inconsistency in this system | 2.2 | 0.96 | 2.2 | 0.6 |
| 7. I would imagine that most people would learn to use this system very quickly | 4.2 | 1.17 | 4.3 | 0.78 |
| 8. I found the system very cumbersome to use | 2.3 | 0.85 | 2.3 | 0.54 |
| 9. I felt very confident using the system | 2.4 | 1.06 | 4.0 | 0.55 |
| 10. I needed to learn a lot of things before I could get going with this system | 3.8 | 1.17 | 4.0 | 0.63 |

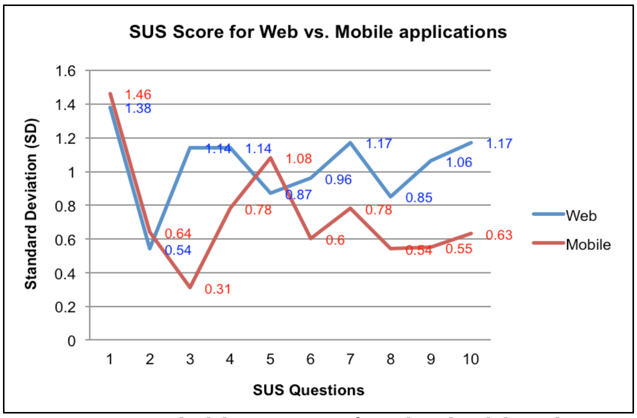


Fig. 4 SUS standard deviation score for web and mobile application

Interesting facts to be discussed from the result is that the SUS score of DES web-based application is higher than mobile application score. Based on Table 7 and Fig. 4 results, it looks like the web version has the upper hand as compared to the mobile application. Users slightly think they would like to use the system frequently on the web as compared to mobile, which is consistent with their opinion in finding the usage of the web is unnecessarily complex with a mean of 1.9 (vs. 2.3 with mobile). Users also think that they would need the support to be able to use especially with the mobile version with 3.7 (mean), as compared to 2.9 with the web. Users are also in the opinion of needing to learn a lot of things with the mobile application before they could get going with the system.

Nonetheless, they thought both applications were easy to use with especially with the mobile (3.8+-0.31) and found both versions' various functions were well integrated, besides imagining that most people would learn to use both versions quickly. They also thought that both versions do not have too much inconsistency, nor the versions were very cumbersome to use. The fascinating fact, however, despite what has been mentioned above about mobile application, users felt very confident using the system on mobile, as compared to the web application. This could be the fact that every user already familiar and has experience with mobile applications.

Additionally, the SUS has allowed us to receive enriched feedbacks as opposed to the usual alpha/beta testing. Fig. 5 portrays six categories namely: Best imaginable, Excellent, Good, Fair, Poor and Worst imaginable - in Adjective Ratings Scale in interpreting the obtained SUS score. Using the SUS calculation formula by Brooke [15], the overall total SUS score for the alpha testing of the web application is 72.75%, which is in 'OK' category and very much near to 'Good' category. Meantime, the SUS score of the mobile application is 68.75% which slightly lower than the 'Good' category.

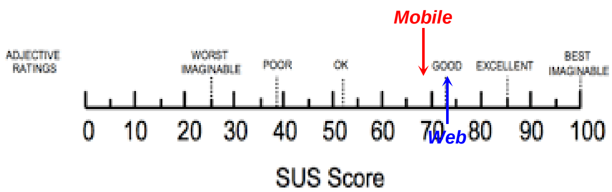


Fig. 5 SUS score for web and mobile applications

Apart from that, there are several recommendations suggested by participants for future improvements of the DES system, as obtained from feedbacks session in this alpha acceptance testing. Firstly, for the functional requirement, participants suggested an update on the current applications' business flow to match the latest business process of a dengue surveillance operation in practice by state health office. Additionally, participants suggested an increment on the quantity of available dynamic report download formats in report generation function. Secondly, for non-functional requirements, participants requested for a reduction in the frequency of data flow that occurs between client and server, in order to improve the performance of the DES system.

## IV. Conclusion

This paper reports on the well-planned experimentation procedures of alpha testing which incorporates the SUS measurement and its findings results in evaluating the user acceptance for the DES system, an automated tool for EPU team in performing the entomological surveillance and dengue control tasks operation. The DES system is a multi-platform application that supports integration of various mobile devices (smartphones and tablets) platforms such as iOS, Android, Windows, as well as the hybrid web technology for desktop applications. The overall findings of the conducted alpha testing highlighted that total SUS score usability for the web-based application is 72.75% much higher, compared to 68.75% for the mobile-based application. For future work, it is targeted that the current DES system will be further validated using beta testing using real settings at the local environment. The beta testing will be conducted once the current prototype is improvised based on the participants' feedbacks during this alpha testing.

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