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Design and Evaluation of Mobile-Based Applications for Supporting Malaria Surveillance Activities in Indonesian Regions

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Keywords

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Abstract

In malaria elimination programs, surveillance is a critical component. In Indonesia, an electronic information system was created to carry out malaria surveillance in the form of a structured excel file as part of an attempt to enhance the validity and completeness of reporting malaria data. However, the use of this method has several obstacles that are still felt by health workers. This study designed an Android-based malaria surveillance application as an alternative solution to the method that has been applied. The evaluation results show that the overall impression of this application is very good (mean, median (on a 9-point scale) and standard deviation equal to 6.84, 6.88 and 0.29, respectively). This means that in general, health officers as application users are satisfied with the applications that have been developed.

Introduction

Malaria is a deadly disease worldwide in both tropical and subtropical regions (Mitchell et al., 2021) caused by the Plasmodium parasite and vectored by mosquitoes WHO estimated that there were 229 million cases of malaria globally in 2019 (World Health Organization (WHO), 2020). Because of various factors, for example, environmental ones in Ethiopia (Dabaro et al., 2021) and mosquitoes and human population mobility in Pangandaran District in Indonesia (Hakim et al., 2018), and malaria control program activities (MoH, Indonesia) there has indeed been a decrease in malaria cases in 2015 when compared to the previous period. However, WHO noted that in 2018 there were 261,617 cases of malaria, globally (World Health Organization (WHO), 2018). This is a sizeable number that shows malaria is still a terrifying threat to our country.

There are several strategies to stop the spread of malaria worldwide such as Insecticide-treated net utilization for prevention activity (Yirsaw et al., 2021), examination of thick and thin blood slide for early detection and diagnosis, malaria microscopy standardized malaria slide set for quality assurance of microscopist (Horning et al., 2021; Yu et al., 2020), high-resolution melt analysis (Kassaza et al., 2021), Automated Detection of Malaria Parasites (Kuo et al., 2020; Rosado et al., 2016), malaria rapid diagnostic test for screening and mass blood survey (Ogunfowokan et al., 2020) and to treat Malaria using Artesunate Combination therapy plus other activity such as environmental management. Investment in surveillance systems to support timely management responses is essential for malaria elimination. (Hasyim et al., 2020[1])

In Indonesia, the National Malaria Program (NMP), the government, local governments, development partners, and the community are all committed to achieving malaria elimination in a systematic and organized manner. The target is Malaria will be fully eliminated by 2030. (Ministry of Health Indonesia, 2018). The stages of elimination are control, pre-elimination, elimination, and prevention of re-introduction. In malaria elimination programs, surveillance is a critical component (Gunasekera et al., 2021). So, it is important to strengthen surveillance to have reliable real-time data that can be used by malaria program managers to eliminate Malaria. One of the most critical aspects of implementing a successful surveillance system is recording and reporting. In 2010, an electronic information system, namely -ESISMAL was created to carry out malaria surveillance in the form of a structured excel file as part of an attempt to enhance the validity and completeness of reporting malaria data.

However, after conducting observations and interviews, health officers still found some problems using the current malaria surveillance system. Because it is spreadsheet-based and uses macros, the installation process for this system is not simple. Even though they have been assisted by the system user manual document, some health officers still find it difficult to carry out this step. Likewise, with the availability of the device to enter data into a macro-based excel file, one must use a computer/laptop. For this purpose, the health center must provide tools for the activity. Some of the health centers only have one computer which is shared. Meanwhile, the health center officers rarely have their own laptops that can be used to enter surveillance data. This is of course an obstacle in itself for health officers so that the process of delivering malaria data is not optimal. In addition, activities that require health officers to go to the field to obtain data are also impractical considering that the equipment for entering data is in the health center. So, health officers need to first record the survey data in a separate document and then enter it into the system when they arrive at the office. This is of course less efficient and risk for data input errors because it is done twice.

Based on these problems, this study aims to design an Android-based malaria surveillance application as an alternative solution to the current spreadsheet method. Several countries have implemented this solution for malaria surveillance, such as India (Rajvanshi et al., 2021)

and Sri Lanka (Gunasekera et al., 2021). This application can later be used by the health center officers to carry out malaria surveillance activities in the field as well as to store and send the data to the data center of the ministry of health. The design of this application will then be evaluated for user satisfaction using the Questionnaire for User Interaction Satisfaction (QUIS) 7.0 questionnaire as a measuring tool to assess user subjective satisfaction with certain aspects of human-computer interaction, in this case, the interaction of health center officers with android -based malaria surveillance applications.

Method

This research consists of the stages of observation and in-depth interviews with selected informants. We have optimized the current e-Malaria Information System (MIS) to an e-MIS android-based mobile in the computer laboratory (comlab) Faculty of Computer Science Sriwijaya University (Hasyim et al., 2002[2]). The data can be accessed in http://sismal.malaria.id/ used with permission.

Requirement Elicitation

Identification of stakeholder requirements was done by conducting interviews with provincial health office officers, sub-directorate of malaria. As noted previously health workers store surveillance data in an Excel spreadsheet that already has a specific data structure based on a laptop computer located in the office/health center. The malaria surveillance data in this file is grouped into five sections: Village Baseline Data for the Health Center Coverage (Key Info), Malaria Patient Register, (Regmal 1), Logistics Data and Malaria Program (Regmal 2), Malaria Vector Control Data (Vector), and Malaria Focus Control Data (Focus). In the reporting period, files containing this data will be sent via a website-based application to the data center of the Ministry of Health.

In the existing system, at this stage, several expected business needs are generated, namely where the officer hopes the application can store data locally and that the determination of the survey location can be done automatically when the health officer is conducting a field survey. The first business need is that the application is expected to store data locally on smartphones owned by employees. When entering data, officers do it one by one and not at the same time. With the local data storage feature, the application does not need to be constantly dependent on an internet connection, which can make it difficult for officers who are in areas with limited internet connections.

Another requirement obtained from the interview results is that the system is expected to automatically determine the location when survey activities are carried out in the area. Applications are expected to reduce data that must be entered manually so that data entry work can be done more quickly. Since there is some location-based data, this feature will significantly increase the work efficiency of officers.

Identifying System Requirement

Based on the results of this interview process, a recent literature search was carried out to find system requirements. From several scientific articles, there are several system requirements related to application design, especially the form part that can be used in malaria data survey applications, namely the use of labels for data forms, one-way scroll, dividing the page into several sub-pages, adjusting the field size (Troiano et al., 2009), table data represented using a simple form display (Łobaziewicz, 2015), automatic location filling using GPS periodically (Heroza et al., 2019), as well as the use of local databases for large data storage (World Wide Web Consortium (W3C), 2010).

Prototyping

After identifying user needs for the application to be developed and researching system requirements, a mobile-based application prototype was created. Applications were built using the Android platform with the Java programming language and SQLite database as local data-storage technology. Android was

chosen because this platform has a market share in Indonesia in the last year of 92.39%, far ahead of iOS in second place (7.39%) (Mobile Operating System Market Share Indonesia StatCounter Global Stats, n.d.).

Evaluation

The prototypes that have been made were then evaluated by 16 health workers. User satisfaction in using the application was evaluated using the Questionnaire for User Interaction Satisfaction (QUIS 7.0). Quis 7.0 was used to determine the user's level of satisfaction on a 9-point scale. This questionnaire has been widely used to evaluate the usability of mobile apps or other softwares (Biduski et al., 2020; Chen & Bell, 2011; da Silva & Magalhães, 2021; Delamarre et al., 2020; Hussain & Kutar, 2012; Moumane et al., 2016). Unlike the System Usability Scale (SUS) which assesses the usability of software in general (Yunita et al., 2018), Quis 7.0 evaluates several aspects of software, namely screen, Terminology and System Information, Learning, System Capabilities, and General Impressions. The results of this evaluation will be used to develop a more complete malaria surveillance application.

Results

A prototype of an Android-based mobile malaria surveillance application has been developed. This prototype is an Android application that can be used by public health center officers to enter the data needed in malaria surveillance activities which includes five types of data, namely the Village Basic Data for the Health Center Coverage (Key Info), the Register of Malaria Patients, (Regmal 1), Logistics Data and the Malaria Program. (Regmal 2), Malaria Vector Control Data (Vector), and Malaria Focus Control Data (Focus).

To make it easier for officers to enter data that has many attributes, each menu is further divided into sub-menus such as Key info divided into key info and a list of villages; Regmal 2 is divided into discovery data, logistical data, withdrawal data, and cross-test data; The focus is divided into active focus and indigenous cases (figure 1). Each data set has a list view that displays the data that has been entered, and a display form that can be used by officers to add new data or change existing data. For example, officers can view village data in an area (figure 2) or add new village data (figure 3).

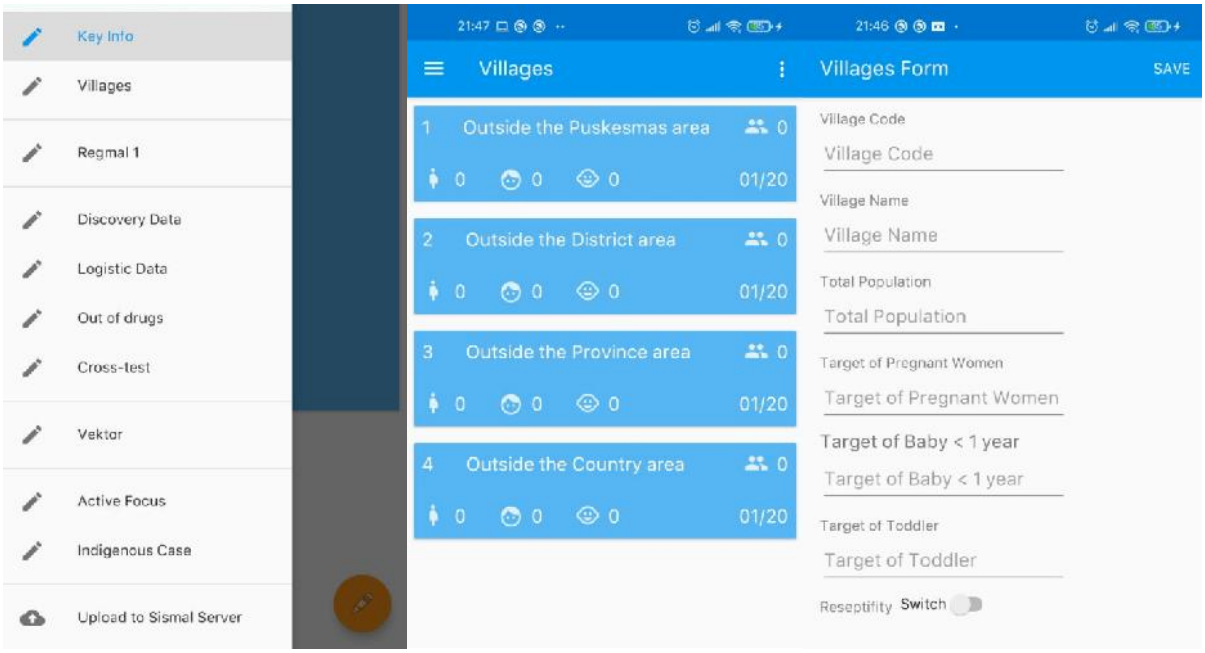

Figure 1. Application Menu **Figure 2. List of Villages** **Figure 3. New Village Form**

During the data entry period, the data entered by the health center staff is stored in local storage media on an Android smartphone. This is so that the process of entering data by officers can be done more quickly. In addition, officers who work at the health center locations with limited internet access can still carry out their jobs properly. After the officer has entered all the data in one period of entering the data, the officer can select the Upload data menu to send the data directly to the database on the central server of the Ministry of Health. Only for this process will the officer need internet access so that the previously entered data can be sent. The data that has been collected can then be seen through the malaria surveillance web application where district/city and provincial level officers can see the recap of data entered by all the health centers in each region.

Evaluation

The results of application evaluation using The Questionnaire for User Interaction Satisfaction (QUIS 7.0) can be seen in Table 1. Satisfaction Measure (On a 9-point scale; the higher the number the greater the satisfaction).

Aspects	Mean	Median	Std. Deviation
Screen	6.81	6.88	0.86
Terminology and System Information	6.61	6.75	0.67
Learning	6.61	6.63	0.47
System Capabilities	6.53	6.5	0.53
General Impressions	6.84	6.88	0.29

Discussion

This section discusses the results obtained by analyzing respondents' answers to the QUIS 7.0 questionnaire. Table 1 shows the measures of the mean, median, and standard deviation of each aspect measured by the instrument. The overall impression of these applications is very good (mean, median, and standard deviation equal to 6.84, 6.88, and 0.29, respectively) [20]. This means that in general, officers as application users are satisfied with the application that has been developed.

For the Screen aspect, the mean, median, and standard deviation values are 6.81, 6.88, 0.86 respectively. This result is in the very good category and can still be improved because the application being tested is still only a prototype. With an improved display design, it is hoped that users will like this application more.

The scores for the terminology and information aspects of the system, mean, median and standard deviation were 6.61, 6.75, 0.67, respectively. This figure is also in the very good category. In general, the application has attempted to provide adequate information, especially in the form section, where users are guided in filling out form fields using labels in each field.

Regarding the Learning aspect, the mean, median, and standard deviation values are 6.61, 6.63, and 0.47 respectively. This shows that the application is easy to learn even though the application manual has not been provided. Even though it is classified as very good, this aspect can still be improved by preparing documentation or application manuals that are shared with applications that are planned to be downloaded directly on Google Play. With this, it is hoped that novice users can quickly get used to operating this application.

As for the aspect of system capability, the results obtained for the mean, median, and standard deviation are 6.53, 6.5, and 0.53. This result is obtained because the application can run smoothly without using an internet connection. All data entered by officers will be stored in a local database using SQLite. This is of course very important considering that this application will later be used in signal-prone areas.

Conclusion

This study succeeded in designing an Android-based malaria surveillance application as an alternative solution to the existing method which uses a structured spreadsheet file. The results of the evaluation using the instrument The Questionnaire for User Interaction Satisfaction (QUIS 7.0) show that the general impression of this application is very good (mean, median, and standard deviation equal to 6.84, 6.88, and 0.29, respectively). This means that in general, officers as application users are satisfied with the application that has been developed. This application has the potential to facilitate malaria surveillance in a user-friendly and efficient way and this can lead to increasing the progress towards malaria elimination.

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