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Design and development of a web-based patient management information system

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Abstract

This study aims to develop web-based hospital management software. Several previous studies discovered some lack, such as manual queue calling, limited patient registration, difficult access to medical records, and the absence of reminders. In this study, we developed queue, reservation, medical record, reminder, and medical action modules. We expected that facilities could improve the operational efficiency of hospital services. The research stage starts with problem formulation, literature study, design determination, system development with five main modules, system testing, and the creation of research articles. Some limitations were identified, including responsive design and the expense of API system.

Keywords: Medical action, medical record, notification, queue, reservation.

1. Introduction

Health service facilities are public facilities provided by the government and the private sector to organize health service efforts. Although the private sector may manage these services, the Government of the Republic of Indonesia is responsible for implementing these health service efforts through law. Health facilities commonly found in the community are clinics and hospitals. According to Haryanto and Setiawan, hospitals have an essential role in providing

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health services to the community, such as treating patients, recovering from illnesses, and becoming educational facilities for health workers and researchers[1].

Based on data compiled by the Ministry of Health of the Republic of Indonesia, 2,522 hospitals operate in Indonesia[2]. The data also shows an increase in the number of hospitals from 2017 to 2021 by more than 14%, as can see in Fig. 1. In addition, data from the Central Bureau of Statistics shows that the population of Indonesia in 2021 will almost reach 273 million people[3]. Hospitals must provide efficient and optimal services with the population increasing every year.

One important aspect of hospital service delivery is the administrative recording process. This process involves using forms and documents under established procedures[4]. In addition, patient flow management is also an essential element in improving the operational efficiency of hospital services[5]. However, administrative recording in hospitals is generally done manually using medical record books or spreadsheet software, which can slow down services and increase the potential for data duplication[6].

The government has issued a Minister of Health Regulation that requires health facilities to use Electronic Medical Records (EMR) and implement them before the end of December 2023[7]. However, data from the Directorate of Referral Health Services shows that the realization of EMR implementation still needs to reach the target[8, 9]. It suggests the need for more serious efforts from the central government, local governments, and the private sector in pursuing EMR implementation in hospitals.

Several studies have been conducted on the implementation of electronic medical records. Rahman et al. developed an electronic medical record application with features including medical record data, patient data, patient cards, doctor data, doctor schedules, drug data, and reports[10]. However, this research has weaknesses in the form of reports that could be more dynamic and have a queue feature. Melyanti et al. also researched hospital queuing systems in implementing electronic medical records[11]. However, this research does not include data integration for patient data which can cause data duplication. Ma'roep found that reports needed to match the hospital's needs and weaknesses in the queuing system[12]. In addition, patients could not determine their schedule, and the queue numbers were collected while at the service location, causing an increase in queues.

The creation of different electronic medical record systems causes difficulties in data integration, differences in technician capabilities for system maintenance, and hospital financial limitations. As a solution, Khanza HMIS is an electronic medical record system managed by Indonesia Khanza HMIS Foundation (YASKI) since 2017. Khanza HMIS has been integrated with various services and used by over 1,500 health facilities in Indonesia. The aim is to provide an electronic medical record system that is easy and cheap to implement[13].

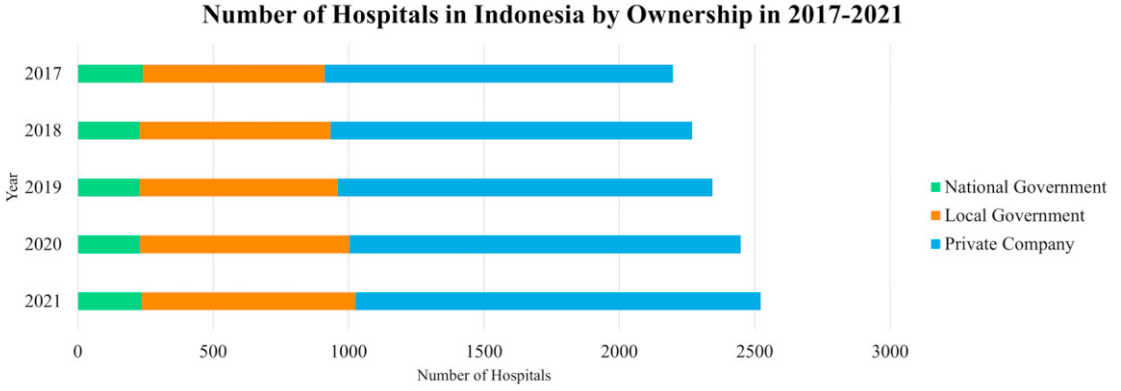

Fig. 1. Number of hospitals in Indonesia by ownership in 2017-2021

Several studies have also evaluated the use of Khanza HMIS. Putratama and Ali have conducted research on the supporting factors for adoption by hospitals to migrate from the old hospital system to Khanza HMIS [14]. Of the many factors in the study, three main points were supported by all participants in the study. First, the affordable cost of adoption. This can be seen from the Khanza HMIS system which is open source and can be used by anyone. This also supports the current study which is based on the previous system and does not require a large amount of money to manage it tends to be less and less because some administrative tasks can now be done directly by the patients themselves. The second is support from software developers. Currently, the developer has a special group of Khanza HMIS users, which makes users feel confident and can be assisted by the developer directly when adopting from the old system to the Khanza HMIS system. The last and most important is feature completeness. Before this study, the features, and modules of Khanza HMIS were quite complete and could be used up to the large hospital level. This research will contribute to the development of Khanza HMIS with more complete features and make it easier for users, including facilities, administrative and health personnel, and patients themselves.

The other studies conducted by Yadhuvanshi in his research said that patient flow management is an important element in improving the operational efficiency of hospital services. Their research also states that patient satisfaction is also determined by timely service delivery. This can be seen from when the treatment will be carried out and what will be provided in the treatment. Patient dissatisfaction can be felt when patients wait in long lines and feel the waiting time is much longer than the actual waiting time [5]. With the development of the current system, the waiting time in line can be improved, both from the patient side and the facility side. This can be proven by updates to the queue calling process which previously could only be manual and can now be done manually or automatically. In addition, the reservation system also helps patients to determine their schedules without having to think about the length and time of waiting in line. In addition to the problems in the study, Khanza HMIS is running as a desktop-based application. Because of that, patients cannot make reservations directly through their smartphones. Another problem occurs when patients want to view medical records. This problem creates an urgency to update the system to run web-based so that patients can receive better service.

In this research, we will discuss the development of a web-based patient scheduling and management system. This development will also be compatible with the current system. The modules to be developed include queuing, reservation and scheduling, medical records, reminders, and medical actions. This development is carried out to overcome the shortcomings that exist in the current system, such as manual queue calling, limited new patient registration, limited access to medical records, lack of sending reminders and health information, and limited medical actions that can be planned. With this development, it is expected that facility can easily manage patient treatment time and patient data and improve the operational efficiency of hospital services.

2. Methods

The methodology used in this study consists of several stages. The first stage is determining the problem formulation. The author determines the problem formulation based on the background of the existing problems. The formulation of the problem obtained is to create an integrated patient scheduling system using a previously developed information system.

The second stage is a literature study. The author searches for various reference sources such as journals, research, books, articles, and others to support the work of this research. These references are limited to the last ten years. Some references needed include healthcare facilities, medical records, Khanza HMIS, HTML, CSS, PHP, and SQL.

The next stage is the exploration of needs. The author explores the needs of the end-users of this information system, both functional and non-functional. The results of this need exploration will be documented in the Software Requirement Specification (SRS), which contains the system architecture and use-case of the system to be created. Use-case design can be seen in Fig. 2.

After that stage, the design is determined. The author determines the design and makes a prototype of the information system to be developed. This prototype will be given to end users before it is fully implemented. The prototype can be either high fidelity or low fidelity using available software.

The next important stage is system development. This stage is carried out in stages according to the priorities that have been determined at the requirement gathering stage. The system development consists of five main modules: queue module, reservation module, medical record module, reminder module, and medical action module. Each

module has a specific purpose and function in solving the existing problems. The development will use some frameworks and libraries like Laravel (PHP), Tailwind (CSS), and jQuery (JavaScript) can see below in Fig. 3.

After system development, the system testing stage is carried out. This stage is used to test the functionality of the information system that has been developed. System testing is carried out in two stages, namely unit testing and acceptance testing. Unit testing aims to ensure system completeness based on predetermined use cases.

The last stage is the creation and publication of research articles. In this research, the author uses these methods to develop an integrated patient scheduling system by paying attention to the needs of end users and following predetermined steps.

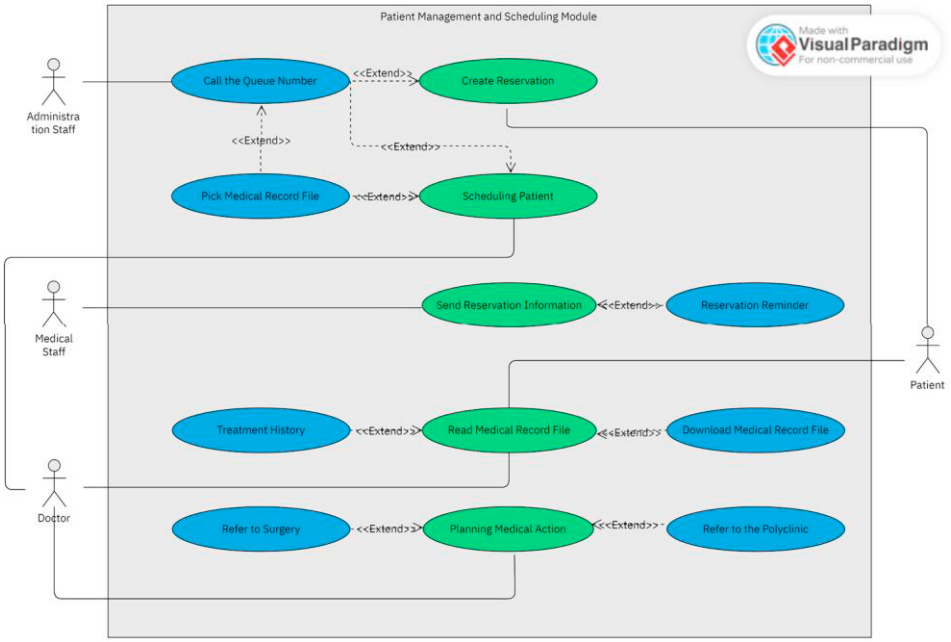

Fig. 2. Use-case diagram for patient management and scheduling module.

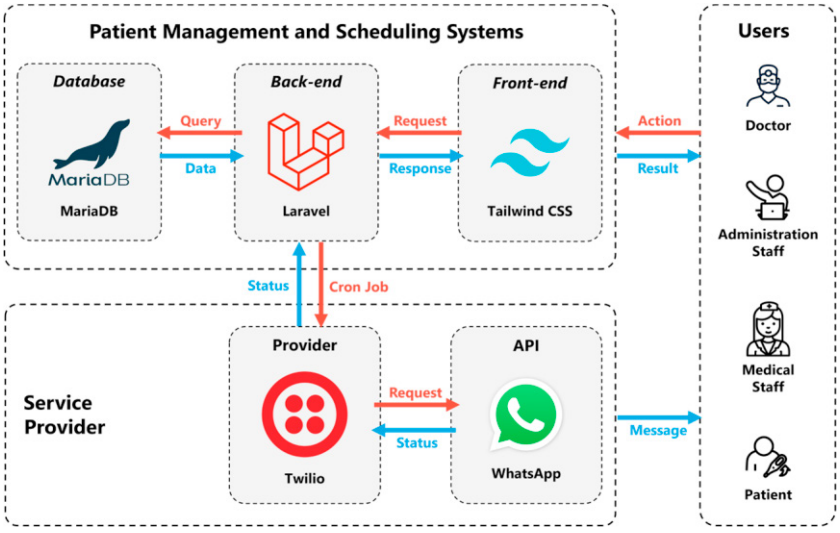

Fig. 3. Architecture design for patient management and scheduling module

3. Result

After building the system, the results are in the form of five modules. The first module is the queue module, which consists of printing queue numbers, calling queue numbers, and sharing queue room locations. In the previous system, the printed queue number was a number only so that it could be used for one room or one counter, which caused the facility to need to install more computers for more rooms. In addition, administrative staff maybe being called twice at different counters or missing queue numbers. It differs from the current system development, where queue numbers are printed using letters, numbers, and room codes so that one system can be used for one facility. In addition, the system can do queue calling manually or automatically to increase efficiency and minimize the risk of human error. The result of queue module is shown in Fig. 4.

The second module is a reservation consisting of doctor reservation features, doctor schedule settings, and room settings. In the previous system, patients could not make their treatment reservations, so they had to come directly to the facility to make reservations or get treatment. In addition, patients may also only know the doctor's schedule if informed by the receptionist, making it difficult for patients who only want to be treated by certain doctors. Patients can make treatment reservations directly through their smartphones in the current system development. It is also beneficial for doctors and health workers to know their busy schedules. In this module, they can access the doctor's availability schedule directly without the hassle of going to the facility to get the available schedule. The result of reservation module is shown in Fig. 5.

Fig. 4. Queue module in the old system (left) and new system (right).

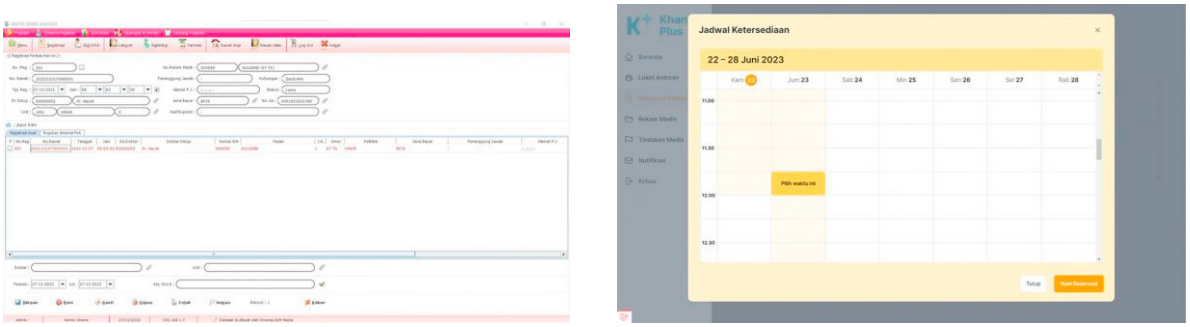

Fig. 5. Reservation module in the old system (left) and new system (right).

The next module is the medical record, which consists of viewing the patient list, the patient's primary data, and the patient's examination and treatment history. In the previous system development, the patient's medical record could only be viewed and printed by the administrative office directly, which was inconvenient for some people. Patients can get their medical record files directly through the web in the current system development. In addition, they can also find out the patient's primary data along with the history of examinations and medical actions provided more efficiently. Patients and doctors also get the same convenience that can help them provide quick treatment. The result of medical record module is shown in Fig. 6.

The following module is notifications or reminders that can send messages about doctor reservation reminders and recap information about the results of diagnoses and doctor actions. In the previous system, this was not available and required the facility to find a new vendor to create this feature. It is also possible that the administrative staff would have to send these messages manually daily to patients who have made reservations. In the current system development, patients will get a reminder of their reservation directly via WhatsApp message along with a recap of the doctor's examination results and actions on that day to know what they might be able to prepare for and avoid. This feature will also simplify the work of administrative staff as all messages will be sent on a scheduled basis and automatically resolved by the system. The result of notification module can be seen in Fig. 7.

The last module is medical action which contains a doctor's action planning feature. This feature was strictly limited to providing medical actions to patients using specific assessment instruments in the previous system. Doctors could not schedule further treatment directly to the patient. In addition, the doctor may not remember his/her availability schedule on the patient's control day, so the human error rate becomes relatively high. In the current system development, doctors can schedule their patient's treatment directly so that patients feel facilitated. Doctors and patients can also make control appointments directly according to the availability schedule without remembering their free time. The result of medical action module is shown in Fig. 8.

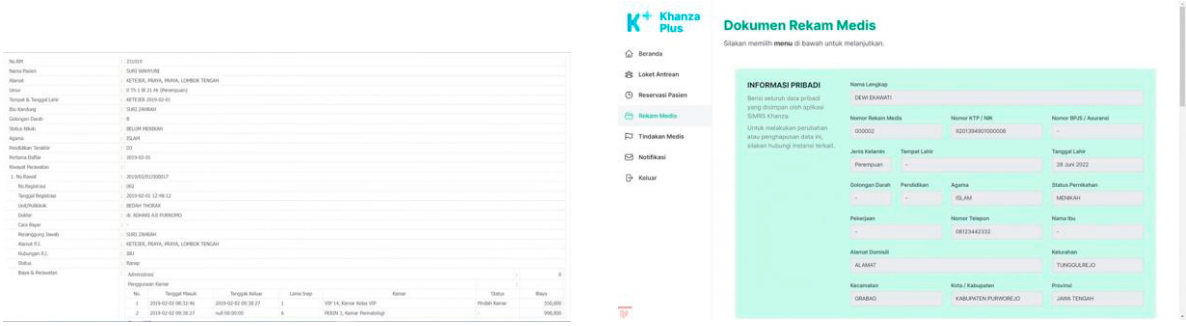

Fig. 6. Medical record module in the old system (left) and new system (right).

Fig. 7. Notification module in the new system.

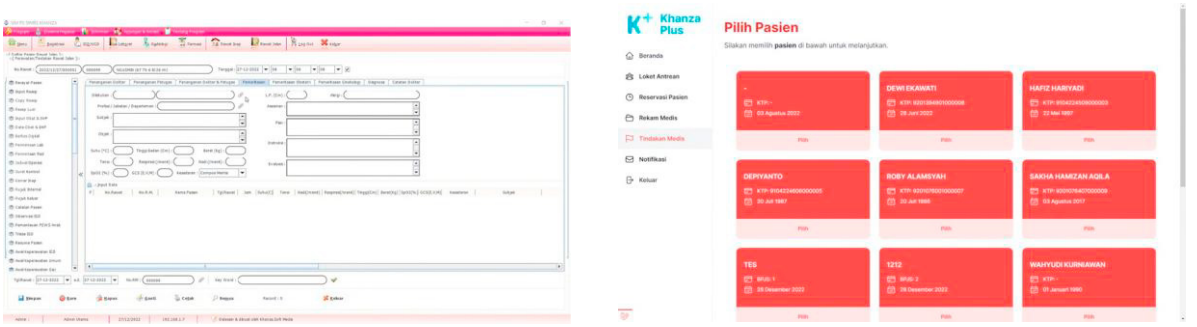

Fig. 8. Medical action module in the old system (left) and new system (right).

4. Discussion

After the system was built, we conducted several end-user tests. The application was tested on patients aged 18 to 30, considered representative of the target users. All test respondents gave both positive and negative feedback on the test. Some felt that online doctor reservations via the web made it easier for patients to make their appointments. Others felt that the app could also view and obtain medical records and treatment history easily. Some respondents denied using the app and felt that the existing conventional system was sufficient to address their concerns. Even so, almost all test respondents agreed that the web-based system is more desirable than the app because it only requires an internet connection and a browser without installing additional applications that further fill up memory.

Based on these results, several things need to be discussed. In general, we have successfully developed five modules, namely the queue module, reservation module, medical record module, notification module, and medical action module. The most influential module is the queue module because the module can be used throughout the facility using only one server. The facility provider only needs to add an external screen and loudspeaker for each room that needs to display the queue. The module has also been equipped with standalone queue number printing and automatic queue number caller which further improves the efficiency of patient flow management. These advantages are also aided by the presence of the reservation and medical record modules as patients can directly view their doctor's availability and examination results via the web regardless of time constraints. Another module that also has an impact is the notification module, because now all patients can get reminders of doctor reservations and doctor examination results automatically without the need to be sent manually by health workers. In addition, doctors will also get the same notifications to remind them of their appointments with patients.

This study also has several limitations. First, there are still some parts of the module that are not mobile-friendly due to the limited time available to develop this system. Even so, researchers have focused on making the web more responsive to screen size, especially in the reservation and medical record modules. The reservation and medical record modules are supposed to be accessed by patients using their smartphones so it is only natural that the module development should focus on responsive web. We hope that in future research, we can consider responsive screens for other modules. This is because the screen sizes in the future are bound to be more diverse, ranging from smart televisions with large screens to smartwatches with small screens.

Another weakness found in this research is the use of the WhatsApp API which is not a cheap solution. In this research, we used an official API affiliated with WhatsApp to accommodate this notification feature. The official API requires us to use a template that has been approved by WhatsApp so that the notification text delivery must exactly matches the template. We found that there are some vendors or companies that offer APIs cheaply and even for free with free text sending without requiring approval, but we found that this is illegal. We hope in future research to find other vendors or other methods (e.g., via SMS or email) that can provide alternatives for facilities that may not have enough funds to pay for the official WhatsApp API.

Finally, we see the potential to create a Key Performance Indicator (KPI) dashboard module that can be used by upper management. With the creation of this module, of course, facilities can compare how much they are performing based on success indicators against the scale or achievement targets that have been made previously. Another potential

that also arises to support the creation of the dashboard module is the patient satisfaction module. Patients should be able to provide an assessment of the services they receive. Not only that, criticism and suggestions are also useful input for facilities to provide better service quality.

5. Conclusion

This research generally resulted in five modules for the existing application: the queue, reservation, medical record, notification, and medical action modules. All these modules have more detailed features in them. The module that did not exist in the previous system was the notification module, so this is an added value for this research. In addition, the queue module has also been changed from desktop-based to fully web-based. It positively impacts patient flow management, which is much better than before. This study has limitations on mobile-friendliness and the cost of WhatsApp API. Future research should consider responsive screens for all modules to accommodate diverse screen sizes. Other alternative vendors or methods should be explored to reduce costs associated with the official WhatsApp API. Furthermore, the system has the potential for further development, including the creation of a KPI dashboard module for upper management and a patient satisfaction module for better service quality.

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