

MyMIS: An Appointment System for Outpatient Department

Mohamed Najib Salleh, Halim Mad Lazim, Mohd Nizam Saad

Abstract: This paper had discussed on the development of MyMIS, which is an appointment system for outpatient department. The main objective of the system is to manage the flow of patients at the department. The system was developed based on the patients and staffs requirement. MyMIS is generated in the format of PreHypertext (PHP) and Apache application server was used to run and read the system. MySQL database was selected to store all the patients and appointment information. The system effectiveness was verified through ARENA simulation model. Results show the system can reduce significantly waiting time at the outpatient department. Even though the system is developed for UUM Health Center, it can also be used by other medical centers as well. It is hope that the system will help government to meet their target of serving patients within 30 minutes.

Keywords: Appointment system, outpatient department, waiting time.

I. INTRODUCTION

The health care industry in Malaysia is under increased pressure from not only national political forces, but also from the competitive marketplace, to manage patient services more efficiently. The most critical challenge for government hospitals is to provide quality health care in the most efficient and cost-effective manner possible. This includes getting the patient well and out of the hospital quickly. Greater attention is now being focus on the effectiveness and efficiency of outpatient clinics in the hospital with particular emphasis on the delivery of care. In the outpatient department, the main indicator of quality assurance for patients is "waiting" itself; patients should be attended to within an acceptable time [1] [2]. Waiting for treatment can be a frustrating experience because the patients cannot do much during waiting.

Ministry of Health Malaysia had promised that waiting time at outpatient department in government hospital to see the doctor is less than 30-minute (Circular no 2-2008). However, studies by [3] [4] indicate that most of the patients had needed to wait for more than an hour. There are many reasons that contributed to the problem, such as staff shortage [5] and long and complicated work process [6]. Even though these problems also arise in Malaysia, but another factor that often being neglected in outpatient department in Malaysia is patients' arrival pattern.

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Unlike other developed countries, Malaysia did not have appointment system for most of its outpatient. For patients with appointment, usually the appointment card only shows the date when the patient is expected to see the doctor, without mentioning its time. The practice is causing congestion in the waiting area since many patients will arrive at the same time, usually during the opening hour [7]. [7] reported that number of patients that arrive before 9 a.m at an outpatient department in a government hospital usually constitute more than 50% of the total number of patients that day. These phenomenal create bottleneck at the waiting area, and cause long delay for patients to get treatment. [7] shows average waiting time for patients based on their arrival time. It reveals that people who come before 10 a.m usually needs to wait for more than one hour. By using a simulation model, Salleh et al. shows that waiting time at the outpatient department can be reduced significantly if patients' arrival number is controlled [7].

II. APPOINTMENT SYSTEM

Appointment scheduling is an adjusted form of a queuing process, where appointment times regulate the arrival process of patients to the system. However, in the application to an outpatient clinic, the steady state of a queuing process is never reached due to the limited number of patients per clinic session. The aim of a general appointment system is to balance patients' waiting time, doctors' idle time, and doctor's overtime.

In this system, physicians divide their available clinic time into appointment slots. In addition, providers determine the number of standard slots needed for each category of appointment request. Certain types of appointments, e.g., physical exams, require multiple slots. Other types, e.g., routine follow-up visits, require a single slot. Providers choose start and end times of their work schedule for each day over a pre-specified period of time several weeks in advance of that time period. They also provide schedulers with any restrictions on how available slots may be assigned to incoming requests for appointments.

[8] has developed a web based appointment system for a hospital and investigate the efficacy of the system in the registration service for outpatients. Their study shows that compared to the usual queuing method, the web-based appointment system could significantly increase patient's satisfaction with registration and reduce total waiting time effectively.



Sometimes, appointment system can lead to overcrowding, due to adhoc appointment. In order to overcome the problem, [9] introduced a new system to streamline an appointment system that leading to overcrowding on some clinic in Uganda. They conducted client health talks about the benefits of keeping appointment and started allocating appointment slots to the clinicians basing on the clients who have already been booked on each day. They concluded that the system is beneficial to both the clients and staffs by reducing preventable clinic congestion.

Another problem in appointment system is the problem of patient *no-shows* (patients who do not arrive for scheduled appointments). No-shows patients will reduce provider productivity and clinic efficiency, increase health care costs, and limit the ability of a clinic to serve its client population by reducing its effective capacity. [10] examined the problem of no-shows and propose appointment overbooking as one means of reducing the negative impact of no-shows.

They analyzed the system by using simulation method and found that even with highly variable service times, many clinics will achieve positive net results with overbooking.

A major challenge when designing outpatient appointment systems is the difficulty of matching randomly arriving patients' booking requests with physicians' available slots in a manner that maximizes patients' satisfaction as well as clinics' revenues. [11] describe a framework for the design of the next generation of appointment systems that dynamically learn and update patients' preferences and use this information to improve booking decisions.

III. METHODOLOGY

All the tasks involved in the methodology were conducted based on prior works done by [12][13]. Figure 1 show a glimpse of the methodology and all the tasks involved.

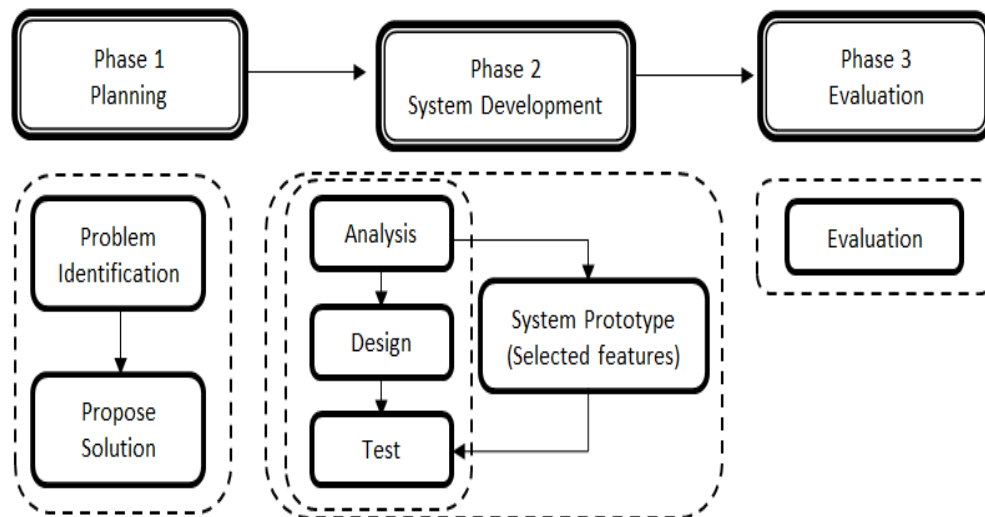


Fig. 1 The methodology of the study

Figure 1 has indicated that there are three main tasks involved in the methodology namely planning, system development, and evaluation. In brief, planning is a phase where the problems involved in the system were identified and later the possible solution was proposed. This solution will become the input to the next phase which is system development. During system development, prototyping method was utilized to create a system prototype so that it can be used in the later phase. Finally, the prototype was evaluated during the evaluation phase by the users.

Planning

In the planning phase, problems that arouse during which the patients want to make appointment with their doctors are identified. These problems are listed and solved systematically in two iterative tasks which are identifying the problems and proposing possible solutions.

In order to identify the problem, a preliminary investigation was performed to evaluate opportunities and difficulties that occurred during the appointment process. The investigation involved several interview sessions with peer friends (possible patients), and medical staffs. During this interview session, opinions from the interviewee and

their feelings towards the current state of the problems and opportunities, goals, and procedures were collected. All answers given by the interviewee are recorded in a log book and later, they are written in an organized form inside computer. Several meetings were conducted among researchers to discuss the problems and ranked them based on the problems priority so that the actual problems in the current appointment system were identified.

When all the problems had been identified, researcher comes out with a solution for the problem. The proposed solution considered all the input from interviewing and literature review related to the system. The MyMIS has been proposed as a solution for assessors in implementing their tasks.

System Development

In this phase, the analysis, design and testing of the system were implemented. Tentative design is sketched and translated into program codes to build the logical design of

the selected feature prototype. Then the prototype is tested for its functionality. Errors found are rectified so that the system can work properly.

In order to develop MyMIS, the requirements of the system were analyzed by utilizing method of interviewing, literature review and document review. The iteration of interviewing method is basically to continuously getting the interviewees feedback during development phase. As the result, the tentative design of the system been released. The tentative design includes the system flowcharts. Figure 2 shows the MyMIS flow charts.

In order for a patient to make appointment using MyMIS (see Figure 2), the patient can make phone calls to the health center. When the health center staff received the call, he will use the system to decide the time that the patient can make appointment with the doctor. The system will prompt the appropriate time for each doctor to the respective staff. Once the suitable time identified, the staff will ask the

patient's agreement either he want to see the doctor at that selected time. If the patient agreed, the staff will use the system to book the time for him and this information will be recorded into the MyMIS's database. If the time is not suitable and the patient want to choose another time or doctor, then he can request the new appointment time from the staff.

If the patient is successfully registered the appointment time using MyMIS, he can goes to the health center at the time that already agreed. Once he reached the health center counter, he has to show his identity (ID) (see Figure 2 on the right section). The staff will verify the patient's appointment time by checking his ID using MyMIS. In this process, the appointment time stored inside the MyMIS's database will be retrieved and all appointment information will be displayed. If all of the appointment information is verified, the patient will be treated immediately by the doctor.

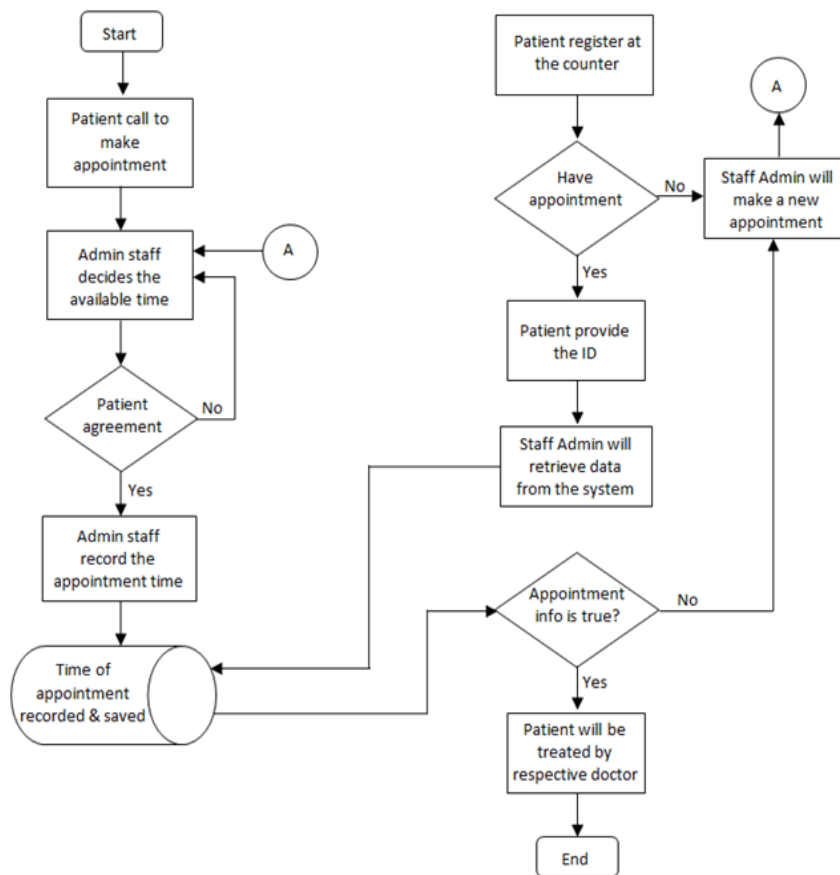


Fig. 2 MyMIS flow charts

Once all the system requirements were analyzed, design and development stages were started.

Evaluation

The main objective to conduct an evaluation towards MyMIS is to identify its effectiveness on shortening the waiting time for each patient before they are treated by doctor. However, since the system is still in development stage and not being implemented, thus it is impossible to compare the performance of the system before and after the implementation. In order to overcome the obstacle, the evaluation process in this research is done quantitatively, which is based on simulation.

Simulation is the act of reproducing the behavior of a system using a model that describes the operations of the system.

Once the model has been developed, analyst can manipulate certain variables to measure the effects of changes on the operating characteristics of interest. This project used a simulation model of the general outpatient flow in Jitra Health Center developed by Salleh et al. (2010).



The simulation model was modified by introducing appointment system in the model. Number of patients was controlled by setting the arrival pattern to become 5 minutes for each patient instead of current pattern. The result from both models is compared.

IV. SYSTEM DEVELOPMENT

There are three main phases involved in the MyMIS development which is system design, system development, and system refinement.

MyMIS Design

The development of MyMIS start with the design of system which include three main tasks i.e. storyboarding, user interface prototyping using Power Point slide, and creating the actual user interface in web editor application. In the task, ordinary papers had been used to draw the rough layout of the system user interface. These interfaces are very important because it will enable the users to interact with the system easily so that they can occupy all the functions available in the system. Storyboarding technique was selected to design the rough layout. The technique is selected because storyboard is a method to visualize the layout of the system where it will reveal the location of buttons, menu, textbox, etc [14]. This technique is very useful because it helps to visualize how the user interface layout will looks like when the system is completed. Hence, storyboards were drawn on ordinary A4 papers and it was discussed among group members to get agreement for each complete storyboard. All group members are free to give their opinion on the storyboard design and amendments were made to the storyboard if it does not meet the system requirement.

Once the storyboarding process is done, these paper based storyboards are brought to another process which is prototyping. Prototyping is an activity with the purpose of creating a manifestation that, in its simplest form, filters the qualities in which designers are interested, without distorting the understanding of the whole [15]. During prototyping, the storyboards were transformed in the form of sketches into computerized layout using Power Point slides. Power Point slides are easy to be created and displayed, and it also permits us to try adding new features into the design if we found it is necessary for the system. Figure 3 shows the storyboard of the MyMIS user interface created in Power Point slide.

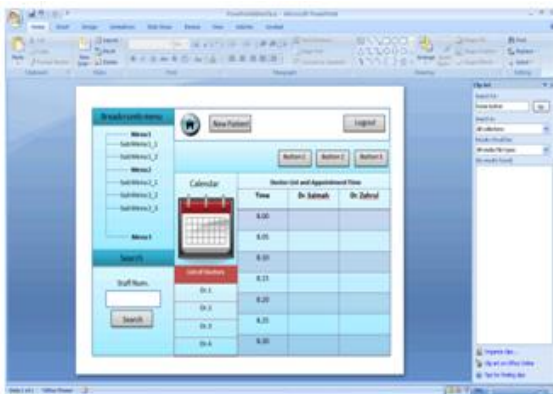


Fig. 3 MyMIS user interface created in Power Point slide

In the final MyMIS design phase, the actual user interface for the system was created using web editor application (Microsoft Front Page). The web pages are designed as similar as the prototype slides that are created before. Later, all the buttons and the web links between pages are tested in a web browser to ensure that they can interact between each other. Although the user interface design is far from completion, it allowed us to have some overview on how the system will operated once it is completed. Figure 4 shows the actual MyMIS main page.

MyMIS Development

The development of MyMIS started after the user interface was designed. MyMIS is a web-based medical integrated system specifically used to help patient making appointment with doctors. It takes almost four months to complete the system development as it is quite complex. Figure 5 show the architecture of MyMIS and the tools used for each data transaction between the patient and the system adapted from [16].

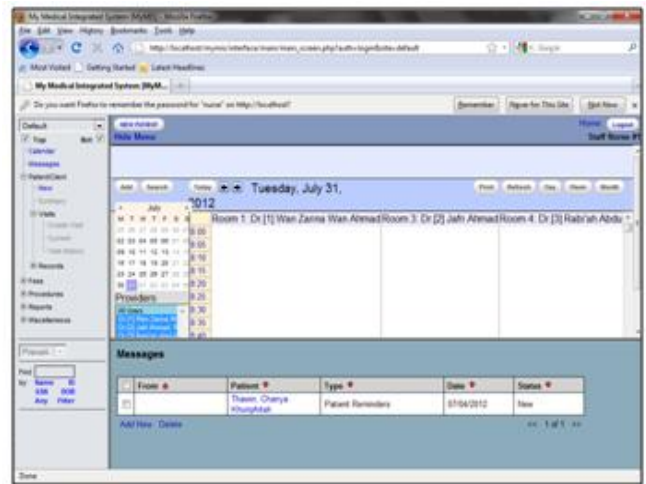


Fig. 4 The actual MyMIS main page

As shown in Figure 5, any patient who wanted to use MyMIS is required to have a web browser installed in their computer. Every appointment will generate Hypertext Transfer Protocol (HTTP) instructions (done by the browser) where it is send to the web server. The web server is installed with the MyMIS system. The development of the MyMIS is done using Medical Content Management System (MCMS). The MCMS is chosen because it simplifies the development process. MCMS is easy to be used and required only minimal programming knowledge and skill. MCMS has enabled us to generate MyMIS pages in the format of PreHypertext (PHP). PHP format was chosen because it is an open source format, thus there is no cost to run this format in web.

Before the appointment request can be completed, MyMIS required an application server to serve the patient request. In this case, Apache application server was used because the application server is the best to run and read PHP pages of MyMIS.

Meanwhile for the database that is used to store all patient and appointment information, MySQL database was selected.

The selection is done because this type of database is free to install while others (like Microsoft SQL server or Oracle)

required some fees. Finally, when every request is served well by the system, application server, and the database, the information of success appointment will be send back to the patient browser in the form of HTTP.

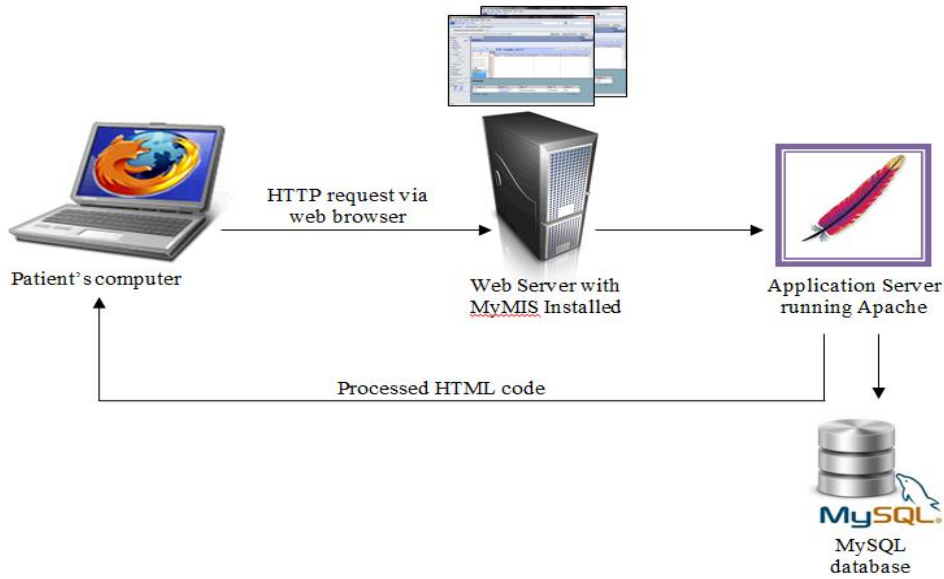


Fig. 5 The architecture of MyMIS and the respective development tools

MyMIS Refinement

The system refinement is performed to adjust MyMIS so that it can function properly when the patient used it. In order to refine the system, two major tests have been executed i.e. system interaction and functionality test to identify problems that might exist in the system. During the interaction test, several problems have been identified such as screen is displayed smaller that it should be, the layout of the system is a bit messy and need to be rearranged and some instructions are misunderstood. On the second test, several functionality problems were recognized like the reporting (the system did not show all doctors who are available), and data entry problem (the patient have to type date manually while the problem can be solved if we made pop-up calendar).

All these problems are immediately solved either via redesigning back the interface, adding suitable space for the display, or reprogrammed the computer code of MyMIS. Once the refinement process is completed, the system is uploaded into the web server and ready to be occupied the patient.

System Evaluation

In order to evaluate the effectiveness of the system to reduce the waiting time at out-patient department, a simulation model was developed based on the previous study by [7]. Figure 4.4 shows the real number of patients per hour and their average, maximum and minimum waiting time for one day.

Time	Patients	Average waiting time (hr)	Max waiting time (hr)	Min waiting time (hr)	Number of doctors
0700	50	1:53	3:04	1:25	0
0800	41	2:31	3:42	1:35	2
0900	19	2:50	3:07	2:13	2
1000	1	1:52	1:52	1:52	2
1100	6	1:23	1:45	1:03	1
1200	0	0:00	0	0	2
1300	8	0:59	1:50	0:43	0
1400	18	0:35	0:57	0:20	2
1500	8	0:29	0:54	0:16	1
1600	1	0:10	0:10	0:10	1

Fig. 4.4 Real number of patients per hour and their average waiting time

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Based on the result, a simulation model was developed. Figure 4.5 shows the comparison between results of average waiting time from the real data and simulation data. Sum of

errors for both data is merely 0.64 hour. The comparison conveyed that the developed simulation model can be used to analyze the effect of appointment system to the system.

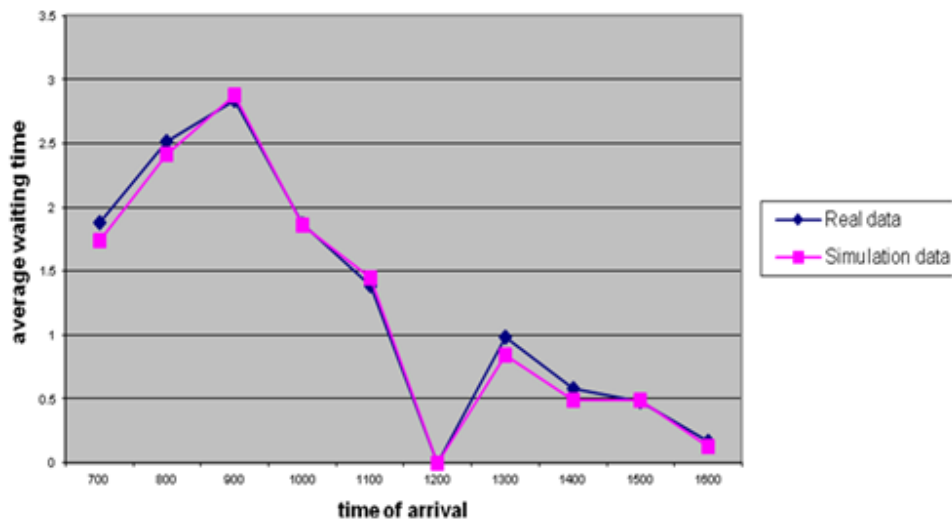


Fig. 4.5 Comparison between results of average waiting time of the real data and simulation data

The developed simulation model was then used to facilitate the new appointment system. In the new system, number of patients is limited for every hour. Each doctor is scheduled to take 30 minutes recess during morning session. The operation hour is started from 8 am till 4.20 pm. Result is shown in Figure 4.6. The result shows a very significant reduction in waiting time to 8 minutes for each patient.

Furthermore, the number of patients in the appointment system is greater than in the real situation. It shows that the number of doctors in outpatient department is not a significant factor that contributes to the long delay in getting the treatment. If the number of patients can be controlled, waiting time can be reduced.

Time	Number of patients	Average waiting time (min)	Max waiting time (min)	Min waiting time (min)	Number of doctors
0800	12	8	8	8	1
0900	24	8	8	8	2
1000	24	8	8	8	2
1100	24	8	8	8	2
1200	22	8	8	8	2
1300	0	0	0	0	0
1400	24	8	8	8	2
1500	24	8	8	8	2
1600	10	8	8	8	2

Fig. 4.6 Simulation result if appointment system is used

V. CONCLUSION

MyMIS has been developed to achieved one main objective, which is to construct a system to allocate appointment time for outpatients to see the doctors. The research has been succeeded in developing the system.

The developed system has several advantages. The first advantages is, the system is simple and easy to be operated even by unskilled staff. User friendly system is very important in the health center because the system will be

used by staff with no or low information technology (IT) knowledge background. The developed system is not a decision making system, but rather than a decision keeping system. All the decisions will be made by the staff with patients approval, and the system is just act as a reminder to the decision.

The second advantage is the system is a stand alone system, thus will make the installation process easier because it will not interrupt other current running systems. In the UUM Health Center, they have severals other systems currently being used to facilitate customer needs. These systems are complex and any interruption on one of the systems will crash other system too. In order to avoid such situation, a stand alone system is the best possible solution for appointment system. The third advantage is the system is suitable to be used at small clinics as well as big hospital.

The fact that it is a stand alone system make it easier to be utilised in these areas. Unlike other appointment systems that needs some integration with other system to function, the developed system can be used independently without other integration, thus can be installed in all healthcare institutes.

The fourth advantage is the system can be converted to become a web based application. Even though currently the developed system is running offline, it can be transformed to online application. The capabilities to become an online application is important because it will enable the system to be further developed, for example patients can make appointment not only through phone call, but they can also through the internet.

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