

Study on the Telemedicine models and developing a cost-effective Telemedicine model for Bangladesh

(A research project report submitted in fulfillment of the requirements for the Research and Extension Center for the fiscal year 2023-24 of Jatiya Kabi Kazi Nazrul Islam University Trishal, Mymensingh-2224, Bangladesh)



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Declaration

I hereby declare that the research project titled “**Study on the Telemedicine models and developing a cost-effective Telemedicine model for Bangladesh**” is done by me. I have completed the project in time and within the budget allocated to me from the research and extension center of Jatiya Kabi Kazi Nazrul Islam University. This project is unique and haven't done before in the Jatiya Kabi Kazi Nazrul Islam University.

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Abstract

Shortage of doctors, health centers, supply of medicine and cost-effectiveness are the major problems facing by healthcare organizations in developing countries like Bangladesh. Telemedicine is an effective tool to address the above problems and offer healthcare services to the unreached community. It is very difficult for the developing countries to ensure proper health care services for the huge number of rural people. In order to carry out this research, all the telemedicine models of Bangladesh will be analyzed first. This research will be justified through this study. The goal of this research is to develop a cost-effective telemedicine model for Bangladesh. This research will find out the potentials difficulties faced by the existing models. Based on the findings on the existing models, this study will develop a model which will overcome all the difficulties of the models of Bangladesh and offer telemedicine to the unreached and unconnected areas in a cost-effective manner.

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ICT cell of Jatiya Kabi Kazi Nazrul Islam university help me for the technical support and finally with their assistance, I can conclude my project in practical stage.

Lastly, I want to give my deepest thanks to my family members for whom I am finally able to complete this research work.

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Dedication

Dedicated to my lovely parents and family members for whom I am now in a position.

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Chapter One

Fundamentals of Telemedicine and Health Systems

1.1 Introduction

Telemedicine is especial types of medical services where patients can get the healthcare services both in store and forward method or in real time method. In both approaches they can get the health advices from expert doctors. They now able to get their health records and quality care at low cost.

In the recent years, health sectors are reforming and people are now able to get improved services from their own areas through telemedicine centers. In Bangladesh there are still the ratio of Patient and health-professional ratio is very low. Most of the people live below the poverty line. Most of the cases experienced doctors give medical treatments from urban areas and local doctors are connected with the rural patients in Bangladesh. For example, in Kashiani upazila of Gopalganj, 10 out of 24 major posts for doctors are vacant as doctors do not want to go there [1]. Of the 11 posts in the Upazila Health Complex such as Junior Consultant Gynecologist, Junior Consultant Surgery, Medicine and Residential Medical Officer are vacant [1].

At the time of Corona Virus, the use of telemedicine played a vital role for the treatment of patients. It was not possible to consult with doctor's face to face in the pandemic period. Then both patients and doctors meet with each other through telemedicine and after consultation, patients can able to get the updated treatment plans from doctors. That helped a lot and saved lots of valuable life of patients in Bangladesh.

By using the tele-health and ICT technologies, different types of symptoms were recorded in the health systems for each patient and based on the findings from health professionals, patients were able to get advices from doctors. By using telemedicine, travel of patients also reduced and their costs were less as compared with other normal period.

Table 1 shows the population-workforce ratio of Bangladesh in the case of healthcare sector. From the table, we can see that the ratio is very low for a densely populated country like Bangladesh. It is very difficult to manage and provide minimum healthcare services to the people of Bangladesh.

S.N	Information on Health System Facilities of Bangladesh	Ratio
1	Population per registered physician	1,487
2	No. of registered physicians per 10,000 population	6.73
3	No. of doctors working under the DGHS per 10,000 population	1.55
4	No. of medical technologists working under the DGHS per 10,000 population	0.60
5	No. of community and domiciliary health workers working under the DGHS per 10,000 people	2.26
6	No. of beds in the DGHS-run public hospitals per 10,000 population	3.30
7	No. of beds in private hospitals (registered by DGHS) per 10,000 population	5.53

Table 1: Population-Health Workforce Scenario of Bangladesh [1]

1.2 Healthcare Network of the Public Sector in Bangladesh

- Facilities expanded down to rural communities

The healthcare network of the public sector in Bangladesh led by the Ministry of Health and Family Welfare (MOHFW) is now expanded down to rural communities. Very recently different health organizations are expanding health facilities all over the country of Bangladesh. Ministry of health is also improving the national health policies so that they can able to give better services to the people of Bangladesh.

Specialized hospitals are now supporting different local hospitals by sharing the expertise of doctors, resources and even facilities. As a result, any remote patients are now able to meet and get advanced opinions from expert doctors of specialized hospitals of Bangladesh.

A new administrative structure in the MOHFW has been built up by dividing it into two divisions in March 2017. The new divisions are: (I) Health Services Division and (II) Medical Education and Family Welfare Division. The structure of the ministry of health and family welfare is shown in the following figure:

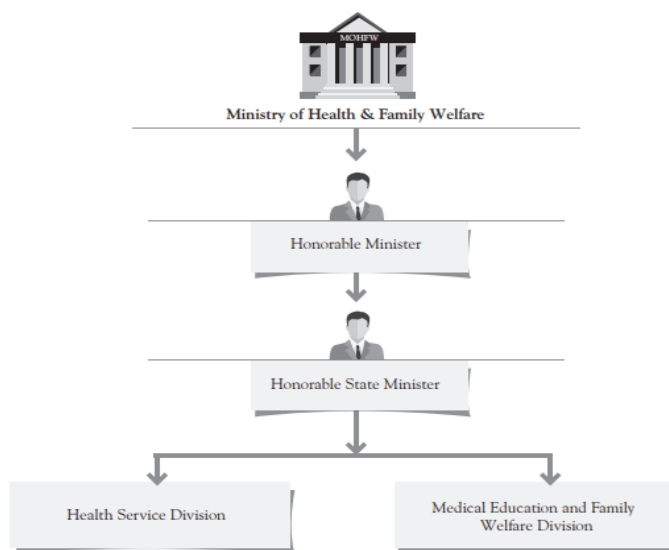


Figure 1: Organogram of Ministry of Health and Family Welfare [1]

1.2.1 Health Facilities Structure in Bangladesh

Types of health facilities under the Directorate General of Health Services (DGHS), Bangladesh is shown in figure 1 b. Primary health care facilities are given to the rural people through ward, union and upazila levels hospitals of Bangladesh. The secondary health care facilities are given through district and divisional level hospitals to urban people. Secondary level hospitals provide more advanced or specialty care to the patients. The district hospitals have fewer facilities than specialty care hospitals. Specialty-care hospitals, such as infectious disease hospitals, tuberculosis hospitals, leprosy hospitals that fall under the category of secondary-care health facilities. More specialty care in different disciplines is given through the medical college hospitals whose are called tertiary-care hospitals. There are some hospitals that deliver high-end health care services are also called tertiary hospitals.

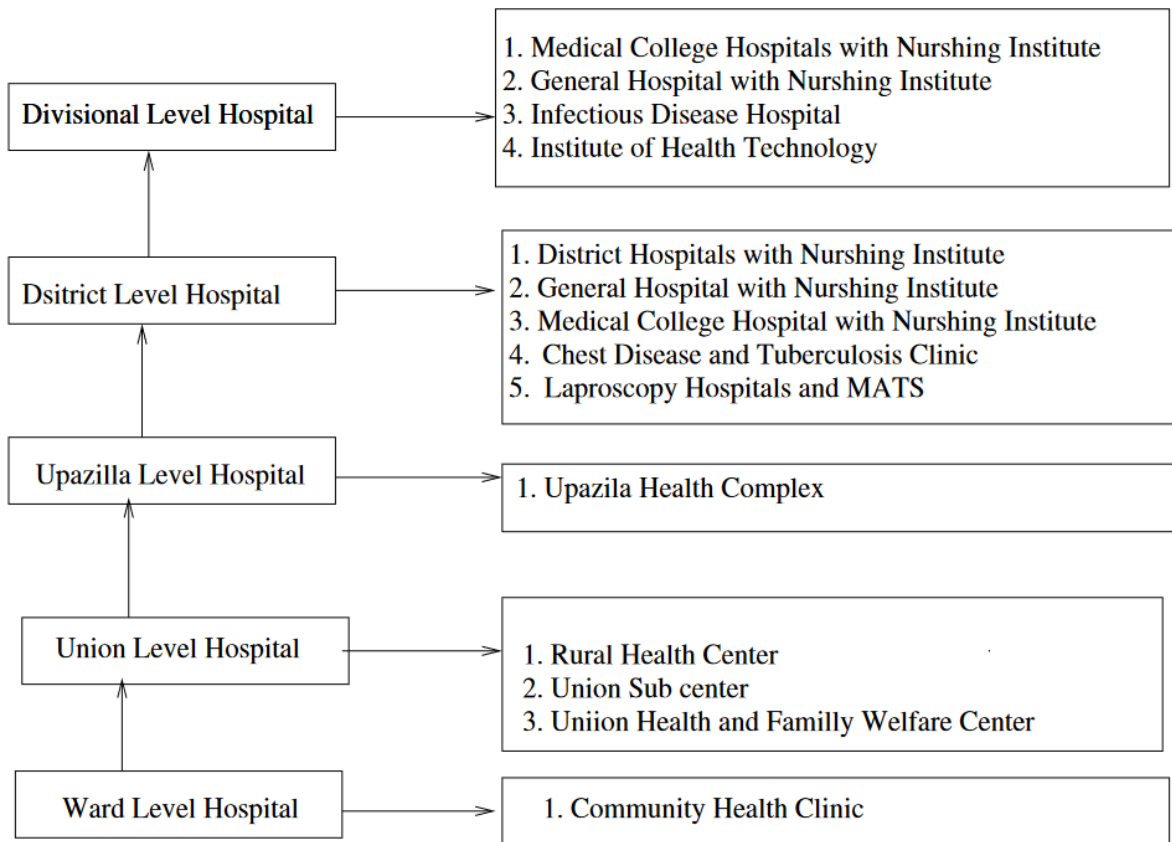


Figure 1 b: Health facilities structure of Bangladesh [9]

As the number of secondary and tertiary hospitals is limited in our country, we can get the expert doctors health services through telemedicine from the primary health care centers.

1.3 Sustainable Development Goals

Health and Nutrition Is Essential for the Success of All SDGs

According to SDGs health and nutrition is essential for all. In order to achieve these goals, Bangladesh is working and taking some of the practical initiatives. Figure 2 shows the maternal mortality status. From the figure, we can see that the mortality rate is decreasing day by day which is a very good sign to reduce mortality rate.

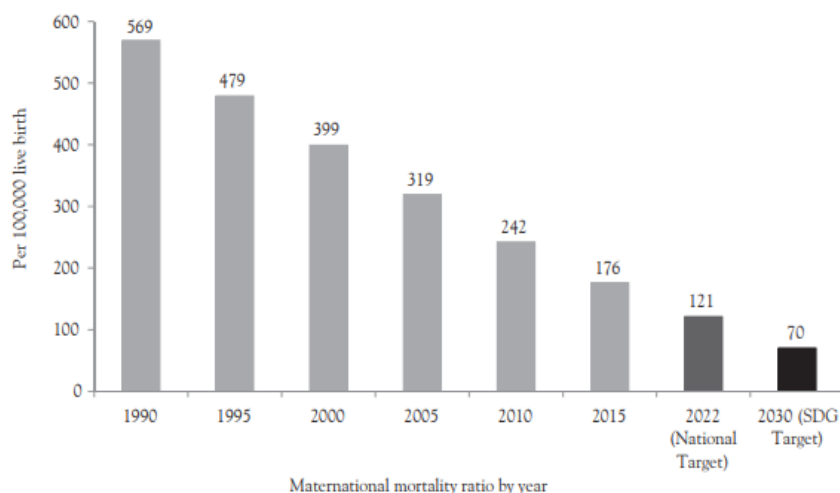


Figure 2: Maternal mortality status [1]

Figure 3 shows the number of beds in all secondary and tertiary-care hospitals in Bangladesh. From the figure, we can see that Dhaka is the highest number of hospitals and in Mymensingh has the lowest number of hospitals.

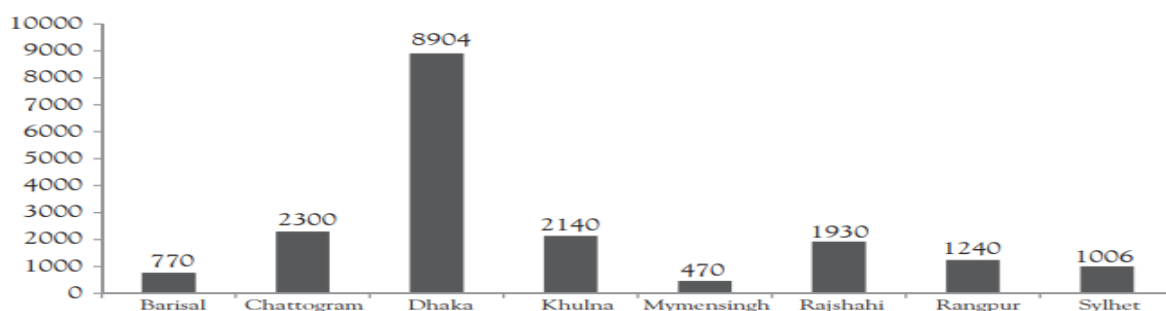


Figure 3: Number of beds in all secondary and tertiary-care hospitals other than medical college hospitals by administrative division, 2018 [1]

Figure 4 depicts the number of beds in all government medical college hospitals by administrative divisions of Bangladesh. From the figure, we can see that the highest number of beds are in Dhaka and Khulna has the lowest number of beds among Bangladesh.

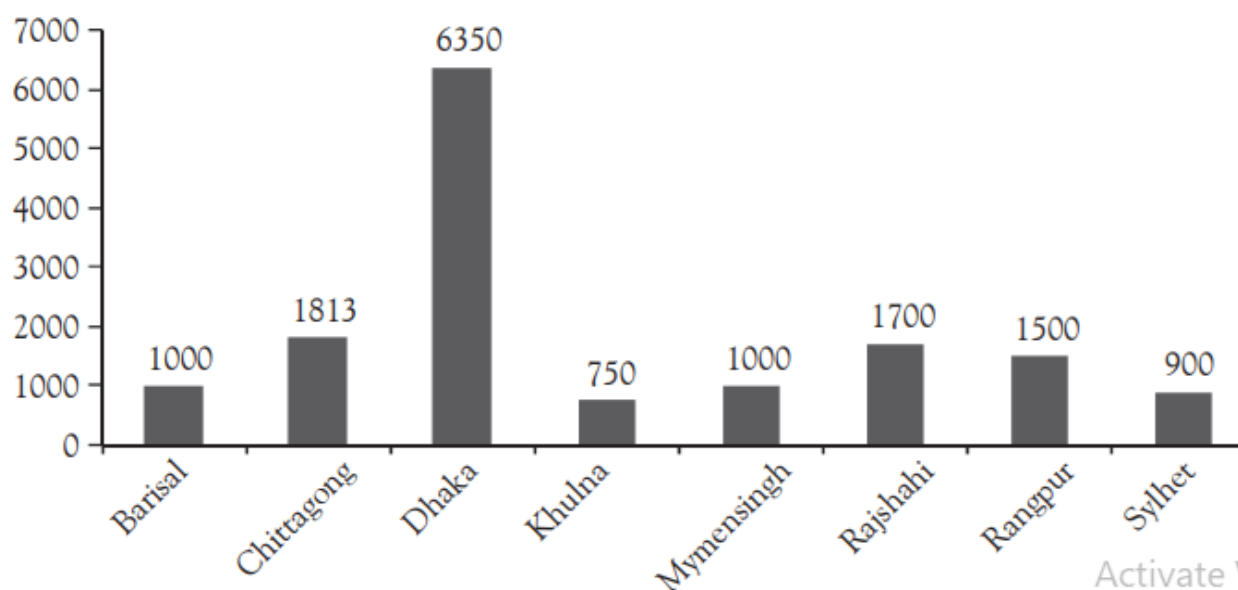


Figure 4: Number of beds in all government medical college hospitals by administrative division of Bangladesh, 2018 [1]

Table 2 shows the number of sanctioned, filled-up and vacant posts under DGHS. From the figure we can see that rate of vacancy for Non-Doctors is the highest.

Category	Sanctioned post	Filled up post	Vacant post	Rate of vacancy (%)
Class I	Doctors	27002	25594	5.21
	Non-Doctors	528	226	57.20
Class II*	989	687	302	30.54
Class III	51580	36319	15261	29.59
Class IV	25155	15792	9363	37.22
Total	105254	78619	26635	25.31

Source: HRIS, DGHS ; *Excluding nursing posts

Table 2: Number of sanctioned, filled-up and vacant posts under DGHS [1]

1.4 Telemedicine service

Telemedicine service has started from 8 telemedicine centers in the fiscal year 2009- 2010. Till fiscal year 2017-2018, there have been 94 telemedicine centers; among these, 9 are at the specialized hospitals, 8 are at MCHs, 11 are at DHs, 65 are at UHCs, 1 is at MIS-DGHS for monitoring and coordination with other centers which, sometimes, provide consultation service also. Figure 5 shows the number of telemedicine centers year-wise (2014-2018).

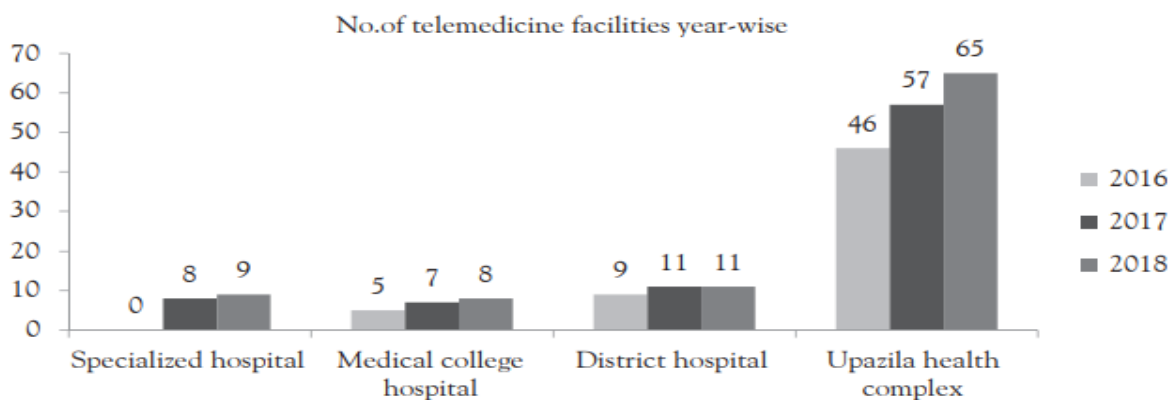


Figure 5: Number of telemedicine centers established in various institutions from 2016 to 2018

Figure 6 shows the year-wise number of patient consultation status through telemedicine. From the figure, we can see that patient consultation status is increasing day by day.

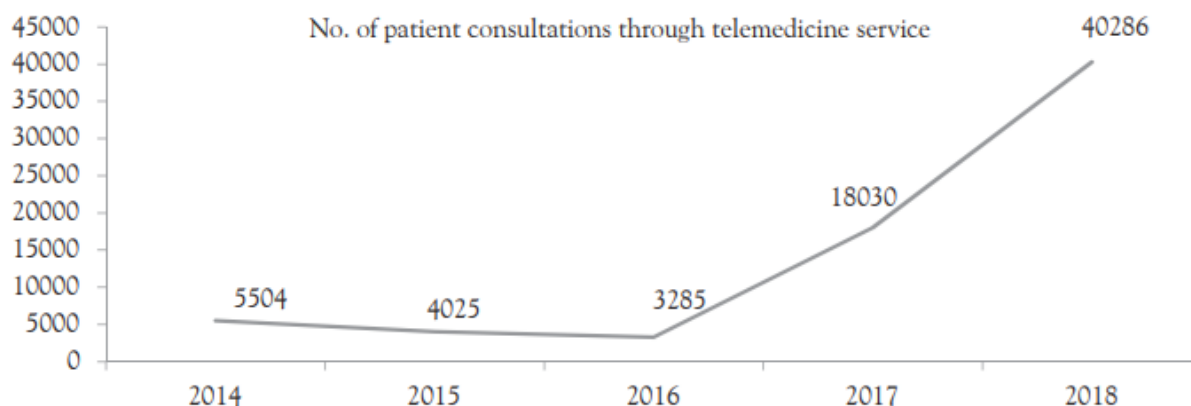


Figure 6: Year-wise number of patient consultations through telemedicine service from 2014 to 2018 (Source: DHIS2, MIS, DGHS)

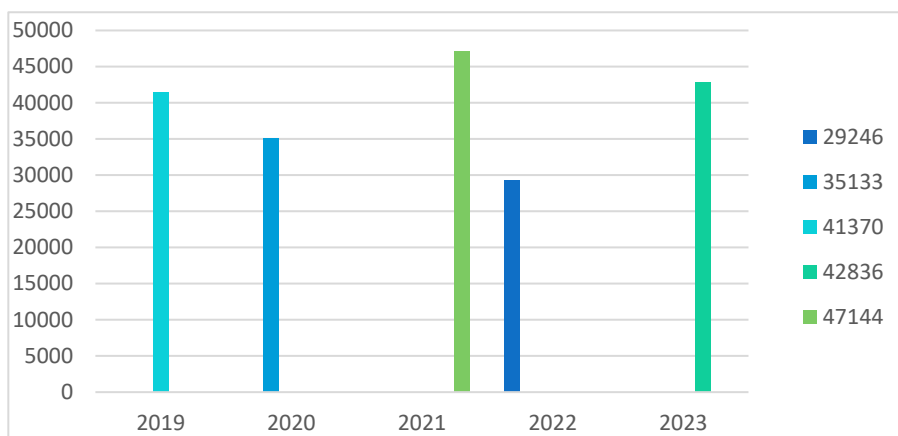


Figure 6 a: Year-wise number of patient consultations through telemedicine service from 2019 to 2023 (Source: DHIS2, MIS, DGHS)

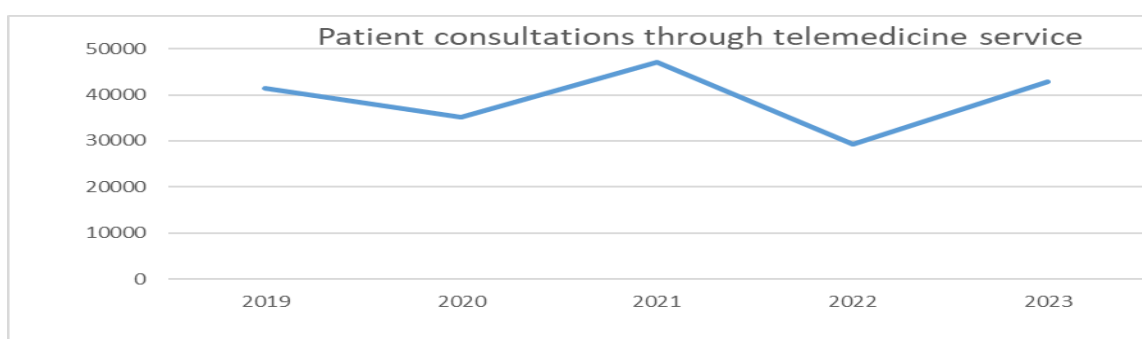


Figure 6 b: Line graph of year-wise number of patient consultations through telemedicine service from 2019 to 2023 (Source: DHIS2, MIS, DGHS)

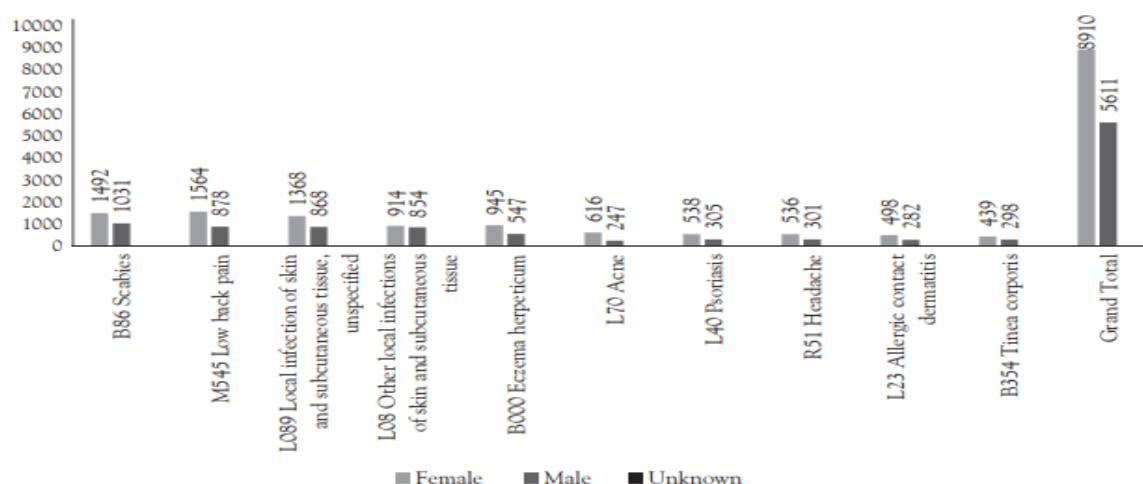


Figure 7: Disease profile obtained from telemedicine service in 2018 (Source: DHIS2, MIS, DGHS)

1.5 Health call center 16263 (Shasthya Batayon)

Shasthya Batayon Call Center 16263 is a initiatives from government. It is called the National Health Call Center. People can get health service by dialing the short number 16263 from any mobile or land phone number. Total 45 doctors support this services.

Key services of Shasthya Batayon

Doctors' Advice and Treatment: A team of efficient doctors provides services. People call 16263 and directly communicate with a doctor about their health-related problems and queries any time they want.

Health Information: Sometimes, it is hard to find a doctor nearby or to get information about any hospital. Shasthya Batayon provides phone numbers of public or private hospitals, clinics, and doctors with required information.

Ambulance Information: Shasthya Batayon has developed a database of ambulance contact numbers with information about locations. Anyone can get information on ambulance during emergency in specific location by dialing 16263. This service has also been connected with the National Emergency Service 999. Ural EMS has now been integrated with Shasthya Batayon so that people can get ambulance through UBER System—a recent innovation in renting of vehicles.

Health Compliant Management: To mitigate health service-related problems and complaints and to improve quality of overall health sector of Bangladesh, Shasthya Batayon is taking and solving complaints on any public or private health services. In addition, Shasthya Batayon also records and informs the complainants about measures taken based on the complaints.

Emergency Accident Information: Shasthya Batayon 16263 takes emergency accident information and quickly informs the relevant authorities. The total numbers of calls received in the last three years (2016, 2017, and 2018) are shown in Figure 8. There is a very slight difference in data of the last two years. People received services mostly for viral fever and diarrheal disease (Figure 9).

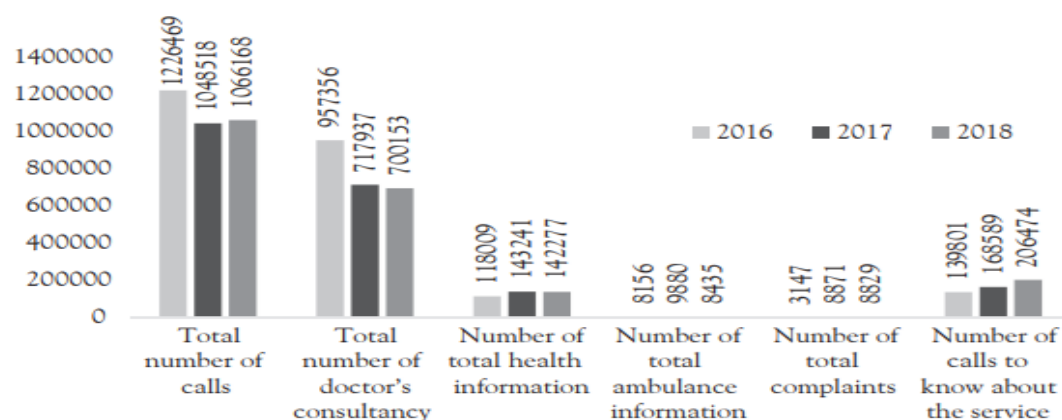


Figure 8: Number of calls received through Shasthya Batayon in the last three years, Source- <http://16263.dghs.gov.bd/report/report.php>

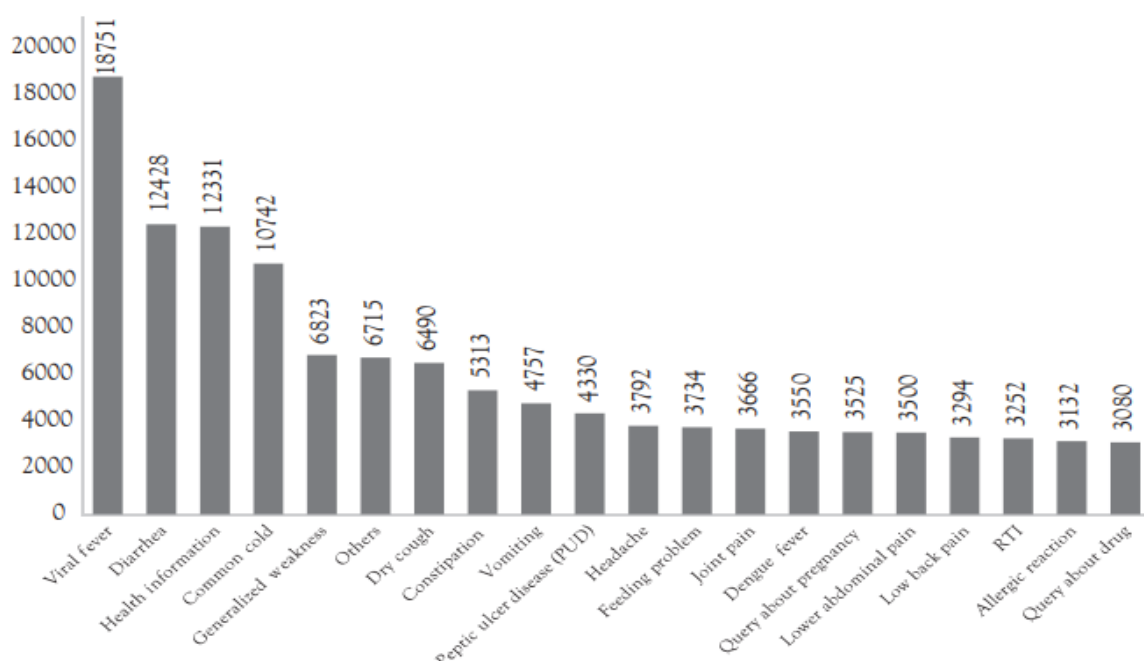


Figure 9: No. of persons who gave calls to Shasthya Batayon for the above-mentioned health problems/issues in 2018, Source: Synesis IT Limited

1.6 Improvements of Telemedicine in Bangladesh

What we have seen for the last few years, tremendous improvements have been made for the health sectors. New medical colleges, health institutions have been built, rural health complexes are increasing, more health workers are employed. All are connected and coordinately they are working. Most of health clinics are now the remote service station for the large rural people of Bangladesh.

Number of hospital beds are increasing, telemedicine consultation rate is increasing, telemedicine centers are increasing, number of doctor's appointments are increasing. As a

result, the rate of getting healthcare for the patients are increasing and patients are now able to share their health history with the expert doctors by residing in their locality.

Some limitations of Telemedicine

There are lots of limitations that are still exist of telemedicine services in Bangladesh. Network issues are one of the biggest problems especially for the remote centers. With good speed of network, it is very difficult to run telemedicine. The availability of portable hardware's, resource persons and standard methods are other limitations of telemedicine.

The security of telemedicine and confidentiality includes the electronic transmission of patient's clinical records and data from one place to another via the internet [6].

1.7 Research Objectives

Healthcare services can be effectively delivered to the huge number of rural people of developing countries through telemedicine. The major objective of this research is to analyses the existing telemedicine models of Bangladesh. In order to do that, we have to find out the facilities, features and problems of current telemedicine models of developing countries. All the challenges will be overcome and improved telemedicine services will be delivered to the rural people through the proposed model.

Most of the people of developing countries live in the rural areas where healthcare services are inadequate. As a result, patients of rural areas will have to travel to urban areas for their health services. The cost of the services is increased. This research will reduce the healthcare costs of the rural people of Bangladesh through the use of the developed telemedicine model.

1.8 Organization of the Research Project Report

In chapter one, Fundamentals of Telemedicine and health systems of Bangladesh are presented in a systematic fashion. In this chapter, all the essentials tools and techniques of telemedicine and how the health systems of Bangladesh are running are discussed.

Chapter two presents the recent literatures related to this study. This review helps this research to go forward in right direction. The requirements analysis is also the basis after the literature review.

Chapter three presents the telemedicine models of Bangladesh. This will depict the features and facilities of each model. A comparative analysis was also be done to get the whole picture of each model. Potential gaps are also be made from this chapter, which will be the basis for this research.

Chapter four shows the developed telemedicine model with its features. This model is presented with deployment diagram, activity diagram, component diagram and through BPMN diagram. The use and the features are also described in details.

Chapter five presents the overall discussions of the research, concludes about the research and gives future indication of the research.

At last references and appendices were given to support this research.

Chapter Two

Literature review

2.1 Introduction

Telemedicine is an exchange of medical information through electrical communication [2]. It is a diverse collection of technology that uses electronic signals to transfer information from one place to another [2].

It is now possible to communicate with doctors in one country or other countries for any advice of a patient case through telemedicine. As a result, better treatment can be given to patients.

Patient's cost can also be reduced by the introduction of telemedicine. Though many doctors get appointed in the rural areas as a cadre of Bangladesh Civil Service, they shift to the urban areas within 1–2 years because of the poor rural health center infrastructure and poor village infrastructure [3].

According to the survey done by Prodhan (2017), almost 94.80% of expert doctors, 74% local doctors, 91.42% patients, and 80.32% of pharmacy owners of Bangladesh feel that telemedicine can fulfill the requirement of providing equal medical service to the rural people [4].

The COVID-19 pandemic has enhanced the importance of telemedicine as there is a possibility of getting infected due to close contact between doctors and patients [5]. Hollander and Carr [6] suggested that telemedicine might not be helpful in all situations in a pandemic, but this can be a great solution in cases with proper infrastructure and availability of doctors. With the help of telemedicine facilities, organizations can provide consulting services.

Mohiuddin [7] suggested that through consulting services, tele-pharmacists can provide information about basic queries regarding COVID-19 including mask selection, standard COVID-19 signs, and symptoms, symptomatic treatment options, breathing difficulties or cough management in comorbid situations, reinforcing behaviors to limit the spreading of the virus through phone calls or video conferencing. Telemedicine can also play a crucial part in maintaining mental health too. According to Zhou et al. [8], in this COVID-19 pandemic, psychological symptoms like anxiety-driven panic buying and paranoia about attending public events had been seen among the mass population.

According to Huda, Akhtar, Dilshad & Maliha [9] due to the huge demand for personal protective equipment (PPE), a scarcity of PPE among the health workers has been created;

as a result, many hospitals and health workers are not providing proper healthcare services fearing being exposed to the Coronavirus. Telemedicine and remote health consultation might be an effective way to strengthen geriatric care during the COVID-19 period [10]. Waiting time for patients and the cost of health system's operation might be reduced by telemedicine, and it can also create an opportunity for sharing best practices among the doctors all over the country, which will also create a better resource allocation [11].

Figure 10 presents various mediums through which telemedicine services can be given. Meanwhile, Figure 11 and Figure 12 show us a comparison between health-tech-based startups based on the services they provide.

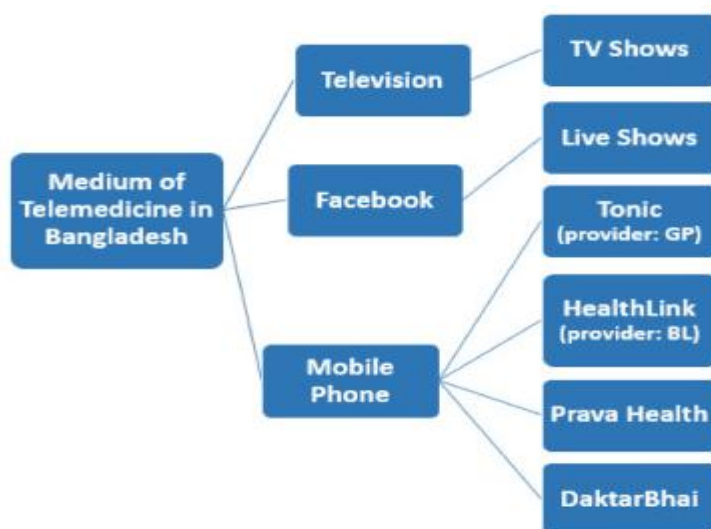


Figure 10: Medium of telemedicine in Bangladesh.

							
Services	Options	Doctorola	Digital Health	Praava Health	Maya Apa	Bangla Meds	Olwel NRB Parent Care
Appointment booking	Video consultation	—	✓	✓	—	—	—
	In person/home service	✓	—	✓	—	—	✓
Medical advice	SMS and chat	—	✓	—	✓	—	—
	Hotline/Calls	—	—	—	✓	—	—
Medicine Delivery	Over the counter	—	—	✓	—	✓	✓
	Prescription Drugs	—	—	✓	—	✓	✓
Ambulance service	Emergency service	—	—	—	—	—	✓
COVID test	Emergency option	—	—	—	—	—	—
	Pre-appointment	—	—	✓	—	—	—
Other test facilities	Home service sample collection	—	—	✓	—	—	✓
	Submit in Lab	—	—	✓	—	—	✓
Health Insurance	Micro health insurance	—	✓	—	—	—	—

Figure 11: Comparison of startups in the health-tech. (Source: The Financial Express, 2020)

								
Services	Options	Sebaghar	Doctor Dekhao	SeekMed	Daktarbhai	iCliniq	Pulse Healthcare	Tonic
Appointment booking	Video consultation	✓	✓	✓	✓	✓	✓	✓
	In person/home service	—	—	—	✓	✓	—	—
Medical advice	SMS and chat	✓	✓	✓	✓	✓	✓	✓
	Hotline/Calls	✓	✓	✓	✓	✓	✓	✓
Medicine Delivery	Over the counter	—	✓	—	✓	—	—	—
	Prescription Drugs	✓	✓	—	✓	—	✓	✓
Ambulance service	Emergency service	✓	—	—	✓	—	✓	—
COVID test	Emergency option	—	—	—	—	—	✓	—
	Pre-appointment	—	—	—	—	—	✓	—
Other test facilities	Home service sample collection	—	—	—	✓	—	✓	—
	Submit in Lab	—	—	—	✓	—	—	—
Health Insurance	Micro health insurance	—	—	—	✓	—	—	—

Figure 12: Comparison of startups in the health-tech.

2.2 Telemedicine in Bangladesh and its role in COVID-19

Bangladesh is an overpopulated country and from the statistics as shown in chapter one there are shortage of health professionals. Different initiatives have already been taken to provide healthcare services for these huge number of people.

First telemedicine services were started in 1999 in Bangladesh by CRP, Savar, Dhaka. That initiatives were store and forward based. They used digital cameras to capture images and sent it to expert doctors through email.

In 2000, Grameen Communications started rural telemedicine by using wireless technology. A link was setup with DAB and Faridpur General Hospital. Video conferencing was held to provide services.

Later telemedicine services were held between specialized hospitals and remote upazilla hospitals through video conferencing system. A central routine was maintained. Different category-wise doctors provide consultation services to the remote patients. Patients get printed medication plan from the remote centers.

Different mobile operators offer phone-based call services to patients. Patients dial a specific number then a doctor pick the phone and based on the conversation, patient will get an advice. An example of such service is called "Health Line Dial 789" in 2006 bu Grameen Phone. Praava health is also another telemedicine service name offered by Praava health.

One of the oldest universities of Bangladesh named Dhaka University has also launched a telemedicine service with the help of the Department of Biomedical Physics and Technology.

Sarkari Karmachari Hospital of Bangladesh also has started as a hospital for COVID. This hospital started telemedicine for any kind of health-related advice at the hospital.

In Bangladesh, there are 232 telemedicine centers are now in active through MIS under the ministry of health and family welfare. Out of 232 telemedicine centers, 38 centers are telemedicine service provider and 194 centers are service receivers. Among 232 centers, 13 centers are specialized hospitals, 13 medical college hospitals, 12 district hospitals and 194 upazilla health complex. In order to coordinate with all telemedicine centers, one central control room is in operation in MIS of ministry of health and family welfare, Bangladesh.

In the Digital Mela 2011, honorable Prime Minister Sheikh Hasina inaugurated 8 telemedicine centers in coordination with MIS in the fiscal year 2009-10. It connected 2 specialized hospitals, 3 district hospitals and 3 Upazilla hospitals of Bangladesh. After that on an average 10 telemedicine centers are being added in each year. Upto 2019, about 94 telemedicine centers were in operation of telemedicine throughout the country of Bangladesh. In 2023, Managing Director of MIS, Bangladesh Prof. Dr. Abul Basher Mohammad Khurshid Alam introduced a remote telemedicine center in Saintmarteen through Bangabandhu Satellite-1. Recently in Radisan Blu Hotel, honorable health minister, Ministry of Health and Family Welfare, Bangladesh has introduced new 100 telemedicine centers around Bangladesh to strengthen and enhance the telemedicine services in Bangladesh.

Telemedicine centers are equipped with Tele-gadgets such as Tele-Stethoscope, Tele-ECG, Tele-Microscope, Tele-Glucometer which are connected with high resolution camera, big screen and with computer. Every consultation is recorded in DGHS2 and doctors can easily get the profile of each patients. Due to the lack of dermatologists in remote areas, in most of the cases the patients with dermo problems wants to get consultation with dermatologists through telemedicine.

Chapter Three

Analysis of Telemedicine Models of Bangladesh

3.1 Introduction

This chapter will analyze all the important Telemedicine models of Bangladesh. Based on the analysis, this chapter finds the potential difficulties faced by the models and proposes some standard recommendations for the standard Telemedicine model which could be implemented in Bangladesh.

3.2 Telemedicine Models in Bangladesh

Model-1: The first telemedicine model was introduced in Bangladesh by the Center for Rehabilitation of Paralyzed, Savar, Dhaka in 1999 [12]. It was a store and forward based model where patients get free medical treatment from the expert doctors of abroad. There are no storage facilities in the model. The flowchart for this model is given the below figure-13.

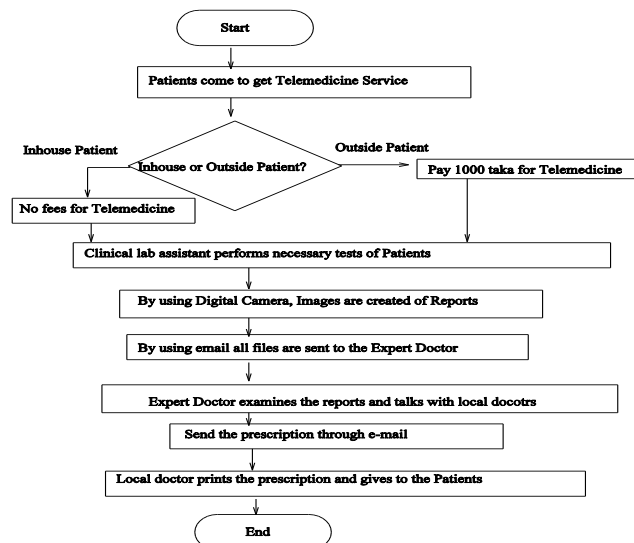


Figure-13: Flowchart of CRP telemedicine model

Spinal cord injuries in-patients get 24 hours a day treatment from CRP. Treatment for the out-patients are open from 8.00 am to 5.00 pm except Thursday. From the financial year report of 2013-14, it was found that 58,687 patients received out-patient treatment services from CRP [13].

From the flowchart as shown in figure 13, we can email based consultation was held in this model. It was also helpful for the local doctors of CRP to the exchange of their knowledge with the foreign doctors for any special cases.

Model-2: Telemedicine services were introduced by BRAC for the slum people of Bangladesh. The critical patients are served through this service. This model has no central patient data storage for future use. The activity diagram of the telemedicine services is shown in figure 14:

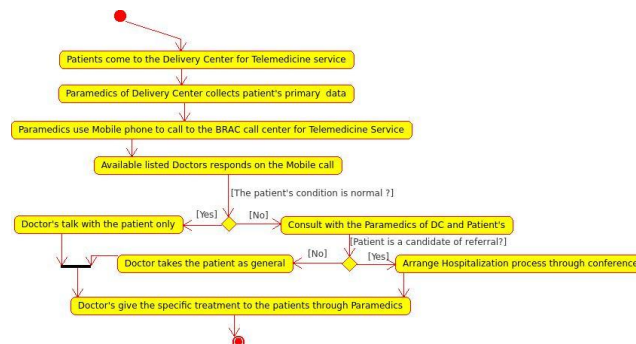


Figure 14: BRAC telemedicine model

Model-3: Ministry of Health and Family Welfare, Bangladesh started the biggest telemedicine project in Bangladesh in different government hospitals [14]. Peoples from the remote hospitals are now getting the telemedicine services from the expert doctors in different hospitals. People need not to go to the urban areas for their treatment. The activity diagram of this project is shown in the following figure 15.

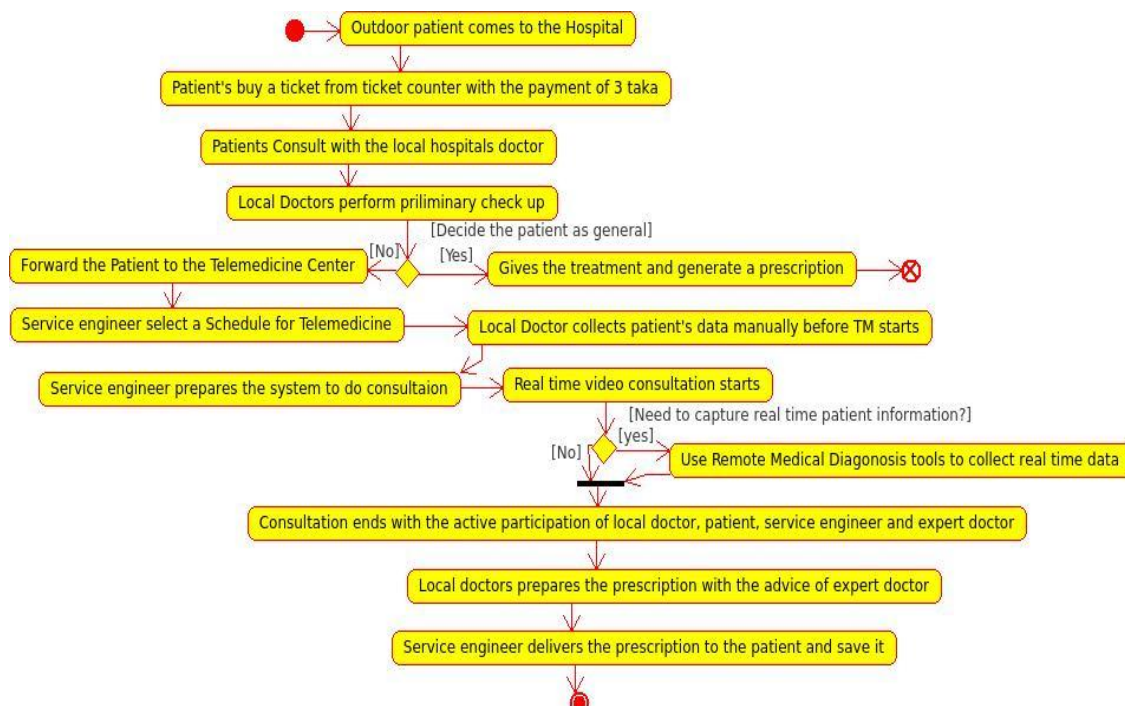


Figure 15: Activity diagram of Government telemedicine project

Model-4: Telemedicine Reference Center Limited (TRCL) started telemedicine project in the US Trade Show 2001 in Dhaka by using Icare software and normal internet connection. It started test-run of the system between the physicians of Bangladeshi and United States [15], [16].

Model-5: A pilot telemedicine project was launched by Bangladesh DNS diagnoses Centre, Gulshan-1 and Comfort Diagnoses & Nursing Home in 2004. This pilot project was stopped for the lack of proper publicity, financial and patient-doctors' disinterest [15-16].

Model-6: Telemedicine was done with Diabetic Association of Bangladesh (DAB), Dhaka and Faridpur General Hospital through Grameen Telecom in 2005. It was a real time consultation project. In some cases, video conferencing system did not work properly, the quality of the images was not satisfactory, lack of dedicated bandwidth and finally the interest of the patients were not good [17-18].

Model-7: Medinova hospital started Telemedicine service from 2006 to till now [19]. The flowchart of Medinova hospital Telemedicine service is depicted in the following figure-16:

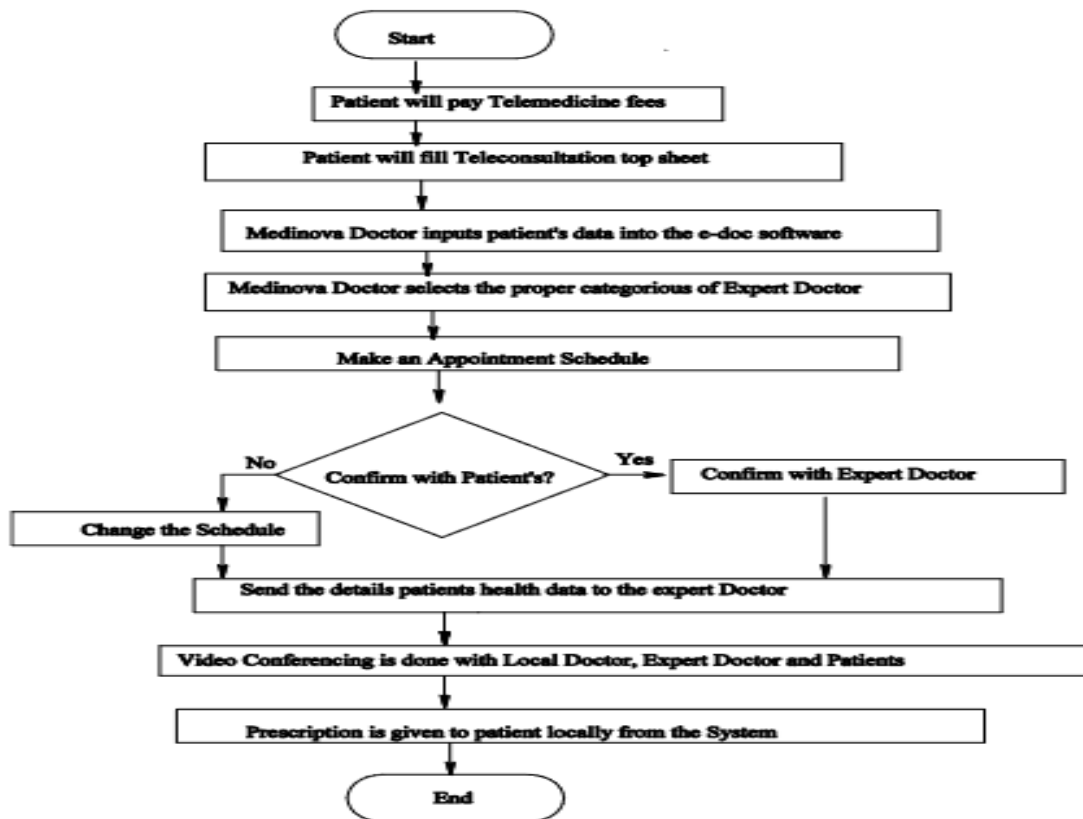


Figure 16: Flowchart of Telemedicine Service in Medinova Hospital

Model-8: Grameenphone started a 24 hours health line service to all of its subscribers called “HealthLine Dial 789”. An SMS based report delivery service is also attached with this service [20].

Model-9: Ministry of Health, Bangladesh implemented mobile phone-based health services in 2009. It was open 24 hours and 7 days. Citizens can make a phone call to the doctors of Upazila and District hospitals and get the medical advice from them [21].

Model-10: Telemedicine Service in Union Information & Service Centers was introduced by Access to Information project, Bangladesh in 2010. Through videoconferencing technology, rural people are getting medical care without going to the urban areas [22].

Model-11: Aponjon mHealth service was started in Bangladesh by USAID in 2011. In order to give service to its receiver, customer service center is introduced for the subscribers and to entry subscribers, answer to the queries of the people and receive complains [23].

Model-12: Grameen Phone started telemedicine services with the Ministry of ICT, in 2013. Peoples of Jessore are getting the health services with the payment of only BDT 200 or 300 from the expert doctors. This process reduces the travel cost and time for patients [24].

Summary of the First Seven Telemedicine Models of Bangladesh:

Model Name	Description of the model
CRP	1. Uses store and forward based Telemedicine 2. Digital camera is used for capturing images 3. No real time technology is used 4. Indoor patients are free for Telemedicine and outdoor patients need 1000 taka for consultation. 5. No storage for patient data.
TRCL	1. Telemedicine services between Bangladeshi physicians and United States. 2. Used Icare software 3. Internet is used for the service
SNDP	1. VSAT is used for this project 2. Connected different nodes of Bangladesh. 3. Different consultancy and diagnostic support are given
BUET and Comfort Nursing Home	1. Uses store and forward based Telemedicine 2. This project was running for short period of time.

Bangladesh DNS diagnoses Centre, and Comfort Diagnoses & Nursing Home	1. This project was discontinuous for financial reasons 2. Lack of promotional activities found 3. Patient disinterest also observed
DAB and Faridpur General Hospital	1. Hardware failure was found in this project 2. Internet connection was disrupted 3. Power failure was frequent 4. Performance of the camera used was not satisfactory 5. Radio link was used for Internet connectivity 6. 600 taka was the fees for consultation
BRAC MNCH	1. Slum people are the beneficiary of this project 2. Patient data is stored in the BRAC data center for further use and treatment plan 3. Limited cost for the service 4. Android phone is used for the information entry and update

Summary of the Last Seven Telemedicine Models of Bangladesh:

Model Name	Description of the model
Medinova Hospital	1. Use customized software for the storage of patient data and management 2. The cost of the service is \$1000 3. Real time video conferencing is used in this project
HealthLine Dial 789	1. Grameenphone used this service as Mobile based 2. SMS based lab report delivery service is also used
mHealth by Ministry of Health	1. Mobile phone is used as the consultancy purpose of District and Upazilla level people at any time round the clock.
Access to Information project	1. Laptop is used for Telemedicine 2. Wireless modem is used for Internet connection 3. Video conferencing is used in this project
Aponjon mHealth	1. This service is mhealth based 2. This service is now Nationwide in Bangladesh
Ministry of ICT and Grameenphone project at Jessore	1. TIMES and DICOT is used for consultancy and record keeping purpose 2. Taka 200 to 300 is required for the registration of patients to get services from this project
Ministry of Health and Family Welfare	1. Largest telemedicine service provider in Bangladesh 2. 232 centers are now running through this project 3. Real time technology is now used 4. No central storage for patient's data

	5. Hardware failure is seen in some centers 6. Connectivity and power failure is frequent in remote areas
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3.3 CONCLUSION

This chapter presents the advantages, features, technology used in each model, challenges and scopes of the different models. Based on these observations, new standard telemedicine model will be developed to face the challenges of current models.

Chapter Four

Developed Telemedicine Model for Bangladesh

4.1 Introduction

Considering the telemedicine models of Bangladesh, this study proposes the telemedicine model suited for developing country like Bangladesh. We have developed this model considering the socio-economic condition of the rural people and the practical state of the healthcare professionals. At present there is no similarity of the patient data collected from the patients, no central storage of the data for future usage, no standard protocol of the message being transferred between health organization and professionals. Taking all these things into consideration, we propose the Telemedicine Model with the portable tool kit and remote doctor's module. The model will be low cost, easily usable and maintainable and removes the data uniformity problems. The below figure 17 shows the deployment diagram of the proposed model.

4.2 Deployment Diagram of Developed Telemedicine System

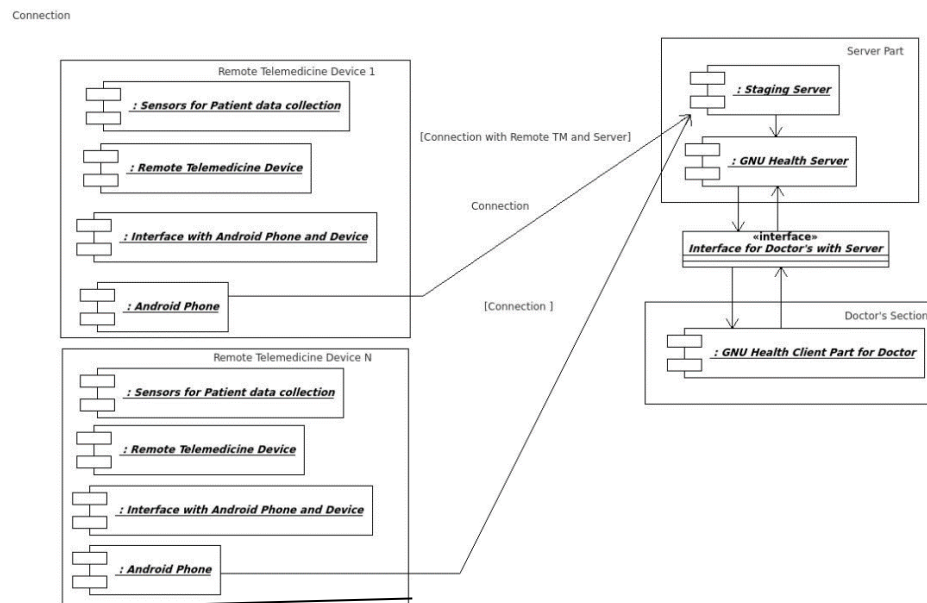


Figure 17: Deployment diagram of developed telemedicine model

From the deployment diagram, we can see that there are four components named portable tool kits, staging server part, GNU health server part and remote telemedicine part. Portable tool kit will be used for collecting patient data, staging server is the repository of patient collected data, GNU health server is used for permanent storage of data. This server is faced from the staging server for the collected data. Client module is used for serving the patient through local doctors.

4.3 Activity Diagram of Developed Telemedicine System

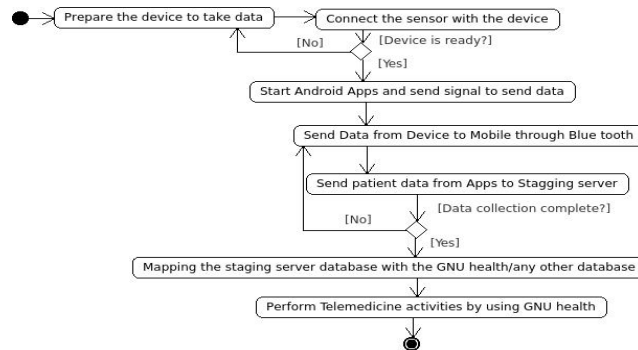


Figure 18: Activity diagram of developed telemedicine model

Figure 18 shows the activity diagram of the proposed telemedicine model. From the diagram we can see that at first, we have to prepare the developed device to collect the patient data. When the sensors are ready, through our developed android apps, the data will be sent to the staging server for storage. When all the data collection is completed, the GNU health server is faced the data to the server. This server is remotely accessed to the remote health professionals for the delivery of the health service.

4.4 Component Diagram of Developed Telemedicine

The components of the telemedicine model were developed independently and finally integrated according to the model shown in figure 18. The details of the components are given in the following:

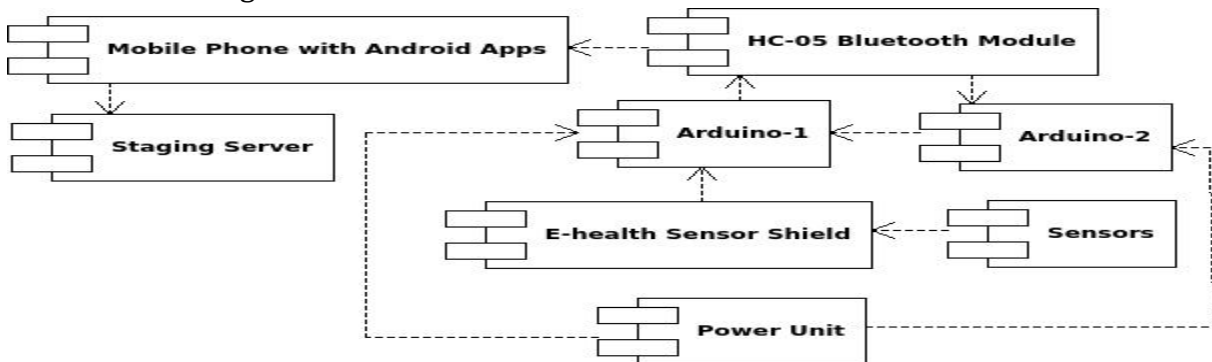


Figure 18: Component diagram of Developed Telemedicine Model

4.5 BPMN Diagram of Developed Telemedicine System

This model is developed based on the findings of the research and the analysis completed on the existing models of both Bangladesh and abroad. This model will enhance the existing telemedicine models by incorporating new components and international standard protocol. The developed model can be easily deploy-able in the rural areas of Bangladesh with a minimum set of components. The exciting features of the model will make the telemedicine service effective and sustainable for the remote sections of Bangladesh where health care facilities are very rare. Both rural and urban doctors will find a feasible telemedicine service for the people. We have designed and developed the model in such a way so that rural people can afford the service and service provider can deliver the health service to the poor people of our country.

In order to demonstrate the telemedicine model, Business Process Model and Notation 2.0 (BPMN) is used in this research. In order to draw the Business Process Diagram (BPD) of the developed model, we have used Cumanda Modeler tool.

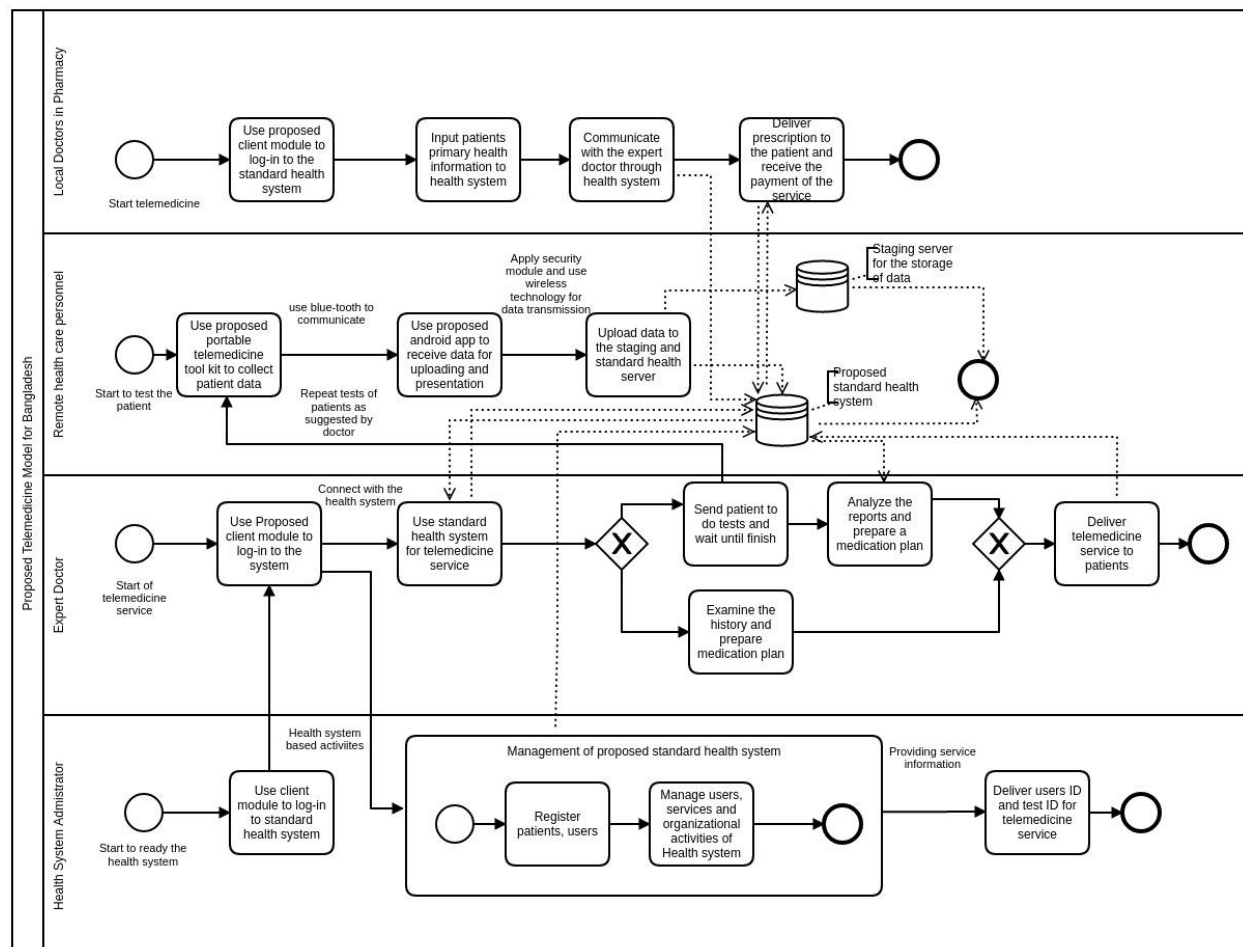


Figure 19: BPMN diagram of Developed Telemedicine System

Figure 19 shows the BPD diagram of the advanced telemedicine model of this research. According to figure 19, the BPD diagram of the telemedicine model consists of four main processes. These are remote health care professional's process, local doctor's process, expert doctor's process and health system administrator process. Remote health care professional process is responsible for caring out the different physical test of remote patients. Remote client log-in module is for local or expert doctor for the treatment of patient through telemedicine and health system administrator process is for the management of the users and health system.

Chapter Five

Discussion, Conclusion and Future Directions

5.1 Discussions

This paper analyzes various telemedicine models of Bangladesh to find out the present development and initiatives taken by Bangladesh for the development of telemedicine services. The results of our analysis show that most of the patient's health records are paper based. This type of records cannot be shared among different organizations. Therefore, records must be available in an electronic format so that health specialists can easily access and review patient's information. Recent telemedicine projects have started seeking e-health solutions that can automate and integrate business processes, enable information sharing across the organization and between different organizations, improve services to patients, and ensure security and privacy of patient information.

From the study we can see that most of the telemedicine models use their customized information system. There are no standard protocols among the models. As a result, the patient's health information transfer does not follow any standard format. The telemedicine-based health data of one country is not recognized by another country in Asia regions. If we want to introduce a standard telemedicine, we have to use the same protocol that can be used and shared by all healthcare centers.

From the deployment diagram of the proposed model, we can see that this model will be used as a standard model for Bangladesh because this model will follow the standard protocol of data transfer, store the same format of data for all the connected health centers and low-cost model for the poor people.

From the paper proposed by Emmanuel Kwame Darkwa and others in 2015 we can see that the living status in rural areas is very poor. Due to the facilities doctors and health professional regulates from rural to urban areas. Most of the Doctors are urban based. As a result, healthcare system of rural areas is greatly hampered in Bangladesh [26]. Considering the recent study, this paper recommends to offer extra allowance to the rural health professionals.

This study will also introduce a portable low-cost telemedicine tool kit for collecting the patient data. Health professionals can use the simple user interface of the kit for their patients. A low-cost client model will also be introduced in this research for the remote healthcare professionals for remote login to the proposed system.

From the survey on the telemedicine services on Bangladesh by Uzzal Kumar Prodhan and others, we came to know that about 94% of doctors want to introduce the telemedicine services to the poor people of Bangladesh [27]. This study was conducted on the primary survey data on four types of persons. So similar percentage of health professions want to introduce this service to the patients of Asian countries.

5.2 Conclusion

This study presents the telemedicine models of Bangladesh. From the comparisons of different models, we can understand the technology, types of telemedicine and protocols used by different countries in this region. From the comparative analysis of the model, we came to know that the use of electronic medical record in the telemedicine is very low among the models. This study developed a standard telemedicine model for Bangladesh with details implementation plan. The developed model will satisfy all the basic characteristic of telemedicine service especially EMR. Finally, we can say that the healthcare facilities to the rural peoples of Bangladesh can be ensured by using the proposed telemedicine model.

5.3 Future Directions

In future, this research work can be extended further in the following areas:

- Low cost portable telemedicine tool kit can be extended to collect more vital signs of patients.
- Pathological tests can be included in the developed system through low cost portable telemedicine tool kit.
- Telemedicine services produce huge amount of patient data every day. Handling this large amount of data are very di-cult to provide more accurate and quick delivery of healthcare services. Methodologies should be developed on how to address these large volume of patient data efficiently.
- New telemedicine security model can be developed to show the security level of the developed system.
- Large scale practical implementation of this model can be carried out in the rural areas of Bangladesh with the assistance of Ministry of Health and Family Welfare and ICT Division, Ministry of Post, Telecommunication and Information Technology, Bangladesh for the telemedicine services of the remote rural people.

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