



# Quick Response Code Based Online Appointment Scheduling System: An Approach towards Health Management

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

For day to day functioning of healthcare services in healthcare sector there is requirement of managing, tracking and keeping patient appointment and medication related information in a effective and efficient way. If a person is suffering from any disease and needs to visit a doctor in a hospital for checkup the patient required to fill hospital registration form in hospital and waits in a long queue while getting an appointment. In some hospitals online appointments can be done by web or smart phone application. Some of these existing applications do not provide information regarding doctor availability, and do not provide patients medical records, etc. This paper proposes a web based application to overcome drawbacks related to existing appointment systems. In this paper the web application will provide a unique QR code to each patient, at the time the patient takes an online appointment for the doctor. The study provides an efficient way of managing health care accessibility in future.

**Keywords:** QR (Quick Response); near field communication (NFC); responsive web application; bootstrap; crystal report.

## 1. INTRODUCTION

Nowadays the Internet has been used so widely in so many areas. The Internet is quickly becoming the place where customers first look to find solution for any real life problems. Nowadays in most countries the healthcare industry is most important and largest industry. As the demand of the healthcare industry increases day by day there is a need for improvement in quality of services provided by the healthcare industry and patient waiting times [1]. In healthcare industry, it is necessary to manage patient appointment, medication scheduling and keep efficient tracking of every day functioning for future reference. An effective and efficient appointment scheduling application will enhance patient satisfaction and physician efficiency and help to deliver timely and easy access to medical services [2]. Continuously hospitals are facing appointment scheduling problems which causes wastage of doctors time, also decrease in patient satisfaction and staff morale [1]. In case of smart health, physicians and other professionals from healthcare industry are always trying ways to improve the interaction with patients providing high quality solutions, services and technologies [3]. Every year many patients are receiving treatment for diseases in hospitals [4]. In order to help patients and healthcare practitioners manage appointments easier, and to improve such operations in individual hospitals or even groups of healthcare facilities there are various appointment scheduling applications that are already available or existing in market [2].

If a person has any disease or illness, and needs to visit a doctor for treatment, the person required to visit the hospital and waits until the doctor is available. The patient also waits in a queue while getting an appointment. If the doctor cancels the appointment for some emergency reasons then the patient is not able to know about the cancelation of the appointment unless or until the patient themselves visits the hospital [5]. Due to increase in number of patients visiting hospitals for treatment there is so much demand of intelligence and automation for health services related processes in hospitals [2].

In hospitals for patient satisfaction there is a need of decrease patient time consumed for waiting in the queues for appointment. Traditionally, patients visit the hospital and fill out registration forms and wait to be called or patient calls in for getting an appointment and waits for

the response for an agreed date which is a time consuming way. Various techniques exist in health care industry to improve the performance, services provided by health care sectors and reduces the waiting time of patient in hospitals for doctor appointment, but still these existing appointment systems have some drawbacks. This paper is proposing a web based application to overcome the drawback of existing appointment systems and some additional features are added in this proposed web application which already existing appointment systems do not have.

This proposed web application is using QR (Quick Response) code based appointment scheduling system for hospitals and healthcare industry. This proposed system provides following features to overcome the drawbacks of existing systems like some of these existing systems or applications not provided information regarding doctor availability, do not provide appointment number at the time of online appointment, and some of this existing application do not provide patients health records, test records, etc . In this proposed web application by using QR code the patient can see, and take print out of patient health records, medical test reports, etc.

Some hospital do not provide hard copy and soft copy of patients health records, checkup and test records to patient, because of this the patient face difficulties when the patient switches his or her treatment from current hospital to some other hospital, this paper proposes a web application through which a patient can find softcopy of their health records, test records and also can take print out of their medical report or test report by clicking print button on screen.

In this proposed web application the patient needs to register themselves through online, after registration completion the patient will get a unique QR code on registered patient mail Id, now whenever the patient visits the hospital the patient does not need to stand in queue for appointment. This patient just needs to scan the unique QR code by showing the QR Code in front of the device or computer system camera installed at the hospital. The computer device will scan the QR code of the patient by QR scanner and if the QR code is valid, the patient can see their checkup or medical report and test report. The patient can also use this same unique QR code for taking appointments for the next regular checkup in the same hospital.

## 1.1 Research Question

Q: How to develop a secure and responsive web application for the healthcare industry?

Q: How to add additional functionality which existing healthcare applications do not have?

Q: How to reduce waiting time of patients, long queue for appointment?

Q: How do patients get to know the availability of doctors?

Q: How to reduce the human resources like Hospital Administrative Assistant, Hospital Secretary or Hospital Receptionist used by hospitals for appointment?

## 1.2 Literature Review

Several research studies have helped to determine the necessity to manage Patient Appointment and medication scheduling in healthcare sector. A researcher Suresh Sankarananrayanan [2] mentioned in paper titled as NFC Enabled Intelligent Hospital Appointment, and Medication Scheduling, traditionally hospitals are following the paper-based system for patient appointment scheduling. In a paper-based system the patients required to fill up the forms provided by the hospital and submit to the registration desk or patient could simply place their identification card or appointment card to the front desk personnel of the hospital and wait for their name to be called. In this case the question comes in mind is what happens if the card is misplaced or taken away by any unauthorized personnel. One issue that has been presented is that if patients records are not to be found or declared as an unregistered patient, the current front desk personnel will delay patient consultation time.

According to a survey report published in 2007 most of the complaints are on the time spent in the waiting room and in that 19% of the patients complained that they could not get an appointment within a weeks time. Outpatient dissatisfaction with healthcare procedures was not only associated with waiting times but over one-third chose to not fulfill the appointment schedule as they expected to have to wait for long periods. This issue still remains a challenge in the healthcare industry worldwide. The researcher mentioned in the conference paper that a efficient and effective appointment organizing applications or systems will help hospitals and patients to deliver timely and easy access to medical services will improve physician efficiency and satisfaction of patients. Some

research has been done in the past towards developing online and mobile enabled appointment systems. But still there exist long waiting intervals and also delay in providing service to patients [6].

By taking this also in consideration a Near Field Communication (NFC) based appointment system was developed in this NFC system the patient requires to tap NFC appointment card at appointment kiosk in hospital/clinic for making appointments. The system does possess prioritized scheduling for appointments and the medicine collection made by NFC card which was purely dependent on nurses rather being automated by software. The NFC based system puts a lot of burden towards scheduling of patients based on priority by the nurse that results into increased waiting time and leads to delay in patient treatment conventionally. To obviate these problems we now have developed an intelligent NFC based appointment system towards prioritized appointment scheduling based on age and profile of the patient. In addition the system also enables automatic calling of patients based on priority for being served by the concerned nurse. Lastly, the system possesses timing constraints towards making/canceling appointments [2].

According to a researcher Fatma Poni Mardiah et al., of a paper titled as The Analysis of Appointment System to Reduce Outpatient Waiting Time at Indonesias Public Hospital in the service or healthcare industry the customer satisfaction has become a serious concern [7]. In the Healthcare industry, to enhance customer satisfaction a number of initiatives have been introduced. The healthcare industry is facing problems with doctors and patients, long waiting times, delays, and queues. The performance of key processes has to be improved to improve patient satisfaction, [8]. There is no doubt that healthcare institutions need to become high performers. To improve patient satisfaction, the performance of key processes has to be improved. The healthcare sector requires the following factors to increase or decrease the amount of exam rooms and/or staff, how would this affect patient waiting time, the length of a medical treatment and the total time spent in the clinic by patient [8].

The healthcare sector needs to become high performers. The aim of the research paper is to provide a study of the main causes of patients length of time for medical treatment and

appointment in an outpatient clinic at one of Indonesian public hospital and to improve the appointment system for maximize the effectiveness and efficiency of resource and capacity, the researcher provided recommendation on the best strategy in the research paper. The hospital queue model uses single-channel multiphase systems. Queuing theory is the first tool to look at patient waiting times on each server independently. As the results of the research it is determined that the hospital should change the appointment system for physicians [7].

The researcher Cristian Cola [3] of paper titled as E-Health Appointment Solution a Web based approach developed a web technology through which the patient can schedule a video call appointment. Two types of appointment are explained in this paper are hospital or clinic visit and video visit. In the hospital or clinic visit the patient will fix an online appointment and then must visit the hospital or doctor clinic for treatment or regular. In video visit the patient schedule appointment using a desktop or laptop with internet connection, web browser and webcam can consult the doctor by video calling. According to the time slots interval availability in a day the appointments are made by patients. The physician or an authorized person of hospital defined the time slots. This web application is not a responsive application that means it will only work on laptops and desktop computers, and if the user of this application wants to access this application on tablet or smartphone the user cannot access the application because this application is not a responsive application.

In a research paper titled as Mr. Doc: A Doctor Appointment Application System the researchers proposed an android application for scheduling appointment. The main aim of this android application is resolve the problems that the patients face during making an appointment for doctors and this android application also provides easy and comfort to patients while taking appointment for doctors. In this paper Mr.Doc is the name proposed to the android application which acts as a client, all the details of doctors, patients details, and all the appointment details are saved in the server database [5]. The application proposed in this paper only works on Android or Smartphone, and because of that this application does not work on laptop, desktop, tablet, etc.

Above mentioned all literatures are not responsive application that means all above mention literature application can only works on any one of the device like Mr. Doc application proposed in research paper titled as Mr. Doc: A Doctor Appointment Application System is an android application, hence the user of this application needs a smart phone to access this application and the user of this android application cannot access this application on desktop computers, and laptops. Some applications proposed in literature mentioned above do not provide the features like doctor availability, and the information regarding the patient available at the hospital on the fixed appointment date & time. This paper proposes a web based application for the healthcare industry; the web application is a responsive web application because this application can work on laptop, smart phone, tablet, etc. To use this responsive web application there is a need for a device like smart phone, laptop, tablet, etc. with the internet and any web browser should be installed on the device. In this application we are using QR code so for scanning this QR code it is necessary to use a device like Smartphone, laptop, desktop, tablet etc. which has a camera or a webcam. This proposed web application generates a unique QR code for each patient at time when the patient requires doctor appointment.

## 2. METHODOLOGY

In this proposed web application there are three modules that are as following: patient module, doctor module, and hospital server module. The hospital database server module is responsible for storing, processing the entire medical, appointment, patients, doctors, etc. information.

### 2.1 Doctor Module

The doctor module as shown in Fig. 1, the doctor first needs to open this proposed web application or website on his/her desktop or laptop for registration even the doctors can do the registration from smart phone or tablet, this is upon the doctor which device the doctor wants to use for registration and for login. In the doctor registration page the doctor needs to enter his/her name, education details, working experience details like the hospital where the doctor worked before and years of experience, etc., the field of specialization, currently working hospital name, doctor designation in the hospital, password, confirm password. After filling all

details the doctor needs to click on the submit button. After Completion of registration of doctor all details entered by doctor is stored at hospital server, and in next step the doctor needs to login from doctors login page provided by the proposed web application.

If the doctor is already registered in this application then the doctor does not required to go through registration steps again. The doctor can access his/her profile by directly login in this proposed web application. For login the doctor required to enter the registered email-id and password then click on login button. the server or hospital server will check that is the mail id and password entered by doctor is matching with the already stored email id and password of the doctor at hospital server database, if the email id and password is matched the doctor is a valid doctor and the doctor get access to access his/her profile, and if the email and password entered by doctor is not matched with the mail id and password registered by doctor then the server will not give access to the doctor or any person to access the profile.

After completion of the login step, the doctor can access his/her profile, the doctor can update his/her availability date and time details by selecting the date and time from the date and time field. The availability date and time selected by the doctor is stored at the hospital server database. By updating and providing availability date and time, it makes aware to the hospital administration and patients of the doctor that at which date and time the doctor will be available at hospital, doctor availability information makes easy for the hospital administration for managing appointments of patients for the particular doctor, and patients also do not need to visit the hospital and do not need stand or wait in a queue, if the doctor is not available or cancellation of appointment due to unavailability of the doctor for that particular date and time.

In the doctor module after login the doctor can see the list of patients appointment for the particular date selected by the doctor from the date picker in the appointments page. The list of appointment of patients for that selected date is arranged according to the appointment number of the patient, for example if on the date selected by the doctors there is only 10 appointments, then the patient whose appointment number is 1 will be display first in the list and, after that the patient whose appointment number 2 will be displayed and at the end the patient appointment number 10 will be displayed in the patients

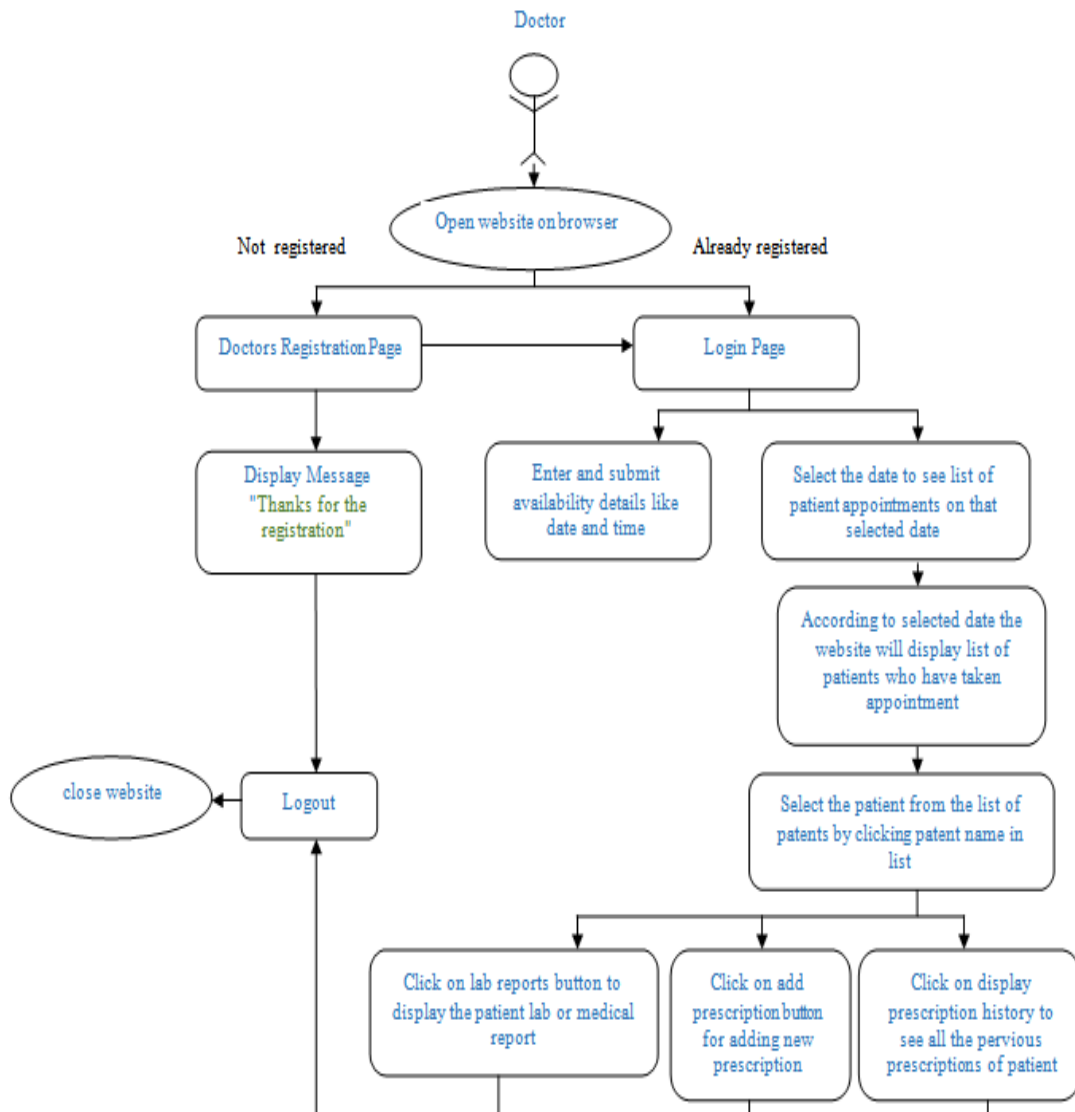
appointment page. If any patient canceled the appointment then in the list of patient appointments the canceled text will be displayed on the confirmation/canceled field of that particular canceled patient. The doctor calls the patient according to the appointment number of patients.

In this doctor module, if a doctor wants to see the particular patients medical history, lab report, add new prescription, etc. The doctor needs to select the particular patient from the list of patients by clicking the patients name in the list. After selecting the patients the doctor can see three buttons displayed in the web application that are the lab reports button and medical report button, add prescription button and medical history button.

The lab report and medical report button is clicked by the doctor, when the doctor wants to see the lab reports or medical reports of the patient. The add new prescription button is clicked by the doctor when the doctor wants to write a prescription for that particular patient. All new as well as old prescriptions of patients are saved on the hospital server database for feature reference, the doctors and patients can see and can take print of all the prescriptions of the patients which are saved at the hospital server database. The medical history button is provided in the doctor panel for displaying the prescriptions of a particular patient. If the doctor wants to take print out of the medical history report the doctor can take print by clicking the print button.

## 2.2 Patient Module

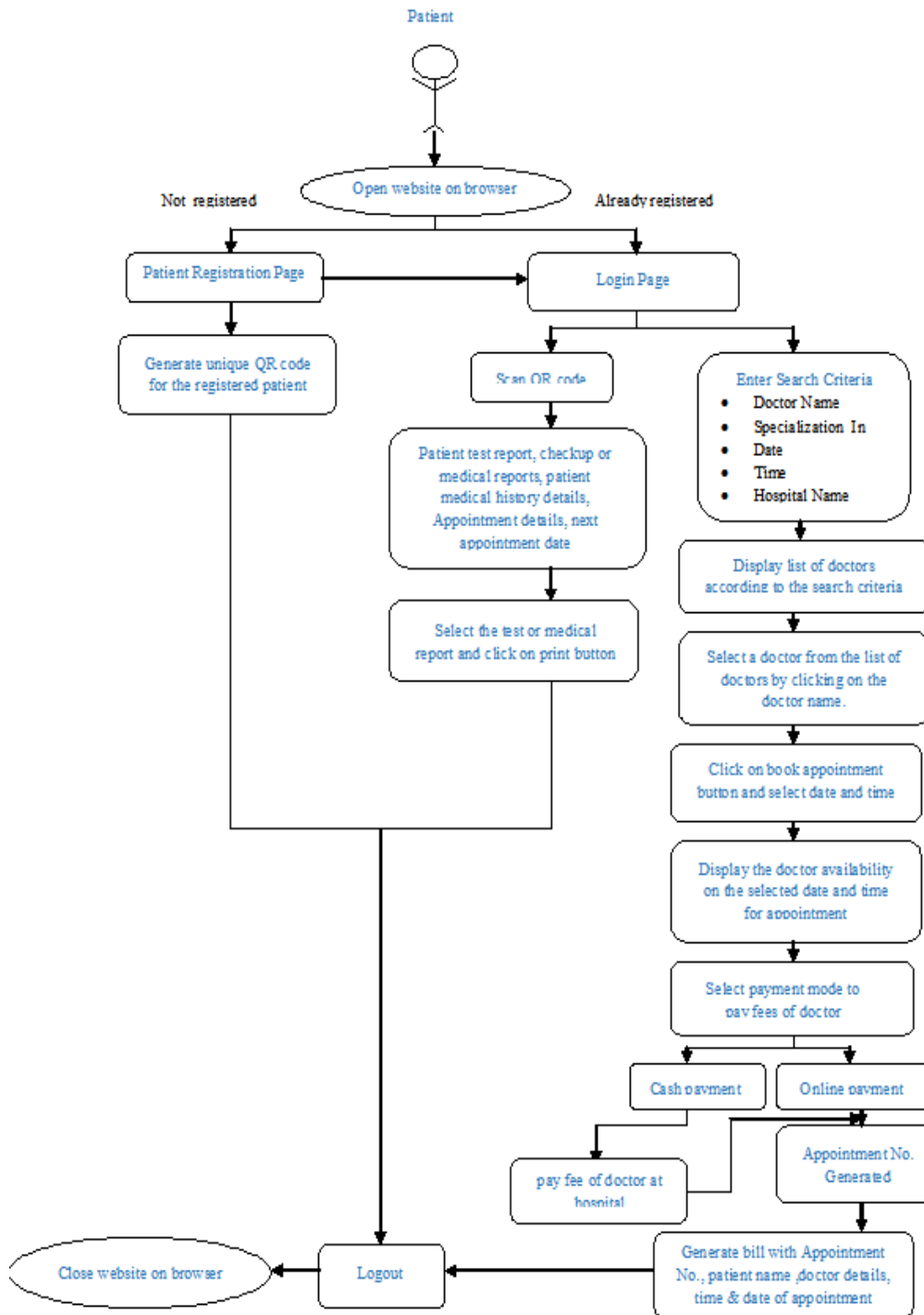
The patient module as shown in Fig. 2, the patients first need to register themselves on this web application for appointment. For registration the patient needs to enter name, address, mobile number, email id, and password, etc. After filling all the required fields of the patient registration page the patient can like the submit button for saving patient registration information on the hospital server database. After completion of the patient registration, a unique QR code will be generated for the registered patient. In the next step the patient required to click the login button in the menu, and then the patient will be navigated to the patient login page. If the patient is already a registered patient then the patient does not need to go through the registration steps again. The patient can directly go to the login page, if the patient is already a registered patient.



**Fig. 1. Step by step working process of doctor module associated with the proposed application**

On the login page the patient needs to enter username or mail id, password and then click on the login button. If the patient entered password, and mail it is matched with the email id and password of the patient saved on the hospital server database then the patient is navigated to his/her profile and the patient can access the profile for taking doctors appointment and the patient also can access or see his/her test report, checkup or medical reports, patient medical history, appointment details, next appointment date. For taking an appointment of any doctor the patient needs to enter some search criteria like doctor name, field of specialization, hospital name, appointment date, and time. The web application will display a list of doctors according

to the search criteria entered by the patient. The patient will select a doctor from the list of doctors by clicking on the doctor name. After selecting a doctor from a list of doctors the patient can see more details related to that selected doctor and for booking appointment of doctor the patient needs to select appointment time, date and click on the book appointment button. After the patient clicked on the book appointment button the patient will be navigated to the payment page, in this payment page the patient needs to select payment mode for paying the fees of the selected doctor. There are two payment modes available in this proposed application, one is online payment mode and other one is offline payment mode or pay at hospital.



**Fig. 2. Step by step working process of Patient module associated with the proposed application**

In online payment mode the patient can pay the fees of the doctor through debit card, paytm, credit card, etc. If the patient selected the offline payment mode then the patient needs to pay the fee of the doctor at hospital to front desk personnel. After completion of payment

transaction an appointment number for the patient will be generated by the hospital server, and a bill generated with patient name, doctor name, hospital name, appointment number, appointment date, and time.

For scanning unique QR codes of patients a device like laptop or desktop will be installed at the hospital. At the time the patient visits the hospital and booked the appointment using this proposed web application then the patient needs to scan the QR code on a device installed at the hospital. By scanning the QR code the hospital authority gets confirmation that the patient is available at hospital for consulting doctor and the patient has not cancelled the appointment. The patient can also use this unique QR code to see and print the particular patient medical report, lab report, a prescription, and medical history.

### 2.3 Hardware and Software Requirements

The hardware requirements of this proposed web application are 64 bit operating system, RAM 8GB, Hard Disk Drive (HDD) 1TB. The software requirement of the explained web application are visual studio 2015, .Net framework, C#, bootstrap, ASP.NET, SQL server management studio, crystal report, google chrome.

### 3. RESULTS AND DISCUSSION

This paper proposes a web application for the healthcare industry, this proposed web application is an appointment scheduling application which is used by patients, doctors and hospital authorities. In this proposed application at the time of registration a QR code is generated. After registration when the patient gets logged-in the patient can book appointments for doctors, the patient can also see or print lab reports, medical reports, doctor prescriptions and medical history of the patient. One more added feature of this proposed application is that the availability of doctors or the date and time when the doctors is available is displayed to patients in this proposed web application. The doctors need to register themselves in this proposed web application. Once the doctor gets logged-in, the doctor can enter and update the availability date and time so according to that the patient can book doctor appointments. The doctor is also able to see a list of appointments of patients on that particular date selected by the doctor. Through this proposed web application the doctor can write prescriptions for patients, and be able to see the patients lab report, medical report, and medical history, etc. In the hospital a device is installed for scanning the QR code of patients. In this paper for scanning the QR code of patients a desktop, tablet, or laptop is installed at hospital, the patient need to scan the QR by using camera or webcam of device installed at hospital, by scanning the QR code the hospital

authority get confirmation that the patient is available at hospital for consulting doctor and the patient has not cancelled the appointment. The patient can also use this unique QR code to see and print the particular patient medical report, lab report, a prescription, and medical history. The patient can also scan this QR code by using a smart phone camera.

### 4. CONCLUSION

The purpose of this paper was to propose a responsive web application responsible for appointment scheduling, displaying the medical history of patients, for providing the availability of doctors on the selected date and time for appointment, for providing lab and medical reports of patients. By using this proposed web application the patients do not need to visit the hospital and the patients do not need to wait in a long queue for booking appointments of any doctor. In this proposed application a QR code is generated for the registered patient and the patient needs to scan the QR code from the device installed at the hospital for confirming that the patient is present for consulting the doctor and the patient does not cancel the appointment. Patients can also use the unique QR code to see and print the particular patient medical report, lab report, a prescription, and medical history. The patient can also scan this QR code by using a smart phone camera. The proposed web application is providing features like security and information regarding doctor availability, generate appointment number at the time of online appointment, provides patients medical records, lab records, medical history of patient, and by using this proposed application the doctor can write online prescriptions for patients because of this we can reduce paper wastage, and there is less risk of losing the medical prescriptions because all the prescriptions of patient are saved in the hospital server database. The future in this proposed application we can add some additional features like the patients can post reviews regarding doctors, hospitals and the patient can give stars to the doctors and hospitals according to the treatment or consultation provided by the doctors, and hospitals. According to the stars and reviews posted by the patients may provide ranks to the doctors and hospitals.

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## CONSENT

It is not applicable.

## ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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