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Scopes and challenges of implementing Telemedicine in a developing country like Bangladesh

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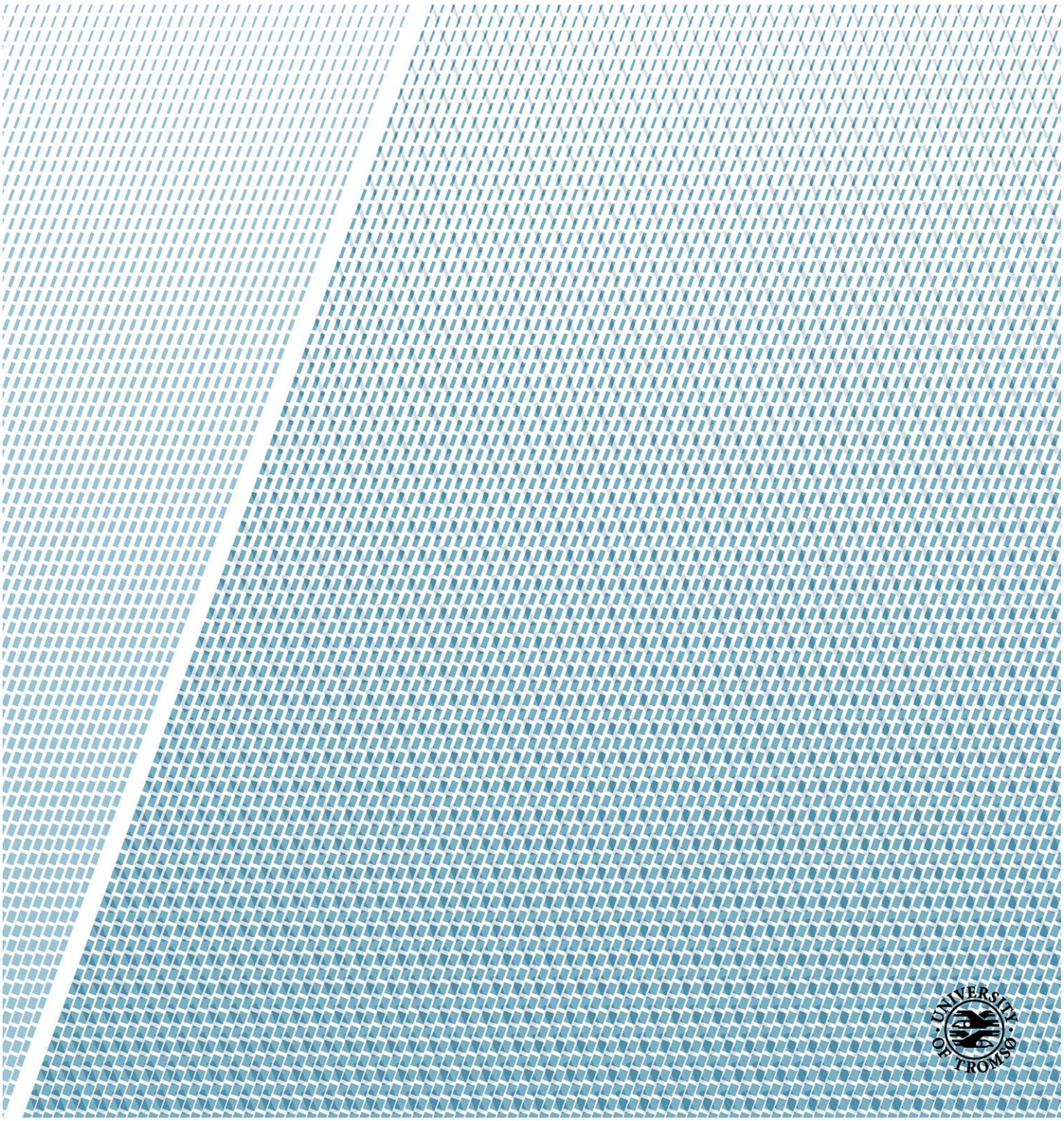
Master's Thesis in Telemedicine and E-health (TLM-3902)



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ABSTRACT

The concept of telemedicine is not new. Telemedicine is a modern, growing concept in both developed, and developing countries. Information and communication technology (ICT) is playing an important role to improve health care for both individuals and community levels. ICT systems are now being used to deliver healthcare across geographic distance through "Telemedicine". The purpose of introducing ICT is to provide decentralized health services. Integrating the use of ICT into existing health systems helps to improve health care in many ways although it is quite challenging for a developing country like Bangladesh. The main purpose of this study is to explore the applicability of telemedicine in Bangladesh and to discover scopes and barriers or challenges of its implementation within existing health care service.

In this study, a qualitative research method was used. As such, interpretive research approach was employed in order to gain an understanding of underlying reasons and motivations, to provide insights into the setting of a problem, generating ideas and/or hypotheses for later quantitative research and to uncover prevalent trends in thought and opinion. Semi-structured techniques e.g. individual depth interviews or group discussions were applied in this study to find out possible explanations to the research questions considered. Collected data from the fieldwork were analysed using the theories of Information Infrastructure (II) and Actor-Network Theory (ANT).

In ICT sector, Bangladesh has many limitations like poor infrastructure (e.g. transportation, electricity supply), inadequate funding, slow internet connectivity, and lack of skilled or trained work force. There exists weak socio-technical network due to lack of internal network, low security, unawareness among citizens, medical practitioners' non-cooperation or lack of confidence to use new technology and so on. If all of these and imminent challenges could be tackled, several telemedicine services would be implemented effortlessly in Bangladesh. From my fieldwork, several scopes were identified for example, Biometric Identification System, Electronic Health Record (EHR), Hospital Information System (HIS), Laboratory Information System (LIS), Radiology Information System (RIS) and Picture Archiving and Communication Systems (PACS), E-Prescription, Computer-based Physician Order Entry (CPOE) System and Automated pharmacy etc.

ABBREVIATIONS

A2I	Access to Information
ADP	Annual Development Program
ANT	Actor-Network Theory
ATM	Asynchronous Transfer Mode
B2B	Business To Business
B2C	Business To Consumer
BSMMU	Bangabandhu Sheikh Mujib Medical University
C2C	Consumer To Consumer
CPOE	Computer-based physician order entry system
CTI System	Computer Telephone Integrated System
DGHS	Directorate General of Health Services
EMM	Electronic Medication Management
EPR	Electronic Patient Record
EHR	Electronic Health Record
F2F	Face-to-Face
GDP	Gross Domestic Product
GIS	Geographical Information System
GPRS	General Packet Radio Service
GPS	Global Positioning Systems
HIS	Hospital Information System
II	Information Infrastructure
IS	Information System
LIS	Laboratory Information System
mHealth	Mobile Health
MIS	Management Information System
MOHFW	Ministry of Health and Family Welfare
NASA	National Aeronautics and Space Administration
NICVD	National Institute of Cardiovascular Diseases
OPP	Obligatory Passage Point
PACS	Picture Archiving and Communication System

PDA	Personal Digital Assistants
PDS	Personal Data Sheet
RIS	Radiology Information Management System
RpMC	Rangpur Medical College
RpMCH	Rangpur Medical College and Hospital
SMS	Short Messaging Services
TMS	Telemedicine Service
TRCL	Telemedicine Reference Centre Limited
UHC	Upazilla Health Complex
UISC	Union Information and Service Centres
UiT	The Arctic University of Norway
UNICEF	United Nations International Children's Emergency Fund
VAS	Value Added Service
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

Information and Communication Technology (ICT) is revolutionizing human life and society. It is helping now to rapid exchange of information as well as to interact with each other. In recent decades, we are experiencing steady growth in the number of ICT innovation projects in the health care sector. ICT is playing an important role to improve health care for both individuals and community levels. ICT systems are now being used to deliver healthcare across geographic distance through "Telemedicine"[1]. Telemedicine refers to the remote delivery health care and health information that involves the electronic transfer of medical and health information between distant sites and participants [2]. Telemedicine uses electronic information and communication technologies to provide and support healthcare from a distance [3]. The World Health Organization refers Telemedicine as:

"The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities"[4].

Telemedicine provides a wide range of clinical services in numerous health care sectors including medical education and preventive health care. Different information systems are now used in healthcare e.g. tele-oncology, tele-dermatology, tele-psychiatry, tele-radiology, tele-pathology, patient administrative system, hospital-based electronic patient record (EPR), General Practitioners' EPR and so on. Effective use of ICT in health care sector will improve disease management, prevent medical errors as well as reduce cost, increase productivity, better management and patient satisfaction. Now-a-days ICT has been promoted in the public organizational sectors and especially in healthcare. In UK, for example, the National Health Service (NHS) information technology program organizes the largest ICT procurement project in the public sector worldwide [5].

Understanding ICT requires an attention on the interrelation between technology and its social environment. Therefore, good and active inter-action between humans and non-humans,

technologies and non-technologies are playing a central role in implementing new open network technologies in complex work practices. Actor-network theory and sociotechnical approach are quite suitable for understanding how ICT applications are developed, introduced and become a part of social practices [1]. Organising communication, workflow and processes by best practice are the main challenges in introducing of ICT at all levels of healthcare sectors especially in rural, sparsely populated areas. The purpose of introducing ICT is to provide decentralized health services. For instance, significant efforts have been provided to build an ICT infrastructure for telemedicine in the north of Norway [6].

Information technology includes people, organizations and software, computer and communications hardware and infrastructure standards. Social and technological investigations, creation and maintenance of coextensive networks of human and nonhuman elements are key factors that has to be taken in consideration. The challenges of implementing a new system can be scrutinised by using actor-network theory and socio-technical approach [7].

Implementation of a new technology mostly depends on the economic condition of a country and economic circumstances has been influenced by geography, transportation and communication systems, people and socio-cultural factors and political conditions of that country. Bangladesh is one of the over-populated countries in the world. A large portion of inhabitants in Bangladesh is passing their days without getting their basic needs including health care. In general, people rely on face-to-face communication with physicians and all types of documentations about diseases in Bangladesh are mostly paper based. As a developing and over-populated country, it is not always possible to provide better health care to all. Integrating the use of ICT into existing health systems helps to improve health care in many ways although it is quite challenging for Bangladesh. Bangladesh is also a country of unequal distribution of resources. Around 70% people live in countryside and on the other hand, 75% of registered physicians are working in town areas due to poor infrastructure in rural health care centres and villages. Every patient visits doctors without having any previous health records. At present, almost whole land is under the coverage of telecommunication network and it is expected that this network will play an important role in our day-to-day life [8]. Due to ill equipment, insufficient numbers of doctors and health care professionals and poor healthcare infrastructure, most people from rural areas have to travel long distance to

access proper healthcare facilities that are located in urban areas. Telemedicine is showing hope for them [9]. At present, some telemedicine projects has been applied in a limited extent as pilot project basis and most of them are limited to urban health-care centres and remaining are directing to rural and remote areas of the country.

To overcome geographical barriers, “Telemedicine” uses ICTs and increases access to health care services, which is particularly effective for rural and underserved communities in developing countries and for peoples who have lack of access to basic health care. Four fundamentals are relevant to telemedicine: to provide clinical support, to overcome geographical barriers, connecting users who are not in the same physical location, to involve the use of various types of ICT and to improve health outcomes [10]. Telemedicine can be the most helpful alternative upon which the authority can emphasise. With the use of information and communication technology, telemedicine has already shown the way how to provide better health care services irrespective of distance at low cost in developed countries.

Qualitative research is now being used in health care research with social and cultural dimensions. It helps to determine the meaning of a phenomenon through description and aims to develop concepts, which support in the understanding of natural phenomena with highlighting the meaning, experiences and views of the participants in natural settings [11]. Qualitative research, an action research that is using observation and interview methods. It is inductive in nature and depends on the purposeful selection of participants. Researcher uses validity [12]. There are several literatures regarding implementation of Telemedicine in both developing countries and developed countries. However, it is quite challenging to get a clear idea regarding Telemedicine implementation in developing countries due to relatively fewer literatures. Qualitative research methods are the most suitable for this research approach because of the emphasis on actual experience of participants and are considered to be well suited for discovering the elaborating meanings, perceptions and assumptions about natural phenomena. Therefore, qualitative research method has been used in this research work to find out scopes and challenges of implementing Telemedicine in health sector (e.g. education, training, management) in developing countries like Bangladesh

1. Motivation for thesis

My enthusiasm in public health issue of Bangladesh dates back to my years in undergraduate level, where I excelled in principles of demography. Moreover, when I began my career as a physician, I had the opportunity to communicate the different types of patients. All of which reinforced my intense interest in demography and public health as well. I have also had the opportunity to study a number of courses, particularly Community Medicine at the graduate level that provided me with a new and different perspective on public health sector of Bangladesh.

During my study and practice, I found serious health vulnerability among the people of Bangladesh. Many Childs are dying due to diarrhoea, pneumonia, malaria and so on. Women are awfully suffering from pregnancy and delivery related complications since access to health care services is beyond geographical, cultural and economic reach. In such situation, to my mind, high-risk approach of preventive measure is the only way to improve the situation by using Telemedicine knowledge since the telecommunication reached almost every corner of Bangladesh.

Bangladesh is an over-populated country. As a result, it is difficult to ensure health management for all. Moreover, most of the people do not get proper health care management because of poverty. Therefore, population based preventive strategy is crucial and very much significant for South Asia, particularly for Bangladesh to slow down these problems. During my master's degree in Telemedicine and E-health at UiT the Arctic University of Norway, I have influenced to do my thesis in my country, Bangladesh. As a health professional (physician), I am interested to explore present conditions of Telemedicine in Bangladesh. I believe that Telemedicine can potentially reduce waiting times for patients, reduce the cost of health system's operations, improve inter-departmental, inter-hospital communication and collaboration, provide opportunity for sharing best practices among physicians within Bangladesh and international hospitals and enhance better resource allocation. As I want to use my knowledge in implementing Telemedicine in Bangladesh, in my sense, it would be very helpful to get an overview about Telemedicine in Bangladesh and at the same time, I can identify the scopes and challenges of implementation of Telemedicine that can help me to achieve my goal in future.

2. Research Objectives and Research Questions

The main aim of my thesis is to discover the applicability of telemedicine in Bangladesh and to explore scopes and barriers or challenges of its implementation within existing health care service. Therefore, this thesis is based on the following research questions:

- What is the present condition of information infrastructure in health care sector of Bangladesh?
- In which sector of health care service can Telemedicine be introduced?
- What are the challenges or barriers to implement telemedicine in health care sector in Bangladesh?

3. Study Design and Study Population

Qualitative research is inductive and new hypothesis can be generated from data that are collected during fieldwork. This research represents insider viewpoint and present multiple perspectives. It provides narrative report with contextual description and direct quotations from research participants with particular and definitive findings. These findings can play an important role for evaluating large-scale and long-lasting ICT projects in healthcare. Qualitative questioning allows more flexibility and an interviewer is allowed to ask questions in a different way for well understanding by the participants. Qualitative research helps to identify and explore, describe and explain an objective. Therefore, the study design will be based on a qualitative methodology. Data will be gathered through both semi-structured open-ended interviews and participant observation from individual, organizational and management level. The target population of this study are from Rangpur Medical College Hospital, Bangladesh. It has been tried to execute interviews in a subjective manner where physicians, administrative staffs and other healthcare staffs are included. It is avoided to take interviews from patients, as there is no established Telemedicine services in Rangpur Medical College Hospital upon which patients can be interviewed. In addition, I have included some data in my thesis from other institutions (e.g. Bangabandhu Sheikh Mujib Medical University, BSMMU, National Institute of Cardiovascular Diseases, NICVD) where few Telemedicine projects have been started in pilot basis (personal communication).

4. Expected contribution of the Research

This study provides an overview of existing telemedicine program in Bangladesh as well as further scopes of implementation along with barriers or challenges that have to be overcome. The study information is obtained by exploring the experiences and views of different

participants who are working in health care program. Findings from this study will help the concerned authorities to outline the existing status of telemedicine program and its strengths. At the same time, it will also point out barriers that help to modernize or remodelling of existing telemedicine programs. In addition, the study information will remain as a landmark to conduct further research activities in the related area not only for Bangladesh but also for any developing country.

CHAPTER TWO

THEORY

Success of Telemedicine implementation mostly depends on structural framework of a country where Information and Communication Technology (ICT) is properly used with the appropriate application of Information Infrastructure (II) Theory and Actor-Network Theory (ANT). However, without huge investment of funds, most of ICT projects in health care sectors can not be successful. Developed countries are a step forward than developing countries as they have abilities to invest more in operating new ICT based Telemedicine projects. This chapter will highlight the concepts on II Theory and ANT. In this study, these concepts have been used to explore and describe the field works.

1. Information Infrastructure (II) Theory

Basic concepts on Information Infrastructure helps to identify and compare scopes and barriers of current telemedicine projects and at the same time, it helps to point out the measures that should be taken in near future, which can be a landmark of having an effective and fruitful project. Effective information system requires a solid infrastructure including software and its users.

When a new technology is going to be introduced in a society, we have to keep in mind that it should not be fixed and we should take preparation for remodelling, reinterpretation and transformation as every user tries to adopt the new technology at his own way. As a result, different interpretations and complexities are arising that are requiring reconstruction. So, implementation and adaptation has been seen as co-design of both users and technologies [13].

With the help of ICT, we are trying to keep everything in an electronic community system. *"An electronic community system is a computer system which encodes the knowledge of a community and provides an environment which supports manipulation of that knowledge. Different communities have different knowledge but their environment has great similarities. The community knowledge might be thought of as being stored in an electronic library."*[14].

However, information infrastructures (IIs) and information systems are different from one another in context of organization developed whether it is closed or open, self-contained or global. IIs provide solutions that are more specialized for communications. Therefore, information infrastructure is an alternative strategy for developing and implementing ICT. It is not an easy task to change a large information infrastructure although it is acting as a powerful participator [15]. An information infrastructure can be defined as *"a shared, evolving, open, standardized, and heterogeneous installed base"* and as all of the people, processes, procedures, tools, facilities, and technology which supports the creation, use, transport, storage, and destruction of information [16]. Information infrastructure (II) is a compound of information systems and other supporting components such as share-ability, enabling and Openness. II is supportive, enabling, shareable, open and heterogeneous [17].

Information Infrastructure is a combination of information and communication technologies. Information technology (IT) is playing an important role in our society by providing stable enhancing flexibility and wide range of computer based information services along with radical improvements in computing power, low costing and software capability. Therefore, distinct information systems (IS), system functionalities and software tools have over time become integrated into complex outfits of various IT artefacts [18]. Information Infrastructure (II) has been progressively used as common term to refer this complex management. Hanseth et al defined II as "*Information infrastructure covers all kinds of technologies, all kinds of use and use areas…and involves lots of political, social, organization, human aspects and issues – all these issues interact, they are interdependent and intertwined*," [17]. In other words, "*an information infrastructure as a shared, evolving, heterogeneous installed base of IT capabilities based on open and standardized interfaces"*[18].

An infrastructure is more than the individual components. It has no limitations and requires better collaboration between different systems within their same network. It includes human beings as well as machines. An extensive combination of traditional approaches and policies for development of telecommunications solutions and information systems are required for successful development and deployment of information infrastructures. However, they contain important paradoxes and therefore, new or modified approaches are required [17].

1.1 Aspects of Information Infrastructures

The concept of Information Infrastructure is more complex and distinct. It includes several key aspects that are identified by presenting and discussion a number of definitions proposed by others.

1.1.1 Enabling

An infrastructure is designed to support a wide range of activities. That means large number of different users can use it. It is not especially personalised to one particular group. Main goal of enabling should be intended to open up a field of new activities, not for just improving or automating a system that is already existing. This should not be especially designed for supporting one way of working within a specific application field. Therefore, it should be designed in a way that it could support various applications [17].

1.1.2 Shared

The members of a community is sharing an infrastructure, which is universal. That means all of them use the same single thing although it may appear differently and infrastructures should be irreducible. Different groups are using this independently this is why it should be irreducible. For instance, electronic communications like e-mail infrastructure. An e-mail infrastructure is shared as irreducible unit although various software can be used here independently. Standardized interfaces integrate different elements of an infrastructure; otherwise, it would be expensive. Standards are economically important as well as necessary for constituting element. When an "infrastructure" is built based on bilateral arrangements, this is not a real infrastructure; this is just only a collection of independent connections [17].

1.1.3 Openness

The word “Openness” indicates anything that has no borders or no limits. Openness of Information Infrastructure means, *“….there is no limits for number of user, stakeholders, vendors involved, nodes in the network and other technological components, application areas or network operators. ……. However, it does imply that one cannot draw a strict border saying that there is one infrastructure for what is on one side of the border and others for the other side and that these infrastructures have no important or relevant connections”*. Limitless number of users, developers, stakeholders, components and areas of using involves several activities with varying relations over time, varying arrangements and alliances,

changing and unstable conditions for development and changing requirements. A healthcare infrastructure in a hospital can be a good example. Information exchange in a hospital is often necessary to access relevant information among other institutions, for example social insurance offices, other public sectors even within and across communities [17].

1.1.4 Heterogeneity

Information Infrastructure involves different types of technological and non-technological components, human and non-human participations, various organizations or institutions for instance, used equipment, information, applications, networks, peoples whom are engaged in II etc. Involvement of different functionalities and interlink among them has given Information Infrastructure a special characteristic which has been termed as "Heterogeneity"[17]. The social and technical diversity and heterogeneity of information infrastructures will increase due to its openness [19] and due to involvement of different kinds of technological components. User communities, operators, standardization and governance bodies, design communities, etc. are also included in information infrastructures.

1.1.5 Socio-technical network

It has been mentioned that Information Infrastructure involves different types of technological and non-technological components, human and non-human participations, various organizations or institutions. Therefore, inter-relation and inter-action between technology and society is very important. The development of an information infrastructure needs to be recognised as an ongoing socio-technical negotiation. The relationship between technology and society may be conceptualised in many ways. The fundamental factor as it simultaneously enables and intensifies the currently dominating movements for restructuring of organisations. This network does not work without supporting people [17]. This characteristic of Information Infrastructure can be explained by actor-network theory (ANT).

1.1.6 Installed base

The installed base, which is the existing configuration of II components, is enabling and controlling the overall evolution of infrastructures [20, 21]. Information infrastructures are always considered to be existing and cannot be changed abruptly. The new one has to be connected to the older. The old one is the installed base where the new one can stand. Accordingly, the existing infrastructure is integrated by the new one [16]. For example, the implementation and use of an electronic medication management system at a university

hospital in Norway (UNN). The hospital moved into new facilities in 2008, and started to use leading-edge technology to improve patient care and hospital efficiency, including an automated medication management system. Implementation of this highly standardized electronic system was quite indistinct and revealed a gap between pre-defined plans and challenges in daily practice. Therefore, the system was reserved for redesign and development. After that, a new electronic chart system has been introduced [22].

2. Actor-network theory (ANT)

An actor network consists of both technical and non-technical elements, human and non-human actors where an unavoidable inter-action between them exists. ANT gives an impression about the heterogeneous nature of actor networks [17]. The concepts of ANT helps to get a clear idea about systemic approach of inter-dependencies and interoperability among heterogeneous elements like technological and non-technological, human and non-human within complex healthcare system.

In health care services, the actors present at different levels especially in primary health care and specialized health care. Physicians, specialists, nurses, administrative staffs, non-medical staffs and other professionals are involved and acts as an actor. Networks, software, computers and mobiles are also now included in technology for improving health information infrastructures. ANT describes the relationships between technological and social arrangements. This arrangement is heterogeneous which means that there is an open-ended array of 'things'. It needs to be aligned including work routines, incentive structures, training, information-systems modules and organisational roles. There can be no strict top-down control over such a heterogeneous collection [23].

Latour illustrates his observation on the relationship between "technical" computer systems and "social" organizations: "*It is no longer clear if a computer system is a limited form of organization or if an organization is an expanded form of computer system. Not because, as in the engineering dreams and the sociological nightmares, complete rationalization would have taken place, but because, on the opposite, the two monstrous hybrids are now coextensive."*[24].

Actor-network can be defined as the co-ordinating and inter-linked act among all factors in producing a network. An actor-network includes both technical and non-technical elements [23]. According to Walsham: *"Actor-network is a heterogeneous network of aligned interests, including people, organizations and standards."* [7].

In actor-network theory, humans and non-humans (i.e., technology, organizations, institutions etc.) are equally treated. Technological and social elements are closely connected into networks. Technologies without user has no importance and humans use non-human objects (technologies and other artefacts') in every aspects of day-to-day life that draws visibility to each other. Therefore, humans and technological artefacts' should be treated as isolated components and as well as heterogeneous networks and they are referred to by a common term "actor"[25]. For example, car driving can give us a clear idea about the relation between human and non-human, technology and society where car is a symbol of non-human and technological element and driving skills, experience, traffic regulations can be seen as human and social elements. Good and effective combination among all of these factors give positive and fruitful effects in introducing car in a society. The relationship between technology and society can be explained in many different ways. IT can be the vital factor as it consecutively enables and intensifies the currently governing trends for organizational reconstruction [26].

Actor-network theory is based on the sociology of science and technology. A key feature of the theory is that actors are taken to include human beings and non-human actors as technological artefacts. Actor-network theory gives emphasis on how science actually is acting, not on how it could be. Exploring the complexity of the surrounding environment is the main field that should be in focus. Monteiro argues that all factors are inter-related in producing a network. An actor-network depends on organization between technical and non-technical elements. *"An actor-network is literally the network of heterogeneous materials that make up the context… The notion of an actor-network, quite literally, instructs us to map out the set of elements ("the network") which influence, shape or determine action."* He describes two concepts from actor-network theory: inscription and translation. **Inscription** refers to the way technical artefacts embody forms of use. In other word, an inscription is the determination by suggestion through which action is introduced into artefacts. He argues that the inscription may be flexible or inflexible depending on the programmes of action [23]. Technological innovation have always initiated contrasting reactions both in the general

people and among members of the scientific community. When a significant technological innovation appears in the public domain, both positive and negative opinions are arising. These helps to identify the difficulties and the potential barriers to the adoption of the new technology. Inscriptions explains the relationship between different technical artefacts and its way to use. It has been observed that it arises problems when users do not follow the directions about using of assigned program and they use the system in an unexpected way. Therefore, the management should know how to inscribe and into what, for that several trials should be made to identify the strengths of different inscriptions [27]. Inscription provides adequate information on the how several kind of resources can be used in successful way [23].

Translation is a problem solving social process that is modified according to the users' interests and mapping out the needs [23]. During diffusion of new technology, it could not be expected that each user is able to adopt the new one in the same way. The adopter has to find out how each user can use the technology in his own work. This denotes a reinterpretation-translation [27]. There are four different moments of translation, "*"Problematization, interessment, enrolment and mobilization"*. In the moment of Problematization, the primary actors identify other participating actors that are consistent and defines the nature and the problems. After that, possible solution has been suggested that would resolve the problems. An obligatory passage point (OPP) is then established between the other actors and the network and all the actors have to satisfy the interest. The second moment of translation is interessement. It is a series of processes through which primary actor sought to lock the other actors into the roles that had been proposed for them in that particular programme. Enrolment is a set of strategies in which the primary actors sought to define and interrelate the various roles they had assigned to others. The last moment is mobilisation, which is a set of methods used by the primary actors to ensure that supposed other actors were properly able to fulfil their assigned roles. However, translation is a continuous process, never a completed accomplishment [28].

Irreversibility is another vital concept in actor-network theory. Callon [29] says all translations are reversible whereas irreversibility of translations depends on the extent to the impossibility of going back to a point and of shaping as well as determination of subsequent translations. Irreversibility limits further translations by aligning actors. When a standard is

implemented and expensiveness will make translation more challenging and make it irreversible.

CHAPTER THREE

TELEMEDICINE AND E-HEALTH

The concept of telemedicine is not new. University of Nebraska medical school and state mental hospital established first a two-way video conferencing link by using microwaves among them since 1959 [30]. Neil Armstrong and his fellow space traveller put on medical telemetry and cardiac monitoring devices during the first moon landing in 1969. NASA and others developed those medical monitoring systems during the 1960s. This example showed the way in which telehealth could help to transform healthcare and our quality of life [31]. Telecommunication technologies comprise a variety of advanced, computerized equipment that are allowing physicians, nurses, and other healthcare professionals to provide complex healthcare thousands of miles away from the location of service [32].

Telemedicine is a modern, growing concept in both developed, and developing countries. "Telemedicine" is combination of two words tele and medicine. The prefix "tele" derives from the Greek meaning "far" or "at distance" or "remote". Therefore, the whole word "telemedicine" represents "medicine delivered at a distance". In short, Telemedicine is the use of telecommunications to provide medical information and services. In other words, Telemedicine utilizes information and telecommunications technology to transfer medical information for diagnosis, therapy and education. The medical information includes images, live video and audio, video and audio sound files, patients' medical records, and output data from medical devices. Exchanged patients' data sometimes has been used to monitor the patient, which is termed as "Telemetry". Another term "Telecare" indicates the application of telemedicine to provide medical services while patients' are staying at his/her home or away from health stations. In broad heading, there are four types of Telemedicine practice has been perceived namely Tele-consultation, Tele-education, Tele-monitoring and Tele-surgery [33].

For diagnosis and management, Telemedicine can be real time long-distance video-conferencing. The patient can consult with a specialist from a remote area and this consultation can be through the transmission of real-time or pre-recorded images and data to a remote professional, as in tele-radiology or tele-pathology. In other word Telemedicine is "*medical activities involving distance and cover diagnosis and clinical management, treatment and education (for both health care workers and patients)"*. There are several forms

that are used as interchangeably for Telemedicine namely Telehealth, Telecare, Telenursing, Telematics [34].

Medical consultation is very important in clinical practice as it is one of the key factors to take clinical decisions. Therefore, **Tele-consultation** can support this decision making by taking place between two or more healthcare professionals with or without involvement of patients. Videoconferencing is going to be a popular way where patient and doctor can have a good contact in real-time to generate interactive feedback. In Tele-radiology, store-and-forward technology is now frequently used for the transmission of X-Ray films, which causes no disruption to treatment. Online information sources over internet can offer excellent educational material as well as low cost and easy access. The use of tele-medical links to deliver educational material fulfils the concepts of **Tele-education**. It includes clinical education from tele-consultation and via internet along with academic study and public education via internet. **Tele-monitoring** is used to gather routine and repeated data on a patient's health condition. Data exchange has been over telephone or computer/modem system and alternatively in real-time or in store-and-forward mode. Mostly it is used for monitoring a patient who is away from his/her physicians, for example monitoring of blood pressure to adjust anti-hypertensive drugs. This adjustment can be communicated verbally by telephone or automatically using a touch-tone telephone and a computer telephone integrated (CTI) system. The most challenging division of telemedicine and telecare is **Tele-surgery** and it is in initial stages. It has been practised in two ways. Tele-mentoring, where guidance is given by specialists to surgeons for carrying out a surgical procedure at a remote location through videoconferencing. The other method is tele-presence surgery, which guides robotic arms to carry out remote surgical procedures and the surgeon manipulates interfaces that are connected mechanically and electronically to surgical instruments. This technique, movement scaling, must be very precise so that tremor-free incisions can be given [33]. With the help of a robotic arm called Puma 560, the first robotic surgery was performed in 1985 for non-laparoscopic neurosurgical biopsies [35, 36]. In 2002, the first robot-assisted transatlantic tele-surgery was performed by using Asynchronous Transfer Mode (ATM) with a constant rate of data transfer of 54 bytes and land networks that covered a distance of above 14,000 km between Manhattan, New York, and Strasbourg, France. Laparoscopic Cholecystectomy was successfully performed due to cholelithiasis on a 68-year-old patient. There were no significant complications during operation and the patient recovered well from anaesthesia and there were also no post-operative incidents [37].

In recent years, ICT especially internet has also been used to provide health information to a distant level. It is used to characterize "Internet medicine" and virtually everything related to computers and medicine. Internet-based medical sites that provide an enormous amount of information about diseases, treatments, pharmaceuticals, and images of pathology. These types of services are known as e-health, a form of telemedicine [38, 39]. The term in line with other "e-words" such as e-commerce, e-business, e-solutions, and so on, has been used to convey the promises and principles around e-commerce (electronic commerce) to the health care sectors. The Internet has created new opportunities and challenges to the traditional health care ICT. It is challenging for the health care ICT to enhance the capability of consumers to interact with their systems online (B2C = "business to consumer"), possibilities for institution-to-institution transmissions of data (B2B = "business to business") and possibilities for peer-to-peer communication of consumers (C2C = "consumer to consumer"). e-Health can be defined as "…. *an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology."[40]*

e-Health services can be used in various ways. Internet is an enormous resource of health information that helps not only health professionals but also patients and their relatives' even general people. It helps them to make right decisions and initiatives. With the help of online communication and information, people can change their lifestyle to achieve better health. For instance, patients with diabetes or hypertensive can get advices about their diet, exercise and so on that plays an important role to control diseases with/without medications. Electronic communications like email, online discussion forum, and social media are also good resource of information.

Not only in the past few decades but also today, electronic devices like camera light boxes, e-mail services, fax machines, interactive television units, multimedia, remote monitoring systems [41], telephones, and videoconferencing [42] have been used as telemedicine technologies. In new digital 21st century, telemedicine has become a standard tool in the way of Internet-based medical sites [39]. For instance, almost excessive, diagnosis of psychiatric illness and subsequent pharmaceutical treatment for the management of these conditions, e-health services can be used to obtain information on many psychological conditions along

with treatments. In other words, many of their psychological questions can be answered with the information provided on e-health web sites [39, 43].

Three main types of telemedicine, which include store-and-forward, remote monitoring and real-time interactive services are now widely used to provide overall health care. **Store-and-Forward** is commonly used in the medical fields of dermatology, radiology and pathology where data such as medical images can be sent to the specialist as needed when it has been acquired from the patient. This technique can save time and allow medical practitioners to provide their services more effectively. **Remote monitoring** uses a range of technological devices to monitor health and clinical signs of a patient remotely. This type of patient monitoring is also called home telehealth or telemonitoring. This is broadly used in the management of chronic diseases such as cardiovascular disease, diabetes mellitus and asthma. It allows physician to track the patient health data remotely and prescribe medicine according to the need. Cost effectiveness and greater patient satisfaction can be achieved through this service. If patient gets proper training on monitoring and supportive instruments can be installed properly, it is very effective to monitor patient remotely. **Real-Time Interactive Services** can provide immediate advice to patients who require medical attention. This service has been provide by teleconsultation, online and home visits. Consultation and assessment from the medical history and complaints has been performed at the same time similar to those usually conducted in face-to-face consultations. Tele-neuropsychology is an example of this type of telemedicine where ideally used videoconference technology [44].

Home health care in the USA is one of the most rapidly growing sections of the health-care market. Telehealth or telemedicine is trying to reduce some of the inefficiencies of home health care in various ways. It includes replacing certain nursing visits with video visits, collecting vital-signs data remotely, improving medication compliance and patient education [45].

Telemedicine is used in different medical fields. Some of the most popular telemedicine solutions specialties are [46]:

- ✓ **Tele-radiology**: Tele-radiology offers providers at one location to send a patient's x-rays and records securely to a qualified radiologist at another location, and get a quick consult on the patient's condition.

- ✓ **Tele-psychiatry**: Tele-psychiatry and telepsychology applications are well accepted by patients and providers, and both diagnostic and treatment outcomes have generally been similar to traditional face-to-face interactions. Because psychiatry often does not require the same physical examinations of the medical field. Tele-psychiatry allows qualified psychiatrists to provide treatment to patients from a distance, and is mostly useful for managing behavioural health. In a study, psychological tests were conducted via videoconference and in-person to subjects, counterbalanced using alternate test forms and standard instructions. Two hundred two adult subjects were tested in both rural and urban settings, including 83 with cognitive impairment and 119 healthy controls. It was found highly similar results across videoconference and in-person conditions [47].
- ✓ **Tele-dermatology**: Tele-dermatology is usually store-and-forward technologies and live interactive services that allows a general healthcare provider to exchange a patient photo of skin lesions, e.g. rash, mole, or another skin anomaly, for remote diagnosis. Doctors from rural areas where dermatologists are not available can provide specialists services with the help of tele-dermatology.
- ✓ **Tele-ophthalmology**: In tele-ophthalmology, store-and-forward technologies and live interactive services can also be used. It allows ophthalmologists to examine patients' eyes, or check-in about treatments from a distance (e.g. diagnosing and treating an eye infection).
- ✓ **Tele-obstetrics:** Tele-obstetrics allows obstetricians to provide prenatal care from a distance. For example, recording a baby's heart rate at one location and forwarding it to an obstetrician for diagnosis at another facility.
- ✓ **Tele-oncology**: Tele-oncology can provide more accessible and convenient care to patients with cancer. It offers not only store-and-forward tools to forward images for diagnosis, but also live video platforms to allow patient consults with the oncologist.
- ✓ **Tele-pathology**: Tele-pathology allows pathologists to share and forward high-resolution images and videos, which helps to diagnose diseases from a distance. It is also used for research, and education.

The rapid and ongoing growth in mobile technologies has given rise to the concept of mobile health (mHealth). mHealth is a component of eHealth. mHealth is defined as *"medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices"*. According to this definition, mHealth includes short messaging services (SMS) as well as more complex applications like general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning systems

(GPS), and Bluetooth technology. The frequently used mHealth services are health call centres /health care telephone help lines, emergency toll-free telephone services, emergencies, mobile telemedicine, health surveys, surveillance, awareness raising, and decision support systems [48].

Now-a-days, social networking is one of the most popular activities on the internet and social media have modernized the communication. There are several types of online platforms and digital tools, which are playing an important role in online communication. First, there are digital communication tools (i.e. e-mail and text messaging), which are used to establish direct communication between peoples. Second, there are digital profiles that are used to provide a source of information on a particular issue, service or provider. Digital profiles classically are used for one-way communication (practitioner to patient). The last one is social media tools. These tools, such as blogs, Facebook, Instagram, You Tube and Twitter, have wide range of public accessibility and can provide exchange of information. Initially these were promoted for their social purposes. This is why the term is "social media". Nevertheless, they are now being used for professional and promotion purposes [49]. Social network sites are defined as web-based applications that allow their users to construct a profile that other users can see and list connections with other users [50]. These sites like Facebook, Twitter have created online social relationships. Different types of relevant information found in social media, chats, ICQ, health forums etc. increase the possibilities to acquire knowledge, facts and evidence. It can also provide social support and even possible recovery for those in a vulnerable health condition as media helps to get a better outlook about health complications and exclude sources of concern. Social reinforcement like posting, sharing and commenting on health-related issues, joining or developing online health communities and exchanging information about health issues [51] enable increased access to information and social advancement [52].

Health professionals are also using social media to create professional network. They are also trying to build a common network where patients can also involve. Health care professionals can share information, discuss health care policy and practice issues, support health behaviours, engage with the public along with educate and interact with patients, caregivers, students and colleagues through social media [53-55]. They can improve health outcomes, develop a professional network and enhance personal attention about news and discoveries.

They can also motivate patients and provide health information [54, 56]. General practitioners' motive to join in social media are due to read articles, research medical developments, discuss with colleagues about different issues regarding patients [57]. In social media, they can share cases and ideas, discuss management difficulties during practice, make referrals, publish their research and even can market their practices [55, 58]. The social media site QuantiaMD found that more than 90% physicians use this for personal activities and only 65% of them use for professional purposes [55, 57]. However, both personal and professional use of social media by physicians is mounting [57, 59].

Social media enables real-time communication through posts, messages, images and videos. In 2005, there were only few users who accessed social media sites whereas in 2014, there were three-fourth of Internet users accessed social media sites (globally 1.43 billion) [60]. The use of social media to disseminate knowledge provides an opportunity to reduce healthcare costs by facilitating self-management of people. A pilot study using Facebook discovered encouraging effects of knowledge acquisition or integration of the evidence-based self-management People Getting a Grip on Rheumatic Arthritis (PGrip-RA) program [61]. Many dental schools use social media to promote their courses and communicate with their students [62]. Dental tutors also use YouTube and blogs to improve the classroom learning experience and rise reflective thinking and learning [63, 64]. Social media has also been used to help new dental techniques (through uploaded videos on YouTube), advertise private dental practices, as well as the sharing of dental research through twitter and the RSS news feeds of leading journals and conferences [65].

Social media application in health care has been clarified by several motives [66]. These motives comprise information searching about disease treatment and medicines [66-68], social support between two or more people who have the same disease [66, 69, 70] improved efficiency and quality care [71, 72], improved relationships with providers [73] and self-care and self-management [74]. A descriptive survey have assessed patients' interest in social media for health care purposes. Their findings discovered that 83% of patients used some form of social media and more than half wanted their providers to use it for health care (i.e. share health information updates, communicate and or help manage health problems) [75].

TELEMEDICINE SERVICES IN BANGLADESH

Bangladesh is one of the most densely populated countries in the world. It is a democratic country. According to WHO statistics 2015, its total population is around 160 million. Health and education levels of Bangladesh is relatively low. In recent years, poverty levels have decreased although Bangladesh is still struggling with poverty, corruption, overpopulation and so on. Most people are still living in rural areas. The total expenditure on healthcare as a percentage of Bangladesh's GDP was 2.8% in 2014 [76]. Government of Bangladesh invested only 7.9% of total expenditure on healthcare as of 2009 and the citizens have to pay most of their health care expanses as the out-of-pocket expenditure as a percentage of private expenditure on health is 96.5% [77].

There is a huge inequality in health care accessibilities between rural and urban areas due to lack of medical expertise and health care facilities. Telemedicine is showing us hope for an easier and cheaper way to provide health care service in the rural areas. Telemedicine activities developed in Bangladesh in 1999 [78]. The goal of national health policy stated as "to create conditions whereby the people of Bangladesh have the opportunity to reach and maintain the highest attainable level of people health."[79] There are 663 Government hospitals in District headquarters and Thana (sub-town) areas. In total, there are 51,648 beds available in both public and private hospitals including clinics. However, the ratio of hospital bed to citizen is around 1:2571 [78] with doctor to citizen ratio 1:43660 [80].

1. Health service through mobile phones and videoconferences

Telemedicine services have been provided at different levels of hospitals especially in two specialized hospitals (Bangabandhu Sheikh Mujib Medical University, BSMMU and National Institute of Cardiovascular Diseases, NICVD), three district hospitals (Shatkhira, Nilphamari and Gopalganj) and three sub-district hospitals (Pirgonj, Dakope and Debhata). Admitted patients in district and sub-district level hospitals can get suggestions through tele-conference from the doctors of specialized hospitals. Web-camera has been installed in each sub-district, district, medical college and post-graduate institute hospitals so that they can provide tele-medicine services through video conferences. A mobile phone has been given to each district and sub-district hospital of Bangladesh. These mobile phone numbers have been announced locally. Citizens can take free health consultations from doctors who are working at these government hospitals. These numbers are also given in the website of Directorate General of

Health Services (www.dghs.gov.bd). People can make calls in these numbers 24 hours and can take medical help at the beginning of any disease. The risk of complication of diseases can be reduced in this way. Many people come to outpatient departments of the government hospitals. It often becomes difficult to provide health care service with limited work force and shortage of medicine. Through mobile phone, many people are able to take health service from their residence. As a result, it will reduce the pressure over outpatient departments and it will be possible to provide better treatment to the patients who are attending there. Thus, patients' satisfaction can be achieved [81].

From 2012, Community clinics that are located in rural areas are in the process of receiving laptop, computers along with internet connection. Around 300 community clinics in different parts of the country have received their laptops. The Government of Bangladesh has planned to establish one community clinic for every 6,000 population and in total there will be 18,000 community clinics. The Management Information System (MIS) is providing laptops to the community clinics. The goals are to update local health data, provide health education to people and train health professionals. There is no doctor in the community clinic, where medical advice is be provided by trained Community Health Care Provider. Some patients that are visiting community clinics require sometime consultation from a qualified medical doctor and Tele-consultation is making a bridge with doctors who are working in the nearby sub-district hospital. As a result, absence of doctors in community clinics does not hamper the health care service.

2. Telemedicine services in Union Information and Service Centres

The Access to Information (A2I) under the Prime Minister's Office operates Union Information and Service Centres (UISCs) in 4,536 unions of Bangladesh, which provide various value added service (VAS) to local people against nominal charge using ICT tools. In 22 of the UISCs, telemedicine service through using Skype has been started on pilot basis. Doctors, who are at the MIS office, are giving medical consultation in every working day [81].

3. GIS in Health Service

Geographical Information System (GIS) helps in locating available health service along with certain kind of services. It helps in disease surveillance and in mapping available services.

Therefore, it can be used for proper planning and for evidence-based decision-making. To generate GIS capacity of health system of Bangladesh, Global Positioning System (GPS) devices have been primarily provided to each Civil Surgeon's and Divisional Director's office. Trained Statistical staffs collect geo-location data from respective health facilities down to sub-district levels. They put data on the Google Map that are accessible worldwide through Internet. As of August 2012, the geo-location data for the union health facilities and community clinics are being added to the Google Maps. The MIS is now giving highlighting on improving GIS based reporting system [81].

4. Annual Development Program (ADP) system

It creates an online database, which helps to monitor the progress as all the directors of the Health, Population & Nutrition Sector Development Program 2011-16 and all the other project directors of different development projects under the ministry are updating the database along with financial and physical data. This database is a great tool for project managers, agency chiefs or the ministry to review progress of ADP anytime and from anywhere through Internet [81].

5. Human Resource Databases

The MIS maintains three databases for human resource management. These are online Personal Data Sheet (PDS), online Human Resource Management System and Field Staff Information System. The doctors working in the Directorate General of Health Services (DGHS) under the Ministry of Health and Family Welfare (MOHFW) use personal Data Sheet (PDS). They create and update this database by themselves. This database provides detail profiles (a complete resume) of each staff maintaining his or her PDS. Human Resource Management System receives human resource data provided by each health organization under the DGHS. This database can provide updated information of all work force in the Directorate General of Health Services (DGHS) any time. Field Staff Information System has been created through collecting data from each field staff, who sent personal information through SMS using respective mobile phone. The information includes names, affiliation, place of work, designation and mobile number [81].

6. Pregnancy Care Advice through SMS

A pregnant woman can get proper advice through SMS if she registers herself in a mobile phone based pregnancy care advice service that is operated by MIS. In the SMS option of mobile phone, she will type following codes and send it to 16345. For example,

dghs reg lmp_date mobile_no. name

dghs reg 04072012 01713018545 Mari

Explanation: lmp is the last menstrual period in format of ddmmyyyy. Mobile number is the cell number where she wants to receive the SMS advice. Name is her name.

After registration, she will receive an instantly SMS reply, which will inform her about expected date of delivery (EDD) and give advice for following the SMS advices she will receive automatically from time to time. The advices have been conjointly developed by a group of specialists from academic institutions, WHO, UNICEF and reproductive health program of the ministry [81].

7. Amcare

Telemedicine Reference Centre Limited (TRCL) in collaboration with Entra Health Systems of the U.S. has launched a mobile phone-based health (mHealth) service for diabetic patients under the brand name 'Amcare.' Initially this service is limited to Dhaka, Chittgong and Sylhet cities and would be extended across the country in phases. mHealth includes routine home test of blood glucose level with a Bluetooth glucometer connected to a mobile phone. After the use of glucometer, the result of blood glucose test will be transferred via mobile phone to the Amcare Diabetes Call Centre [82].

CHAPTER FOUR

THE RESEARCH METHOD

This chapter mainly focuses on the study design and methods that were used in the study. Research method is playing a key role of a study. This chapter will first provide the purpose of the research. Then a brief overview on qualitative methods. It will support the reason for selecting the research method that seems to be suitable for this study. Later, I will also discuss about how I got access to the field of study and what type of experiences I gained during fieldwork. Finally, ethical consideration and limitations of the study will be discussed.

1. Purpose and Research questions guiding the study

The principle purpose of the research is to carry out a study to discover the applicability of telemedicine in Bangladesh and to explore scopes and barriers or challenges of its implementation within existing health care service. Therefore, this thesis is based on the following research questions:

- What is the present condition of information infrastructure in health care sector of Bangladesh?
- In which sector of health care service can Telemedicine be introduced?
- What are the challenges or barriers to implement telemedicine in health care sector in Bangladesh?

2. Qualitative Research (design and approach used in the study)

Research design is an important element in any kind of enquiry or research. Success of a research depends mostly on its design [83]. Research design is an outline for the whole research that includes purpose, theory, research strategy, methods sampling etc. "*Design deals primarily with aims, purposes, intentions and plans within the practical constraints of location, time, money and availability of staff. It is also very much about style, the architect's own preferences and ideas (whether innovative or solidly traditional) and the stylistic preferences of those who pay for the work and have to live with the finished result*."[84]
Not all data can be expressed in numbers. Qualitative or interpretive research means different things to different people [85]. Qualitative data sources combine observation and participant

observation (fieldwork), interviews and questionnaires, documents and texts, and the impression and reaction of the researcher [86].

According to Orlikowski et. al. "*Interpretive studies assume that people create associate their own subjective and inter-subjective meanings as they interact with the world around them. Interpretive researcher thus attempt to understand phenomena through accessing the meanings participants assign to them*"[87]. Walsham defined it as "*Interpretive methods of research start from the position that our knowledge of reality, including the domain of human action, is a social construction by human actors and that this applies equally to researchers. Thus there is no objective reality which can be discovered by researchers and replicated by others, in contrast to the assumptions of positivist science*"[88].

In some cases, there is no significant variation between qualitative research and interpretive research [89]. However, Myers [90] argued that depending upon the philosophical statement of the researchers; qualitative research may or may not be interpretive. Chua's [91] classification of research epistemologies apparently describe qualitative research can be done with a positivist, interpretive or critical stance.

Interpretive research helps information systems (IS) researchers to understand human meaning and action in social and organizational perspective. Interpretive field research requires critical reflection on how the research data are socially constructed though the interaction between the researcher and participants. Interpretive research has emerged as a well-significant number of authors are working within the interpretive tradition [89].
The interpretive perspective is based on the assumption that individuals use symbolic forms such as ideas and concepts to express meaning and to structure their social experiences. Researchers focus on understanding the meaning of these contextually-grounded social experiences from the viewpoints of the actors [92, 93]. This perspective accords greater importance to the ideas, concepts, beliefs etc. – the language which actors use to convey meaning – than does traditional research which focuses primarily on behaviour [94-96]. The idea behind interpretive or qualitative research is to address questions concerned with developing an understanding the meaning as well as experience dimensions of humans' lives and social worlds [97].

A good research is based on its construction. We have to know the research is comprehensive as its findings can be trusted and it provides evidence for understanding events that is happening, taking actions and designing future research [98]. Successful research comprises the design and implementation of the study, the collection and analysis of data, and the interpretation and reporting of findings. Lincoln and Guba defined principles for assessing the trustworthiness of qualitative research (credibility, transferability, dependability and confirm ability) that is equal to internal and external validity, reliability and objectivity, respectively [99]. However, in recent times it has been argued that qualitative research should be evaluated against criteria more consistent with its specific philosophical attitude and aims [100].

The central to the quality of qualitative research is participants' perspectives that have been reliably represented in the research process and the interpretations from the collected information (authenticity); and the findings are comprehensible in the sense that they 'fit' the data and social context from which they were originated. Principles of the quality for ethics in qualitative research is extended to the importance of the power relations between the researcher and researched, and the need for transparency (openness and honesty) of data collection, analysis and presentation [101].

Klein et al. [89] proposed the seven principles to evaluate the interpretive research in Information Systems (IS). These principles are derived from two sources: the practice of anthropological research and understanding the underlying philosophy of phenomenology and hermeneutics.

The principle of the hermeneutic circle is the most fundamental principle and the remaining six principles are based on this. Hermeneutic circle has been proposed that all human understanding can be gained by iterating between considering the interdependent meaning of parts and the whole that they form [89]. Lee's (1994) study of information richness iterates between the separate message fragments of individual e-mail participants as parts whereas the over-all context that defines the full meanings of the separate messages to interpret the message exchange as a whole [102].

The Principle of Contextualization demands critical consideration of the social and the historical research setting. It is obvious that through this principle intended audience can

observe how the current situation under investigation emerged [89]. Ciborra et al. (1996) show how old Fordist production concepts still had a significant influence in spite of radical changes in work organization and operations after discussing the historical forces that led to Fiat establishing a new assembly plant[103].

The Principle of Interaction between the Researchers and the Subjects deals with the interaction between the researchers and participants. This principle requires critical reflection on how the research materials (or "data") were socially constructed through the interaction between them [89]. Trauth (1997) explains her understanding improved by increasing self-consciousness and addressing her own assumptions [104].

The Principle of Abstraction and Generalization relates the idiographic details revealed by the data interpretation. The data interpretation can be achieved through the application of principles one and two to theoretical as well as general concepts describing the nature of human understanding and social action [89]. In relation to Latour's actor-network theory (ANT) Monteiro and Hanseth's (1996) findings have been discussed [105].

The Principle of Dialogical Reasoning is the principle which requires understanding of potential contradictions between the theoretical preconceptions that guide the research design as well as actual findings ("the story which the data tell") with subsequent cycles of revision [89]. Lee's study (1991) shows that how Nardulli (1978) revised his preconceptions of the role of caseload pressure and it has been a central concept in the study of criminal courts several times [106].

The Principle of Multiple Interpretations entails sensitivity to possible differences in interpretations among the participants. These participants are normally stated in various stories or narratives of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it [89]. The conflicting expectations for the Threshold system in the Bremerton Inc. case has been interpreted by Levine and Rossmore's (1993) [107].

The Principle of Suspicion deals with the sensitivity to possible "biases" and systematic "distortions" in the narratives or stories collected from the participants [89]. In order to

negotiate the problem of data acquisition, Forester (1992) looks at the inappropriate figures of speech used by city planning staff [108].

Table 4.1 Features of Qualitative Research [109]

	Qualitative Research
Objective / purpose	To gain an understanding of underlying reasons and motivations To provide insights into the setting of a problem, generating ideas and/or hypotheses for later quantitative research To uncover prevalent trends in thought and opinion
Sample	Usually a small number of non-representative cases. Respondents selected to fulfil a given quota.
Data Collection	Unstructured or semi-structured techniques e.g. individual depth interviews or group discussions.
Data analysis	Non-statistical.
Outcome	Exploratory and/or investigative. Findings are not conclusive and cannot be used to generalize about the population of interest. Develop an initial understanding and sound base for further decision making.

3. Why? How?

In this study, different health professionals including administrative staffs have been involved. They have different academic backgrounds and social status with different psychology. Therefore, I think the main advantage in using qualitative research approach is the ability to get review into responses or observations and to obtain more detailed descriptions and explanations of experiences, behaviours and beliefs. This is concerned with finding out answers to questions that begin with “how?” and “why?”. Before I went for fieldwork, I had achieved a clear conception about what to observe, whom to interview, how

to collect additional information from different participators. For analysing data, theories of Actor Network Theory (ANT) and Information Infrastructure (II) were always in my mind.

4. Data Collection

It is important for the researcher to consider carefully about which data collection approach will provide the best information to answer the research questions under investigation before starting their fieldwork. Researchers must carefully construct their interview guide, and collect their sample of participants. Finally, all interviews or transcripts must be completely transcribed and analysed to identify important themes [110]. First, I got an introductory letter from my supervisor, and it acted as an evidence of my studentship in The Arctic University of Norway. I picked Rangpur Medical College and Hospital as my field of study, because I graduated from Rangpur Medical College and Hospital. Therefore, I know the campus very well and have good contact with the doctor society as well as administrative staffs. After getting the approval from The Ethical Committee, I went to Bangladesh to start my fieldwork. Furthermore, I contacted personally with my seniors, friends and juniors who were working at different hospitals (both government and private) and are familiar to Telemedicine services. In addition, I contacted with several persons over telephone and emails to get an overview of status of Telemedicine services.

I was present in two audio-video teleconferences, which were among Rangpur Medical College Hospital and Gangachara Health Complex (sub-district hospital). Each teleconferences lasted around 20 minutes, which had been recorded by voice-recorder after taking verbal informed consent. I was sitting there just as an observer not as an influencer. Frequent relevant notes were taken during teleconferences.

4.1 Observation

Observation is a systematic data collection approach where researchers use all of their senses to scrutinize people in natural settings or naturally occurring situations. Observation of a field setting involves prolonged engagement in a natural setting, clear expression, and self-conscious notations of how observation is done. Methodical and tactical improvisation is done to understand fully of the setting of interest. It focuses also on “standardization” and can record one's observations [111]. I observed the participants, how

they interacted during their work, their working protocols, rituals, temporal elements, critical incidents, interpretations and in organizations.

4.2 Interviews

One of the most popular and frequently used methods of collecting information from the participants during research is interviews. The interview helps to explore the views, experiences, beliefs, attitudes of individuals on specific matters. It helps to provide a deeper understanding of social phenomena. Most of the interviews were semi-structured with open-ended questions. I conducted also informal discussions to get a clear view of phenomena. I preferred semi-structured interviews as I can prepare relevant questions during interviews and it allows informants the freedom to express their views in their own ways and can provide reliable, comparable qualitative data.

In total, I conducted eleven interviews: six face-to-face (F2F), three over telephone and two by videoconferences (skype). Of the interviewees, eight were males and three were females. Three interviews were not recorded as interviewees did allow me to record. Therefore, traditional notes were taken during these interviews.

Table 4.2 Interviews with durations

Interviewee	Department	Interaction	Duration
Informant 1 (Administration)	Rangpur Medical College Hospital (RpMCH)	F2F	22 minutes
Informant 2 (Doctor)	Rangpur Medical College (RpMC)	F2F	31 minutes
Informant 3 (Doctor)	National Institute of Cardiovascular Diseases (NICVD)	F2F	33 minutes
Informant 4 (Doctor)	Bangabandhu Sheikh Mujib Medical University (BSMMU)	F2F	23 minutes
Informant 5 (Doctor)	Rangpur Medical College Hospital (RpMCH)	F2F	26 minutes

Informant 6 (Doctor)	Rangpur Medical College Hospital (RpMCH)	F2F	27 minutes
Informant 7 (Nurse)	Rangpur Medical College Hospital (RpMCH)	Telephone	19 minutes
Informant 8 (Lab. Technician)	Rangpur Medical College (RpMC)	Telephone	18 minutes
Informant 9 (Record keeper)	Rangpur Medical College Hospital (RpMCH)	Telephone	19 minutes
Informant 10 (Doctor)	Upazilla Health Complex (UHC)	Teleconference	24 minutes
Informant 11 (Doctor)	Upazilla Health Complex (UHC)	Teleconference	20 minutes

5. Reflections on method

When I was taking the theoretical classes and courses in "Telemedicine and eHealth", I was interested to know present situations of "Telemedicine" in my country, Bangladesh. Telemedicine utilizes information and telecommunications technology to transfer medical information for diagnosis, therapy and education. The medical information includes images, live video and audio, video and audio sound files, patients' medical records, and output data from medical devices. I got an impression on the modern telemedicine services that were available in developed countries. At the same time, I was thinking about my thesis that could provide data on the present situation of Telemedicine in Bangladesh and find out challenges or barriers in implementing telemedicine services.

Bangladesh is an over-populated country. Therefore, it is difficult to ensure healthcare management for its entire population. Moreover, most of the people do not get proper health care management because of poverty. Population based preventive strategy is crucial and very much significant for South Asia, particularly for Bangladesh to slow down these problems. Telemedicine could potentially reduce waiting times for patients, reduce the cost of health system's operations, improve inter-departmental, inter-hospital communication and

collaboration, provide opportunity for sharing best practices among physicians within Bangladesh and international hospitals and enhance better resource allocation.

I was a physician in my country. During my practice period, I found serious health vulnerability among the people of Bangladesh. Many Children are dying due to diarrhea, pneumonia, malaria and so on. Women are awfully suffering from pregnancy and delivery related complications since access to health care services is beyond geographical, cultural and economic reach. In such situation, to my mind, high-risk approach of preventive measure is the only way to improve the situation by using Telemedicine knowledge since the telecommunication reached almost every corner of Bangladesh. Before deciding the area of my interest, I discussed the topic with my supervisor and got approval to work on that area. However, it was not an easy task to get involved in telemedicine services of Bangladesh since telemedicine projects had been applied in a limited extent as pilot project basis and most of them are limited to urban health-care centres and remaining are directing to rural and remote areas of the country. In addition, there were also few articles, reports, documents related with Telemedicine projects in Bangladesh. Therefore, I took in consideration the articles, which were upon Telemedicine projects in developing countries.

During my field visit, I tried my best to take contact and interviews with them who had at least minimum ideas about telemedicine projects or were planning to get involved in telemedicine projects. One of my senior colleagues, who was also continuing his job as physician, suggested me some persons' name to whom I could meet. I planned to gather data by using qualitative approach (e.g. semi-structured interview, participant observation, both formal and informal discussion) since it aims to address questions concerned with developing an understanding of the meaning and experience dimensions of humans' lives and social worlds and the research participants' subjective meanings, actions and social contexts can be illuminated [112]. The in-depth case study that involves frequent visits to field site over an extended period, is playing a key role in such research [113].

6. Ethical Consideration

The supervisor reviewed my research proposal. After getting approval for my research proposal, I asked a supporting letter from my supervisor, which would also act as a document of my studentship under The Arctic University of Norway. I submitted that letter with a copy

of my project proposal to The Ethical Committee of Rangpur Medical College and Hospital with the help of my senior colleague. After getting approval, I went to Bangladesh to start my fieldwork.

This study did not include patients' data and interviews. Information was collected from government employees who were working at different levels under Directorate General of Health Services (DGHS).

This research had been done in easy-going process. The participant were treated as a unique human being within the context of his or her community system and freedom of choice were safeguarded. The research had shown respect for basic rights of the individual as a human being and for the dignity of people involved and did not expose them to intentions and motives not directly attached to the research project, its methodology and objectives. Informed verbal consent were taken and the respondents were assured that their confidentiality would be maintained strictly in all circumstances. Documentation would also be safeguarded. These would be viewed as strictly private according to the limits set by the research project.

7. Limitation of the study

The study has been conducted in Rangpur Medical College and Hospital. There is no established Telemedicine Department, even in the whole country. Therefore, it was difficult to get contact with professional who are specialized on Telemedicine. The study included only few respondents who were employees under Directorate General of Health Service (DGHS). Therefore, findings cannot be generalized to define the entire picture of telemedicine services in Bangladesh. It was challenging to acquire required information to scrutinize the findings because of lacking relevant literature on Telemedicine services in Bangladesh. Lastly, this study is conducted as a part of academic curriculum. This is why; duration of fieldwork was for short period. The study was also conducted with limited resources and funds. Hence, I had to manage the study according to the resources and funds.

CHAPTER FIVE

FINDINGS

1. Present status of health care system in Bangladesh

Bangladesh has shown significant improvement in a number of health indicators including reduction in under-five mortality, immunization coverage, maternal mortality and total fertility. The country has also improved women's education, economic conditions and life expectancy. In spite of having all of these improvements, poverty and income inequality are still persistent challenges in Bangladesh. The health system of Bangladesh has four key actors namely government, private sector, non-governmental organizations (NGOs) and donor agencies. The Government or public sector is the first key actor, which by constitution is responsible for providing of comprehensive health services including financing and employment of health staff. The Ministry of Health and Family Welfare is providing healthcare through the two Directorates General of Health Services (DGHS) and Family Planning (DGFP). These two directorates are working through district hospitals, Upazila Health Complexes, UHC (with 10 to 50 beds) at sub-district level, Union Health and Family Welfare Centres at union level, and community clinics at ward level. However, quality of services is quite low due to insufficient allocation of resources, institutional limitations and absence or negligence of healthcare providers [114].

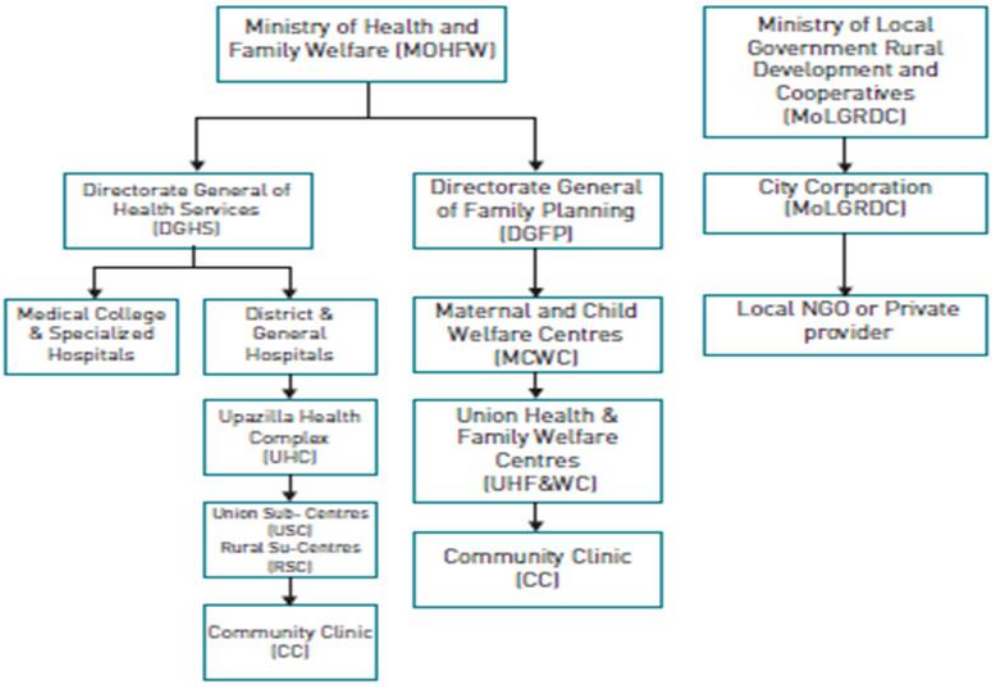

Figure 5.1: Health service delivery organizational structure in Bangladesh [114]

I conducted most of my fieldwork at Rangpur Medical College and Hospital, Bangladesh where the Principle governs Medical College and the Director governs Hospital. Pre-clinical departments are under Medical College and clinical departments are under the hospital administration. However, every department has staffs for teaching, clinical service (where applicable) and administration.

The hospital is organized into an outpatient department (OPD) and an inpatient department. Every clinical department has outpatient and inpatient department. Initially, patients have to attend OPD and outdoor medical officers decide on the patients' admission and referral. The hospital is organized into several wards, namely medicine, surgery, paediatrics, gynaecology, ENT, ophthalmology, cardiology, ICU, CCU, nephrology, psychiatry, skin and so on. Almost all wards have to admit two to three times more patients compared to their capacities.

2. Scopes and challenges of implementing Telemedicine services (TMS)

My interview with the Informant 1 (Administration) illustrates scopes of implementing TMS:
"*Our hospital is a 1000 bed-hospital. However, more than 4000 patients are taking healthcare services from this hospital every day. They are getting these services free of cost. This is not a matter of joke to manage such patient-flow. We have shortage of work force in every sector although internee doctors are helping us. Still we need more work force. Government could not able to provide us more work force. Because of huge patient-flow, our doctors could not able to attend all patients in time. We cannot monitor the management properly. As a result, many agents from several private clinics and hospitals motivate patients to be admitted in those private healthcare providers that are also too expensive. Telemedicine can be a good option not only for patients but also for us. Telemedicine could reduce patient-flow by providing necessary advice when patients are staying at their own house. If telemedicine can help us to reduce patient-flow, we can provide better healthcare service to our patients especially to the poor patients."* (Informant 1, Administration)

Informant 9 (Record keeper) stated more or less the same thing.
"*At present, we do not have electronic patient record (EPR) system. We are keeping paper-based patients' record only for admitted patients. We have already so much paper-based record that it is difficult to preserve. Due to huge patient-flow, it is very problematic to keep*

all records in one place. We have limited resources as well as shortage of work force. Out-door patients preserve their prescriptions in their own responsibilities for future reference. In addition, emergency medical officers and indoor medical officers had to attend so many patients so that they could not get time to register all patients' records when we tried to include record in computer as a part of a pilot project. After some days, we had to come back to the previous paper-based record system because there was huge chaos especially in emergency outdoor."(Informant 9, Record keeper)

In the laboratory, pathology and biochemistry department have analyzers and capabilities of archiving patients' reports in a computerized form. However, lack of adequate equipment (e.g. computer, internet) and expertize, it is often not possible to provide laboratory reports in time. Besides this, all departments have no intercommunication except making telephone call and physical contact. My interview with both Informant 2 (Doctor) and Informant 8 (Lab. Technician) gave an impression about present infrastructure.
"We have not yet able to implement Laboratory information system (LIS) where laboratory tests and results can be stored and exchanged. To diagnose diseases quickly, we are trying to help our physicians as much as possible, but we have severe limitations of equipment related to ICT and of course skilled work force who can input all data in proper place. Therefore, we are sending paper-based laboratory reports and it takes some time to get in the proper places. If we can implement LIS in future, I hope, our physicians can access the reports immediately when reports are available." (Informant 2, Doctor)

"We need to establish an automated laboratory where we can perform more laboratory tests at a time and it will reduce cost as well as help to save time. In our laboratory, we are only six technicians who are working. However, three of us have proper skills, and experiences. Therefore, most of the time, those three technicians have to perform around 200 laboratory test in each day. It is often difficult to maintain a standard level of service. If we had automated laboratory, we could employ less skilled labor." (Informant 8, Lab. Technician)

Prescriptions are the most important part of conducting patient treatment. Clinicians prescribe medications to initiate, continue or modify a treatment process. This prescription can be effectively managed by e-prescription and send them to the pharmacy database where medications can be dispensed to the patient. In this system, only clinicians have the right to

access and modify the prescriptions and the other related agents (for example, pharmacists) can access the database without the right of modifying. E-prescription can provide complete and accurate information, automatic dose calculations. This includes also drug interaction and hypersensitivity checking. The system can warn clinicians when they are going to prescribe a medicine, which has significant interactions (positive or negative) with other drugs. As a result, clinicians can be more conscious to prescribe this medicine. The e-prescribing system can include all information for safe dispensing, such as dose and frequency. This can be an evidence-based best practice. It can also improve medication management and help to reduce significantly medical and dispensing errors. The robotic medication management can reduce waiting time for both inpatient and outpatient prescriptions and this automated dispensing can reduce the number of errors during

Dispensing and labelling. Almost every practicing physicians were agreed about the importance of having e-prescription after getting an overview on that system. As Informant 3 (Doctor) from NICVD illustrated this:

"Deaths from cardiovascular diseases (CVD) are more common and have been increasing in the developing countries. We are prescribing several cardiovascular drugs to prevent CVD. It has been observed that patients are getting low-quality medicines instead of good-quality medicines. Because some physicians are prescribing these without knowing their quality and even pharmacists are selling low quality medicines instead of prescribed medicines. E-prescription can help us to minimize these type of practices. This system can help physicians to get proper knowledge about drugs before prescribing and physicians should be aware of that their prescriptions will be stored in a universal database and pharmacists have to include information about selling products in database. The authority can explore it anytime and can identify who are responsible for malpractices. In this way, e-prescription can be used as an evidence-based service." I got same reflection on that from the interview with Informant 7 (Nurse) of RpMCH, who stated her experience as *"…. We do not have all medicines in our drugstore. Patients have to buy some life-saving medicines from outside of the hospital. Patient's attendants often have to buy low quality medicines from the pharmacy nearby hospital because of low-price or they are not aware of the quality of medicines. In addition, we have shortage of skilled nurse. Sometimes we face problems in medicine distribution and patients get fail medications. If we can introduce any electronic medication management system, it can reduce the incidence of medication errors."*

Informant 3 (Doctor) from NICVD mentioned about scopes of tele-cardiology as

"Doctors from rural areas can send electrocardiographic data, which is transmitted remotely, in real time, for interpretation by a specialist. People can access specialist care in remote locations and it will help to early detect life-threatening cardiac conditions like myocardial infarction."

As mentioned earlier, each district and sub-district hospital of Bangladesh has a mobile phone and videoconferencing devices. The numbers of these mobile phones have been announced locally. People can also access these numbers from the website of Directorate General of Health Services (www.dghs.gov.bd). People can make a call to receive free health suggestions and doctors from rural area can have a chat with doctors in district level or in medical college hospitals to get better healthcare suggestions. During my interview with Informant 6 and Informant 10, I received mixed feedback about mobile healthcare services, teleconferences and videoconferences.

"Mobile health-consultation is playing an important role to reduce distance. People gets necessary health tips from us while staying at home and we are able to diagnose many diseases through this consultation and can give necessary management or advice over mobile phone. When we are confused about diseases or measures, we can consult instantly with the doctors of medical college hospital, if needed we can have videoconference. This will increase our confident level during practice. I think it is very useful especially for pregnant women who are experiencing different types of health problems." (Informant 10, Doctor, UHC)

"Teleconsultation is a good alternative for both patients and doctors. Success of this mostly depends on work force and patients' attitudes. We are only five medical officers in duty now and we have to attend both indoor and outdoor patients alternatively. There are massive flow of patients in both sections. We are often very busy with those patients. It becomes a burden for us when we have to attend teleconferences. There is no separate department for teleconsultation and no separate work force. Sometimes we are able to participate in teleconferences. However, our experiences is not good enough on teleconferences. Some patients do not accept tele-videoconferences cordially. They think we record the video-consultation and there is a chance of exposing their secrecy to others. Patients or their relatives want to consult with us immediately and often they are irritated when it takes time. They often use slang words to express their angriness to us. Some people make call just for fun and our female doctors often experience sexual harassment over telephone. As a result,

our female doctors try to avoid teleconferences. However, teleconferences with doctors from rural areas like UHC, district hospitals are more effective. We can give them proper instructions over teleconferences. Sometimes they send us images of skin lesions and wounds to get proper diagnosis and management." (Informant 6, Doctor, RpMCH)

Directorate General of Health Service (DGHS) is operating Pregnancy care advice service with the help of Management Information System (MIS). After registration, pregnant mother automatically receives advices by SMS time-to-time along with expected date of delivery (EDD). Practically, it is not effective as it planned. Informant 11, Doctor, UHC described as, *"Most of the people who are living in rural areas are illiterate. They are not concerned about their health especially about pregnant mothers' health. They have their beliefs on several myths. When pregnant mothers come to visit us, we register pregnancy care advice service (PCAS) in their mobile. They receive regular health tips with advices in their mobile. We tell them to ask people who can read those SMS. They do not follow our instructions. It may be due to illiteracy or shyness. However, only few who can read, are benefitted a lot with this service."*

Patient satisfaction is one of the most important factor in implementation of TMS. Face-to-face consultation and physical examination are very important in diagnosing and patient management. Patients are confused about the success of disease management when they are receiving advice only through teleconferences or videoconferences. They have little faith on this. However, they accept telemedicine services in addition to face-to-face consultation. According to physicians' observation, patient who has taken telemedicine services (e.g. teleconsultation, video-consultation), does not follow the advices and does not take medications until he or she is taking face-to-face consultation with the same doctor or with another doctor. Besides this, willingness and cooperation from physician's side are also essential factor to introduce telemedicine services in Bangladesh. Most telemedicine services are provided free of cost. Physicians do not get any salary to participate in TMS. Therefore, they are reluctant to use their time in teleconferences or videoconferences.

Social media is now widely used in healthcare services. Healthcare service providers creates blogs, web pages and uploads audios, videos in social media. Health professionals and patients can get relevant information from these sites. Mostly used social media are Facebook,

Twitter, YouTube, Blogs, Google, Yahoo, LinkedIn etc. However, using social media is limited in academic purpose and marketing. Informant 5, Doctor, RpMCH described use of social media as,

"……. Through search engine Google, Yahoo, Bing, I can access most updated information about certain diseases, drugs and health centres. Often I watch videos from YouTube to get better conception about pathology of diseases. I also watch normal anatomical and physiological pathways. I have installed some mobile applications like DIMS, PDM, Medicine directory Bangladesh, Health service that provide me useful information about medicine and diseases. Online forum interconnects physicians and physicians share their experiences, problems and disease management. Patients get also an overview about their diseases with the help of social media. However, all of this information takes no responsibilities when physicians are applying them in practical field. When there is any complications, you cannot say those online forums, blogs or social media have all responsibilities for that. I think social media can only be used for academic purpose and marketing, which helps to get a better idea, and nothing else. Another thing I want to mention here, our physicians are often not aware of secrecy. Often they upload information, audios, videos and pictures about their patients that violate the law of secrecy. Sometimes they are exposing these without taking patients' consent."

It is not always possible to transcribe whole interview in words. I have mentioned earlier about the interviewees experience on telemedicine services. At the same time, they proposed some telemedicine services that could be introduced in healthcare service of Bangladesh. Therefore, in Table 5.1, I am pointing out interview results about scopes of implementing Telemedicine Service (TMS) in Bangladesh:

Table 5.1

Interviewees	Scopes
Informant 1 (Administration), Rangpur Medical College Hospital (RpMCH)	1. Biometric Identification System to reduce paperwork, improve accuracy, and prevent identity theft 2. Electronic Health Record (EHR) to create a paper-less information system 3. Hospital Information System (HIS)

Informant 2 (Doctor), Rangpur Medical College (RpMC)	1. Automated laboratory to perform more tests at a time 2. Laboratory Information System (LIS) to store and access reports anytime
Informant 3 (Doctor), National Institute of Cardiovascular Diseases (NICVD)	1. E-prescription to secure proper drug distribution and to prevent malpractice 2. Automated pharmacy to ensure proper distribution 3. Computer-based physician order entry system (CPOE) to monitor management quality 4. Tele-cardiology
Informant 4 (Doctor), Bangabandhu Sheikh Mujib Medical University (BSMMU)	1. E-prescription and CPOE to secure proper drug distribution and to prevent malpractice 2. Electronic Health Record (EHR) to create a paper-less information system
Informant 5 (Doctor), Rangpur Medical College Hospital (RpMCH)	1. Electronic Health Record (EHR) to create a paper-less information system 2. Automated pharmacy to ensure proper distribution
Informant 6 (Doctor), Rangpur Medical College Hospital (RpMCH)	1. Teleconsultation 2. Radiology Information Management System (RIS) to access radiology related medical data 3. Picture Archiving and Communication Systems (PACS) to access pictures such as X-Rays, CT-scans, ultrasound images
Informant 7 (Nurse), Rangpur Medical College Hospital (RpMCH)	1. Electronic Medication Management (EMM) system 2. Automated pharmacy to ensure proper distribution.
Informant 8 (Lab. Technician),	1. Picture Archiving and Communication Systems (PACS) to access pictures such as X-Rays, CT-scans, ultrasound images

Rangpur Medical College (RpMC)	2. Automated laboratory to perform more tests at a time 3. Laboratory Information System (LIS) to store and access reports anytime
Informant 9 (Record Keeper), Rangpur Medical College Hospital (RpMCH)	Electronic Health Record (EHR) to create a paper-less information system
Informant 10 (Doctor), Upazilla Health Complex (UHC)	1. Picture Archiving and Communication Systems (PACS) to access pictures such as X-Rays, CT-scans, ultrasound images 2. Automated laboratory to perform more tests at a time 3. Laboratory Information System (LIS) to store and access reports anytime 4. Tele-videoconference
Informant 11 (Doctor), Upazilla Health Complex (UHC)	1. Knowledge Management (KM) to access patient management guidelines, clinical decision support 2. Tele-videoconference 3. Mobile healthcare tips and advice

CHAPTER SIX

DISCUSSION

I will discuss here first about study findings and these findings will be correlated with the Information Infrastructure (II) and concepts of Actor-Network Theory (ANT). I will also explain how important socio-technical network is for implementing telemedicine services (TMS) in Bangladesh. Finally, I will give an overview about scopes and challenges in implementation of TMS in Bangladesh.

1. Telemedicine as an Infrastructural Tool

Telemedicine shares most of the characteristics of Information Infrastructure (II). It supports a wide range of activities and large number of different users can use it. Its members use a universal infrastructure and all of them use the same single thing although it may appear differently. Because of its different user interface boundless number of users, developers, stakeholders, organizations can involve in several activities with varying relations over time, varying arrangements and alliances, changing and unstable conditions for development and changing requirements. Therefore, different types of technological and non-technological components, human and non-human participations are involved here. Finally, the whole system is based on the existing system, which can be modified according to the need [17].

Bangladesh is one of the most densely populated countries in the world. Its population is around 160 million. Due to insufficient number of doctors and healthcare professionals, a developing country like Bangladesh can provide basic healthcare service to its people. The rural healthcare centers are often ill equipped and have inadequate infrastructure. Therefore, most of the doctors are city-based and this is one of the reasons for inequality of healthcare service between rural and urban areas.

During my fieldwork, I observed existing organogram and data system in Rangpur Medical College and Hospital. Telemedicine refers here to the use of ICT to provide consultation, medical procedures and examinations to remote areas. The principal purpose is to healthcare service to patients who are away from specialized care. This existing system can be modified by the use of advanced technology to implement telemedicine information infrastructure. This infrastructure covers a wide range of medical specialties for example, cardiology, nephrology,

psychiatry, dermatology, ophthalmology, pediatrics etc. Medical professionals, other healthcare providers, pharmaceutical professionals, patients and their relatives are also in the infrastructure who are playing an important role as active participator. Rapid access to information acts not only as decision-making tool but also as problem-solving tool for healthcare professionals. Through telemedicine services, we can overcome geographical barriers and can involve wide range of users. Now Government is trying to extend this network in private sectors. It is expected that share ability and user group will be increased and better access to healthcare service is possible from remote areas. For instance, tele-videoconference between district hospitals, sub-district healthcare centers, UHC, medical college hospitals and BSMMU has established interconnection among healthcare professionals who are working at different places. Even tele-videoconferences have also been performed globally. Patients and their relatives can also get information instantly with the help of different telemedicine applications. This **shareable** characteristic creates larger user community (**openness**) that includes doctors, students, nurses, assistants, administrative staffs, different organizations, patients and different equipment suppliers.

Due to openness and shareable characters, everyone can use telemedicine and gives rise to **heterogeneous** networks. In this network, expanding and wide range of equipment along with technologies as well as human and non-human artifacts are involved. Telemedicine is integrating different networks in technological networks. For example, different academic and administrative departments like medicine, surgery, psychiatry, dermatology, pediatrics, gynecology, clerical departments, pharmaceutical companies and equipment supply companies are interconnected by the technological applications (e.g. email and teleconference). These technological applications help to achieve knowledge, skill, overview and confidence on healthcare management. As Information Infrastructure has unlimited borders, it can easily intermingle with the external environment. Therefore, Information Infrastructure (II) can be modified according to the needs of its user groups and organizational policies. Usually in rural areas, telemedicine infrastructure has been built up where patients' satisfaction and benefit has to be considered first. However, installation of such infrastructure is expensive and mostly depends on how much financial assistance can be achieved. Due to insufficient fund, it is often challenging to install advanced technology. It is often tried to provide better healthcare service with limited resources.

Telecommunication network is a rapid growing industry in Bangladesh. This network provides also good internet facilities throughout the country. Government has started to use this network in healthcare service and is trying to provide user-friendly programs according to the need of patient and healthcare professionals. For example, Pregnancy care advice service. Government is now focusing on enhancement of **evolving** process by introducing user-friendly programs based on the country's structural and economical condition. Government has already provided laptops, internet modems and web-cameras in every district, sub-district hospital and union health complex in order to have internet access. As a result, evolving process of telemedicine service has been amplified.

"**Installed base**" concept refers to the new technology that has to be connected with the old one to make them interoperable [17]. Telemedicine service is expanding continuously according to its users need and organizational or governmental policy. The study finding shows that several telemedicine services have been started in small-scale at sub-district level and in large-scale at district level although these projects are struggling with proper resources and related software with same user interface. Therefore, TMS is limited to tele-consultation and videoconferences. The process of standardization and modernization is improving day-be-day and of course, new ideas, technology, user interface, features are included to the older existing one. In Bangladesh, a charitable trust named Swifne Charitable established telemedicine link between the Centre for the Rehabilitation of the Paralysed (CRP) in Dhaka (the capital city of Bangladesh) and Royal Navy Hospital, Haslar, UK in 1999. It was email and image based. It was very successful project. An evaluation of the 27 referrals made during the first year of operation showed that tele-consultancy had been useful and cost-effective [115]. This project showed the way of telemedicine service. At present, TMS is being provided through tele-consultation and videoconferences at different healthcare centres. In a word, infrastructures are emergent, growing slowly over time and building on the installed base [21].

2. Telemedicine service (TMS) and Actor-Network Theory (ANT)

Walsham stated, *"Successful network are created through enrolment of sufficient body of allies, and the translation of their interests so that they are willing to participate in particular ways of thinking and acting which maintain the network."[7]*

The technology extends and integrates steadily to line up the technology with the interest and conception of the users toward technology. According to Actor-Network Theory (ANT), success of new technology introduction mostly depends on the good interrelation and interaction between technical and non-technical elements, human and non-human elements. In other word, strength of socio-technical network helps to align the new technology in a society. ANT provides systematic understanding on the complex interrelations and interoperability among various human and non-human elements, technical and non-technical elements or several heterogeneous elements. To make TMS in Bangladesh effective and successful, these heterogeneous elements should have strong and effective interrelation and interaction. To increase this interrelation and interaction, it is very important to initiate a translation process that is operated according to the interest and need of its user.

Actor-Network Theory is concept where human and artefacts as actors are linked together in networks. The actors' participation in the network helps to pursue specific interests and will negotiate with and possibly associate themselves with other actors for trying to achieve their goals [116]. Technological determinism and social reductionism can play a significant role in this network. The first one is focusing on the determinants of technology use. The second one is focusing on the social aspects to point out how society can use the technology in a best effective way [17]. In other word, we can say that inscription and translation are important in this iterative process. Inscription refers to the way technical artefacts embody forms of use and is the determination by suggestion through which action is introduced into artefacts. It can be flexible or inflexible depending on the programmes of action. Translation is a problem solving social process that is modified according to the users' interests and mapping out the needs [23]. However, ANT treats them as inseparable; people and artefacts should be analysed with the same conceptual apparatus [7].

During my fieldwork in Rangpur Medical College and Hospital, this interrelation and interaction between technical and non-technical, human and non-human elements seemed to be weak or inadequate. From interviews, Informant 2 and Informant 9 mentioned that due to limited resources, shortage of work force, doctors had to manage many patients and they could not get time to register all patients' records. When it had been tried to include all health record in computer system in a pilot project, goals could not be achieved. In addition, lack of ICT equipment had been observed at all levels. Many users did not know how to use and

handle this equipment. Even they did not have proper knowledge on it, as they did not get proper training before using this. Existence of poor network between technical and non-technical, human and non-human elements had been detected throughout the study.

Patients are often confused about the success of disease management when they are receiving advice only through teleconferences or videoconferences. They have little faith and sometimes show negative attitudes on this, may be, due to lack of knowledge and awareness. Besides this, physicians who should play principal role in telemedicine service are reluctant to provide TMS properly, as they are very busy with their private practice. During their working periods in hospitals, they do not get additional allowance to provide TMS or they are very busy with their outdoor and indoor patients. Lacking of proper work force and ICT equipment act as barriers to establish an effective Actor-Network. As a result, many telemedicine projects could not be succeeded due to poor Actor-Network. Besides these, patients are feeling unsecured about their secrecy while they are receiving healthcare through TMS. Informant 6 revealed reason behind this during his practice. Patient thinks the video-consultation has been recorded and his or her secrecy might not be maintained properly. Therefore, negative attitudes and misperceptions regarding telemedicine service are playing an important role in establishing weak network between its different elements.

Mostafa et.al [117] in a study stated *"Even though enthusiasm has been observed in deploying telemedicine in Bangladesh from different quarters, however, lack of sustainability and long-term deployments are major issues. Unfortunately, many pilot projects are not followed up to turn into stable and fully functional healthcare systems. The primary reason is that the projects started with a narrow scope and did not address a proper framework for telemedicine application in Bangladesh."* Another study indicated that technical issue was one of the major reasons for deployment of a telemedicine service in Bangladesh [78]. In short, unavailability of proper starting and maintaining cost, poor ICT, participators ignorance, lack of skilled work force and awareness, illiteracy do not allow to build an effective Actor-Network in telemedicine services in Bangladesh.

3. Scopes of Telemedicine in Bangladesh

As I have mentioned earlier, majority of the people in Bangladesh lives in remote and rural areas. Due to poor infrastructure, ill equipment, inadequate work force, they are not able to

access modern healthcare facilities. Often they have to travel long distance to access healthcare facilities. Many of them even have no ability to travel because of poverty. Now, telecommunication network and internet facilities are available throughout the country, which opens a new door for telemedicine services in Bangladesh, as the principle goal of telemedicine is to overcome geographical barriers and can save time. Telemedicine can be a cheaper and easier approach to make available modern healthcare facilities among large population who are living in remote areas.

Because of high population, Government of Bangladesh does not need to think about workers. Government can just focus on proper training, investment and infrastructure. During my fieldwork, I observed that concepts of teleconsultation and videoconference are already in use. Infrastructures for these only need modernization, investment and employment of skilled workers. Therefore, I am not discussing here about these services. Every interviewee has suggested some telemedicine services that can be used in healthcare system in Bangladesh. Many of these services have already established in developed world. As a developing country, Bangladesh can use their policies in implementing TMS.

3.1 Biometric Identification System by palm reading

To reduce paperwork, improve accuracy, and prevent identity theft, palm-vein biometrics system can be introduced in all healthcare centres. Palm-vein pattern recognition technology is also referred as "vascular recognition" that uses near infrared light to capture person's palm-vein pattern for generating a biometric template, which is compared with a database of enrolled users to make a match. The underlying vascular pattern recognition technology has a false acceptance rate of only 0.00008%, that means only about one in 1.25 million can be wrongly identified. Therefore, infrared light can be used to scan the palm, and link the unique biometric trait to each patient's electronic patient record (EPR). Thus, it helps to ensure the privacy of patients and prevent duplications [118]. Doctors have to entry patient's data every time when he or she takes visit in hospital or healthcare centres. EPR can easily be accessed with the help of biometric identification system. As a result, doctors can properly use more time to consult and examine their patients. Informant 1 (Administration) proposed to introduce biometric identification system in hospital management. He believes that this system would reduce paperwork and to identify patients. In addition, he suggested to introduce this new technology in large-scale. For example, it would be used to ensure the

presence of hospital staffs at hospital and would help administration to monitor daily attendance of healthcare staffs.

Figure 6.1 Biometric Identification Device [118]

3.2 Electronic Health Record (EHR)

An electronic health record (EHR), or electronic medical record (EMR), refers to the systematized collection of patient and population electronically-stored health information in a digital format [119]. In other word, EHR is a record system where health information of a patient is stored and transmitted securely, and can accessible by multiple authorized users. This information usually can be in the form of patient demographics, medical history, laboratory report, billing information, etc.[120] Electronic Patient Record (EPR) is often used as a synonym of Electronic Health Record (EHR). EPR is useful in preservation of previous and on-going clinical documents, and is also used as clinical decision-making tools. EPRs can be used as a standard tool for all clinicians and can be configured for specific needs supporting the high level of specialization that each clinical specialty represents [121]. EPRs can be used by general practitioners (GPs) in their practice, hospitals to access hospital-based EPRs, laboratory systems, radiology systems and patient administrative systems [116]. If IT connections are in place, primary healthcare data from EPRs can be used for secondary purposes such as research, financial management and administration [122]. Work practices are often more visible, reviewable and manageable when patient's record has been shifted from paper-based to electronic-based. It has positive impact on inter-professional relations within hospital [123]. The transition from paper-based to computer-based support is not an easy task. It involves core activities in clinical practice and comprises many aspect of patient care. It also involves collaboration between different professionals and is distributed across

time and space. This transition is an interplay between multiple task, work practice and supporting artefacts [22].

All interviewees were agreed about the need of electronic patient record so that healthcare professional and administrative staffs could access easily patients' information and could save their time. According to Informant 1, Informant 3, Informant 4 and Informant 5, electronic health record can help to get a quick overview on previous illness of a critically ill patient.

As strength of socio-technical network is obligatory for implementing a new technology, the Government of Bangladesh is now taking initiatives with its limited resources. To implement Electronic Health Record (EHR), all citizens must have a unique ID. At present, Government of Bangladesh has started to provide National ID (NID) card with a unique ID number to its residents. This NID number can be used as personal identification (PID) number in near future. Government is trying to provide adequate ICT equipment to all departments in hospitals and healthcare centres and has started to train gradually all healthcare staffs to be skilled on the information technology. Some private hospitals are keeping computer-based patients' record for their own and outsider do not have access to the records.

3.3 Hospital Information System (HIS)

Informant 1 (Administration) suggested introducing Hospital information system (HIS) that helps to proceed the process of patient care, improve quality, increase satisfaction and reduce costs by exchanging patients' information among healthcare centres. All therapeutic, and management and financial actions of patient would be performed by this new system and could be sent to clinical and para-clinical and administrative centres for instance, accounting, pharmacy, warehouses, and other units. Through this, hospital could also able to provide necessary information about available services that will help people to know about services, locations, some basic information (e.g. directions to and opening hours of hospital) etc. They can also make an appointment by themselves with doctors and specialists.

3.4 Laboratory Information System (LIS)

A laboratory information system (LIS) is a computer-based software where patients' laboratory data (e.g. pathology, immunology, biochemistry, cytology) are processed, stored

and managed from all stages of medical processes and tests. With this system, doctors can electronically send requisition for laboratory tests along with clinical information and all results of laboratory tests will be stored on that database when reports are available. Doctors can access those reports immediately after being notified. This process saves time and allows doctors to diagnose quickly and subsequently, patient will be benefitted. In Bangladesh, the whole process is mostly paper-based and it takes around 3-4 days even longer than that after requisition for laboratory test. During my interviews, all physicians agreed to have universal LIS to be able to diagnose disease within shortest possible time. Informant 2 and Informant 8 expected that LIS would help physicians to rapid access the laboratory reports and patient would get proper management in real time.

3.5 Radiology Information System (RIS) and Picture Archiving and Communication Systems (PACS)

Imaging technologies (e.g. X-rays, CT-scan, Ultrasonography) are playing an important part in patient management. For the last 50 years, only one-time image was supplied to the patient hand-to-hand and patient himself preserved it. It was often difficult to archive. It took long time to register, schedule, send requisition and acquire the report along with images. Interviewees at all level suggested having an information system that would help in patient registration and scheduling, patient list management, workflow management in Radiology Department, document scanning, result(s) entry and electronic delivery, patient tracking, interactive documents, material management, billing etc.

Radiology Information System (RIS) and Picture Archiving and Communication System (PACS) offer new opportunities of electronic management of digital imaging in healthcare system. These two information systems allow short-term and long-term storage, retrieval, management, distribution and presentation of medical images and establish inter-departmental, inter-institutional communication. Patient can get rid of frequent visit to his doctor. Informant 6, Informant 8 and Informant 10 were optimist about to introduce RIS and PACS in healthcare sector of Bangladesh and they expected that these would create a bridge between radiology department and physicians to establish direct effective communication and at the same time, all diagnostic images would be efficiently preserved for future reference.

3.6 E-Prescription, Computer-based Physician Order Entry (CPOE) System and Automated pharmacy

In Bangladesh, many laws and regulations have been approved to prevent drug misuse and to ensure safety and quality of the prescribing process. In practical, these are not in use. A few government-approved organizations has been given the responsibilities to monitor and take proper measures for achieving these goals. However, the goals have not yet been achieved due lack of work force, corruption and ignorance.

People can buy medicines without any prescription from local pharmacies. Even an un-skilled person can operate a pharmacy and he prescribes his clients to take medicines that are available in his pharmacy instead of sending them to physicians. Due to illiteracy, unawareness and low-cost, people are taking those without knowing the consequences. Antibiotic-resistance is one of the most alarming consequences in Bangladesh. In addition, many physicians are not aware of prescribing antibiotics. It is also observed that patients are not satisfied on his physician if he or she does not get any antibiotic. They believe that they will not be cured without taking antibiotic. Interviewees were giving emphasis to implement a system that would help to decrease prescribing and medication errors and allow proper distribution of medicine. E-prescription, CPOE and automated pharmacy can fulfil these requirements in Bangladesh. Informant 2, Informant 3 and Informant 4 gave emphasis on implementation of E-prescription, CPOE and automated pharmacy for achieving different goals. Some important goals were

- ✓ To prevent malpractices
- ✓ To ensure proper drug distributions
- ✓ To control unnecessary use of antibiotic
- ✓ To aware physicians about adverse effects, side effects, interactions and other related information about drugs.

E-prescription, a computer-based electronic system that enables generation, transmission, and filling of a prescription. It allows prescribers to send prescription electronically to the pharmacy and decreases prescribing and medication errors, saves time and cost. This inter-connection between physician and authorised pharmacy systems reduces paperwork and mistakes from unclear handwritten notes. In this system, only clinicians have the right to access and modify the prescriptions and the other related agents (for example pharmacists) only can access the database without the right of modifying. E-prescription can also provide

complete, accurate information and automatic dose calculations. It can provide physicians clear information about drug interaction, adverse effects and teratogenic effects. The system will warn clinicians when they are going to prescribe such medicines. Therefore, clinicians will be aware of prescribing these medicines. This is also an evidence-based best practice.

Computer-based Physicians Order Entry (CPOE) system gives access to clinicians for entering directly or digitally in the database of pharmacy, laboratory, and radiology and for transmitting orders electronically to the respective department. The order is documented in a digital, structured and assessable format for multiple safety and other uses[124]. CPOE system supports standardized, evidence-based and readable orders, and through Clinical Decision Support (CDS) that can improve quality and safety by reducing medication and other errors, accelerating the ordering process and delivery of care, reducing care delays, adverse effects and errors [125, 126].

Automated pharmacy has Robotic Prescription Dispensing Systems (RPDS) that can count and dispense tablets, apply prescription and auxiliary labels and collate the uncapped vials into slots for final inspection using on-screen drug image verification. Barcodes ensure accuracy and quality control. Central fill stations assemble prescriptions, verify, package and deliver them either to a pharmacy or directly to a patient. These pharmacy technology systems free up pharmacy staff to work with patients, perform medication therapy management, and perform management tasks.

Figure 6.2 Automated pharmacy (e.g. PharmASSIST ROBOTx [127])

4. Challenges of implementing Telemedicine Services

Success of Telemedicine Service depends mostly on the development of Information and Communication Technology (ICT), effective Actor-Network and proper planning and

implementation. At the same time, motivation and acceptance over modern technology among participators are very essential.

In Bangladesh, an ICT task force was formed in 2001 in order to introduce e- Governance. At that time, Government tried to implement e-Governance instant without taking proper planning and steps. As a result, e-Governance could not be implemented properly. The current Government of Bangladesh has given enormous importance to ICT for development (ICT4D) for economic growth and poverty reduction [128]. In 2008, Prime Minister Sheikh Hasina declared her (current) Government's slogan as
"*We shall turn our country into Digital Bangladesh*"

The Honourable Prime Minister herself is supervising the national ICT Task Force and has given more importance on recognizing challenges to implement nation-wide e- Governance. Government has started several pilot projects in various sectors and the Government of Bangladesh is getting significant foreign co-operation in terms of financial assistance and technical collaboration [129]. As a part of this, Bangladesh has built up their ICT sectors dramatically from almost zero position in the last eight years although the country has not yet achieved the goal. To achieve the goal, Government of Bangladesh has to overcome several barriers. During my fieldwork, the following barriers has been identified that are challenging the success of Telemedicine Services.

4.1 Poor Infrastructure

Due to absence of modern transport infrastructure and communication, a large area of Bangladesh remains inaccessible. It is often expensive to travel from rural area to urban area. Therefore, huge disparity in healthcare distribution between rural and urban areas has been observed. Even health professionals do not want to stay in rural areas because of poor healthcare infrastructure. As doctors are unavailable in rural areas, rural inhabitants often have to depend on "quacks" who are not qualified to diagnose diseases or prescribe medicines. In addition, unskilled people are selling and prescribing medicines in local pharmacy. Authorities cannot control such malpractice due to poor monitoring infrastructure.

Load shedding of electricity is one of the principal problems in Bangladesh. Even and continuous electricity supply is necessary for maintaining information and communication

technology related equipment. Some rural areas have still no electricity access. Without electricity, it is not possible to establish connectivity. Government has now taken some initiatives to establish power plant project to improve electricity supply.

4.2 Government's policy and funding

Building local and vital structures, developing transport infrastructures, buying and installing ICT equipment require massive funding. Any technology in its primary stage needs care and support. Success of implementation mostly depends on Governments planning and funding. The technology should be applied and adopted in a smaller user group in the initial phase and it should be gradually expanded based on the gained experiences by using the technology [25]. The logical steps that has been suggested to determine the place of telemedicine in the developing world would be [130]:

(1) To identify potential telemedicine projects

(2) To carry out properly controlled pilot projects in order to demonstrate technical feasibility and to count the benefits to the healthcare system

(3) To calculate the costs of large-scale deployment

It had been tried before to implement large-scale projects without any planning and obviously, those projects failed due to improper planning and lack of specific TMS implementation strategy in Bangladesh. However, without Government's cooperation and supervision, it is not possible to introduce new technology in healthcare sector as only the government has the resources and the power to help. A developing country like Bangladesh that is still struggling with its huge population and poverty has economical limitations. It is difficult for Government to invest massive fund in introducing new technology and it is risky as well. Government needs efforts from all the sectors, regional, national and international levels to implement an effective telemedicine service in the healthcare sector.

4.3 Internet connectivity

Many of the healthcare centres and hospitals are out of internet connections. If they have, connectivity and speed is very slow although Bangladesh are now connected with high -speed fibre optics connection. Therefore, healthcare professionals do not have access to internet during their work time. They do not even have enough computer or laptop facilities. Most of them are using internet with the help of their mobiles. However, it is still expensive to use mobile internet in Bangladesh.

4.4 Internal network / Intranetworking

Internal network between healthcare service providers has not yet been established due to lack of human resource, supporting technology and environment, software and hardware. As a result, exchange of patients' information, laboratory reports and other administrative information between them is totally paper-based and time-consuming. To implement TMS, internal network improvement is essential to have borderless information exchange.

4.5 Security and ethical issues

Different types of information both secret and open can be accessible through telemedicine services. Employees who are working within TLM projects may misuse the accessibility and so, there is a chance to violate privacy issues. Especially female patients are often worried about their privacy and safety when they are receiving telemedicine services e.g. videoconferences. Hence, they are reluctant to take TLM services and still have faith on face-to-face consultation.

4.6 Unawareness

In the traditional health service system, doctor examines physically the patient and this examination along with consultation gives mental satisfaction to the patient. People believe that without physical examination it is not possible to get better healthcare service. They are not aware how the new technology will work and how effective it is. Many of them think that TMS is too expensive and unreliable. Government has not yet completely able to aware people about TMS in rural areas. Illiteracy and poverty are also another factor that Government has to overcome.

4.7 Perspective of medical practitioners

Physicians, who should play a vital role in TMS, are not yet fully convinced and familiar with this new technology. They are not enough confident when diagnosis is made over teleconsultation without physical examination. They prefer to face-to-face consultation. The reasons, may be, most of the services are provided free of cost or they are not motivated enough. Local and rural doctors often resist TMS system, as they are worried about their professionalism.

4.8 Lack of skilled or trained work force

All interviewees has immensely mentioned about lacking of skilled work force especially in IT sectors. There is no separate Telemedicine department or ICT department in Rangpur Medical College and Hospital. Therefore, it is not possible to train healthcare professionals on ICT system and healthcare professionals are not confident enough to use the new technology. Not only in Rangpur Medical College and Hospital but also all other healthcare centres and hospitals do not have ICT department. In addition, very few specialists have academic background on Telemedicine and e-Health.

At present, Government is trying to overcome these problems. Several workshops, seminars and projects are being arranged through Directorate of ICT. Physicians, policy makers, telecom and ICT specialist are now being included to promote eHealth, telemedicine and associated fields including research, development, practical applications and initial and supplementary training.

CHAPTER SEVEN

CONCLUSION

Health and wellness are vital to our lives and are acting as major determinants of quality of life. The efficient delivery of effective healthcare is a key societal objective when especially provided progressively with limited economic resources and with modern technology. The technology and health science must come together along with health professionals to overcome barriers [131]. Efficacy and success of healthcare services mostly depends on the integration of modern technology in health science. Telemedicine can be a good example where modern technology and medical science are well integrated to provide better healthcare and to create a paperless world in healthcare system. Development of information infrastructure, computing technology and telecommunication networks are showing us hope to achieve these goals.

Telemedicine enhances the quality of treatment in underserved populations. A developing country like Bangladesh is struggling to ensure better healthcare along with specialist's health service to all of its inhabitants. Due to poor organizational and transport infrastructure, poverty and unawareness, a large group of population cannot access primary healthcare services and specialist's service and huge disparity in healthcare distribution in rural and urban areas has been observed. Telemedicine can act as a bridge between urban and rural areas and makes possible rapid diagnosis and treatment to patient who are living in rural areas. Telemedicine can be used not only for healthcare purpose but also for administration purpose. This research work carried out in a Government Hospital in Bangladesh to find out present condition of information infrastructure in the hospital, scopes and challenges of introducing telemedicine services.

Information and communications technologies (ICTs) can play a significant role in improving health care not only for individuals but also for communities. In developing countries, ICT can help healthcare sectors by providing modern, effective and user-friendly ways of accessing, communicating, and storing information. Medical errors can also be prevented with the help of ICTs. However, a good and effective network between technology and its participators from the human society is essential to have a productive ICT. Therefore, service providers should give emphasis on fruitful development of socio-technical network. It is

necessary to develop and expand ICT infrastructure as well. In ICT sector, Bangladesh has many limitations like poor infrastructure (e.g. transportation, electricity supply), inadequate funding, slow internet connectivity, and lack of skilled or trained work force. There exists weak socio-technical network due to lack of internal network, low security, unawareness among citizens, medical practitioners' non-cooperation or lack of confidence to use new technology and so on. If all of these and imminent challenges could be tackled, several telemedicine services would be implemented easily in Bangladesh. From my fieldwork, several scopes were identified for example, Biometric Identification System, Electronic Health Record (EHR), Hospital Information System (HIS), Laboratory Information System (LIS), Radiology Information System (RIS) and Picture Archiving and Communication Systems (PACS), E-Prescription, Computer-based Physician Order Entry (CPOE) System and Automated pharmacy etc.

Government of Bangladesh is now taking initiatives to improve ICT sectors and taking proper strategic plans, visions, effective monitoring and evaluation measures. At the time, Government is inviting private sectors to participate in ICT development. It requires all-out efforts from people, institutions and Government to create a strong socio-technical network or Actor-Network and to have advanced information infrastructures.

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APPENDICES

Appendix 1: Letter from Telemedicine Department

UiT
THE ARCTIC
UNIVERSITY
OF NORWAY

Faculty of Health Sciences/
Department of Clinical Medicine
Date: 02.12.16

The Director
Rangpur Medical College and Hospital
Rangpur, Bangladesh

Dear Sir,

Letter of support

Mr. Abu Mohammed Ferdous is a Master student in Telemedicine and E-Health at UiT – The Arctic University of Norway.

As part of the requirement for the M.Sc. degree, he plans to submit a thesis on the topic "Scopes and challenges of implementing telemedicine in a developing country like Bangladesh".

It is required that Mr. Abu Mohammed Ferdous applies for and receives the approval of Rangpur Medical College and Hospital as well as from the appropriate local Medical Ethics Board to collect data in the form of interviews and observation, and I hope you will support his application.

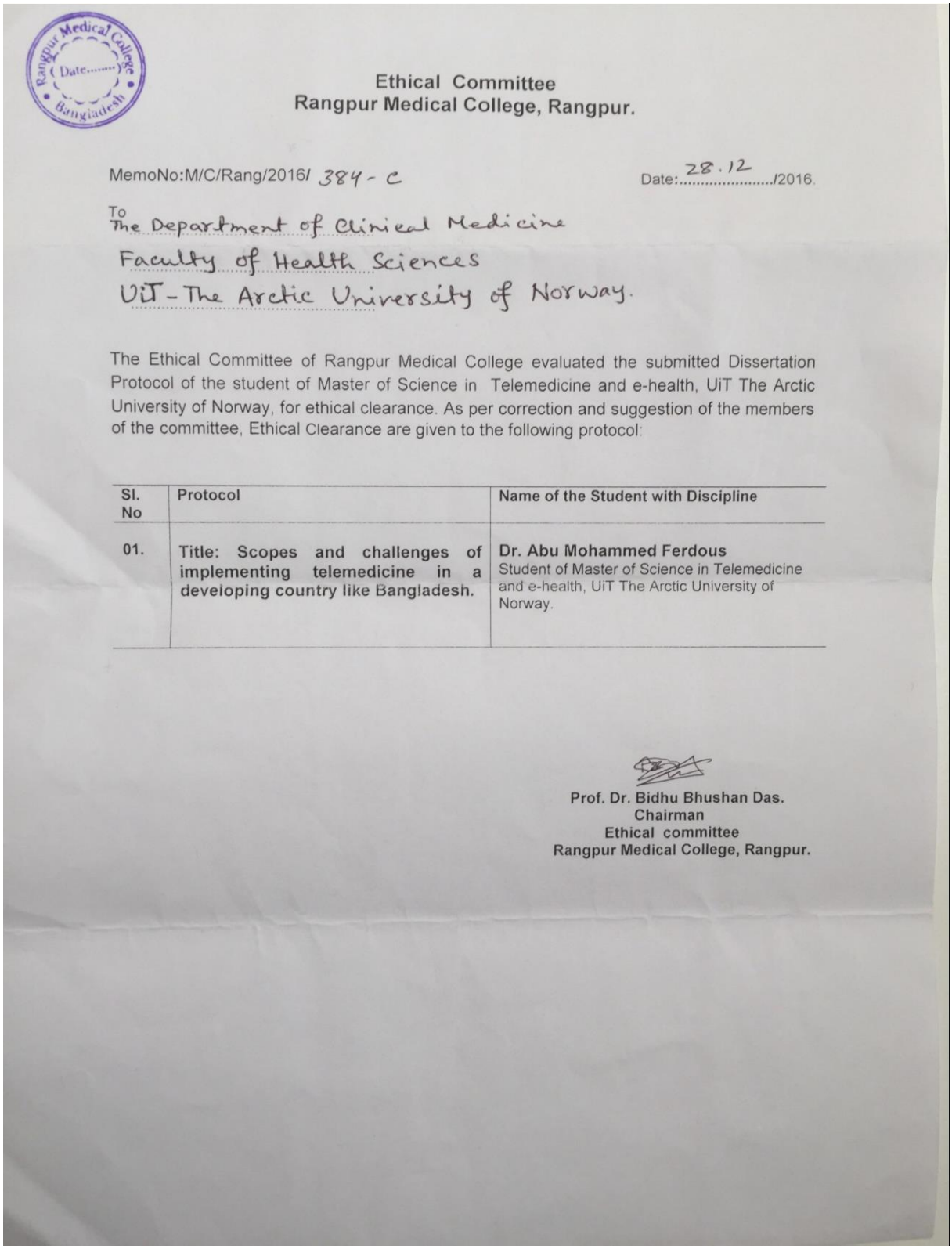
Thank you,

Sincerely,

Professor Rolf Wynn, M.D., Ph.D.
Department of Clinical Medicine
Faculty of Health Sciences
UiT – The Arctic University of Norway
E-mail: rolf.wynn@uit.no
Phone: +47 776 20888

PO Box 6050 Langnes, NO-9037 Tromsø / +47 77 64 40 00 / postmottak@uit.no / uit.no

Appendix 2: Ethical Approval



Rangpur Medical College (Date.....) Bangladesh

Ethical Committee
Rangpur Medical College, Rangpur.

MemoNo:M/C/Rang/2016/ 384 - C Date: 28.12 /2016.

To
The Department of Clinical Medicine
Faculty of Health Sciences
UiT - The Arctic University of Norway.

The Ethical Committee of Rangpur Medical College evaluated the submitted Dissertation Protocol of the student of Master of Science in Telemedicine and e-health, UiT The Arctic University of Norway, for ethical clearance. As per correction and suggestion of the members of the committee, Ethical Clearance are given to the following protocol:

Sl. No	Protocol	Name of the Student with Discipline
01.	Title: Scopes and challenges of implementing telemedicine in a developing country like Bangladesh.	Dr. Abu Mohammed Ferdous Student of Master of Science in Telemedicine and e-health, UiT The Arctic University of Norway.

Prof. Dr. Bidhu Bhushan Das.
Chairman
Ethical committee
Rangpur Medical College, Rangpur.