A study and an implementation of online doctor consultation system

Wang Jack Huan
School of Computing
Asia Pacific University of Technology
and Innovation (APU)
Kuala Lumpur, Malaysia
Tp041988@mail.apu.edu.my

Dr Kuruvikulam Chandrasekaran Arun
School of Technology
Asia Pacific University of Technology
and Innovation (APU)
Kuala Lumpur, Malaysia
kchandran.arun@staffemail.apu.edu.my

Abstract— **Consumers want to do things quickly and get the services (shopping, ticketing, etc.) done as soon as possible in today's digital age, which is why immediacy is becoming the norm. The internet has recently emerged as another way of making appointment for various purpose and it has reached medical industry too for making doctor appointment online. This paper studies different parameters that are really helpful in bringing few advantages of Online Booking Doctor's Consultation Time system. Also, the paper focuses on how an Online Doctor consultation system can be implemented using the RAD methodology.**

Keywords— RAD, IDE, SQL injection, Waiting Time, IOM.

I. INTRODUCTION

In today's digital age, customers want everything to be done quickly through online like online shopping, online ticketing, and making an online appointment soon. The growth of the internet has recently made an online appointment easier for various purposes and to be specific online appointment for medical industry is making the rounds now. Most of the people expect the medical services to be as quick as possible without much delay. In today's fast paced work schedule most of the people are probably juggling with multiple schedules from home to work and finding very difficult to make an appointment with a doctor by going to the clinic/hospital or making a phone call to get much needed medical services for them. This traditional way of booking appointment with a doctor is posing an inconvenience for people who needs a hassle free medical service as quick as possible. One of the best ways to eliminate traditional way of booking an appointment is by booking an appointment online in just a few easy steps [6]. So, this paper studies different parameters that are really helpful in bringing few advantages of Online Doctor Consultation system. Also, it implements an Online Doctor consultation system using the RAD methodology. The following literature review brings out different parameters that justifies online system is more viable than the traditional appointment system. Also, it reviews similar systems and justifies the implementation of the proposed system.

II. LITERATURE REVIEW

A study has shown that Online Booking Doctor's Consultation Time system bring out quite a few advantages, one of it is that it can save the patients' time. By using the system, they can book the appointment with doctor through online instead of going to the hospital or clinic and wait for register and wait again for their turn to consult with a doctor after the register. Some of them even need to wait for the nurse or workers there to get their medicine.

This waiting process is obviously too long for them and it is time-consuming too [6]. The purpose of literature survey is to give a description of research topics related to patient opinions and feeling on the current way of making appointment with doctors. Waiting in the waiting room of the doctor is a common phenomenon. In general, the patients need to go to the hospital or the clinic and register at the counter first. After that, they need to wait for the doctor to consult them when he is free. If the clinic or hospital is crowded, how long is the patient need to wait? 20 minutes or more? This is so cruel to see the patients, who are already sick, still need to wait for such a long time to wait for their turn to consult a doctor.

A) Waiting time

Waiting time is essentially a period of time to wait for a certain action to take place after that action is demanded or ordered [2].Waiting time is the duration that a patient already waited in the clinic before meet by anyone of the staff [10].Patient's waiting time is a very important indicator of quality of services offered by hospitals [11].One factor affecting the use of healthcare services is the amount of time a person spends waiting to be seen. Patients view long waiting times as an obstacle to receiving services effectively. For both patient and doctor, letting patients waiting unnecessarily can cause them stress. Waiting time is a measurable part of the profession which clients will use even more than their knowledge and ability to judge medical professionals. According to Institute of Medicine (IOM), the patients should wait less than 30 minutes of their schedule appointment time [10].But it is not achieved by most of the clinic and hospital in some of the places like Malaysia. The duration of waiting time varies from country to country, and even within country, it varies from center to center.

Long waiting times have been reported in both developed and developing countries. According to a research done in 2017[1] the average waiting time for each clinic's registration time is 17.20 minutes. The pre-consultation time has an average of 13.66 minutes of waiting time while the waiting time for consultation has an average of 24.05 minutes. The research has also shown that the total average waiting time of registration for consultation is 41.06 minutes. Another 2011 research study of outpatient waiting time in 21 hospitals in Malaysia found that the average waiting time was 60 minutes to see the doctor [4].A research in Kedah found that patients waiting less than 2 hours were happier with the ambulatory service compared to those waiting longer than 2 hour [7].From these research findings, one thing can be sure is that the patients rather wait for almost 1 or 2 hours for outpatient service rather than waiting for consultation inside the hospital

or clinic. This shows that the patients are really dissatisfied with the current waiting time for consultation.

B)   Appointment Delay

Appointment delay is defined as the time between the days a patient requests an appointment and her actual appointment date, the higher the chances that he/she will cancel or not show up[5].According to the research done by [5], 31 percent of the 5901 samples cancelled or did not show up at their appointment with doctor.

These appointments are mostly scheduled for a few days after the making the appointment. Thus, asking the patients to come right away or make appointment requests on the day they want to be seen is the solution [8].

C)   Waiting for Registration

The clinic and hospital have a counter for patients to register first before their consultation with doctor. The intentions of this step are actually queuing up for the consultation and wait for their turn. It is actually the reason of many of patients were still waiting very long time to register at the counter to see the doctor. The Registration must be a very quick process and also simple to avoid long waiting time. The research done in 2017 identified that the long waiting time is because of long queues at the registration counter being operated by one staff who is also responsible for giving out appointments to patients[1].The number of staff is not enough is also a known reason for longer waiting time in hospital and clinics. The solution to this issue is by implementing an online booking system. This can save the cost hiring more staff to handle the registration counter and also can reduce the waiting time of patients.

D)   Earlier Arrival

Most of the patients tend to arrive earlier even though they already book consultation time with doctor. This is usually happening on those who need follow-up consultation. Scheduling is very important to make sure a smooth and fast consultation process and to decrease waiting times [1]. A research study found that those patients who had an appointment time and arrived at the appropriate time had shorter waiting time than those who came in without an appointment [13].A more reliable scheduling system can also increase waiting times, such as scheduling appointments in line with the planned consultation period. Hence, an online booking appointment system with scheduling function is needed and can significantly reduce the waiting time of patients.

E)   How the Online Booking System can help

The significant help of online booking doctor's consultation time system is able to reduce the waiting time of patients. By using the proposed system, the patients can choose their desired time to consult with a doctor and book the time from the system. This can reduce the registration step at the counter. Thus, for the patients that looking for follow up consultation, they can book the consultation time for a future time. Those patients who need faster consultation from doctor like having fever can check for nearest doctors available time and book that slot and reach there on time to avoid long waiting time. Usually registration at the counter has two purposes. One of it is to queue up and another is to check

whether the patient have any consult history at that clinic or hospital. Using the booking system can reduce the step of registration because the necessary patient's details are in their profile.

When they book a consultation time, the nurse or doctor can see their records. Thus, when the patients arrived at the clinic or hospital, they can immediately enter the doctor's room without wasting the time for registration. Besides that, online appointment booking is great for those people that doesn't have much free time, especially the working adult as it gives a patient to book an appointment through online whenever he/she is free and convenient to book. This is very convenient for those needs to book a consultation time for a follow-up check-up.

That means they can do this after-hours, on weekends, or whenever the best works for them. The online booking doctor consultation system will show the time slots available to patients. It is time-efficient, transparent and helps patients to feel better educated and in control [6].Furthermore, with the implementation of the online appointment booking system, the no-show up rates can be reduced because the system allows patients verify, cancel and reschedule their appointment at their ease. Some of the people will miss their appointment schedule without giving any prior notice and result in wasting the doctor's time and also the other patient's time. The time slot of them can be given for those who is really needed.

F)   Similar Systems

In this section, similar system like TeLeMe is taken for a review to justify the idea of implementing the proposed online doctor consultation system. The existing online booking doctor's consultation time system is TeLeMe. Unlike the proposed system, it allows patients to consult through online video or messenger call. The proposed system is focused on booking consultation time with doctors and can meet the doctor as per the consultation time. Whereas, TeLeMe is focused on the entire consultation through video call/Voice chat. Though TeLeMe has all the security features, the system that is proposed here gives more importance to patient's privacy and safety of their information.

The proposed system will use SQL injection prevention features to avoid any hacking from SQL injection. Besides that, it also encrypts the patient's username and password, and also their information to avoid hacker from hacking the database and get their information. Besides that, the proposed system will use the various techniques like indexing to improve the database performance for a better user experience and faster data retrieval. Access control will be the main focus of the system too. For example, doctors will only be able to see the patient's name, age, gender and symptoms but not their login credentials.   The following section research methodology spells out the how the proposed system is developed.

III.   METHODOLOGY

This section focuses on the system development methodology used for implementing the proposed system. The proposed system that focuses on the patient's privacy is developed using Rapid Application Development (RAD) methodology.
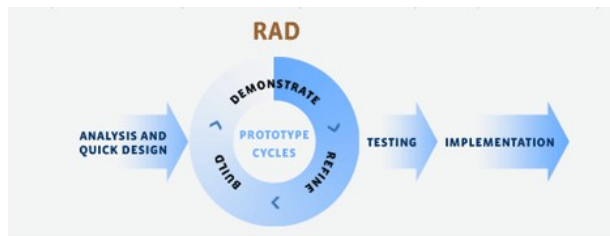
A)   RAD

Fig. 1.   RAD Model (Ghahrai, 2018)

The figure above shows the concepts of RAD methodology which is chosen to follow when developing the proposed Online Doctor Consultation System. The RAD model, including analysis, designing, building, and the final testing phase. These steps can be divided to make them more easily understandable and achievable [12].

The first stage is business modelling. At this stage, the team should gather information from company through many business-related sources. This information is later combined into a useful description of how the data can be used when it is processed [12].The second stage is data modelling stage, which is analyzing all the data that's gathered on stage 1 and grouped all the information into different group that can be useful to companies [12].

The third stage is process modelling. In this stage, all the data gathered on stage 2 are converted into usable information and all the changes and optimizations should be done along with defined sets of data. Any other add, remove or change of the data objects also created in this stage [12].At the stage 4 which is Application Generation, all the information gathered is coded and the system prototype is built too. The data model generated in the previous stage are turned into actual prototype [12].

The last stage is testing and turnover stage. This stage is for developer test the developed prototypes and all the unit of the prototype should be tested separately and adapt the components quickly to create the most effective product [12].

B) Research Method

After selecting the RAD methodology for developing the project, the methods used to implement the RAD is described over here. The first stage in RAD is data collection. So, the data collection is done by using the Questionnaire. A questionnaire is the most effective way for quantitative research as it can reach out to a large number of people can be reached relatively easily and economically. A standard questionnaire provides quantifiable answers for a research topic. These answers are relatively easy to analyze [9]. Besides that, a questionnaire is the most affordable way to gather quantitative data too. Compare to interview, Questionnaire doesn't need to hire surveyors to perform face-to-face interviews, and able to quickly collect massive amount of information from a large number of people in a relatively short period of time [3].

Questionnaires are not only affordable but also a practical way to collect data. It allows the researcher picked and handled in various ways for groups of their choice. They can pick and choose the questions asked as well as the format (open-ended or multiple choice). It offers a way to gather vast amounts of data on any subject and can be used in a wide variety of ways [3].

Furthermore, many providers of survey and questionnaire are qualitative in nature and allow for simple results analysis. Using built-in software, even without a background in statistics or scientific research, it is easy for researchers to analyze the data. Mail-in questionnaires also provide total invisibility, increasing the security of respondents. Digital questionnaires provide the strongest sense of privacy and anonymity.

This type of questionnaire is good for all kinds of businesses and subjects and contributes to the most honest answers. Such concealment helps respondents feel comfortable and allows them to respond truthfully; nevertheless, these phone interviews still have a human touch. There is no time limit when using mail-in, online or e-mail questionnaires and no one on the other end is waiting for an answer. The respondents can take their time at their own leisure to complete the questionnaire. They will often respond more honestly, as research has shown that having a researcher present can lead to less honest and more socially desirable responses [3]. The second and third stage is modelling that comes in the form of system architecture. In system architecture, the way of computer system built will be discussed and it is a conceptual model that describes the system architecture and its behavior. Therefore, the abstract architecture will be discussed first and then the database design which includes an entity relationship diagram and database table structure will be discussed after it.

At last, the interface design which is also known as storyboard will be discussed too. The core features of the system will be booking a consultation with doctor. With this function, users can book consultation through the system and they can select any time or date they want as long as the clinic or hospital are open. Besides that, the system also has feedbacks function. They can give feedbacks in the system for the consultation. If they think the doctor is very nice and patient, they can rate it very good and give a good comment on it. If they are not satisfied with the consultation, they can rate it lower and tell the reason why he/she was not satisfied. After that, they can also edit their own profile after they had registered their account regardless any details such as username, password, email etc.

Besides that, the system is implemented with two security protocol which is SQL injection prevention and encryption. With SQL injection prevention, the hacker cannot hack into the system and caused any deletion or modification of the data table. With encryption, even the hacker can gain access into the database, they won't be able to read the information in the database too because the data is encrypted into an unreadable form. The third stage is Application Generation which is described in the form of implementation in the following section with an associated screenshots.

IV.   IMPLEMENTATION

A) IDE

The IDE (Integrated Development Environment) that is chosen for developing the proposed system is Microsoft Visual Studio as it is a great application to use for running C#. Besides that, by using Visual Studio IDE, the users provide live coding assistance regardless of the programming language they are utilizing. The built-in intelligence provides hints and description of the APIs and auto-completes lines for better speed.

In addition, it has debug supports for developers deploy apps on the desktop or emulators in mobile devices and other debugging methods.

Furthermore, it also contains customization options function for users as they can extend the functionalities of the platform through extensions and add-ons available from the Visual Studio Marketplace. The database that is chosen is SQL Server. SQL Server allows developers to use row-based filtering. The row-based filtering method filters data via database mode on a database. In addition, the filtered data is stored in a separate database for delivery. Hence, filtering multiple rows without considering the number of databases is simpler for programmers. In addition, SQL Server will not block the database while the data is being backed up. The feature allows users to backup and restore large amounts of data without additional time and effort.The chosen operating system is Windows 10 as the proposed system is designed primarily for Windows Platform. Using the above platform the proposed system is developed and the screenshots that explain the functionality of the proposed system is shown in the following section.

B) Application

This section describes the functionality of the proposed system and its associated screenshots. The first page is the Home page (Figure 2) where users first surfing the website. There is some information for users to see. At the top of the page, there is where the navigation bar locates at. There are a few options for users to choose what they want to do with the website. But some of the functions like booking and feedbacks are exclusively for members which means they must sign up an account and login if they want to use those functions.
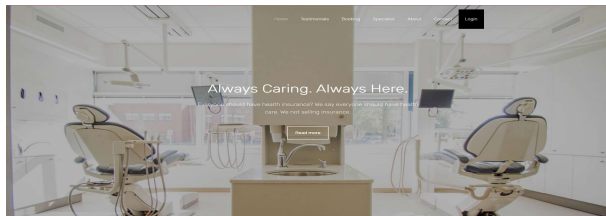

Fig. 2.   Home Page

The login page (Figure 3) is where the users enter their registered username and password to log into the system when they sign up an account. The red button under the textbox is the login button and beside it is the sign-up label. For those who haven't registered an account, they can click on that label and the website will lead them to the sign-up page. Users must enter correct both username and password in order to log into the system, if not, they wouldn't be allowed to access to the system.

In the login page, it is implemented with SQL injection prevention. Whenever users try to input any symbol, it is not allowed. This is one of the ways to prevent SQL injection. If the system is vulnerable to SQL injection, the hacker can gain access to the system and lead to deletion, modification and stolen of data. It can also be used to bypass authentication and authorization, shut down or even delete the entire database in the program.
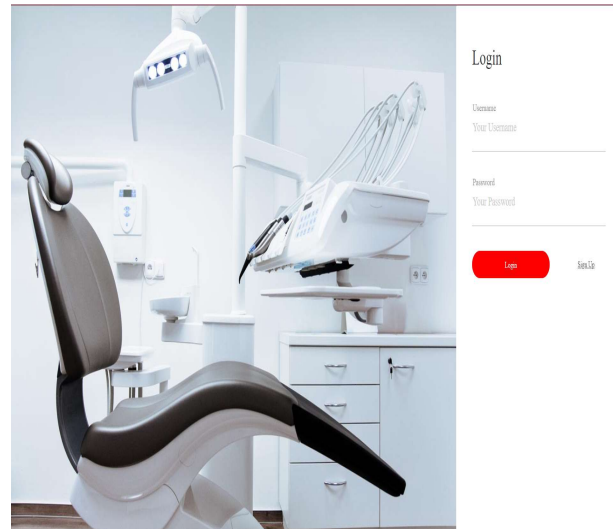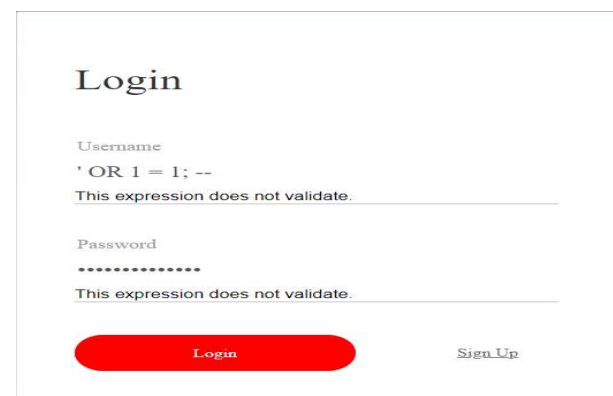

Fig. 3.   Login

Fig. 4.   SQL injection Prevention

The sign up in Fig 5. is for the users that haven't created an account at the website and wanted to use the system. Without an account they cannot log into the system which means they can't use the system's functions. Users are required to fill in their full name, username, email and password to successfully sign up into the system.
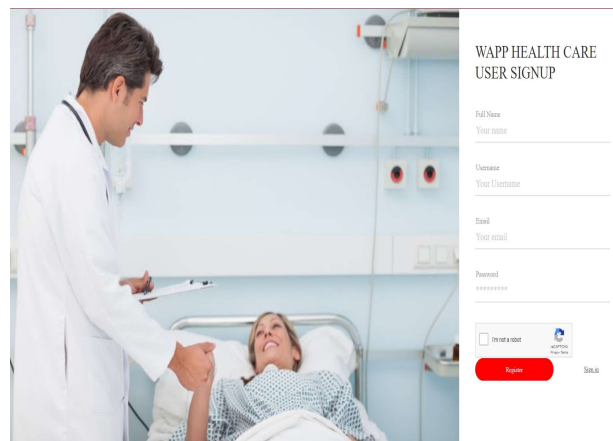

Fig. 5.   Sign Up

After logging into the system. In Fig 6. Users can book the consultation time of doctors. First, the user requires to type their name and follow by selecting the category that their disease is such as dermatology, endocrinologists etc. After that, they need to select the date and time that they want to meet the doctor. At the end, there is a section for them to describe their disease so that the doctor can know it earlier and prepare the suitable medicine first to reduce waiting for take the medicine.

Fig. 6. Booking

There is another page for users to submit their feedbacks as shown in Fig. 7. If the users have any comment to the consultations that they just had, they can submit the feedbacks to the system and the admin will look at it. Users need to insert name, category, rating and description of their feedbacks or comment to the consultations.

Fig. 7. Feedbacks

If users want to edit details of their profile, they can go to edit profile page and make changes to their profile as shown in Fig 8. They can change the full name or username, email and password also. However, all users can only edit their own profile but not the others.

Fig. 8. Edit Profile

If login as admin at the system, the system will log into the admin page which is different with the user's page. There are four pages in the admin page. The first page is the Dashboard as shown in Fig. 9. At here, admin can view the overall information of the system. They can see how many total users registered their system now and how many consultations are waiting and how feedbacks they had received.
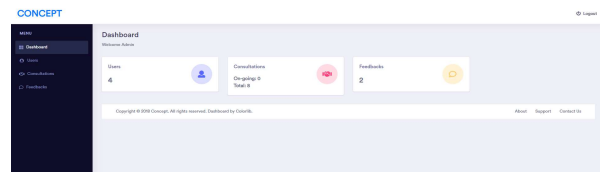

Fig. 9. Admin dashboard

On the Users page, admin can view the details of members right now and they can also help modify it. They can even delete the users if they want as shown in Fig. 10

Fig. 10. Admin view users

At the consultation page, admin can view the overall consultation booked by the users and the details of it. Therefore, they can arrange the consultations for users as shown in Fig. 11.

Fig. 11. Admin view consultation

The admin can choose the status of the consultations, there is a column for them to change the status of the consultations. They can either choose to confirm if the patients are in consult or choose done when patients finish the consultations.

On the feedback page, admin can view the feedbacks that the users send to them. There are rating and description for each feedback. They can look into it to see what can be improved in the future as shown in Fig. 12.

Fig. 12. Admin view feedbacks

The above screenshots and its related explanation clearly described the functionality of the proposed system. After successful implementation, finally the system is tested using various testing method and documented as per the software development standards.

V.   CONCLUSION

Booking doctor consultation can be a troublesome issue for most of the people. It is very inconvenient when people need to physically be there just to book a consultation and waiting for their turn. Therefore, the online booking consultation is needed to solve this issue. In this paper, a study is performed on the online booking consultation system and a new system has been designed and implemented using SQL injection prevention and encryption in the database. The system's main function is for users to be able to book a consultation through the online system, therefore they don't have to go to the clinic or hospital to book it and then waiting there for their turn. They can just sit at home and go there when the time is scheduled for their appointment. Besides that, the users can also give feedback on the consultation that they had. No matter the comment is good or bad, they can send feedbacks to the system and the admin will take a look on it. Furthermore, users can edit their own profile after they register an account on the system. If they want to change the username, password or email in the future, they are able to change it. The proposed system is also tested with different types of users in order to make sure that there are no bugs and user interface is friendly enough to use the system. In the final user acceptance testing, users have given a positive feedback that the system has met their requirements in booking an appointment online through the proposed systems and felt that the online system is more viable than the traditional appointment system.

REFERENCES

[1]   BA, A., 2017. An assessment of patient waiting and. 12(1), pp. 14-21.

[2]   CM, F., 1994. Emergency department patients who leave without seeing a physician: the Toronto Hospital experience.. 6(24), pp. 1092-6.

[3]   Debois, S., 2019. 10 Advantages and Disadvantages of Questionnaires (Updated   2019).   [Online] Available at: https://surveyanyplace.com/questionnaire-pros-and-cons/ [Accessed 12 10 2019].

[4]   DI, P., 2011. Hospital waiting time: the forgotten premise of healthcare service delivery?. 24(7), pp. 506-522.

[5]   Gallucci, G., n.d. 2005. Brief Reports: Impact of the Wait for an Initial Appointment on the Rate of Kept Appointments at a Mental Health Center.

[6]   Gelbolingo, R. M., 2019. Why Patients Want An Online Appointment Booking   System.   [Online] Available at: https://www.website4md.com/blog/why-patients-want-online-appointment-booking-system/ [Accessed 13 10 2019].

[7]   Hassali, M. A., 2014. Assessment of general public satisfaction with public healthcare services in Kedah, Malaysia. 7(1), pp. 35-44.

[8]   Idowu, A. P., 2014. DEPENDABLE ONLINE APPOINTMENT BOOKING. 6(4), p. 3.

[9]   Manual, F. E., 2019. Advantages and Disadvantages of Questionnaires. [Online] Available at: https://wiki.ecdc.europa.eu/fem/w/wiki/advantages-and-disadvantages-of-questionnaires [Accessed 12 10 2019].

[10]   Oche, M., 2013. Determinants of Patient Waiting Time in the General Outpatient Department of a Tertiary Health Institution in North Western Nigeria. 3(4), pp. 588-592.

[11]   RJ., M., 1984. Quality assessment in health.. 288(6428), pp. 1470-2.

[12]   Solutions, M., 2017. A Comparison between MySQL vs. MS SQL Server.   [Online] Available   at: https://medium.com/@mindfiresolutions.usa/a-comparison-between-mysql-vs-ms-sql-server-58b537e474be [Accessed 2 10 2019].

[13]   S, S., 2003. Managing a mixed-registration-type appointment system in outpatient clinics.. 70(1), pp. 31-40.