ORIGINAL ARTICLE

Malaria Surveillance Information System using an Android Mobile Phone: A Qualitative Study in Lahat District, South Sumatra Province, Indonesia

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ABSTRACT

Introduction: Delays in case-based surveillance are a significant obstacle to eliminating malaria. This study aims to optimise the current electronic malaria information system (eMIS), which uses an eMIS android-based mobile. **Method:** Qualitative research was conducted in the Lahat District, South Sumatra Province. We select informants directly involved in, or playing a role in, malaria control activities, such as program managers at community health centres (Puskemas) and health services. The system is built using the Framework for the Application of Systems Techniques (FAST), a structured method for analysing complex systems. It helps professionals break down problems, uncover hidden relationships, and make better decisions. FAST is widely used in engineering, project management, and business process optimisation to tackle complex challenges and improve problem-solving. **Results:** The paper revealed suggestions for designing and optimising the current eMIS. One recommended method for overcoming the obstacles is to optimise an eMIS Android-based mobile for malaria reporting. Eight key informants participated in the interviews. The main obstacles by key informants are the free time available for giving deep information and annoyance from outside during interviews due to their other activities. Hence, the researchers made appointments with informants and interviewed in a particular room, not the informant's office. **Conclusion:** Our study demonstrates that eMIS android-based mobile is a better refinement of the current eMIS based on PC to support malaria surveillance for malaria elimination programs in an endemic area. Data entry with an eMIS android-based mobile is faster, more accurate, and allows real-time collaboration, outperforming sheet applications.
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INTRODUCTION

This paper begins with a brief review of the literature on malaria, one of the world's major health problems caused by *Plasmodium* (class of Sporozoa)[1, 2]. In 2005, 107 malaria-endemic nations reported cases and deaths for the first World Malaria Report [3]. Malaria occurs in Southeast Asia, Africa, South America, and included in Indonesia [4]. Malaria causes one million deaths yearly and 500 million episodic cases [5]. There are more than 6 million patients with clinical malaria in Indonesia, with 700 deaths reported annually. Malaria remains a significant obstacle to achieving all people's highest possible level of health [6]. The national malaria morbidity rate from 2009 - 2018 declined from 1.8 per 1,000 population in 2009 to 0.84 per 1,000 in 2018. However, Papua had the highest Annual Parasite Incidence (API), 52.99 per 1,000 inhabitants [7]. Around the world, millions of people remain without access to malaria prevention and treatment, and most cases and deaths go unregistered and unreported. Given the projected growth in the world's population by 2030, more people will live in countries where malaria is a risk. Delays in case-based surveillance hinder malaria elimination [8].

The malaria elimination program must be supported by improving information systems for malaria surveillance. Implementing such mobile health (mHealth) for Public Health surveillance using a mobile phone-based application has helped establish an area of evidence-

based practice in mobile health (mHealth) surveillance [9]. Malaria case management factors include providing kits and medicines, training and using insecticide-treated bed nets, and accessing a good information system [10-12]. The national malaria program must improve access to and usability of information systems. These systems should use standard indicators of malaria surveillance [13]. A nationwide surveillance mechanism and strategy is the main reason for effectively controlling infectious diseases [14]. Lahat is a malaria-endemic area in South Sumatra, Indonesia. The previous research showed some variables affecting malaria cases, including mosquito breeding places around the respondent's house [15]. Others include social factors and other environmental variables [16-18]. One of the policies and functional strategies for malaria elimination is strengthening the information system that supports malaria elimination [13].

The malaria surveillance system is a tool for elimination programmes. Indonesia developed an Excel-based malaria surveillance system for data integrity previously. We identified a few community health centres that do data entry machines (PCs) and insufficient malaria surveillance. Spreadsheets and macros complicate system installation. Health staff need another document to enter survey data. Repeating causes data entry and efficiency difficulties. The process causes problems that occur in the existing malaria surveillance information system.

The significant health and socioeconomic implications of malaria include causing illness and being sick, not coming to work, and resulting in anaemia, affecting a person's work productivity (estimated to be five working days for each malaria sufferer). Then, pregnant women who suffer from malaria because of anaemia will have an impact on the development of the baby's brain, which is not optimal because nutrition and oxygen to the brain are not flowing smoothly due to the anaemia suffered by the mother and the occurrence of LBW and can cause death in the baby being born. There was an increase in school children's absenteeism due to suffering from malaria. With an optimal information system, extraordinary malaria events will be prevented because an increase in malaria cases can be detected early. Then, a good migration surveillance system at the Port Health Office can prevent transmission in areas where malaria cases will occur. Furthermore, with an optimal information system, the appropriate vector control efforts can be identified, whether vector control is by (a) indoor residual spraying, especially for endophilic Anopheles behaviour that likes to rest at home or (b) Use of long-lasting insecticidal nets, especially for endophilic Anopheles behaviour which likes to bite in the house or; (c) With environmental management, either environmental modification or environmental manipulation [16] or; (d) With a cattle barrier (prevents Anopheles bites due to proper placement of livestock pens) because of the behaviour of Anopheles which prefers livestock blood (zoophilic) [18].

Malaria elimination programmes require surveillance. SISMAL, an electronic information system, was designed in 2010 to conduct malaria surveillance in a structured Excel file to improve data quality and completeness. After observations and interviews, health centre officers detected issues in the malaria surveillance system. Because it employs spreadsheets and macros, installing this system is complicated. The system user handbook helps some health officers, but some still struggle with this phase. A computer/laptop is needed to enter data into a macro-based Excel file. For this, the health centre must give activity tools. Some health centres share one computer. Health centre officers rarely have laptops for surveillance data entry. It is a barrier for health officers, making malaria data delivery inefficient. Since the health centre has data entry equipment, operations requiring health officers to go to the field to collect data are unfeasible. Health centre officers must capture survey data in a separate document before entering it into the system at work. It is inefficient and increases data entry errors because it's done twice. So, it requires innovation in malaria reporting. Stronger surveillance is needed to provide malaria programme managers with real-time data to eliminate malaria. Recording and reporting are crucial to surveillance system success.

Lahat is one of the endemic areas in South Sumatra that has not yet achieved malaria elimination. The area that has eliminated malaria will prevent the spread of malaria to other regions. The Lahat location with its coal mining, considering that many coal mining workers come from malaria-endemic areas and can return to the site of origin, plays an essential role in realising malaria elimination in South Sumatra Province. The requirements for provincial malaria elimination are achieved if all districts/cities have eliminated malaria, including the Lahat Regency. Improved information systems will help with effective malaria surveillance and control, thereby helping Lahat achieve malaria elimination by 2025 and, at the same time, perform the target of eliminating malaria in the South Sumatra region, such as the milestone set by WHO after the Java and Bali regions in 2023.

The study addresses whether optimising the Android-based mobile application is better than the current electronic-Malaria Information System (eMIS). This free and open-source application is simple, allowing for quick, efficient, and accurate decision-making.

MATERIALS AND METHODS

Study Site

Lahat District has a total area of 46,377.40 km^2 and is located between 1°46′ and 4°55′S and 102°4′ and 104°41′ E. [19] The study site can be seen in Fig. 1.

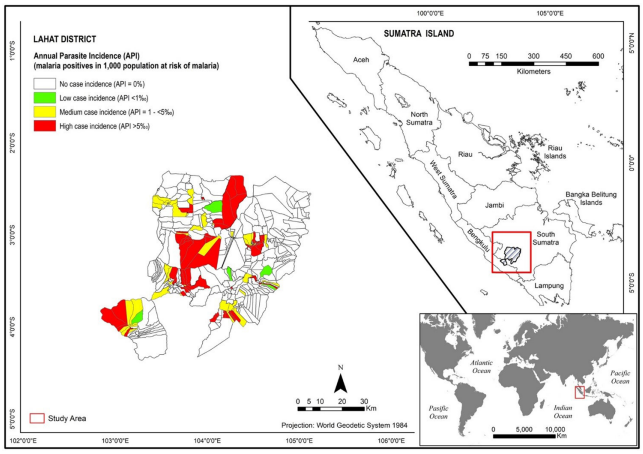

Figure 1: The study site

Study Design

This qualitative research comprises observation and detailed interviews with selected informants. The data was analysed in the Faculty of Public Health, Universitas Sriwijaya. In the next step, we optimised the current eMIS to an eMIS android-based mobile in the Sriwijaya Human-Computer Interaction Laboratorium, Faculty of Computer Science Universitas Sriwijaya. The data can be accessed at http://sismal.malaria.id/ used with permission; however, the dataset cannot be shared publicly, and we need permission from the Ministry of Health of the Republic of Indonesia to access the dataset. It can be requested from the Malaria Program Manager, South Sumatra Provincial Health Office (Indonesia).

A detailed interview was conducted among health professionals who worked on malaria prevention and control programs in the District Health Office (DHO) of Lahat District in 2020. Key informant perceptions in DHO were obtained through interviews. Informants were selected in pre-determined types based on their knowledge and experience with a current eMIS. In another stage, we optimised a current eMIS to an eMIS android-based mobile that supported the Provincial Health Office (PHO) and was agreed by the sub-directorate of malaria, Director-General Communicable Diseases Control Prevention of the Indonesian Ministry of Health (MoH).

There were eight informants. Selecting informants, namely those involved in, or play a role in, malaria control activities directly, such as program managers at community health centres and health services. Information obtained repeatedly is considered saturated and can be used as a conclusion. This research consists of the stages of observation and in-depth interviews with selected informants. Limitations are the free time available for information and annoyance during interviews. Hence, the investigator made appointments with informants and did interviews in a particular room, not the informant's office.

Android-based cell phones receive information faster and reach more people, so the Malaria Early Warning System can be implemented effectively, including the entomological situation, with residents from malaria-endemic areas, different arrivals in receptive areas (there are Anopheles), and non-receptive arrivals. By understanding entomology, vector control efforts can be precise and effective. Areas with Anopheles Sundaicus and Subpictus, especially the coast, are influenced by the salinity of the breeding places, where a lagon/puddle with optimal salinity for Anopheles forms at the start of the rainy season. sundaicus/subpictus, different from hilly areas with lots of trees/forests, because Anopheles Balabacensis emerges with the rainy season, Anopheles Aconitus with rice planting season in rice fields, and Anopheles Maculatus with the dry season in riversheds.

Optimisation of an eMIS android-based mobile

The system to be optimised stores primary data in a database. The data that has been stored can later be monitored via Android applications, which can be downloaded on the Play Store.

Community health centre officers can use an Android mobile phone to enter malaria surveillance data, including Village Basic Data for the Health Centre Coverage (Key Info), the Register of Malaria Patients (Regmal one), Logistics Data and the Malaria Programme (Regmal two), Malaria Vector Control Data (Vector), and Malaria Focus Control Data. Key info is divided into crucial info and a list of villages; Regmal two is divided into discovery data, logistical data, withdrawal data, and cross-test data; and the focus is divided into active focus and indigenous cases to make it easier for officers to enter data with many attributes. Officers can add or update data in each data set's list view and presentation form. Health centre officers can access or add village data.

This primary data is stored locally in each Android device after a health centre officer submits it. This allows data input to be done anywhere, even remotely, without a reliable internet connection. When a health centre's officers can access an internet connection, they can send the locally saved data to the main server for integration and analysis. The system architecture design can be seen in Fig. 2.

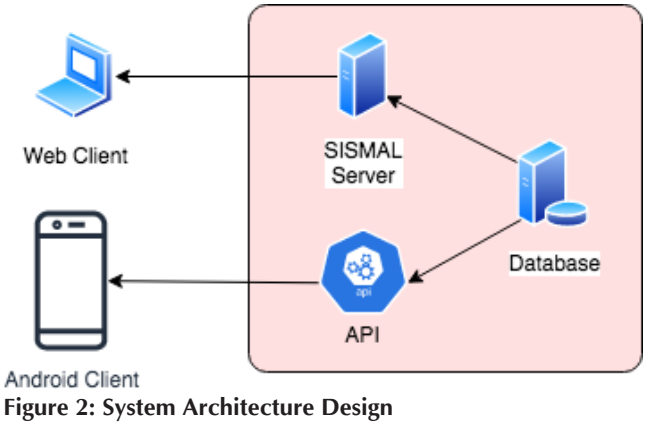

Figure 2: System Architecture Design

Data Analysis

We optimised a prototype using the Framework for the Application of Systems Techniques (FAST methodology), a variation of the System OptimizationLife Cycle (SDLC) [20-22]. The FAST methodology comprises the subsequent stages: The academic rephrasing of the user's text is as follows: (1) The delineation of the scope; (2) Examination and evaluation of the problem; (3) Assessment and evaluation of requirements; (4) The rationale behind the design; (5) Critical evaluation of the decision; (6) Development of the physical design; (7) Construction and testing procedures; (8) Implementation and delivery. The FAST system demonstrates a suitable approach to standardisation and a consistent process for comprehending the system and planning management. The FAST method is a development methodology created to support application system development. This system is designed to make data and information management more efficient, effective, accurate and timely. This method is known for its efficiency and ability to produce results quickly. The FAST method makes system design more accessible and helps ensure the design is on target. The application is designed by considering a good user experience such as labels for data forms, one-way scroll, dividing the page into several sub-pages, adjusting field size, table data represented using a simple form display, automatic location filling using GPS periodically, and local databases for sample data storage are system requirements for malaria surveillance, by implementing a modular design. The features can be developed efficiently. For example, we created only one list view for data presentation, which any data can be used multiple times. This modularity makes the application size smaller, essential in developing an Android application.

Ethical Approval

The Health Research Ethics Committee Faculty of Public Health, Universitas Sriwijaya, approved the study, with "Ethical Approval" (No:344/UN9.1.10/KKE/2020). Participation was voluntary in this research, and there was no financial incentive.

RESULTS

Key informant characteristics

The eight key informants included the Director of the District Health Office (DHO), the Head of Diseases Prevention and Control (P2P), and the Section Chief of Prevention and Control of Infectious Diseases (P2PM). As well as the Malaria Program Manager, four community health centres (Puskemas) directors who were directly engaged in the malaria program were included. The community health centres were purposively selected. The informants are almost all 40 years and over; only one person is 38. Four informants have an education for a master's degree, two have an undergraduate degree, and two have a Diploma. Generally, the informants have worked for at least ten years, while the longest worked for 31 years. As for the length of service in the current position the informant holds, the informant has worked for at least four months and a maximum of three years. All informants signed the informed consent agreement to collect the interview data.

Evaluation of the existing eMIS

The interview recordings were first transcribed. Then, the main concerns related to an existing eMIS were constrained to three areas of concern. Themes were identified based on the following: (a) The current eMIS which was used; (b) Benefits and issues faced in implementing the current eMIS; and (c) Optimisation of the eMIS android-based mobile application.

The current eMIS, which was used

This section addresses the results of interviews using a structured list of questions. According to all informants, information related to the Malaria reporting system showed that the API in their area had decreased in the last year. It was obtained according to the excerpts from the interviews with the following informants:

... "The API is now experiencing a decline." (Informant 1 to 5).

According to five of the eight informants, implementing the present eMIS in this activity in their respective workplaces is satisfactory. According to the other two informants, it has been integrated between case data and surveillance. In contrast, another informant has applied it at the sub-health centre/village birth facility level. The excerpts from the interviews with the following informants illustrated this:

... "So far, the implementation of eMIS has been good." (Informant 2).

... "So far, the implementation of eMIS has been perfect." (Informant 3).

... "So far, the implementation of eMIS has reached the sub-health centre / a village birth facility level." (Informant 5).

... "So far, the implementation of eMIS has been integrated between surveillance and case data." (Informant 8).

Benefits and problems faced in implementing the current eMIS

The types of data that have been collected are in the form of case or surveillance data. The advantage or benefit in implementing eMIS, according to six of the eight informants, is data validation, while according to other informants, the data becomes systematic and nationally integrated, as quoted from the following interview results:

..."The type of data that has been collected for input into eMIS is PHC surveillance data. The advantage or benefit in implementing eMIS is that it is integrated nationally." (Informant 2).

..."The type of information gathered for input into eMIS is case data. The advantage or benefit in implementing eMIS is systematic" (Informant 3).

..." The kind of information gathered for input into eMIS

is case data. The advantage or benefit in implementing eMIS is validated data" (Informant 6).
..." The type of data collected for input into eMIS is case data. The advantage or benefit in implementing eMIS is validation" (Informant 7).

According to the following informants, the Director of the DHO, the Head of P2P, and the Section Chief of P2PM. Furthermore, Malaria Program managers, including Directors of community health centres, and local government support in developing eMIS is good, even though there are still obstacles in implementing eMIS, namely interference with the signal or internet connection. In contrast, other informants claim to be constrained by the system. The excerpts from the interviews with the following informants illustrated it:
..."Those involved in eMIS activities are the heads of offices. The form of support from the local government in developing eMIS has been good, but the system still constrains it." (Informant 1).
..."Those who participate in eMIS activities are PHC. The form of support from the local government in developing eMIS is good, but the signal still constrains it." (Informant 3)
..." Those who work on eMIS projects are program managers. The form of support from local governments in developing eMIS is good, but it is still constrained by network connectivity." (Informant 5).
..."Those involved in eMIS activities are the head of PHC Merapi II and program managers. The form of support from the local government in developing eMIS has been perfect, but the signal still constrains it. "(Informant, 7).

Optimisation of the eMIS android-based mobile application

Almost all informants considered the implementation of eMIS was good; only one informant did not understand it. According to all informants, the view of informants on malaria reporting using eMIS is good but still needs improvement. The excerpts from the interviews with the following informants illustrated this:
..." The implementation of eMIS has been exemplary. The current view of malaria reporting by eMIS is good. (Informant, 1).
..." An eMIS implementation is excellent. The current view of malaria reporting by eMIS is perfect, but needs improvement. "(Informant 7).
..." An eMIS implementation is excellent. The current view of malaria reporting with eMIS is good, but needs improvement." (Informant 8).
..." The Implementation of eMIS doesn't understand. The current view of malaria reporting with eMIS is good, but needs improvement." (Informant 5).

Likewise, the opinion of the informants regarding the integrated and synchronised implementation of eMIS stated that it was good and needed improvement. According to all informants, an eMIS program is beneficial for eliminating malaria cases in their working areas. The advice given is ease of access. The excerpts from the interviews with the following informants illustrated this:
..."The integrated and synchronised implementation of eMIS is good. An eMIS program is beneficial for eliminating malaria cases in its working area." (Informant 1).
..."eMIS implementation that is integrated and synchronised has been perfect. An eMIS program is useful for eliminating malaria cases—suggestions regarding the development of eMIS are easy and high-speed access. "(Informant, 2).
..."The implementation of eMIS, which is integrated and synchronised, is generally reasonable. An eMIS program is useful for eliminating malaria cases in its working area" (Informant 4).
..." implementation of eMIS that is integrated and synchronised has been good. Suggestions regarding the development of eMIS are easy to access." (Informant 5).
..."eMIS implementation that is integrated and synchronised has been perfect. Suggestions regarding the development of eMIS are accessed." (Informant 7).

Furthermore, the informants suggested the need for improvement or development in optimising eMIS through the Android-based mobile application for easy access. The excerpts from the interviews with the following informants illustrated this:
... "The desire related to the optimisation of eMIS through the MIS android-based mobile application is an increase in network effectiveness." (Informant 2).
... "The desire related to the optimisation of eMIS through the MIS android-based mobile application needs improvement." (Informant 3).
... "The wish related to the optimisation of eMIS through the MIS android mobile application is easy to access." (Informant 5).
... " The wish is for the optimisation of eMIS via the MIS Android-based mobile application in terms of access." (Informant 7).
... "It is simple to access the wish related to eMIS optimisation via the MIS Android-based mobile application.." (Informant 8).

Optimising an eMIS Android-based mobile

An eMIS android-based mobile application is used by health centres to enter the data required by eMIS, which includes five types of data. The types of data, namely Basic Data for Village Coverage of community health centres (Key Info), Register for Malaria Patients (Regmal 1), Logistics and Program Data Malaria (Regmal 2), Malaria Vector Control Data (Vector), and Malaria Focus Control Data (Focus). Before being able to use an eMIS , community health centres officers must first log in using the account they have obtained from an eMIS system (Fig. 3). When the officer has entered the username and password, the system will check the username and password data on the centre of the eMIS server for verification. After verification, the officer will find a

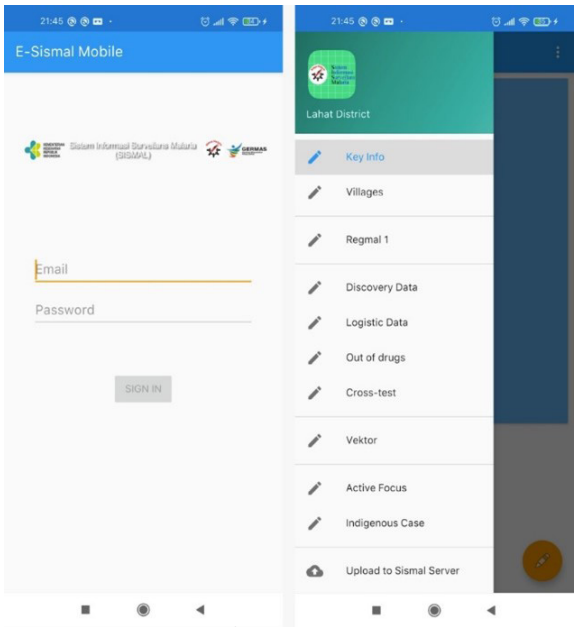

Figure 3: Log-in page and Menu

menu list to enter the five data types at the health centre level: Key Info data, Regmal 1, Regmal 2, Vector, and Focus. Each Menu is subdivided into submenus, such as Key info subdivided into key info and village lists, to expedite data entry with several qualities by officers. Regmal two is subdivided into discovery, logistics data, withdrawal data, and cross-test data; Fig. 3 subdivides the focus into active focus and indigenous instances.

Each data entry has a list view that displays the data entered and a display form that officers can use to add or modify new data. For example, officers can see village data in an area or add new village data cases, as shown in Fig. 4.

During the data entry period, the data entered by the health centre staff is stored in local storage media on an

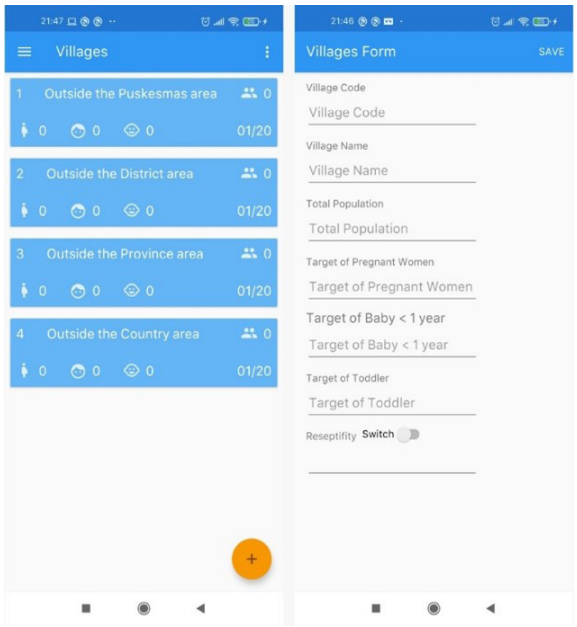

Figure 4: Village list page and Village form

Android smartphone. It is so that the process of entering data by officers can be done more quickly. In addition, officers who work at PHC locations with limited internet access can still do their job well. After entering all the data in one data entry period, the officer can select the Upload data to the eMIS Server menu to send data directly to an eMIS database in the MoH Data and Information Center. The officer needs internet access to send the previously entered data for this process to run smoothly. The data that has been collected can then be viewed through an eMIS web application where district/city and provincial level officers can see the recap of data entered by all community health centres in each region.

Most informants agree that the data entry with an eMIS android-based mobile is faster, more accurate, and allows real-time collaboration, outperforming sheet applications. The lack of a near-real-time case-based surveillance system hinders malaria elimination efforts. An urgent need is to initiate a system to incorporate data into a digital platform. This platform will offer all stakeholders near-real-time epidemiological, entomological, and commodity surveillance data, enabling transparent and evidence-based malaria control policymaking.

DISCUSSION

An investigation study concluded that an eMIS android-based mobile is better than an eMIS based on a PC currently used to support malaria surveillance in an endemic area. Also, a smartphone is more accessible than a PC for health officers and facilitates malaria data input using an eMIS android-based mobile application [23].

The study's key findings emphasise that the eMIS android-based mobile is superior to the PC-based system for malaria surveillance. In the current system, the health officer believes the programme can save data locally and automatically determine the survey site while conducting a field survey. The first business need is that the app stores data locally on staff devices. health centre officers enter data individually. With local data storage, the application doesn't need an internet connection, making it challenging for cops in locations with poor internet access. The system findings also require the technology to locate survey activities automatically. The application is expected to eliminate manual data entering to speed up data entry. Since it uses location-based data, this innovation will boost officer productivity.

The advantages of using an Android-based mobile application for malaria surveillance over other mobile device platforms: the study proved its feasibility and the extent to which community healthcare personnel in low-resource settings could utilise it efficiently to

perform routine duties, even in remote areas. Further, according to the data by Statcounter, Android held the highest market share in Indonesia's mobile operating system (OS) market over the last decade due to its affordability and the availability of a wide range. So, Data entry with an eMIS android-based mobile is faster and more accurate, outperforming sheet applications by providing automated data entry and suggestions such as location coordinates and addresses by using GPS. It also allows real-time collaboration by sending the data from an Android device to the main server.

eMIS, managed by the health office, is a system for recording and reporting malaria surveillance based on electronic data. Malaria case data input is carried out at the community health centres or hospital level and at the district/city, provincial and central levels, summarised nationally using eMIS. Electronic malaria data management is part of managing information resources on malaria, including all malaria data control activities that are accurate, up-to-date, safe, and available to users/providers, government, stakeholders, and the community. The system for recording malaria disease data includes routine and specific findings. Routine data sources result from passive case detection (PCD) and active patient detection (ACD) activities. The activities need application tools for the Android-based mobile that are easy to use by health officers for inputting malaria data. Previous research in northeast Tanzania advocated optimising and scaling up mobile phone-based tools used by village health workers (VHWs) in monitoring and timely reporting in rural locations to improve malaria case management [24].

Several countries, such as Cambodia, Lao PDR, Myanmar, and sub-Saharan Africa, have implemented mobile solutions for malaria surveillance [25-27]. However, in Indonesia, an electronic information system was created to carry out malaria surveillance in a structured Excel file to enhance the validity and completeness of reporting malaria data. A malaria surveillance system is based on system inadequacies, and few primary health centres (community health centres) personnel have computers for surveillance data entry. Spreadsheets and macros make installing this system challenging. Therefore, health personnel must record survey data in a separate document and enter it into the system at work. Due to repetition, this is inefficient and causes data entry errors. In this current study, the advantage of the application is that the health centre officers can carry out malaria surveillance activities in the field and store and send the data to the data centre of the Ministry of Health with the advantage that the application can work offline, which proves its feasibility and the extent to which community healthcare personnel in low-resource settings could utilise it efficiently to perform routine duties, even in remote areas. Besides, this application has been evaluated for user satisfaction with certain aspects of human-computer interaction; in this case, exchanging health centre officers with Android-based malaria surveillance applications and malaria elimination programs is a critical component, and we hope it can be used in other malaria-endemic areas.

Furthermore, mobile phone technology has accelerated in recent years, accompanied by an increase in coverage and a decrease in the cost of connectivity. A systematic review showed that mobile health interventions could benefit healthcare delivery processes [28]. The health sector can access the potential of mobile phone technology to increase efficiency and performance for service delivery. Besides, the previous study showed that scaling up mHealth projects in Africa is innovative in delivering health services [29]. Another study in Zanzibar used mobile phones for malaria surveillance. It showed that mobile phones are one of the tools that can help accelerate malaria elimination by improving coordination, timing, coverage, and responses [24]. Prior research has shown that a web-based malaria reporting information system (MRIS) can improve malaria reporting and management [19]. The reporting system could also be adapted for reporting other diseases, so its benefits could extend beyond the current application.
This application has been meticulously crafted to provide users with an alternative avenue for efficient and streamlined data entry, complementing the pre-existing methods. When users employ this application to input data, it initiates a seamless integration process, ensuring that the newly entered data harmoniously merges with the extensive dataset already residing within the established database infrastructure. This strategic approach enhances the overall data management capabilities and simplifies the user experience, optimising data entry procedures for heightened productivity and data consistency across the board [30].

Consequently, even though our original blueprint did not explicitly outline a direct integration strategy with the national policy of integrated HealthOne data system in Indonesia, an intriguing aspect unfolds: as long as the prevailing system successfully forges connections with the integrated health data system in Indonesia, our system's integration is indirectly ensured, forming a dynamic link within the broader integrated HealthOne data system in Indonesia framework. In this way, our application acts as a vital bridge, facilitating data exchange and synergy within the larger healthcare ecosystem.

CONCLUSION

Our study indicated that the current eMIS is suboptimal because of its handling of reporting complexity. It can be remedied by implementing an Android-based mobile eMIS. Ultimately, investment in information technology-based, android-based mobiles that support surveillance and response systems in a timely and targeted manner is essential to eliminate malaria. The malaria elimination

program must be supported by improving information systems to help malaria surveillance. An eMIS android-based mobile system is an innovative tool to input reporting of malaria, which is more effective and efficient than an eMIS, which previously input data on malaria using a PC. The devices include rapid and complete case reporting, incorporating related data, central data storage and management, automated and expert data analysis, and customised outputs and feedback that lead to timely and targeted responses.

Malaria surveillance can be carried out offline using a smartphone, which almost all health officers have. Not all health officers can access the PC or have a laptop to report malaria cases electronically. National malaria management strategies increasingly include malaria elimination planning. Resources are needed for commodity security, intense case management, a more detailed surveillance system, and adaptable people and technologies that can quickly adjust to local epidemiological changes. This health system readiness evaluation in low-incidence districts helps lahat areas design an elimination strategy by assessing resource and staff capacity to conduct essential elimination operations. The electronic malaria information system (eMIS), which employs an Android-based smartphone, proved helpful in documenting malaria elimination readiness across a health system in the district. Strong malaria surveillance systems also help the region design effective health interventions and evaluate the impact of their malaria control programmes.

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