

## **Telemedicine System for Financially Unstable People of Bangladesh**

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*Telemedicine is the process of delivering service and exchanging information related to health care issues across distance. Telemedicine is all about a procedure or system where patients get help from doctors at home. Interaction between the patient and the doctor through different media like, audio, video, video call, image and information exchanging by web, mobile and internet technology is also a mean of telemedicine. In this paper we are presenting a telemedicine model which we are developing in the context of Bangladesh. We have designed the system by taking feedback from people of every profession of Bangladesh. As the poor people are the main sufferer of health related issues, so we have mostly emphasized on their thoughts and feedback.*

**Keywords:** Telemedicine, Health Care, Web API, Cross platform, Mobile application, Financially Unstable, Hospitals.

### **1. Introduction**

Telemedicine is not a new sector of medical science, not even related to a new technical innovation. Telemedicine is all about a system that connects patients with the doctors from a distance through different media. In this paper we are presenting a telemedicine model in context of Bangladesh. Before designing the system we have interviewed people from all sphere of life and take their valuable feedback and suggestions. We have mostly emphasized on the suggestions and problems of poor and rural people. Because they are the main sufferers of health care related issues in Bangladesh. Our proposed system consists of web application, web API, mobile solution and tab application. We have developed our system in such a way that will run in the mobile of poor rickshaw puller or poor farmers. We are developing these solution using cross platform app development technologies so that all the mobile platform (Android, iOS, Windows Phone, Symbian, Blackberry, Bada) users will be able to use this solution. We believe this will make their life easier than before. Our proposed system is the reflection of the feedback of all sphere of life. 114 people participated in our offline and online survey and the professions of survey participants were doctor, rickshaw puller, teacher, student, service holder etc. Our system has 2000+ doctors' information and 1300+ hospital location with information in the map. In developing countries like Bangladesh, rural parts are still undeveloped. For illiteracy, blind-faith, prejudice they are falling behind. To give them a better life, healthcare service is important as one of the primary need. By the help of telemedicine people can also learn about the basic of health issues. Our proposed system can give the underprivileged people most of the services in low cost and it can be used anywhere in Bangladesh. In this article next we will talk about related work regarding

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this topic then we will discuss in brief about the architecture, methodology, discussion and conclusion.

### 2. Related Work

We have reviewed existing telemedicine systems of Bangladesh and other worldwide telemedicine researches. We will briefly talk about some of the successful telemedicine systems all around the world in this section.

Researchers E.J Gómezemail et al proposed telemedicine system is designed to complement the daily care and intensive management of diabetic patients through telemonitoring and telecare services. This system comprises a patient unit (PU) used by patients in their day-to-day activities and a Medical Workstation used by physicians and nurses at hospitals. The evaluation of this system consisted in a six month cross over pilot study.

The survey consist of sending and receiving text messages between patients and physicians. They have conducted 24 exercise reports including 3524 blood glucose reading and 1649 day-to-day insulin adjustments.

Chen Z. et al has said, online telemedicine system works like a vehicle for the patients who are willing to visit a doctor but unfortunately unable to visit in time. Researchers want to develop a web based telemedicine system where patients can live communicate with the doctor at home. They have also developed a digital payment system with encryption and decryption. They have extended their system with the Picture and Archive Communication Systems (PACS).

Chan, K.W et al presents a new method for obtaining blood pressure readings noninvasively with telemedicine application. Through the pulse transit time technique, the systolic, diastolic, and mean blood pressures can be predicted using the time interval between the electrocardiogram (ECG) and photoplethysmography (PPG). The data can then be relayed to the Internet for analysis and viewing. The wireless application protocol (WAP) is used for displaying the information on portable wireless devices. The subjects' cardiovascular condition can thus be obtained for monitoring or pre-diagnosis purposes.

Pattichis, C.S. et al have said Telemedicine system will be more popular in future considering its current state. In near future medical service will be in peoples hand. Everyone can get medical treatment and solution via mobile phones. Wireless network will be more powerful media for telemedicine system. Commination with doctors, consulting problems will much easier. Making mobile application for better service to the citizen.

Chin-Feng Lin has advised for long distance communication between patients and doctors, wireless telemedicine is very useful. Furthermore, mobile telemedicine is the best solution in this case. Researchers studied several telemedicine system to make it more beneficial for further improvement of biomedical system. In biomedical system, to deliver biomedical signals over long distances need a reliable wired or wireless medium. Advanced concepts and techniques can be applied to overcome the restriction involved in conventional telemedicine and improve the quality of telemedicine service.

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Hu, F. et al have said, the integration of telemedicine with medical micro sensor technology (Mobile Sensor Networks for Telemedicine applications - MSNT) provides a promising approach to improve the quality of people's lives. Researchers proposed a mobile sensor based network infrastructure to support the third generation telemedicine application and to provide quality of service for a large scale of users. Using discrete-event-based simulation model using OPNET to verify the schema of their proposed solution. The simulation results show that our system can satisfy the adaptive QoS requirements in large-scale telemedicine sensor networks.

Mair, F. et al has proposed that, real time communication in telemedicine system between patients and doctors will bring a whole new era in the field of telemedicine system. 32 studies were conducted and the result is truly impressive. Most important thing is quality of service because in real time communication the video conference must be buffer less and voice must be clear. A wide variety of studies concerning telemedicine, interactive video consultations, have been performed in different settings throughout the world. Commentators on telemedicine frequently highlight the need for research into safety, efficacy, and cost effectiveness. Future research in this subject needs to be more scientifically robust in order to assist policymakers in reaching informed decisions about the appropriate use of this technology.

People who are not able to visit doctor frequently specially curtail ill patients, for those the researcher Dias, J.S et al proposed a mobile based telemedicine system like mobile telephony which will monitor the patient's current state with a simple mobile interface. The system proved to be quick and reliable. Therefore, it represents an applicable solution to telehomecare.

ECHONET (Echocardiographic Healthcare Online Networking Expertise in Tasmania) based research project, mainly concern about cardio graphic medical problems. Researchers Hansen, S. et al have studied the patient's problem with pilot study. Talked to patients about their problem and how they can be benefited with telemedicine service. To find the problem of the medical solution and how it reflects in patient's life was the main concern.

Major survey in intensive care unit (ICU). Survey conducted by sending emails to 483 individuals and 63 healthcare institutions (North America and Europe). Most of them are web based survey. Response rate was impressive. Individual response rate was 21.9% and institutional was 60.3%. Rogove H.J. et al have proposed Robotic Telemedicine System (RTM). They have found several barriers like Financial, Regulatory and Cultural in the context of traditional medical system.

To ensure the Economic Development and quality of life perspective. To deliver the medical service with most advanced technology. By developing workforce and business recruitment, the researchers showed, they can keep the dollar in their local economy. In this case it's also beneficial for the government.

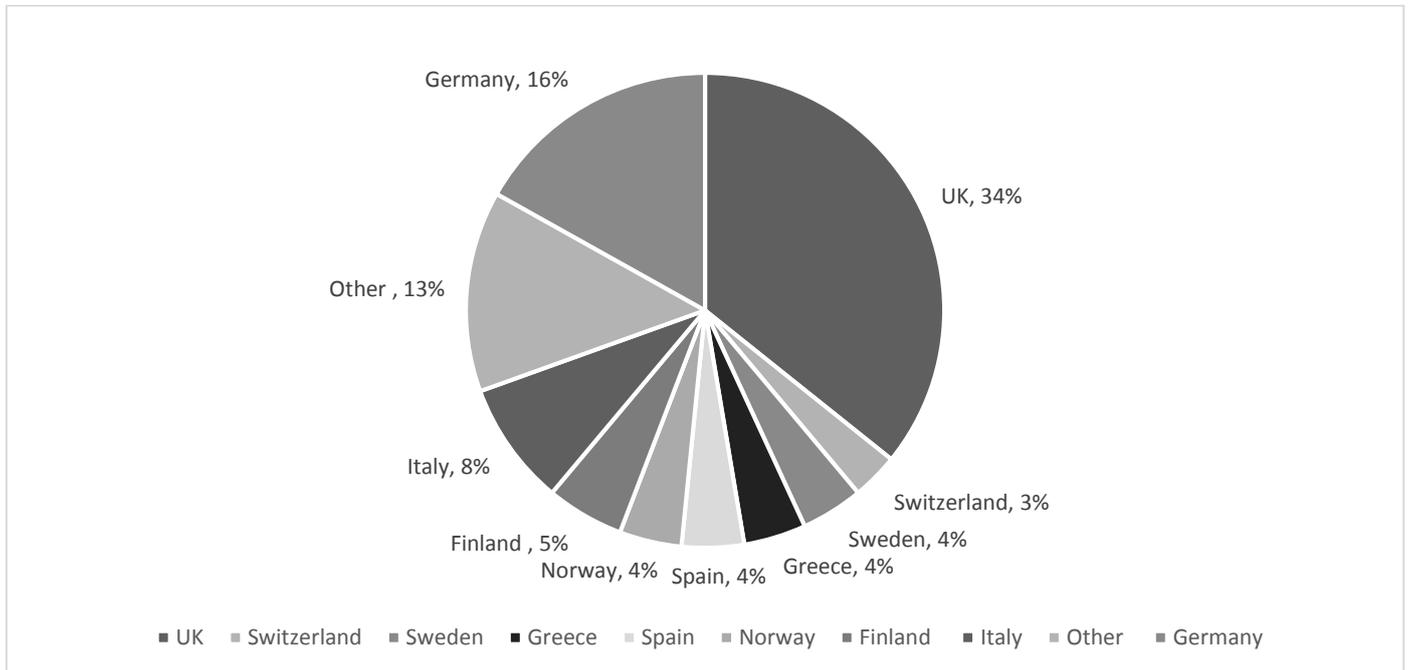
Policy development is a very important issue. In future the expansion of this service and the handling a vast amount of data is challenging. Connectivity in rural areas, cost and security also main concern of this research.

Most important sector in telemedicine system is video conferencing. Farr, H. et al have conducted 15 years of local program to improve the existence system. Also proposed

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adult healthcare system, mental health, community health centres services and concept of employee health program. By their survey they received 90% positive feedback, 8% neutral and 2% negative feedback.

Now a day's telemedicine is becoming popular day by day. Because of getting classified medical service by sitting at your home. In this research, researchers Craig J. et al mentioned mostly about real time communication, which is mostly important for telemedicine services. They have found several data of their survey about need of telemedicine in the twenty first century.



**Figure 1: Current Uses of Telemedicine**

This figure actually shows the current uses of telemedicine around the Europe. There is no doubt that telemedicine is effective in certain situations.

Most of the cased telemedicine system is proposed with same conventional way. In the context of Bangladesh telemedicine system was first proposed in 1999 but afterwards several proposal came but did not see the success. In this paper researcher Chowdhury, M.S. et al proposed a fiber optical based online telemedicine system where patient and doctor can communicate and their data will be saved in their database.

### 3. Motivation

In Bangladesh telemedicine is need badly because 80% people live in rural areas and most known doctors and hospitals are in capital. So, people face difficulties to visit the doctors in time. Moreover, there are only 663 Government hospitals in district headquarters and sub district areas and total number of beds available in both public and private hospitals and clinics are 43,293 which leave 3,063 persons per hospital bed. Similarly the resultant of population per physician is 4147. So, to communicate with the other doctors and clinic telemedicine is must in the time we are living [15]. Wireless network is becoming popular like 3G internet service. This can help to implement a mobile based wireless telemedicine service for the rural or remote areas [5]. Visiting

a doctor in regular basis and finding time to get appointment is really hectic. Getting opportunity to get consultancy and medical service at home make this project more acceptable to the users [3]. In rural areas there is not enough specialist doctors so, in case of emergency patients suffer a lot and they have to come to capital or district town to consult with a specialist doctor. But telemedicine system has the ability to solve this problem through teleconferencing, report sending as media element etc. We have interviewed 114 people and among them 52 were offline survey participants and 62 were online survey participants. Most of them visit doctor by asking their relatives or neighbour's and they prefer local doctors rather than specialists because of transportation issues. Even they visit Govt. hospitals for less charge and suffer in emergency situation. To reduce their sufferings and solve their problems, we believe our proposed telemedicine system will reduce their sufferings. We have addressed their problems first through surveys and then designing our system to solve their problems and reduce their sufferings.

### 4. System Architecture

To improve the existing tradition of Telemedicine System, we are working to build a helpful easy solution for the people of Bangladesh. As our research we have conducted two major survey in different types of people. One of the survey is online based and another is offline. By evaluating both the survey, we have come to a solution that suits every kind of people in Bangladesh based on the current situation.

Improving an existing idea is not an easy work that is why we have proposed a whole new concept of telemedicine that occupies lots of features which are really needed for everyday life for every people. Currently, we have developed two major part of our system that run in both web based application and mobile based application. We have tested in different types of devices like desktop, tablet and mobile phones. Our cross platform mobile application runs very fast and smooth in several devices we have tested. All the testing process is under surveillance. We have given the applications for using and testing to the general users and get their feedback. Still we have not received any kind of negative feedback from them. Sometimes it takes time to load the application in some devices based on the configuration of these. Low end devices takes little time than high configuration devices. Considering this fact, we have tried to optimize the system as much as we can.

Two major part of our system which are currently running are, Specialist Doctors List and Hospitals map. We have occupied our system with 2000 plus Doctors and 1300 plus Hospitals. These vast amount of data takes approximately one second to load in desktop based application and two to three second in mobile devices. It may vary based on the internet connectivity of the users. As 3G is available in most of the area in Bangladesh, we are hopeful about our system to work properly without any problem.

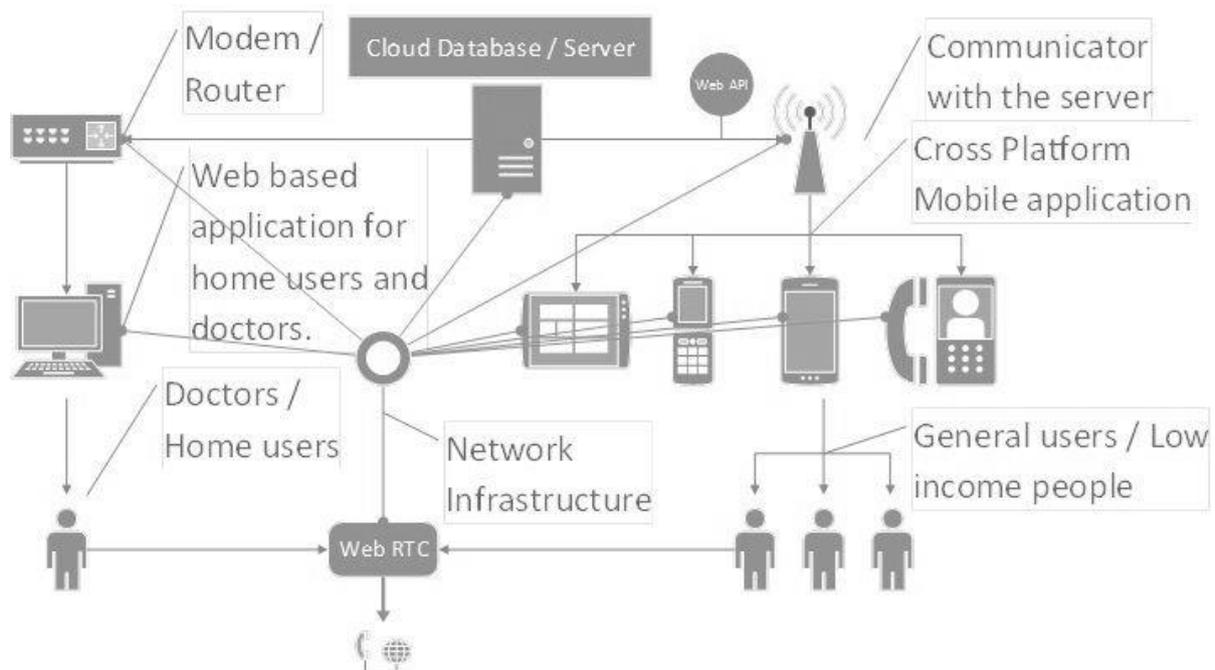
We have designed our system thinking the possibility of future. Moreover, our system architecture consists a lot more features like Real Time communication, Patients and Doctors database. Every patient and doctor can make the proper use of our system by utilizing the necessity of Telemedicine. Their home will become the virtual hospitals and remote patients who are living in rural areas can be benefited by the real time communication with the specialist doctors. They do not have to visit the doctors only to show the report in regular basis. Our system will provide medical record system as well as several new implementation which we are working on.

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The medical record system is a database management system that uses database technology to construct, maintain and manipulate various kinds of data about a person's medical history and care across time. The DBMS can track and update all the information of registered patients in the medical center during a particular time span. Medical records are created when a patient receive treatment from a health professional. Records may include the patients:

1. Personal information
2. Medical history
3. Laboratory test results
4. Medications prescribed
5. Reports that indicate the results of operations and other medical procedures

The medical record serves a variety of purposes and is essential to the proper functioning of the medical practice - especially in today's complicated health care environment. The medical record is a key instrument used in planning, evaluating, and coordinating patient care in both the inpatient and the outpatient settings. The content of the medical record is not essential for patient care.



**Figure 2: Complete Proposed System Architecture**

We are proposing a whole new concept that of Telemedicine where patients and doctors can communicate through web, mobile and tablet applications along with the traditional medical record system. Our system will provide the latest technology of cloud computing. We'll use Microsoft Azure database, which gives support multiple platforms that is what we need in our current time.

Doctors can keep their profile and patient can have also. Administrative system can maintain, the whole hospital connection with the other hospitals. Can also keep track of their doctors and surveillance patients.

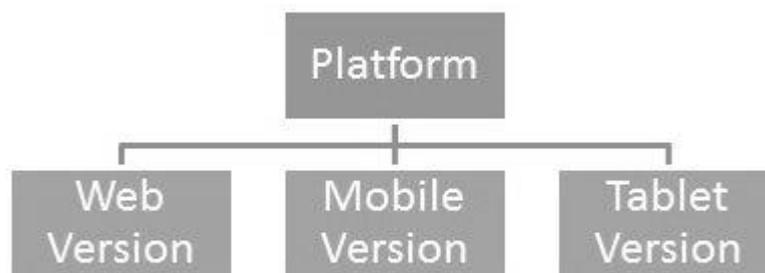
We have updated about 2000 Doctors and 1300 plus hospitals database in whole Bangladesh. We almost spend two years to update our database with the current data.

Our system provides a whole Bangladesh hospitals map with their information like, addresses, capacity and contact numbers.

To communicate with the doctors, patients like low income people, they can use their mobile devices to discuss their problems with the doctors via our mobile application which runs seven different mobile platforms. We have used web RTC a reliable communication API which provides clean and noise free video conference between two devices.

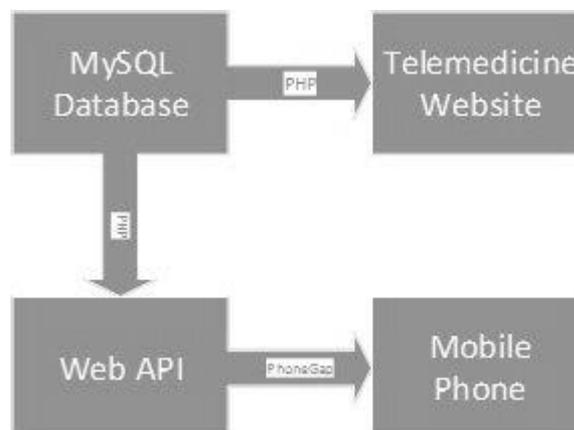
## **5. Methodology**

Our System consists of several segments like, Web service (Web based application), Mobile and tablet service (Mobile devices as well tablets). In mobile service, we have used Cross Platform technology like PhoneGap. Several advance technology have used both for web application and mobile application.



**Figure 3: Different Platforms**

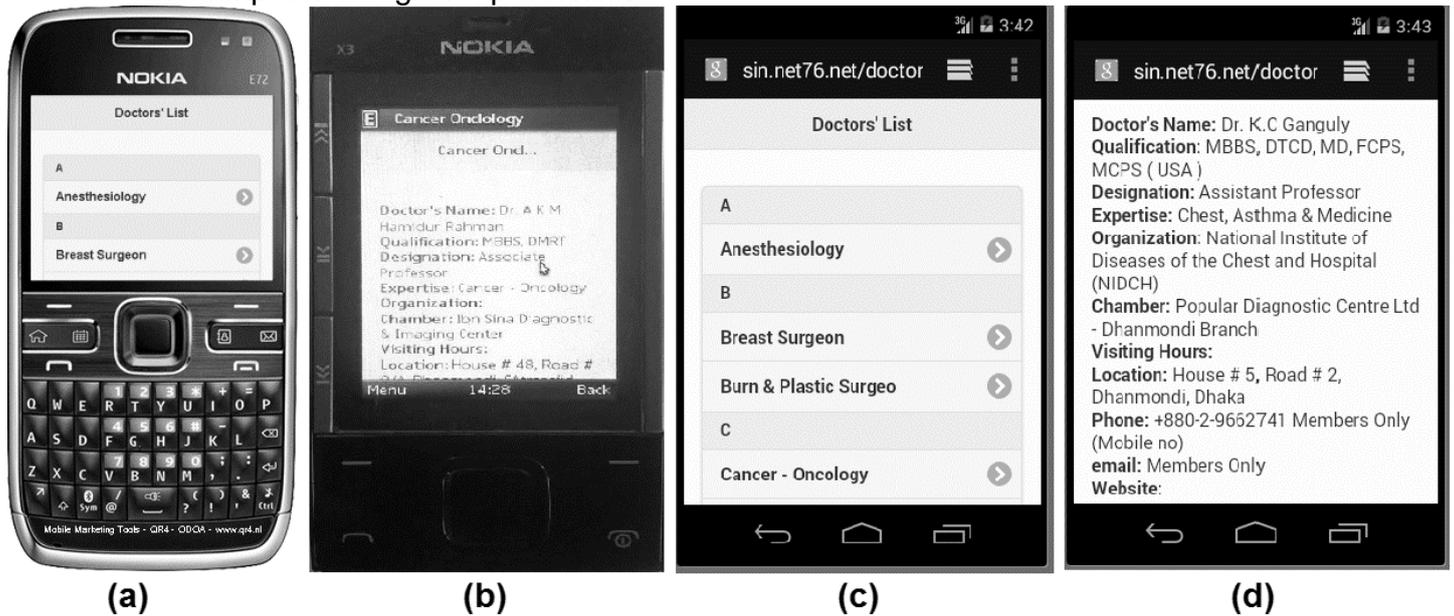
In web based application, we have used HTML5, CSS3, JavaScript, PHP and Json. We have used both Json and SQL server for our database system. We have used Microsoft Azure Cloud Database Service because it is one of the best Cloud Service now a days because it provides all web application language support and most of all mobile platform like Android, iOS, Symbian, Blackberry, Bada and Windows Phone. It's totally secure and most importantly we can make backup service as well form different locations.



**Figure 4: Web API Support**

Json is very light weight data model for managing external data. We have used Json for our hospitals locations and the corresponding information to display in the

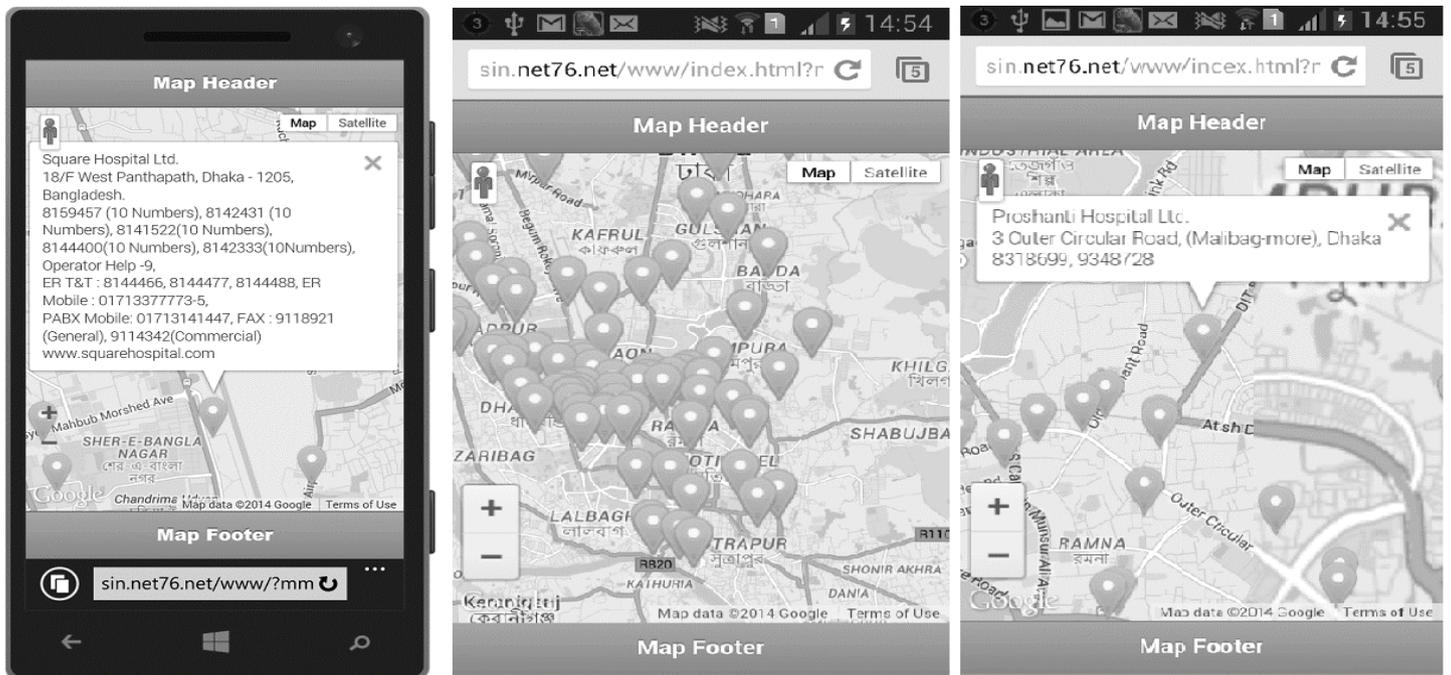
Hospitals Map. The reason behind using Json is, it is very fast to load data in JavaScript for Google Map Service.



**Figure 5: Full Doctors List Page Running on Nokia S40 Devices (A), Symbian X3 Device (B), and Low Configuration Android Devices (C) (D)**

To develop our web application, we have used HTML5, CSS3, JavaScript and PHP. For designing purpose we have used HTML5 and CSS3 because both work for our cross platform mobile application like universal languages. For server site scripting, we have use both JavaScript and PHP. PHP is worldwide used scripting language for web applications and security issue it not so vulnerable than others existing languages.

For our Mobile Application, we have use PhoneGap technology which is very popular around the world. It supports seven different platforms like Android, Windows Phone, iOS, Symbian, Blackberry and Bada. In PhoneGap, it requires HTML, CSS and JavaScript. To make it more reliable and functioning we have used JQuery plugin. It provides some advanced features to run the same mobile application in different platforms. PhoneGap build service gives the opportunity to build the application package for the seven different platforms just making a single platform application.



**Figure 6: Full Hospital Map Page on Dhaka City Hospitals Running on Nokia Lumia Windows Phone 8.1 Device (A), Low Configuration Android Device (B) and High Configuration Android Device (C)**

In Hospitals Map Service, though we have used Google Map Service using JavaScript and JQuery plugin, to optimize the view and make it more efficient for the general users, we have used lazy loading technology which will load only the data near the user's location. It is approximately hundred meter radius. If there is no Hospitals in this range, it will load another hundred meter radius of the Map. It tracks the user's current location via their web browser. We have used JavaScript to locate the current position by the web browser as well mobile application. Moreover, we have also used Map Clustering for our Hospitals Mao. That reduces data loss and cost effective for mobile users. Thinking of the poor people, we have used these technology to make it more reliable and cost effective.

Several technology have been used for developing our system. We have also used web cache save state technology that will save your previous browsing information to load the web application faster when you want to browse second time after login.

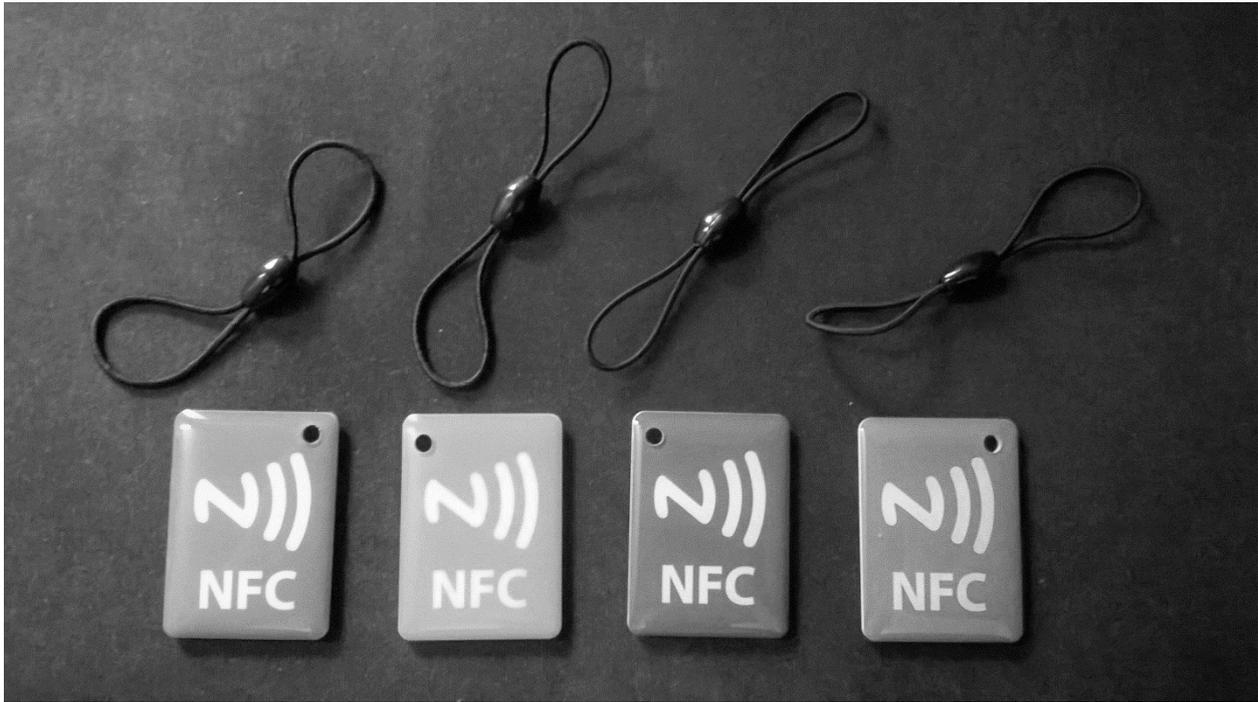
We have tested our application bot web and mobile, in different platforms like Android, Windows Phone, iOS, Symbian and the performance is really satisfactory for the low end mobile devices like which have 256 and 512 mb memory. Both the web and mobile application have same User Interface, so that people do not have to bother about the functionality for different platforms.

## 6. NFC Tag

NFC (Near Field Communication) is a wireless technology which allows for the transfer of data such as text or numbers between two NFC enabled devices. NFC tags, for example stickers or wristbands, contain small microchips with little aerials which can store a small amount of information for transfer to another NFC device, such as a mobile phone. Our preferred option, the NTAG213 or NTAG203 chip is the

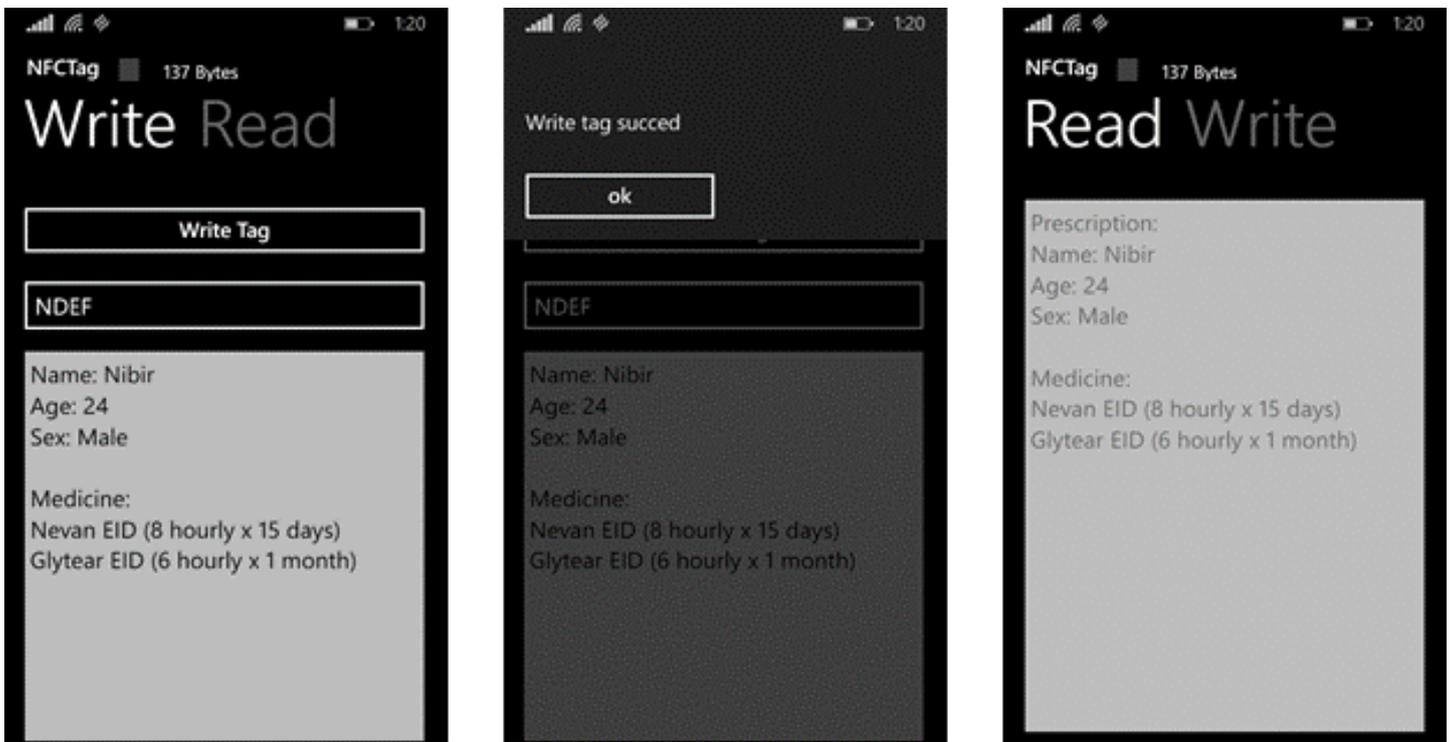
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perfect choice. The memory size 144bytes which can store around 132 characters. Usually, this information is stored in a specific data format (NDEF - NFC data exchange format) so that it can be reliably read by most devices and mobile phones. It's perfect for making a patient's prescription which we're thinking to implement in our project.



**Figure 7: Mobile OS Choice Graph on User Survey**

In hospitals, doctors and nurses have to carry patient's related papers when they visit. Sometimes, these papers torn up. If we can use NFC tag instead of these papers, they can easily read and write patient's prescription, when to give medicine and others information. They just have to tap the NFC tag behind the phone and can read the corresponding information.



**Figure 8: Graph on the Profession of Survey Participants**

By this application and NFC tag, doctors can easily maintain patient's medicine profile during patient's admission in the hospital. Nurse can use it when the patient need medicine and can carefully take care the patients.

## 7. User Survey

For our research, we have done both online and offline surveys. In online surveys 60 people have participated and the result is very convenient. In our online survey we have asked several questions, among them one is, "Which Mobile OS you want us to use to focus to develop this app with Hospitals map and country wide Doctors list?" And the answer is very straight forward. 28.3% people have said Android, 26.7% have said Windows Phone, 13.3% have said iOS and 25% have said above all. Only 3.3% have said Symbian and Blackberry. So, Most of the people have said Android, Windows Phone and iOS and that's why we have focused to develop all seven different mobile platforms like Android, Windows Phone, iOS, Symbia, Blackberry and Bada.

Which Mobile OS you want us to focus to develop this app with Hospital map and country wide Doctors list.

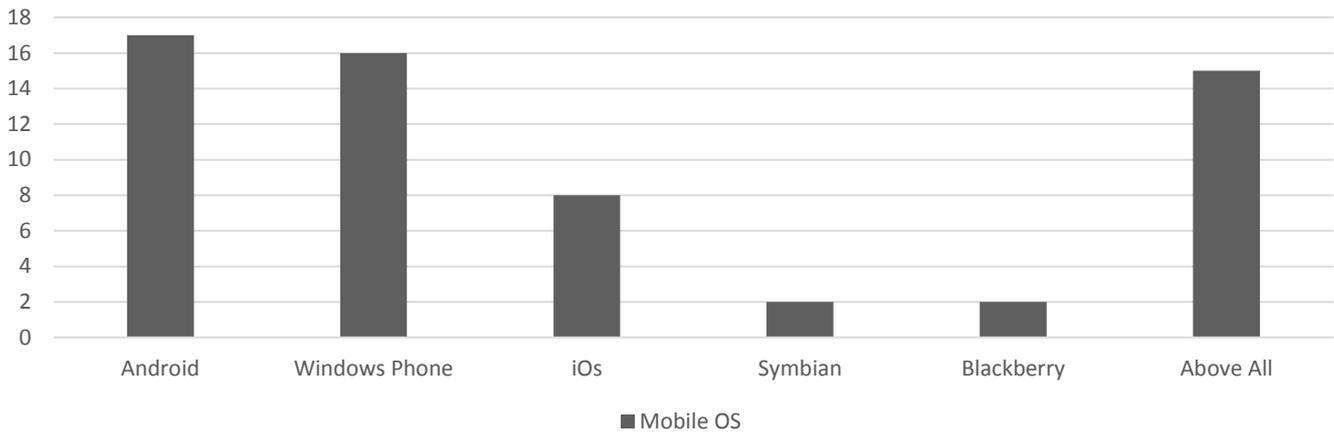


Figure 9: Mobile OS Choice Graph on User Survey

To learn the need of mass people of Bangladesh, we must to get in touch of them. That's why we have done our offline survey in different places with different types of people. In the first phase, we have focused on the low income people like Rickshaw puller, Garments worker, Shop keeper, Security guard and House keeper. In our survey, 34.5% Rickshaw puller, 6.9% Garments worker, 13.8% Shop keeper, 6.9% Security guard and 1.7% House keeper have participated. We focused on them, because they are the main sufferer of medical service and they have really a little knowledge of the medical treatment and their basic rights.

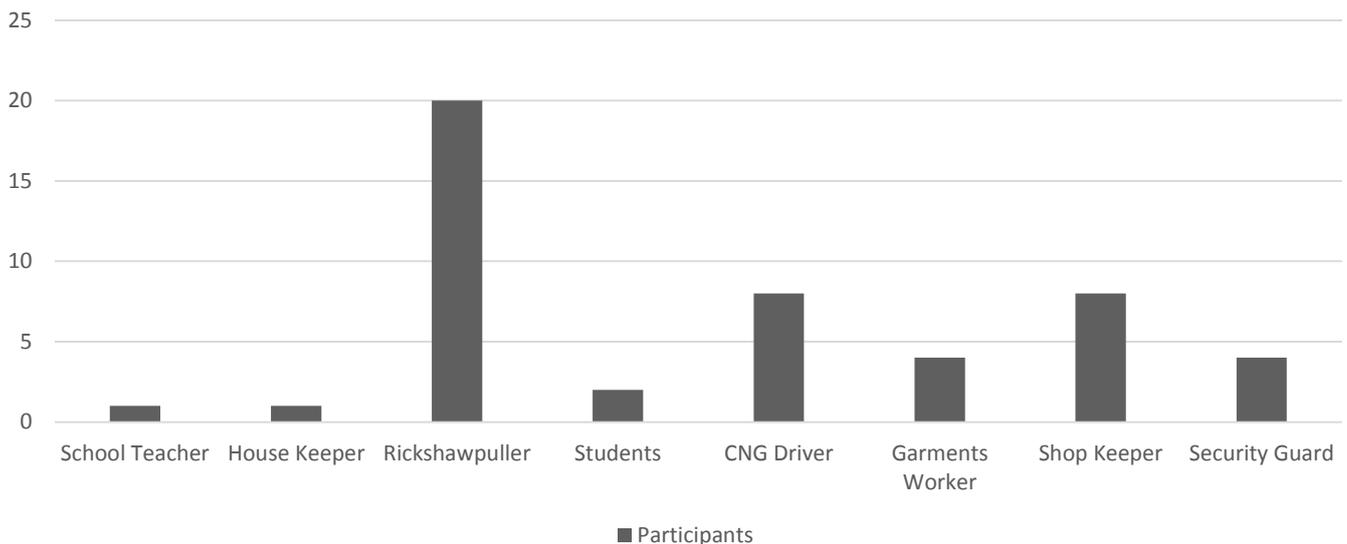
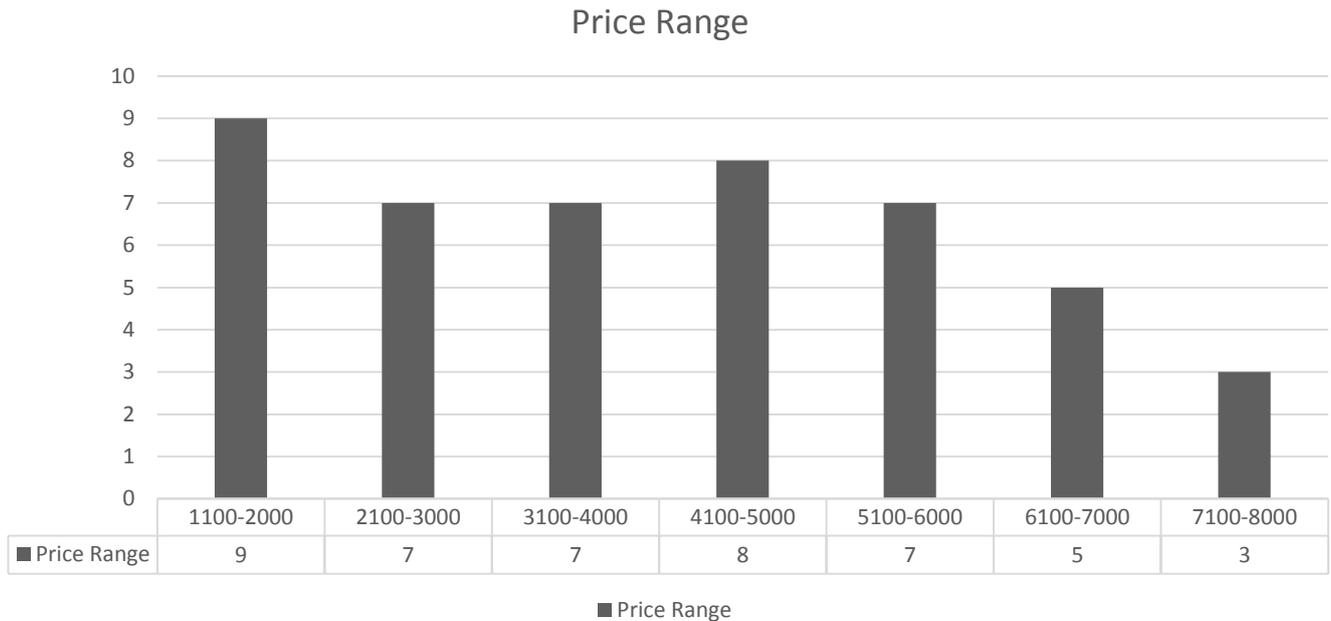


Figure 10: Graph on the Profession of Survey Participants

Another point of survey is to know about the price range of mobile phones they use. The price range between 1100 to 2000 is 15.5%, 2100 to 3000 is 12.1%, 3100 to 4000 is 12.1%, 4100 to 5000 is 13.8%, 5100 to 6000 is 12.1%, 6100 to 7000 is 8.6% and 7100 to 8000 is 5.2%. So, it is obviously clear to us that most of them use low end mobile phones. But it is also hopeful for us that now in Bangladesh Android and Windows as well Symbian phones are available in low range price which most of the

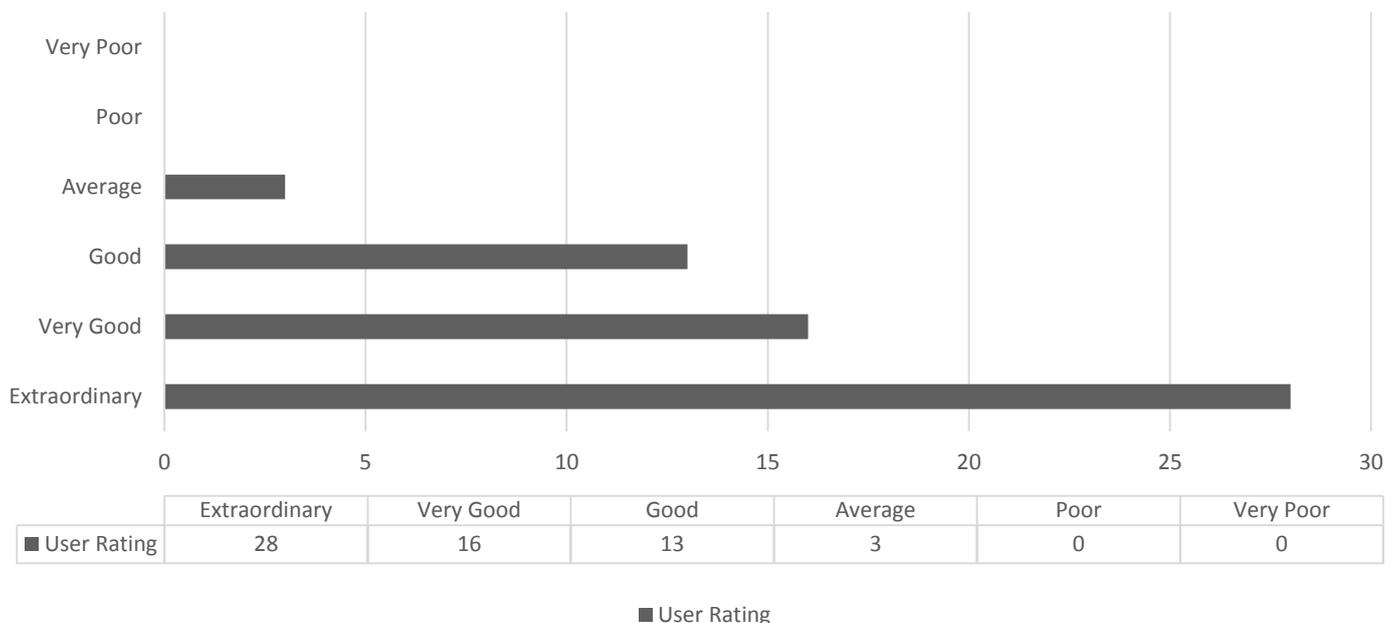
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people are using. Moreover, our mobile application runs seven different platforms which covers most of their needs.



**Figure 11: Graph on Price Range of Survey Participants**

Another question is, “Rate our Concept or Thought” and we have received very positive feedback from them. Among them, 46.7% have rated it “Extraordinary”, 26.7% have said “Very Good”, 21.7% have said “Good” and only 5% have said “Average”. No one has rated it “Poor” or “Very Poor”. That is much convenience for us to develop this project.



**Figure 12: User Rating Graph**

Some valuable comments we have received from them, like one rickshaw puller have said, “Nice, as we’re detached from our family, it will be helpful. Even we don’t need

to visit doctors in regular basis.” One problem we have faced that the literacy problem in Bangladesh. But we have become really interested by hearing this comment, “Probably if I can read or someone read for me that will be a good thing for us.” Over this, cost effectiveness is very important for any kind of system and people are also aware of the cost of using this system. Someone have said, “If it is less costly then it will be okay.” Sometimes people do not aware of visiting the doctors because by this time they can earn some more. This is actually have happened when we are conducting survey. A rickshaw puller have said, “If I don’t have to visit doctor, I can earn more on that time.”

It is really a challenging problem for us to find a better solution for the low income people but we have come to a conclusion that our system have served a proper service both for the middle class and low income people also in remote area where specialized doctors are not available any time.

### 8. Conclusion

The main contribution of this paper, while conducting our both online and offline surveys, we actually come to know about their needs and their thoughts and finally have developed the system to provide them quality service. Quality of Service (QoS) is very important in Telemedicine System. Providing service in timely manner is must also in remote areas where internet connectivity is a barrier for them. That is why we focused to develop our system for low end devices as well low income people. As in our offline survey, we focused mostly in low income people like Rickshaw puller, Garments worker, House Keeper, CNG driver and Shop Keeper. They mainly use low priced mobile devices because they cannot afford the high end devices. They are somewhat detached from their family member and when they become sick, they hardly visit a doctor. Our system provides all current information of Specialist Doctors List and Hospitals Map both for web and Mobile devices also they can directly call the doctors from the mobile application. Our research based on the needs of low income people generates several clue to improve the Telemedicine System in the Context of Bangladesh. Working people do not have that time to find out the correct doctors for their need and sometimes they buy medicine only going to dispensary without doctor’s advices. By using our system anyone can get to know the Specialist Doctors’ information and nearest Hospitals Locations. We have given our solution to the survey participants for testing purpose and to observe the usability. Only few kilobit of data cost to load our application in low end mobile devices and cost is very low. Anyone can use our application in low end devices only spending 2 TK per day but in mobile application it costs less than this. Simplified User Interface makes it easy to use for low or semi-literate people. In our survey, we have found many key points regarding the healthcare issues like, poor people are the main sufferer of healthcare issues and most of the cases they have to wait for a longer period of time to get treatment from a govt. hospitals. Even sometimes they are deceived by the fraud and intermediary. By using our solution they can easily get the medical service in a shorter period of time. Our system design and development of Telemedicine System with further improvement will change the traditional Medical System to a whole new arena. People do not have to suffer to find the correct Hospitals and illegible doctors to serve them better treatment. We are still working betterment of our solution. Further research, Real Time communication with patient and doctors is still in progress. There are some major issues like, internet connectivity. As Bangladesh is a developing country, internet is not reachable in every district not like the developed countries. People will

get proper benefit of this solution when they can afford internet connectivity and little bit of knowledge of mobile phones. It can be helpful as a learning tool and people can get the information of healthcare services around them.

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