# Smart Management Waiting System for Outpatient Clinic

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| ARTICLE INFO | ABSTRACT |
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| <br><br><br><br><br><br><br><br><br><br><br><br><br><br><br> | Queuing has become a common occurrence in malls, train stations, and others. Queuing especially in healthcare intuitions has become a center of attraction because of the long waiting time either at the registration or in receiving treatments. Therefore, in solving this problem, a smart management waiting system for outpatient clinics is developed by using AppGyver and Backendless as the data storage. This system will be operating by QR code scanning for administrators to obtain patients' personal information before patients obtain the queue number via MyQUEUE mobile application (patients' interface). By providing queue numbers through the mobile application, patients don't have to wait in a small uncomfortable waiting lounge instead patients can wait at their desired places such as cafeteria, in their car, and others. Patients also don't have to worry about missing their turns because there will be a 10 minutes reminder before their turn. Other than that, there is a feature that digitalized the appointment details which means patients don't have to worry about missing their appointment book or card. The performance of both systems which are the patients' interface and administrators' interface is successfully designed and the output obtained. The administrator is able to assign queue numbers, notify patients 10 minutes before consultation time, and assign follow-up appointments to patients. |

## 1. Introduction

As the world's population grows, queueing becomes a common occurrence in public places like malls, banks, transit hubs, and even hospitals [1, 2]. Therefore, previous researchers believe it is important to determine the role of technology readiness on the success of smart cities, including the use of the smart waiting system. Technology readiness, as a resource availability, has been extensively studied in many areas of work, particularly in the change management of organizations seeking to improve their performance. The smart city is a futuristic city which, once completed, has the capability and ability to balance the economy, the environment and human social relations [3].

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Queueing in today's healthcare management system has long been a major concern for the wider public [4]. This is owing to the lengthy waiting period for healthcare treatments. Long waits are caused by an increase in the number of outpatients visiting the hospital while the service system stays constant.

For ages, health institutions are still using a manual service system in which patients have to physically register at the registration kiosk in order to get a queue number before getting treatment. Patients also have to wait for the administrators to fetch their existing medical records before obtaining the queue number. Other than that, there are also a lot of complaints that the news report portrayed by the media such as lacking beds in the hospital, the long queue at the pharmacy department as well as not enough equipment to treat a large number of patients at the same time [5]. Hence, it is clear that queueing issues among outpatients is not a new issue faced by healthcare institutions.

Despite the availability of knowledge and the advancement of medical technology, the current healthcare system still has a problem with patient wait times [6]. The manual registration method is a very time–consuming task for hospital administrators. Administrators have to take a long time to analyze patient information and get their medical cards ready for treatment. Administrators have to keep track of a huge number of fillings that contains details on patient medical records. This could lead to data redundancy since administrators have to search the patient's file in a short period.

When many patients arrive at the same time, for a drop-in consultation there is a risk of crowding to get a queue number which contributes to long waiting lines. This could lead to an unintentional gathering in confined places which could contribute to the spread of the virus, COVID – 19 since there would be less social distancing between patients who are waiting in lines to get queue numbers. After obtaining the queue number, another problem is not knowing when to be served is a stressful factor that harms the patient's experience. Sometimes it could take about one to two hours, and even three hours for a patient to be served. Long waiting times could affect patients' satisfaction with the service [7]. This could be a major problem for patients who come with their kids or senior citizens. Since there will be a lot of people, therefore, the seats available for them to wait comfortably will be limited. In fear of missing their turn, they have to stand for a long time in the lounge waiting area.

Therefore, this work suggested a smart management waiting system is developed in order to help reduce the long waiting time issues faced by outpatients. By implementing virtual ticketing, this technology automates the human queue procedure and may remove the need for patients to stand in long lines. Patients have to scan a code given by the health institution by using their cell phones, for administrators to get patients' personal information such as identification numbers to get the medical cards ready to be viewed by the doctor in charge before receiving treatments. The administrators can manage the time needed to fetch patients' medical records and can update a ticket number for patients in real-time using the cloud server. Patients can get real-time updates regarding the status of the queue as patients will be getting 10 minutes reminders before receiving treatments. Because of the pandemic, this solution provides patients with the choice of briefly exiting the waiting era and waiting in desired places. Patients don't have to worry about missing turns since there will be a reminder for them. In addition, with help of digitalizing details of follow–up appointments, patients don't have to physically carry an appointment book. This solution came out in order to achieve the aim of possibly reducing the waiting lines that cause by manual registration services and ticketing problems as well as increasing the patients' satisfaction in getting treatments by the healthcare institution. Providing queueing information helps improve patients' experience. Furthermore, managing queues is significant since it can reduce inefficient resource allocation and revenue loss [8].

The paper is divided into the following sections. In Section 2, the application related to the smart management waiting system is briefly discussed. In section 3, the methodology of this work is presented. The results and discussions are presented in Section 4 which shows the output of this system. For conclusion will be concluded in Section 5.

## 2. Literature Review

Waiting is a common phenomenon that happened in everyday life in terms of receiving services, especially at a healthcare clinic. According to research about an assessment of patient waiting and consultation time in a primary healthcare clinic, there are five stages of waiting that patients have to undergo which are waiting periods for registration, pre-consultation, examinations, an appointment, payment, and finally, pharmacy [9]. For four weeks, research was conducted on patient waiting and consultation time in a primary healthcare clinic. Patients who visited the clinic during the time period are included except for people who were extremely sick or came in for repeat medicine without needing to visit a doctor. The results reveal that more than half of the patients (53%) were registered within 15 minutes, and the overall average processing time from registration to visiting a doctor was 41 minutes. There are 99% of patients waited less than 30 minutes to get their medicines. The average consultation time was 18.21 minutes [9]. According to a study conducted in Kedah, patients who waited less than two hours were happier with the outpatient service than those who waited more than two hours. From the study, it is found that a high percentage of patients still have to wait an unnecessarily long time to be registered and receive treatments. It is proven that the long waiting time is caused by the long queues at the registration because of the lack of staff who handled the manual registrations.

Other than that, the research found that management software can help in enhancing outpatient clinics by reducing patients' waiting time [7]. This case study discusses the problem faced by the outpatient clinics in the long waiting lines which could literally affect the level of quality services and patients' satisfaction. These articles focused on the problem with the use of Outpatient Management Software (OMS) and the solutions in order to reduce the waiting times. There are a lot of outpatient clinics like hospitals in the USA, China, and Si Lanka that succeed in reducing the queue time by 15%, 78%, and 60% respectively. The solutions to this problem are depending on adding more human resources or changing some business or management policies. Solutions come out in this article by enhancing the software used to manage outpatient clinic services. There are two methods that were being considered such as the quantitative and qualitative methods are used in order to understand the current OMS to examine the level of patients' satisfaction.

There are five problems that might be the reasons for the high waiting times that have been identified such as appointment type, ticket numbering, doctor late arrival, early arriving patient, and patients' distribution list. As the late doctor arrival problem is solved, this will contribute to reducing clinic service time by up to 20%. However, solutions for patients who arrived early reduces to 53.3% of the vital time, 20% of clinic time, and overall, 30.3% of total waiting time. Lastly, the patients' distribution list has made improvements by 54.2%. This improvement contributes to the increase in patient satisfaction.

Not only management software can help in reducing patients' waiting time, but other research found that a virtual queueing system can be developed by using cloud computing also have the same purpose as management software in reducing patients' waiting time. The system development will be providing an android-based application where the user can join or create a virtual queue [10]. The program provides an easy and time-saving method of managing queues, allowing companies to assist their customers without having to wait in a long line. This system has a lot of benefits for the

customers and organizations such as the customers don't have to waste their energy and time to queue instead customers can just join or create a virtual queue in order to get their needs. For organizations, this system helps in improving customers' satisfaction with the services provided. There are three existing systems such as Kiosk Based system, Third-Party Solutions, and Personalized services. A Kiosk Based System is one in which a small kiosk/registration counters are often located in high–traffic areas for commercial purposes. The drawback of this system is, that customers must physically visit the site in order to access the service. Meanwhile, the Third-Party Solutions which consists of the use of third-party software by organizations on subscription bases. By using this system, user can digitally obtain their token using their credentials. This system is easy to be used, but not available for small-scale organizations due to expensive subscription fees.

Therefore, the development of this virtual queue application allowed organizations to use it for free in any type of industry. This technique may be utilized without the requirement for a physical user to obtain the token because the user can produce the token themselves, which is more convenient. Users can create a new queue or join the existing queue. Other than that, users can also join multiple queues without the need to be there physically. Another solution to the issue of consumers' frustration with high wait times linked with certain services is by developing a smart mobile system that has real-time tracking and management of service queues [1]. This intelligent queue management system is designed to deliver real-time visual and auditory updates on response demands via a smartphone app. Customers will receive digital tickets and are free to leave the waiting area until their turn to be served. Customers are given a choice to stay and listen to the signal of the television set. The system is made up of interconnected elements that form a web of things. As smart devices, there are those for ticket registration and authentication, audio capture and broadcasting, appointment scheduling, and customer unit. The user unit is presented by an android smartphone application. NFC antenna is used for registration and authentication. An embedded Linux target board is utilized for audio recording and broadcasting. The Apache Hypertext Transfer Protocol (HTTP) server is in charge of processing requests, whereas the MySQL Relational Database Management System (RDMS) database manager is in charge of storing and updating requests. The results obtained show that the total time waste by users is 58.8 minutes which is an average of 2.4 minutes per user. As a result, the smart queue management system has the ability to reduce service wait times. Not only will it increase user contentment, but it will also give audio-visual updates and amusement to the user by offering reading material and a TV audio feed.

Lastly, other than developing an application or software in order to reduce the customers' / patients' frustration over long waiting times, an appointment system can provide a positive output in reducing the amount of time wasted by customers during the registration process. Based on this journal, which the research takes place in Nigeria, patients waiting for a long time to receive services is not an odd problem faced by Nigerians [11]. This practice is growing, and it poses a danger to healthcare services since it has impacted the quality of customer service. In Nigeria, specialist, academic and medical centers with a significant number of patients may be unable to tend to patients on time, while some are sent home without treatments. As a remedy to the long wait times at these institutions, an effective queuing model for an appropriate appointment system is presented in this work. Meanwhile, Vijayasarveswari [12] developed an E-healthcare management system for government or private institute to make doctor appointment online. This system is able to cater all the needs in appointments and organizing the patient record.

Based on the previous works, a few limitations of the various systems used can be pointed out such Outpatient Management Software (OMS) is not available in Malaysia, since Malaysia used different methods in handling patients such as by using ClinicPlus, Clinic Management System (CMS), and Patient Management System (SPP). Secondly, the system mentioned in the literature review

above such as the use of a third party, the system is not available for small-scale operations because of high subscription fees. And, with the appointment system mentioned above, the presence of patients according to the appointments is difficult to be predicted.

## 3. Methodology

This work proposed a smart management waiting system for outpatient clinics. With the long queueing situation that is faced by patients during the registration process, this smart system will be operating through QR code scanning to get patient information and to give queue numbers to patients via mobile application. By using this method, patients do not have to physically be at the registration counter to fill up personal information for registration purposes. Moreover, patients can wait at the desired places such as at the cafeteria, and didn't have to wait in a small lounge that is relatively uncomfortable for senior citizens or patients with kids. Furthermore, patients do not have to worry about missing turns since there will be a reminder before consultation time as well as an additional feature where the follow–up appointment will be digitalized and patients do not have to carry an appointment card/book. This work has been developed by using AppGyver and previewing the designed application by using AppGyver Preview. This web–based software will be connected to Backendless which is a Visual App Development Platform (VADP) that holds the database of patients' personal information. There are three main functions, first is to obtain patients' personal information by QR code scanning. Second, once the clinic administrators gain patients' medical information from the personal information obtained, administrators will provide queue numbers via an app. The last one is to improve customer experience by providing 10 minutes reminders before their turn of treatment so that patients don't have to worry about missing their turn. During work testing, the created UPTH Outpatient Appointment System application was utilized to get an appointment slot for consultation, and the following results were obtained such as patient information was inserted into the input settings and patients' appointments were scheduled, and a monthly, weekly, and daily view of appointments was displayed. At the hospital side or staff admin, the information needs to be displayed such as assigning consultation time slots, patient registrations, and the medical history of the patient is saved in a database (which can be accessed).

This works consists of two queueing system interfaces, "MyQUEUE", which are the interface for patients to use, and "MyQUEUE SYS", an interface for administrators to use in order to handle the queue system. Figure 1 and Figure 2 show the block diagram and flowchart of the proposed work.
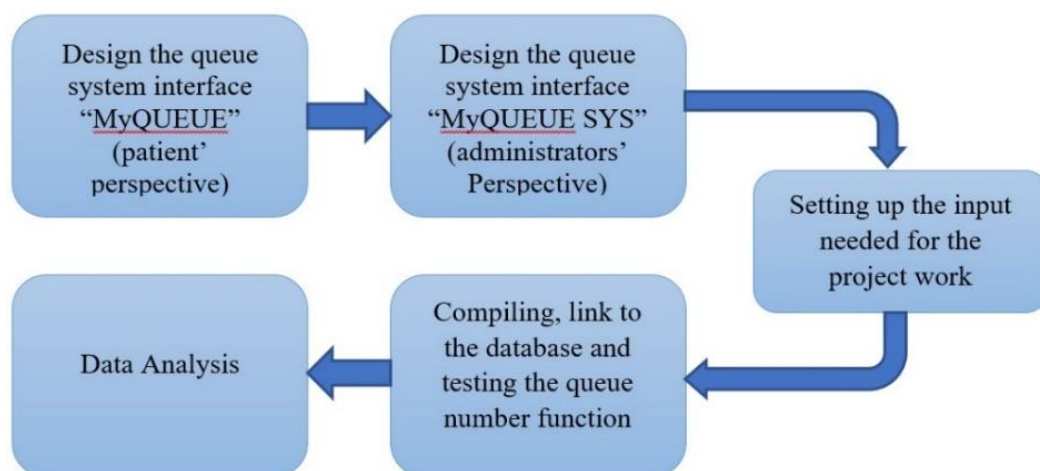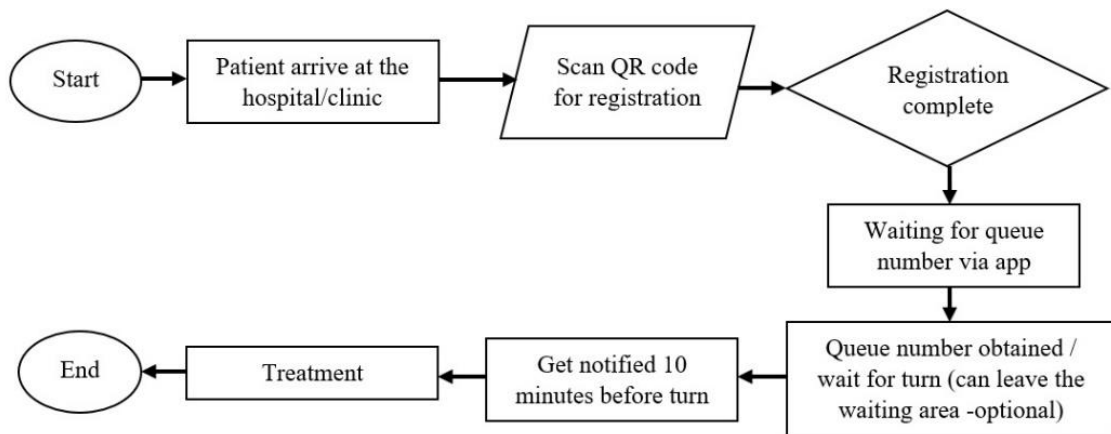


**Fig. 1.** Block diagram of this work

**Fig. 2.** Flowchart of the proposed work

Based on the flowchart in Figure 2, once patients arrived at the health institution, patients have to scan a code for the registration process. Notification will be given if the registration is successful, if it's not then patients have to scan the code again. Then, wait patiently for the administrators to update the queue number via the app. Patients can choose whether to stay inside the waiting lounge or to leave the area and wait at the desired places. Lastly, patients will be getting 10 minutes' notification before their treatment so they don't have to worry about missing their turn.

The software used in this work is a web-based software which is called as AppGyver. With AppGyver, a quality application can be built without compromise. It has an easy drag and drop function that is easy to be controlled [13]. In this work, AppGyver will be used to design the interface for patients which is "MyQUEUE" and the interface for administrators which is "MyQUEUE SYS". The input data will be linked to a web–based data management called as Backendless. The data will be linked using REST API direct integration. Figure 3(a) shows the interface of web-based software, AppGyver. The interface from AppGyver also can be viewed in a smartphone by using the AppGyver preview. The AppGyver Preview is also used to test of testing whether the designed interface was working perfectly or not. Figure 3 (b) shows the interface of AppGyver Preview.



(a)                                                                (b)
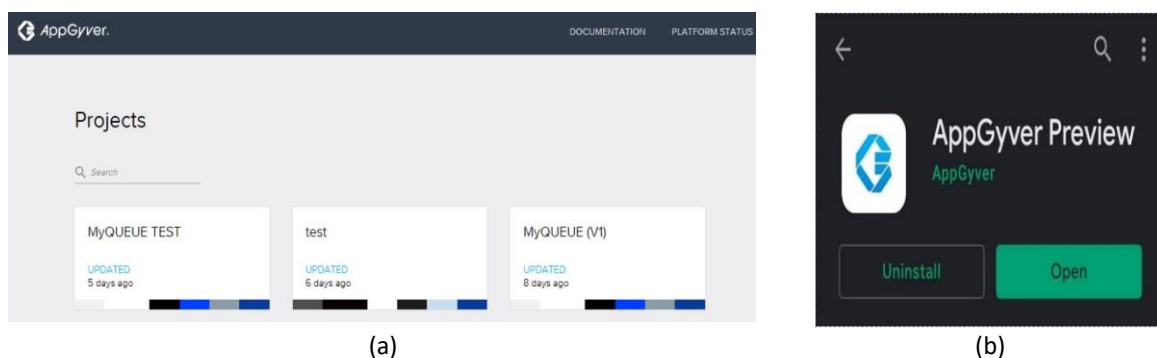
**Fig. 3**. The interface of (a) AppGyver. And (b) AppGyver preview

The input data from the interface AppGyver will be linked to a web–based data management called as Backendless. The Backendless is known as a Visual App Development Platform (VADP) that can combine API, user, and database management functionality. It is a web-based interface and UI Builder that is user–friendly [14]. Backendless supports a real-time chat and geolocation-based function, and not only that it also has the ability to send emails and a push notifications function.  In this work, the Backendless has been used in order to manage the database of patients from AppGyver

such as the profile or personal information and the symptoms they happen to have [15]. Figure 4 shows the interface of database management known as Backendless.
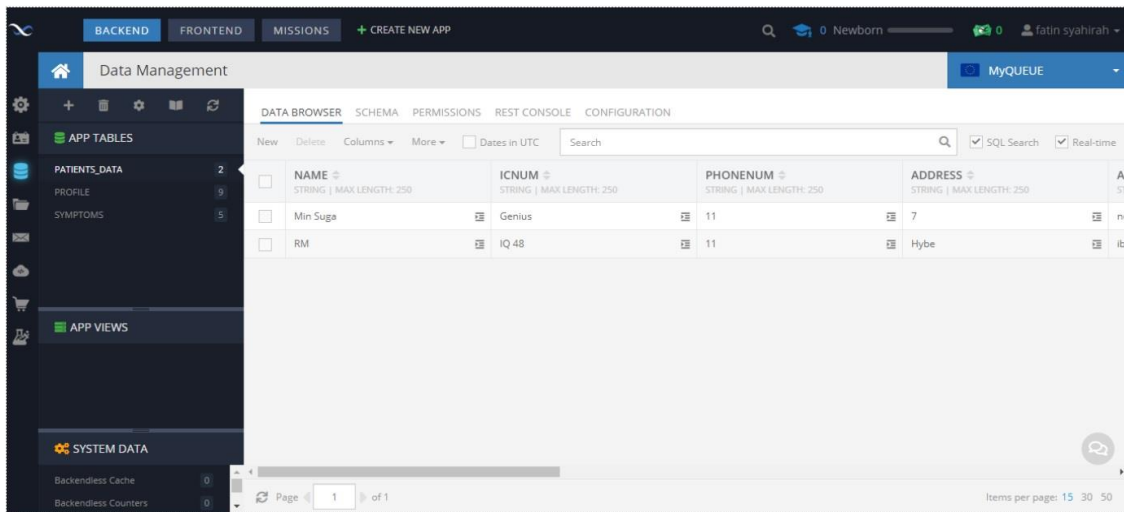


**Fig. 4.** The interface of Backendless

REST API direct integration is a type of data resource that informs a Composer how a specific HTTP REST API can be accessed such as JSON – format. Base URLs, headers, query parameters, and schemas will be defined by REST API [16]. Figure 5 shows the example of using REST API direct integration to store the login information to Backendless.



**Fig. 5.** An example of using REST API direct integration

Based on Figure 5, the Resource ID is a unique ID for the resource that will be used. For this case, the resource ID is log-in. Any schemas that have been set such as the username, password, the email will be passed to the resource URL that will be stored to Backendless. There are several data that need to be collected and filled in from patients such as from the signUp and login interface (Name, Email, Password), Patients profile (Name, IC Number, Phone Number, Address), Symptoms (Temperature, Date of Registration, Types of symptoms such as flu, fever, cough, allergies and other symptoms) and Application data (Name of patient, Date of appointment, Time of appointment). All of this data of patient information then can be sent (through QR Code scanning) to the administrators for registration purposes and for administrators to provide a queue number to every patient that has been registered, as well as if the patient has a follow–up an appointment, the details will be digitalized and pass-through patients' interface so that patient doesn't have to physically carry appointment book/card.

## 4. Results and Discussions

This section will discuss the findings and outputs of this work based on the methodology described in the previous section. There are two parts of app designation which are "MyQUEUE" for patients' interface and "MyQUEUE SYS" for administrators' interface. For part one, in the "MyQUEUE" patient's interface consists of Registration, App Guide (How to use the app), Navigation Pane, Patients' Profile, Patients' Symptoms, QR code scanner, Queue Number and Appointment Displayer, and Log Out buttons. For the registration, important data like name, email, and password are needed in order for patients to be able to use the applications and make a registration in a certain clinic. There are two patients who have been the subject of testing for MyQUEUE "Ikhwan" and "Nabila". Figure 6 shows the interface of the application guide including registration for the patient name "Ikhwan".



(a)

(b)

(c)

(d)
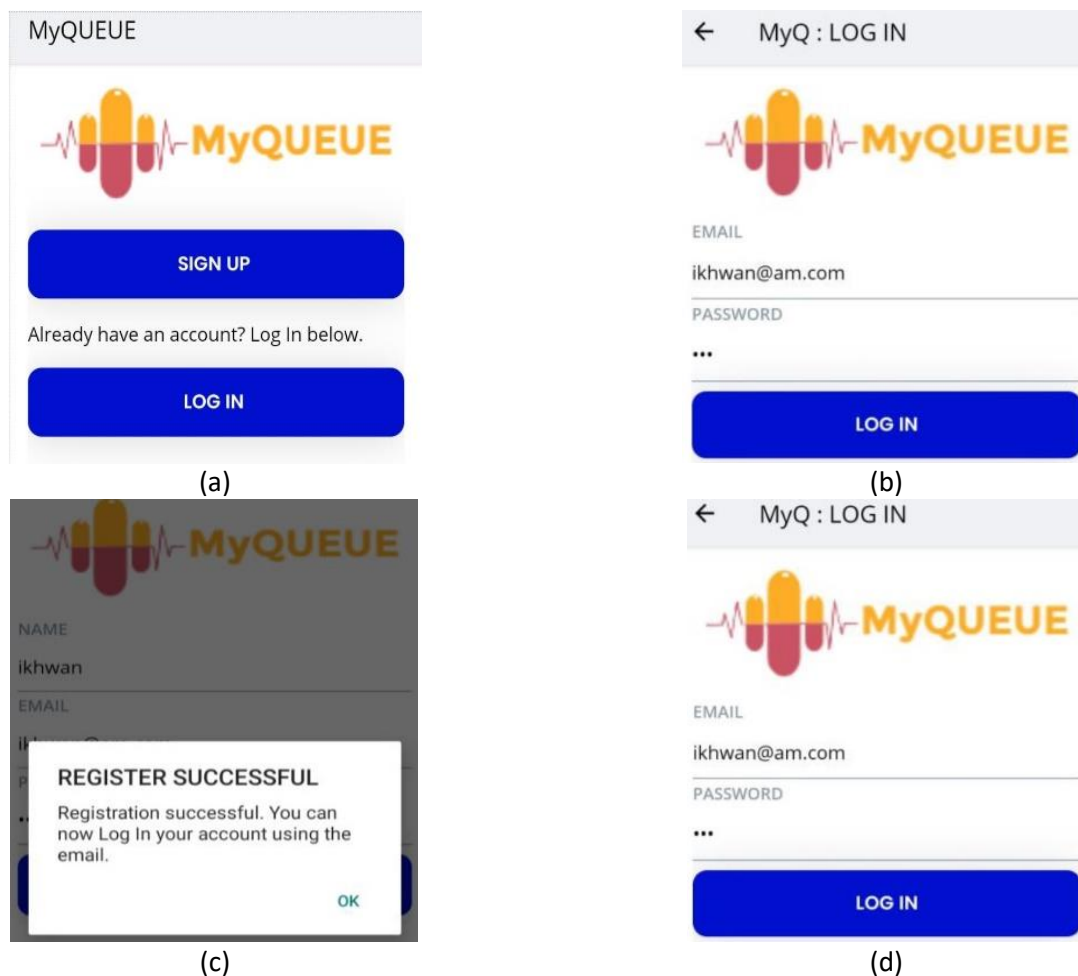
**Fig. 6.** The interface of application guide; (a) MyQUEUE: Front Page, (b) MyQ: SIGN UP, (c) successful registered, (d) MyQ: LOG IN

Based on Figure 6 (a), the patients have to choose whether to Sign Up (new patients that don't have any history with the clinic) or patients can choose to Log in (if patients already have a medical history with the clinic). Then, Figure 6 (b) show the interface that patients need to sign up by filling up the information such as name, email, and password in order to register and get a queue number. Next, once the patient hit the sign-up button, a pop-up notification will be shown as in Figure 6 (c), and the patient can proceed with the login process using the same email used for the sign-up process as in Figure 6 (d). The Login interface also can be used directly by patients that have a history of

receiving treatments at a clinic and for patients who already Signed up. Patients have to log in to the apps by keying in information such as email and password. Furthermore, Figure 7 shows the process after the patient successfully signed up and log in to the system.



(a)           (b)           (c)

**Fig. 7.** The interface for the patient: (a) navigation pane – MyQHOME, (b) symptoms-MyQ: SYMPTOMS, (c) scanning interface - MyQ: QR SCAN

Figure 7 (a) shows the navigation pane or home interface for the patients. After that, the patients need to select a symptom panel and fill up all the questions in order to ease the administrators to handle patients' data for treatments as shown in Figure 7 (b). After patients done filled in the personal information part, patients have to scan a QR code given by health intuitions in order to complete the registration as shown in Figure 7 (c). When patients scan, all the personal information will be passed to the database by using the REST API direct integration method. Then, patients will obtain queue numbers once the administrators acknowledge the registration. Once patients successfully scan the QR code given, patients' information in MyQ: PROFILE and MyQ: SYMPTOMS will be passed to the Backendless database as shown in Figure 8.



**Fig. 8.** The Data successfully linked to Backendless database

Figure 9 shows the process of testing the MYQUEUE system. Based on Figure 9 (a), patients can view the given queue number and in case there are a lot of patients, there will be a search function for patients to straight-up view their queue number. Then, the patient will get the notification in 10 minutes before their turn as shown in Figure 9 (b). After treatment is done, if the patient has a follow–up an appointment, the appointment details such as the name of the patient, the date, and the time

of appointment that are given by the doctor in charge will be recorded here. Moreover, the patient doesn't have to physically carry an appointment book since the details of appointments will be digitalized as shown in Figure 9 (c). The patient can log out of the system anytime and there will be a pop–up notification for the patient to confirm whether the patient really wants to log out. After the log-out process is completed, patients will be brought back to the front page.



(a)　　　　　　　　　　　　　　　　　　　　(b)



(c)
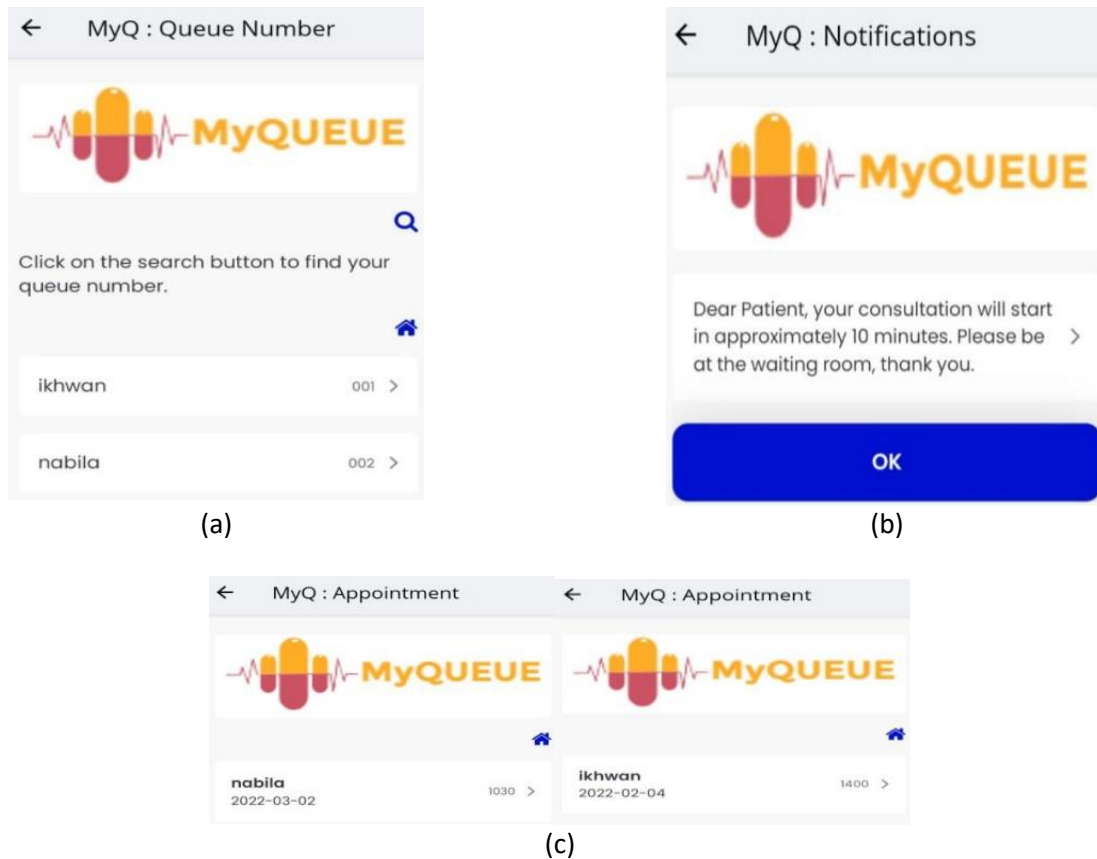
**Fig. 9.** Testing MYQUEUE: (a) The queue number that are successfully assigned by administrators to patients, (b) The notification that patient will get 10 minutes before consultation time, (c) The details of follow-up appointment

For part two, in the "MyQUEUE SYS" administrator's interface consists of Registration, Navigation Pane, App Guide (How to use the app), Patients' Information, Queue Number Input, List of Patients and Queue Number, 10 minutes reminder for the patient, Set Patient's Follow – Up Appointment, Appointment List and Log Out buttons. For the registration, important data such as name, clinic ID that every administrator have, and password are needed in order for the administrator to be able to use the applications and check the list of patients that have been registered for that day in order to provide queue number to patient. Figure 10 shows the interface of the application guide including registration for the administrator name "clinicdrsyakilla".
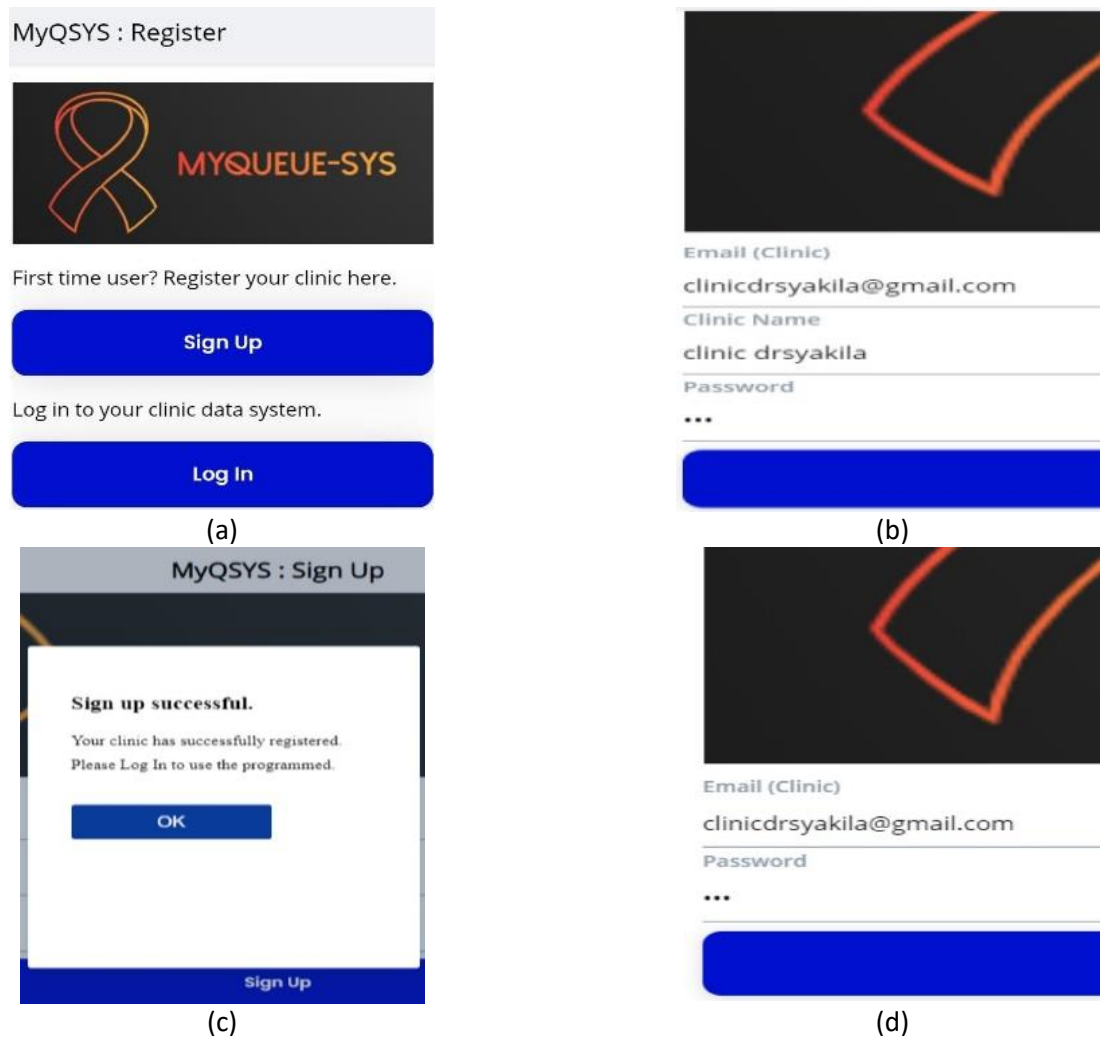
**Fig. 10.** The interface of application guide: (a) MyQUEUE SYS: Front Page, (b) MyQUEUE SYS: SIGN UP, (c) successful registered, (d) MyQUEUE SYS: LOG IN

Based on Figure 10 (a) the administrator has to choose whether to Sign Up or login into their respective account. If the administrator chooses to Sign Up, the administrator needs to key in the information such as clinic name, email of the clinic, and password in order to use the system as shown in Figure 10 (b). Next, once the administrator hit the sign-up button, a pop-up notification will be shown as in Figure 10 (c), and the administrator can proceed with the login process using the same email used for the sign-up process as Figure 10 (d). Furthermore, Figure 11 shows the process after the administrator clinic successfully signed up and log in to the system.

(a)            (b)            (c)

**Fig. 11.** The interface for the administrator: (a) navigation pane MyQSYS – Home, (b) MyQSYS: Patients' Information, (c) MyQSYS: Q-Number

Figure 11 (a) shows the home page of MYQSYS if the login process is successful and each of the buttons displayed has its' own function such as patient information, Q-Number, and appointment. If the admin clicks the patient information button, all information of patients that already registered for consultation will be viewed as shown in Figure 11 (b) and the admin can search patient names easily by using the search button. After that, in order for the administrator to assign the queue number, the administrator needs to click on the desired patient and the queue number page will open as shown in Figure 11 (c). In this example, the administrator assigned a patient named "Ikhwan" with the queue number of "001". A pop–up notification will show as the process of assigning queue numbers is done. After assigning queue numbers to patients, the administrator can or nurses who are in the consultation room can notify the next patient approximately 10 minutes before their turn of consultation as shown in Figure 12. This feature will make it easier for patients to be in the waiting room just 10 minutes before their turn.
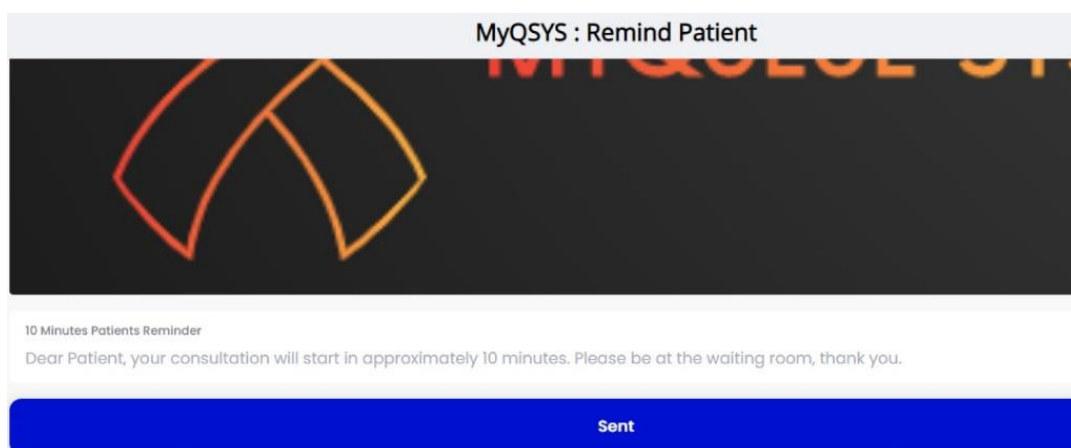


**Fig. 12.** The reminder that patient will get 10 minutes before consultation starts

An extra feature of this system is the administrator can set the follow–up appointments for patients. Usually, patients will get a book that contains the details of the follow–up appointment such as the date and time of the appointment. There is a high probability that patients forget where they put the appointment book/card and even worst lost it. By using this feature, patients don't have to worry about having to bring the book physically during the follow–up appointment since all the

details of the appointment can be found in MyQ (patients' interface) as well as there will be a search function for administrator to look up at patients' details of the appointment in MyQSYS (administrators' interface). The details of the feature as shown in Figure 13 with two patients ("Ikhwan" and "Nabila") as the testing subjects. Once the "Set Appointment" button is clicked, a pop–up notification will indicate that the appointment is successfully set up. Patients will get their follow–up appointment details in their MyQUEUE apps.
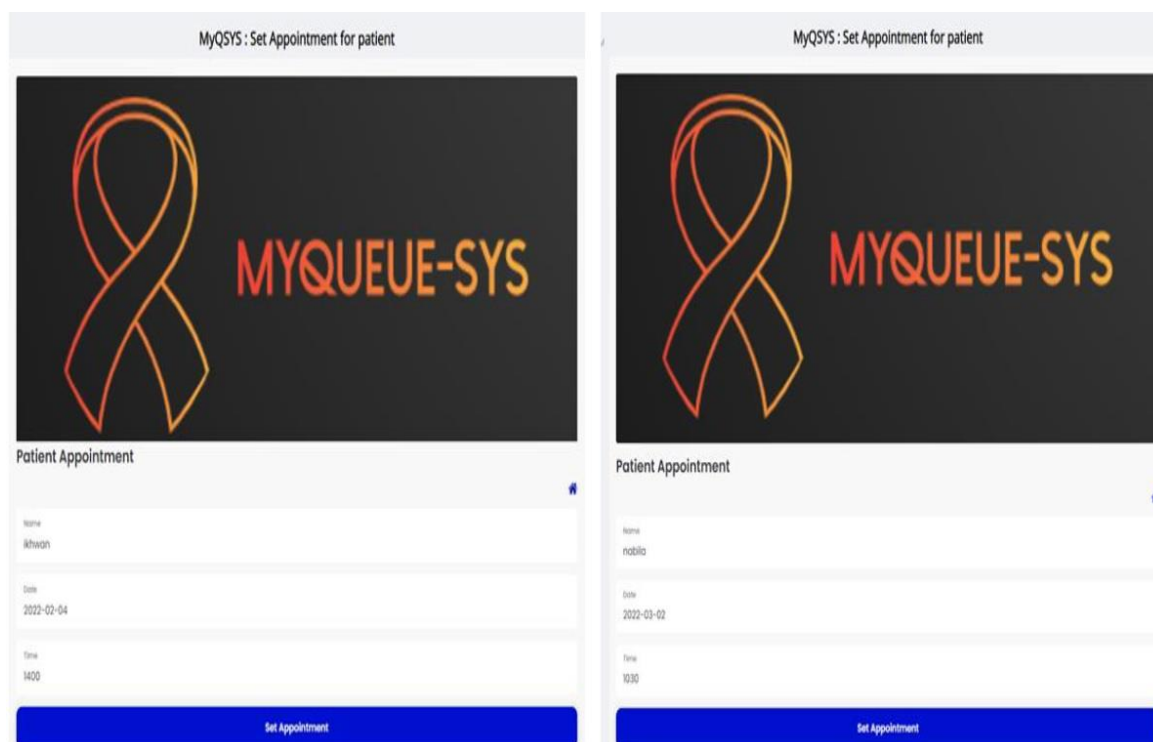


**Fig. 13.** The follow-up appointment for both patients

The administrator can view back the details of appointments that have been assigned to patients. There will be a search function that will make it easier for administrators to find specific patients to view the details of the appointments. Once the work is completed, administrators can log out of the system. After log-out process is completed, administrators will be brought back to the front page.

## 5. Conclusions

This work has introduced a smart management waiting system for outpatient clinics by using AppGyver and Backendless as the database, the interfaces of patients' applications (MyQUEUE), and interfaces for administrators' applications (MyQUEUE SYS). The queue number will be provided via the mobile app from the administrators' application (MyQUEUE SYS) and can be viewed by patients in the patients' application (MyQUEUE). The result shows that this system is able to improve outpatient experience and management service with 10 minutes reminders before treatment which the administrators successfully notify patients approximately 10 minutes before the consultation time started. With this feature, if the patients decided to wait outside of the waiting lounge or at the cafeteria, patients don't have to worry about missing their turns for consultation. Furthermore, the additional feature of providing digitalized details information about the follow–up appointments help in reducing the probability of losing the appointment book and forgetting about the details of the appointments. Here are some extracted points for advantages that have been achieved based on the

result of this work. The first point is, long waiting time can be reduced because of the assignation queue number through mobile apps, therefore it gives patients the freedom to wait in their desired places. Secondly, With the simplification of gaining queue numbers, will help in fastening the registration of patients and reduce the waiting time faced by patients as well as help in reducing workload stress faced by healthcare workers. Lastly, a user-friendly system to assign and control the applications both on patients' and administrators' sides. This proposed system is suitable for clinics and hospital environments to use in controlling and handling outpatients that visit the premises every day. This system will help in reducing the waiting lines and long waiting times faced by outpatients.

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