Introducing an e-Health card for Developing Countries: A case study of Bangladesh

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Abstract

Health care system is one of the important sectors in any country for its national interest. Bangladesh is one of the over populated countries in the world. Health care sector in this country is undeveloped and communication technology has not been introduced significantly to improve its quality of service. Growing use of information and communication technology (ICT) facilitates many countries to develop their ICT based e-health card system. At present there is no existing electronic health care system in Bangladesh. Our proposed idea carries the advantages of secure health care in Bangladesh by using ICT technologies. This thesis studies to find a solution for coordination and integration of the problems of current health care system in Bangladesh through case studies and literature review, then to give a solution to improve cost efficiency and control prohibited selling of medicine to un-prescribed patients. The aim of this proposed e-health card system is to improve efficiency, access and accountability of health-care services. The thesis presents research, design and implementation of e-Health card based solution that can be used to integrate and to coordinate with heterogeneous IT environment. Using the e-Health card all patient’s data, doctor’s prescription, patients present and previous health history could be accessible through PDA by the relevant parties. In order to conduct the thesis, we have followed qualitative research method which includes a survey among the potential parties and collecting relevant data from the existing e-health card system in different countries. It is notable that the research is funded by 1SPIDER. Based on the collected data we have proposed the new PDA based e-health care system.

The aim of the thesis is to propose a PDA based e-Health card system using smart card for patient identification which would improve overall health care system. Implementation of the system as well as identifying its pros-cons has been left as an open research for future work.

**Keywords:** e-Health card, Electronic Health Record, Smart card, PDA, Telemedicine, m-Health, IT Security.

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1 SPIDER - The Swedish Program for ICT in developing region (SPIDER) is a resource center for ICT for Development (ICT4D). Spider was established in 2004 and financed by the Swedish International Development Cooperation (Sida), with complementary funding from Stockholm University.
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<th>Full Form</th>
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<tr>
<td>e-Health</td>
<td>Electronic Health</td>
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<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
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<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
</tr>
<tr>
<td>m-Health</td>
<td>Mobile Health</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>MOHFW</td>
<td>Ministry of Health and Family Welfare</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>CMC</td>
<td>Comilla Medical College</td>
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<tr>
<td>MMC</td>
<td>Mymensingh Medical College</td>
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<tr>
<td>NBMC</td>
<td>North Bengal Medical College</td>
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<tr>
<td>MBMC</td>
<td>Mawlana Bhashani Medical College</td>
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<tr>
<td>MBBS</td>
<td>Bachelor of Medicine and Bachelor of Surgery</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Product and Service Solutions</td>
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<tr>
<td>PHR</td>
<td>Patient Health Record</td>
</tr>
<tr>
<td>EHR</td>
<td>Electronic Health Record</td>
</tr>
<tr>
<td>EMR</td>
<td>Electronic Medical Record</td>
</tr>
<tr>
<td>SMS</td>
<td>Short Message Service</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
</tr>
<tr>
<td>ROM</td>
<td>Read Only Memory</td>
</tr>
<tr>
<td>OS</td>
<td>Operating System</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>HCI</td>
<td>Human Computer Interaction</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>EUC</td>
<td>European Union Commission</td>
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<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
</tr>
<tr>
<td>IDB</td>
<td>Inter-American Development Bank</td>
</tr>
<tr>
<td>JAICA</td>
<td>Japan International Cooperation Agency</td>
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<tr>
<td>AUSAID</td>
<td>The Australian Government's overseas Aid Program</td>
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Chapter 1: Introduction

1.1 Introduction

Developing countries are facing difficulties for better healthcare system in order to reach out to remote and rural parts of the nations. Health care system is one of the major issues for developing countries and thus the information technology is becoming progressively more important now a days. Health is one of the most important and valuable things in human life. Every nation is aware of its public health. Each year millions of people die from basic health care deficiencies. Major public health threats face all from shortage of health professionals, insufficient health education, to out of date clinical treatment. Lack of access to accurate and health awareness is an important contributory factor. The social and economic burden of disease in the developing countries also motivated factors of health and economic development. But due to lack of governmental initiatives and political issues, it is not implemented yet in Bangladesh.

Now–a-days, health awareness is not only a growing trend among the nations but also among the individuals. The implementation of electronic health (e-Health) systems particularly in developing countries is now a challenge shared by United Nations agencies and health authorities (NGO’s) at the international, national and local levels. Over the past few years, health sector in developing countries increase vast development by using Information and Communication Technology (ICT) tools on an approach and methodology which holds the most promises for success (Sunyaev, A., Kaletsch, A., Mauro, C. & Krcmar, H., 2009).

Bangladesh is a developing country in the south Asian region, the total area of 144,000 square kilometer is a densely populated country with the highest density area of population of 948/square kilometer. Bangladesh has a population of more than 150 million and 80 percent of them live in rural areas. According to United Nations Population Fund (UNFPA) Bangladesh, though the poverty declined by one percent per year (59% in 1999 to 49% in 2001), more than 63 million people still continue to live below poverty line (ITU, 2008). Health care system is one of the big issues for developing countries. According to the World Bank, more than 80 million people have no access to modern health care facilities and services. Rural areas have limited health care system and facilities available compared to cities.

In this thesis work, after analyzing and surveying the current health care problems in cities as well as rural areas, we have proposed a PDA based electronic health (e-health) card system in order to improve the health care facilities in Bangladesh. Then we have focused on analyzing
the performance of the proposed health care system to eliminate problems in the existing health care system.

1.2 Background

Interaction between patients and physicians through the use of electronic tools for health related purposes has been broadly defined as “e-Health”. e-Health is considered the most appropriate situation to improve the quality and safety of health care with the use of latest information and communication technology to meet the need of citizens, patients, doctors, health care providers etc. The e-Health activities are becoming common and have the potential to improve health care sector in both developed and developing countries (ITU, 2008; S. Denise, 2003; e-Health News; Drury P; e-Health Europe, 2009).

According to the country’s infrastructure, currently health sector is mostly undeveloped and communication technology trends don’t affect the quality of the health care system to reduce several problems. We are going to propose an e-Health card infrastructure in Bangladesh to the local hospitals which will contain all the records of patient data, where a doctor can prescribe medicine for patients electronically into a machine-readable card. This PDA based e-Health card system contains all kinds of patient data, e.g. name, date of birth, sex, national identification number, photograph, doctor’s prescription and patient previous health history etc. and all the patients record will be reserved in secured database. Initially some pharmacies will have an e-Health card readable machine and they can access the database to see the doctor’s prescription to deliver medicine only for the appropriate patients. Since health service based on money and corruptions are involved in this sector in Bangladesh. As a result e-Health card will reduce and control prohibited selling of medicine to un-prescribed patients in the pharmacy and hospitals. We will try to establish our proposed model to help and benefit people in cities and rural areas to enhance quality health care system. Though there are a lot of constraints and difficulties, e-Health card would be a hope for providing effective solutions in health care sector in Bangladesh.

1.3 Problem Discussion

There are several problems in health care sector in Bangladesh and it would be a hope to overcome the problems using ICT facilities such as e-Health card. According to Bangladesh Bureau of Educational Information and Statistics, the literacy rate for male is 49.6% and female 40.6% over seven years and literacy rate over fifteen years for male is 53.9% and female 40.8%. The total population of 76.57% lives in the rural area and 23.43% are in the
urban area. Most of the people in the rural area don’t even know much about the technological improvement over the world. Even the people who live in the rural areas are worried about the basic needs of their daily life; sometimes they depend on their local health facilitator who has no academic knowledge of medicine. Health care facilities available in the Government hospitals are having not enough seats for patients and there are always a lack of doctors, nurses, proper medical instruments and free medicines. Local pharmacies are selling medicine with or without prescription from the doctors. So the abuse of selling medicine that affects the general people suffering different diseases and young generations getting addicted which spread out over the country. Most of the doctors prescribe medicine on a hand written prescription paper and giving suggestion to make the laboratory test to the patients to verify their diseases. Mostly, patients lose their previous prescription and also the laboratory test report which will create problem to doctors to verify their previous diseases and to make decisions. At present in the cities, healthcare and diagnostic centers practice limited applications of electronic patient record mainly in the diagnostic services but having no share or access to their database in the local hospitals. Although the patients are paying a lot for their health services, they are getting less benefit from these health care systems and they feel that they are victim by themselves. As a result patients are mentally disappointed, isolating their important health record; suffering different problems and can not store their health record safely. (BANBEIS, 2006).

1.4 Research Problem

Introducing PDA based e-Health card system has been a challenging task for the developing countries like Bangladesh. At present, there is no such kind of system for performing electronic health activities and save patient data record in Bangladesh. So in this thesis, we propose a solution as e-Health card that can be effectively used to establish for all the citizens to change health care system of Bangladesh.

1.5 Research Goal and Purpose

The purpose of our thesis work is to find out how ICT facilities can improve the health care system by using e-Health card in the cities and rural areas of Bangladesh. Thus an e-Health card can play a significant role to save patients data record and decrease the corruptions of health care system. It will also provide easy to carry and access facilities everywhere in local hospitals and pharmacies, in the cities and the rural area of Bangladesh.
1.6 Research Objective and Scope of Work

The main objective of the thesis is to investigate the usability and to establish an e-Health card for the general people of Bangladesh. According to the discussion about the main problem and purpose of this thesis work, we have pursued the following steps to accomplish our main goal.

- Identifying major problems of health care system in the cities and rural area of Bangladesh by doing field survey analysis. Compare and ask questions to general people and people who are involved with health care sector for example- hospital doctors, nurses and staff etc.

- Doing methodical analysis about how to motivate general people to use the proposed e-Health card that could be helpful in the health care system and a benefit to them. Also we have focused on finding the way to reduce corruption in health sector and how it can be solved by using this e-Health card.

- Analyzing and comparing with e-Health card system in developed and developing countries with different case studies, we have figured out the key points about the lacking of developing an effective health care system in the developing countries like Bangladesh.

- We have investigated how the health care system would be efficient and less time consuming regarding patient’s treatment.

- Finally we have presented a design and framework of an effective PDA based e-Health card system using smart card which would be secured and highly efficient to provide health care service. Our investigation shows that it would reduce health care cost and prevent corruption in the health care sector of Bangladesh.

1.7 Research Questions

According to the problem discussion and purpose we could summarize our research question as follows-

a) What are the problems in the existing health-care system and their impacts on the mass people in developing countries like Bangladesh?

b) How to resolve these problems by establishing a convenient health care system?
c) How the PDA based e-Health card can contribute a vital role to decrease the current health care problems of Bangladesh?

d) Why it is more effective to use PDA rather than other relevant tools in the proposed system?

1.8 Research Methodology

We have carried out the thesis work following the qualitative research approach (Qualitative research method, 2011). In this case we have conducted the research work in the following stages:

1. **Data Collection**: In this research, relevant research data has been collected in two ways: i) investigating previous research work and existing e-health card system in different countries and ii) conducting a survey. In the first stage to identify requirement and environment, several research articles, journals and related works have been studied thoroughly. Then a survey has been conducted in some selective areas that reflect the real picture of the Bangladesh health care system. The study used the questionnaires to find out the impacts of e-Health card services to the citizens. The survey focused on the real scenario about the current health condition among the local people, doctors and nurses in cities as well as in rural area. Further interviews have also been conducted among the medical staff to understand the possible impact of the proposed system in the health care system of Bangladesh. More details about the data collection have been stated in section 3.6.

2. **Data Analysis**: Collected data has been further analyzed to resolve the existing problems in the health care system. These data has been used to design the proposed PDA based e-health card system. Various data analyzing tools have been used for data analyzing. More details about data analysis are depicted in section 3.7. In this research, the study has investigated the features of e-Health card services and finds the reality on impacts according to rural point of view.

3. **Designing the proposed system**: We performed a feasibility and field survey analysis about the current health care system in the city and rural area of Bangladesh. We have also investigated the existing health care system in different countries in terms of population, financial capability, weather, culture, and financial capability of the relevant country. The design issue of the proposed system is to develop a PDA based e-Health card system to resolve existing problems in the current health care system of
Bangladesh. More details about the proposed PDA based e-Health card architectural designs are stated in chapter 5.

4. **Analyzing the proposed e-Health card system**: After designing the system, we have analyzed the possible pros-cons. In this regard, we have presented some trade-offs in section 7.2.

### 1.9 Limitations

Bangladesh is a developing country and using ICT facilities in health sector is changing day by day. Although an e-Health card is not designed and implemented yet in the Government of Bangladesh. In this thesis, we propose a design model of e-Health card that has some limitations:

- This is a general solution and it is not implemented by software.
- The analysis is not based on the whole country, only covers some specific area.
- Only use specific hospitals and pharmacies in the cities and rural areas of Bangladesh.

### 1.10 Target Audience

The thesis work proposes nationwide for providing patient electronic health record services especially for developing countries where ICT infrastructure is improving gradually. This can be also beneficial for ICT based Research Company to improve health sector or Software Company which have an interest to establish a database as electronic patient record among other developing country.

### 1.11 Thesis Outline

In Chapter-2: Literature review has been presented elaborately, Chapter-3: describes Research methodology of this thesis. In Chapter-4: describes importance of ICT in rural and urban area of Bangladesh. In the Chapter-5: Implementation of the proposed model has been described elaborately. In the Chapter-6: & in Chapter-7: Evaluation of the Survey results and Discussion have been stated respectively. Finally, in Chapter-8 describes the Conclusion and future work.
Chapter 2: Literature Review

2.1 Extended Background

This chapter has formulated as extended background knowledge regarding this thesis. It has illustrated the consequences of e-Health and previous research related to the topic. We have studied and try to discuss different health care systems which are currently being followed in developed countries such as Germany, Denmark, Sweden, Austria and developing countries like India and Kenya. Then we have addressed the standard which are followed by developed countries and collect the important facts from previous research, which have been pointed out here. After that, discussed about the present healthcare condition in Bangladesh, the basic needs of healthcare system and general requirements to establish patient’s electronic health card record system according to the rural condition of Bangladesh have been discussed through rest of the paragraphs.

2.2 Definition of e-Health and Scope

Electronic health (e-Health) care system describes the application of ICT across the whole range of functions that affect the healthcare through the various existing solutions (S. Denise, 2003). e-Health can also be described as any electronic exchange of health related data through an electronic connectivity for improving efficiency and effectiveness of health care delivery (e-Health News, 2009). Health applications then became known as "Health-telematics" or "Telemedicine", and now "e-Health".

Telemedicine had made a remarkable progress since 25 years and it is a major component of e-Health. It enables administrative data exchange and transfer of medical images and laboratory results between healthcare center and physicians. The development of these recent technological progresses gives high bandwidths capabilities, storage and processing capacities, and high levels of security. Therefore it reduces costs and increasingly user-friendly features in overall situation. It is expected that by 2015 every citizen of our planet regardless of location and time will be able to access the necessary medical information to maintain or to pursue a treatment for his/her disease. So we can expect that the telemedicine in future will make a technological revolution for implementing and introducing new scope in healthcare sector which would be beneficial for the citizens (ITU, 2008).
2.3 Initiative from UN and Other International Organization

United Nations agencies and other international bodies dealing with health have a huge plan of action known as Millennium Development Goals (MDGs) which is right now a challenge and aim to reduce poverty and supporting development in health sector throughout the developing countries. They have found that e-Health sector is one of the main components in the development process since there is no health without development, no development without health. The World Health Organization (WHO), UNDP, UNAIDS, International Telecommunication Union (ITU), The World Bank, Global Alliance for ICT and Development (UNGAID), UNESCO, some private organizations and non-governmental organizations (NGOs) are driving forces behind e-Health initiative in developing countries. The following groups of players are coordinating in the field of e-Health (ITU, 2008):

- United Nations (UN)
- Government authorities
- Academic and research institutions
- Local health professionals and their associations
- Donors
- Non-Governmental Organizations (NGOs)
- Private sectors which is related to health and ICTs
- The media

2.4 Initiative from Ministry of Health and Family Welfare (MOHFW), Bangladesh

The e-Health initiative in Bangladesh started in 1998 when the Ministry of Health & Family Welfare (MOHFW) undertook the Health & Population Sector Programme (HPSP) to enhance efficiency of program implementation. The MOHFW is currently working with -

- Collection and exchange of health service data across all service delivery points, health managers at different levels, and officials at MOHFW to support monitoring of progress of health program and policy decisions.
- Conducting annual household survey.
- Telemedicine centers.
- E-records.
- Provide computers to the health managers in all national and regional tertiary hospitals to 64 districts.
• Ensure an effective health care system that responds to the need of a healthy nation, a health policy provides the vision and mission for development.

The MOHFW is currently conducting a project under the support of health metrics network to assess the Health Information System (HIS) of Bangladesh and develop a plan for future HIS in the country. This project will examine, along with other issues with Governmental and non-governmental organization, and planning how to introduce e-record systems in Bangladesh within short period of time (MOHFW-Bangladesh; Commonwealth Secretariat).

2.5 Health Care System in Developed (EU) and Developing Country

To better understand and find the main barriers for the implementation of information technology facilities in Bangladesh, we have studied and analyzed a well-structured and systematic e-Health care system from Germany, Denmark, Austria and Sweden as developed (EU) country; these e-Health care systems are developed and serving for more than 10 years and lots of changes were done since the system was started to use. After every five years, the advantages and disadvantage issues were analyzed for the better development of the system according to public interest. So this system could be a good example for the other countries that want to develop their own health care system and also to use information technology as the main tool behind the development. As a developing country, we have chosen to study the health information system of India and Kenya in a primary stage, because we have got some valuable and related information about their health information system (MedCom, 2006).

2.6 Health Care System: Developed (EU) Country

There are several pieces of research being conducted using patient’s e-Health card system in developed countries. A literature review was carried out to acquire an understanding of patient e-Health card record in developed countries and to learn from what had already been researched, how it had been researched, and to understand what are considered to be the key issues, especially the reasons and importance.

2.6.1 Germany

German healthcare system is one of the most expensive of other European Union countries. The German Federal Ministry for healthcare and social security launched the “biT4health” (better IT for better health) project in 2003. The project organized the patient’s data cards as token in prioritized applications. The application provides better services for patient’s safety
and others possibilities of health care securities by installing a health telemetric and telemedicine platform. After a while, in 2007 a nationwide telematics project called “Gematk” was set up in order to introduce the electronic health card in Germany for establishing health within a telemetric platform.

“The Gematik project infrastructure was divided in the central part, which consists of data centers with central databases and peripheral parts, with different services – e.g. in local physician’s practice, hospitals and pharmacies” (Sunyaev, A., Kaletsch, A., Mauro, C. & Krcmar, H., 2009). The connector allows the local physician’s practice systems and the card reader to interact, which are components of the peripheral part as well. This project is highly prioritized in security and telemedicine. We have observed that German healthcare system followed some good application, which are as follows (Sunyaev, A., Kaletsch, A., Mauro, C. & Krcmar, H., 2009):

- Patient centered card to use in kiosks, homes or any place.
- No secrecy between patient and doctor.
- Electronic health card contains microchip which helps to protect data privacy and security.
- Contains patient electronic health record (EHR) and cryptographic keys.
- It also contains obligatory data (e.g. health insurance, e-Prescription, drug interaction check) to use in voluntary application (e.g. emergency, medication history).
- Telemedicine or Tele monitoring.
- Aim is to save the administrative cost.

The advantage is that according to the business analysis, the health card technology will save about 700 million Euro in a year. Previously 25,000 patients die every year due to medication errors or wrong information. German electronic health card complies with the corresponding European health insurance card proposed in 2008 to implement in all EU member states (Sunyaev, A., Kaletsch, A., Mauro, C. & Krcmar, H., 2009; Bernd B., Peter P., 1996).

2.6.2 Denmark

Denmark has initiated a project named MedCom in 1994 which is the first project regarding e-Health care services. The main idea of developing the MedCom system was to provide information to all patients and health professional and about all prescribed medicine related with them. MedCom had targeted to fulfil their goals in five different steps and timeframe. These are as follows (MedCom, 2006):
• MedCom 1 - pioneer spirit and professionalism (1995-1996)
• MedCom 2 - implementation and consolidation (1997-1999)
• MedCom 3 - quality services and diffusion (2000-2001)
• MedCom 4 - adopt internet and web based technologies (2002-2005)
• MedCom 5 - realization of “Good Web Services” (2006-2007)

At the first stage of MedCom 1, the importance was prioritized to the establishments of national communication standards and those standards were indicated as the basics for proper implementation and maintenance of MedCom system. After the achievement of the first stage the second aim of the project was the massive dissemination of health network. But after five years of running a project, the developers indicated that the actual standards were not precise enough and so the Danish health system met a challenge at this point. In the last part of developing the project, massive effort was given for building a technical platform and a common structure of information for a future national internet health portal (MedCom, 2006).

We have also observed through studying that the idea is already fulfilled by the system, connecting to the Danish Medicines Agency’s prescription data server which maintains a list of patients’ records about the prescribed medication of each person from both hospitals and general practitioners. Danish health service and facilities is free of charge to all the legal residents. The most important system we found that the information flow between several actors in the system and especially in 9 areas of e-Health which are as follows (MedCom, 2006):

a) **E-booking**: Patients can book and see information regarding booking according to their needs for a specific doctor.

b) **E-prescriptions**: To maintain prescriptions electronically and information flow from primary care doctors.

c) **E-reimbursement**: The information flow from general practitioners (GP) to the public insurance.

d) **E-discharge letters and referrals**: The information flow between hospitals and specialists and physiotherapists.

e) **E-lab requests and results**: The information flow between the doctors and laboratories.

f) **E-pathology, microbiology requests and results**: The information flow between general practitioners, specialists and laboratories.

g) **E-radiology requests and results**: Means the request and results between GPs and hospitals.
h) **E-correspondence**: Means free text letters go between parties.

i) **E-municipality**: Means administrative and clinical messaging run between hospitals and community care centers.

So we have found that the above information flow between various actors is most important part of the Danish healthcare system.

### 2.6.3 Sweden

The Swedish health care system is government-funded and heavily centralized. The Ministry of Health and Social Affairs helps the Government offices who is responsible to cover health and medical care, public health, social insurance, policy for the elderly, child policy, social services and disability policy. The health care system in Sweden is financed primarily through taxes levied by county councils and municipalities. Sweden regularly comes top or nearly top of worldwide healthcare ranking position (eHealth Era, 2007).

Sweden is one of the advance uses of IT based central health care system which was established by an organization named “Carelink” in 2000. Since 2002, all hospitals and primary healthcare center have been connected via Sjunet with the joint telecommunication network dedicated to healthcare which was administrated by “Carelink”. Here a patient first goes to a health care center such as hospital or primary healthcare center (Vårdcentral) where the patient is identified with his Swedish ID card, after that doctor have a discussion with the patient and start finding his/her problem and prescribe medicines if necessary. The patient gets electronic prescription from the doctor which is accessible to all pharmacies named Apoteket (eHealth Era, 2007).

The overall aim of Swedish public healthcare policy is to create social conditions which ensure good health for the entire population. It is also established that improving the public health care of those groups whom are helpless to make treatment on their health is particularly important. The overall health care policy goals are: cost containment, cost effectiveness, high quality and equal access (eHealth Era, 2007).

### 2.6.4 Austria

Austria developed their health care system based on the IT support. Since 2005, the private sector doctors do their practice inside the nationwide electronic communication network. This e-Health card project is the long-term goal, which implementation of a decentralized electronic health record system. In this visualization, patient data will remain in hospitals, but made accessible to doctors in private practice and the patients themselves. The citizens of Austria have the opportunities to upgrade their E-card as a citizen card. However the patient E-card work as identification tools for patients, the administrative patient to check the
accuracy by the central social security database. All of the Austrian state hospital and doctors will have access to it to review the patient’s history (eHealth Europe, 2009).

An online portal with health information for the Austrian citizens will also be developed in the future, which gives citizens’ access to their individual patient data after e-Health card identification. Finally, a national medical document registry will be required to enable doctors to view the medical history of a patient and to access patient data, which will also be followed by international standard. The key applications of this E-card infrastructure will be nationwide by the year 2012, which include 4 major parts (eHealth Europe, 2009):

- An electronic medication history.
- An electronic radiology.
- An electronic laboratory data.
- An electronic release letter (when the patient is moving out from hospital).

Some of these applications are already undergoing, testing and which will be implemented soon (eHealth Europe, 2009).

2.7 Health Care System in Developing Country
Health care deliveries in certain developing countries in Asia and Africa regions have made considerable progress in e-Health within the context of national health-care systems. In this section, we have summarizes the experiences of e-Health care system in India and Kenya.

2.7.1 India
India is a huge populated country in Asia. The central government does not have a national health insurance policy but each state government has the responsibility for primary and public health-care delivery. Currently ICT in India is now self-sufficient in fulfilling their needs of hardware, software, connectivity and services. Thus e-Health makes the potential bridge between this gap to integrate into existing health-care delivery systems. Both public and private sectors are actively working for the development of e-Health sector in India (UNESCAP, 2010).

The main fields of e-Health rapidly developing in India which includes electronic medical records, internet connectivity based hospitals and electronic learning. Mostly the private and few of public sector hospitals have implemented electronic medical records and hospital computerization which is helpful to handle many patients within short time. In addition since 1999, Ministry of Health and Family Welfare, Ministry of Communication and information Technology, state governments in India and some tertiary level hospitals with specialties have
also taken initiatives in e-Health project and telemedicine activities which had been carrying out Tele-education and Tele-health care (UNESCAP, 2010).

### 2.7.3 Kenya

In 1994, the Government approved healthcare policy as a blueprint for managing and developing healthcare services in Kenya. For the rural people and to solve their health problems, the Ministry of Health in Kenya decided to decentralize their healthcare system in the whole country. The Ministry of Health (MOH) in Kenya covers public and private sector healthcare service to the citizens which include facilities for-profit and non profit NGOs. The public healthcare system involves with the following levels of healthcare facilities which include: national level hospitals, regional level hospitals, district and sub-district hospitals, health centers, and pharmacies. The Government has ICT policy and framework for healthcare sector which include: train medical professionals with computer operation, using the technology for telemedicine, research and training program. ICT infrastructure revealed that the majority of hospitals are already starting modern IT based financial systems. Most of the private and few public hospitals have fully networked but partly integrated systems with each other. Internet access is only available for administrative tasks, internal and external communications between departments and consultants. The majority of hospitals and clinics are still maintained patients’ diagnosis and treatment records manually (Dr. Muga R., Dr. Kizito P., Mr. Mbayah and et al., 2011).

The Ministry of Health has a plan to make all the patient records in a database system in all the hospitals and offices very soon. The main goal is to establish such a system that generates and utilize health information for different policy formulation, management planning, budgeting, implementation, monitoring and evaluation of services. By establishing healthcare information offices in all districts could be processed and a fair idea of the country. But the health information system faced many problems regarding data and information collected from different sources. Some problems are inadequate reporting tools of ICT, inadequate health records and information personnel, inadequate competency and capacity for the data analysis and management etc. It seems therefore imperative for a country’s healthcare sector to develop an ICT based healthcare policy that addresses the main technical challenges and opportunities (Dr. Muga R., Dr. Kizito P., Mr. Mbayah and et al., 2011).
2.8 Comparison and Analysis in Health Care System

2.8.1 Analysis of Existing PHR, EMR and EHR System in Developed Counties

Personal Health Record meets the need of the government health care system to initiate a better plan, execute, control and keep the electronic health records on the database. The observation says that the standards and interoperability of all countries suffer from the same issues due to the lack of infrastructure and health care standards in the common barriers to inter-system communication. "France, Sweden, Australia, Canada, the UK and the Netherlands are trying to standardize EHRs within their respective countries" (Steve, Joseph, Fhimss and et al. 2007 & Leonidas, Panagiotis and Barry, 2004).

Electronic Health Record (EHR) improves the patient’s safety through the use of paperless health records and in the same time it will offer more efficiency for the health bodies and the patients (Janice, RN, & Deborah, 2006). Every time nurses and physicians monitor patients and create their records according to the patient’s health observations such as X-ray report or diagnosis of the treatment plan. Doctors and nurses depend on the medical report generated by the lab technicians who work hard behind the scenes actively ensuring all records are properly identified, signed and kept in the file. The lab technician documents the entire patient’s data in the paper based format. Data input is not transparent for the patients, there might be some errors during the entry because of all the electronic data entry done centrally from the paper based observation or reports. This approach of documenting is much difficult and time-consuming and does not required feedback from the staff collecting data (Fraser, Biondich, & Moodley et al., 2005). The computer specialist need to work hard to give input of all the medical records by using different types of computer programs to manage and to analyze all the medical information. The accuracy of all this information is very important, so medical records technicians must pay strict attention to details. This work is not a satisfactory work for the medical authority but it is one of the big challenges to provide a high quality medical care system for the people.

"American Health Information Community Potential Breakthroughs" published in October 2005 describes the national health organization as the use of health information technology, where the technology produces a tangible and specific value to the health care consumer that can be realized within a 2-3 years period. The organization has defined three major categories of potential breakthroughs, which are PHR, EMR and EHR. Patient Health Record (PHR) works for the consumer medical records, health records locator and registration of demographic information.
Electronic Medical Records (EMR) distinguished by its scope, it is holding permanent documents and store all kind of information electronically about a patient’s physical, mental and social condition in primary, secondary and tertiary care (Leonidas, Panagiotis & Barry, 2004). Electronic Health Record (EHR) deals with the improvement of the transparent data from the consumer records; and it offers e-prescribing to control the quality monitoring or reporting, chronic disease monitoring, childhood immunization records etc. Patient Health Record (PHR) deals with a web-based technology with a number of dimensions; it makes a communication chain between patients and providers, improves the quality of efficiency of medical practice and increases the drug security. “On December 8, 2005 Web-based PHR technology that has been deployed successfully throughout the European Union (EU) and other countries” (Janice, RN, & Deborah, 2006).

PHR creates lifelong patients data where the service provider can modify and update the records through the internet access. Web-based PHR are increasingly available on the market, the technology provides high protection and security via encryption, distribution of data storage, authorization and authentication. All the records are created according to the patient’s personal diagnosis history; the documents into the record can be printed directly in PDF format from any application. Patients’ can be communicated with the physicians directly through the fax and they can upload the patient’s documents in the database. Based on the observation from the above description, e-Health card takes some role to implement in a developing countries health prospective. However e-Health card will provide secure, transparent and feasible services to the doctors, patients, pharmacy and other related bodies (Janice, RN, & Deborah, 2006).

2.8.2 Comparison between Developed Country and Bangladesh

In compare to some EU countries and Bangladesh, we have identified five major problems which are as follows:

1. **Education awareness**

Mostly people of the developing countries are illiterate also with health education awareness. But in EU countries, the people are mostly educated with less illiteracy problem. Health care facilities are very limited in Bangladesh, so in any emergency situation the patient are suffering the most. On the other hand in the EU countries, any patient can get instant help in case of emergency. They have well-structured health care system and also get health education from their school level.
2. **Web-portal health information**
In Bangladesh, there is no such website or web based portal for health information which contain lots of information on health and proper instruction on how to get the appointment of a doctor or about the symptoms of a disease. In the city areas, there are some private hospitals where they maintain their websites with patient’s previous history which is very important for further treatment and giving prescription to the patient.

3. **Technological structure and supply of electricity**
In Bangladesh, there is no good infrastructure for the technological advancement as well as poor internet connections in the cities and in the rural areas. The network infrastructure is very bad and load shading or supply of electricity is found often, and they are maintained only in the city areas. Though now-a-days a significance change happened in the mobile technology areas and it has reached almost all parts of the country. But in a developed country like Germany, Denmark, Sweden, Austria they have good technological infrastructure and smooth supply of electricity which is the basic tool for the creation of electronic health care system and to stabilize the network system for whole the country.

4. **Poverty and social in advancement**
The people of Bangladesh are very poor and don’t have enough education and maturity to adopt the new things earlier. They are not familiar with the technical things and not ready to take the advantages of new things because of conservatism in some cases. So at first they should be convinced about all the new things and how they can benefit by these. But in case of European countries, the people are very much familiar with internet and educated enough to grab the new things. So there are several barriers for the implementation of e-Health card system and development in health sector usually in the village areas.

5. **Vaccination and awareness for health diseases**
The vaccination program is very important for all the people especially for the mothers and children for health diseases. In Bangladesh, vaccination program is running more accurately than past years and several international organizations are involved in this program to ensure the health of mothers and children. In the health complex of rural areas computer is now used for various report generation regarding how many children and mothers have been vaccinated. However in developed European countries, people are already aware of these problems and have resolved.
Chapter 3: Research Methodology

3.1 Study Area

The study has been conducted in a developing country Bangladesh. It is located in South Asia; geographical location is “20°34' to 26°38' north latitude and 88°01' to 92°41' east longitude. Maximum extension is about 440 km in E-W direction and 760 km in NNW-SSE direction” (Islam, Ahmed, Chowdhury and et al., 2006) the area is 147 570 sq km. the country shares maximum border with India. Bangladesh has 6 administrative units (Divisions) & 64 districts. The administrative units are Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet. The population of Bangladesh is 123.1 million, density 834 people per square kilometre, male and female ratio 106:100. The urban population of Bangladesh is 28.8 million and the rural population is 94.34 million. In this highly density people’s country, health is an important issue to consider. It is found from the reference data that there are, “1,289 Hospitals of which Upazila Health Complex and Rural Health Complexes are 398; hospital beds 43,143; registered physician 30,864; households per physician 674”(Islam, Ahmed, Chowdhury and et al., 2006) and the below map represent a total country geographical overview.
3.2 Selection of Study Area

Dhaka, the capital city of Bangladesh, has been selected for the proposed research work. This city is selected as an appropriate place to introduce the e-health card system since the density of population is very high and the general people are deprived of adequate healthcare service. For this reason, respondents from different medical colleges of the country have been selected to complete the survey for the research work. It is essential to take the potential doctors’ and patients’ views and suggestions regarding the PDA based e-Health card system to find the possibilities to introduce the proposed system for the improvement of better healthcare system.

Figure 1: Study area Map-Bangladesh (Islam, Ahmed, Chowdhury and et al., 2006)
3.3 Research Methodology Flowchart

In order to carry out the research, we have followed the steps stated in the Figure 3.

Figure 2: Dhaka city base map [Roy & Masum, 2008]
We have followed the qualitative research method (which reflects in the Figure 3) to carry out this research work. According to the Figure 3, we have reviewed necessary literature and existing similar system in different countries which are stated in chapter 2. Depending on gathered data from literature review we have made plan to carry out the research. The next step for this research was to data collection. In this step we studied existing e-health care system in different countries, various articles from different journals and conference papers.
Then we have conducted a survey to identify the potential problems in the existing health care system in Bangladesh. Then we have sampled the collected data. Analysing this collected data (studying from existing system in different countries and survey data), we have proposed a PDA based e-health card system. Then we have analyzed the possible trade-offs (that might be arisen during implementation) in order identify the challenges for the proposed system as in section 7.1 and 7.2. In this research we have also proposed some alternative approaches to resolve these challenges as in section 7.3. For example, a special device can be given to a physically disable patients (e.g. a patient without hand or dumb) in order to use the proposed PDA based health system. Therefore this type of circumstances should be taken into account during to the implementation of the proposed system.

3.4 Selection of Respondents

The respondents of this study were the doctors, students, internship doctors of different medical college hospitals in Bangladesh. Among 20 medical college hospitals of Bangladesh, we have selected 4 medical colleges - Comilla Medical College (CMC), Mymensingh Medical College (MMC), North Bengal Medical College (NBMC) and Mawlana Bhashani Medical College (MBMC) and each medical college represents the sampling unit of the research. Respondents from the corresponding medical colleges have been selected by using simple random sampling process and the sample size of this study was 80 where 20 of them were taken from each.

3.5 Data Sources

To carry out the study sources of both primary and secondary data were used. The main respondents under this study were the doctors, students and internship doctors of different medical college hospitals in Bangladesh. Secondary information was collected from the various reports, research journals, newspapers, related books, articles and online sources.

3.6 Data Collection

Required information about the study area was attained by preliminary field investigation. Respondent’s perceptions and suggestions were taken from the selected medical colleges in Bangladesh to fulfil specific purpose of the research within the particular time. To introduce an e-health card system in Bangladesh, sample survey was conducted in different medical colleges among the 80 respondents who were doctors and internship doctors. Simple random sampling procedure was used for the research. Primary data was collected using the
interviews of the respondents from selected medical colleges of the study area. The methods of data collection were survey and questionnaire.

3.7 Data Analysis

Findings was processed and analyzed by using both descriptive and inferential statistical data by using SPSS, MS Word and MS Excel. The tools used for data analysis are as follows:

i. Code book
ii. Tabular form
iii. Percentage, and
iv. Graph

Based on this thesis, the following figure 4 shows a complete structure diagram during the process of methodology of data analysis.

![Data Analysis Flowchart](image)

Figure 4: Data Analysis Flowchart
Chapter 4:

Importance of ICT Healthcare in Rural and Urban Areas of Bangladesh

In this chapter, we have described the current health care system and usage of ICT in the rural and urban areas in Bangladesh. The first ICT policy of Bangladesh was formulated in 2002 and which has been adopted by the Government in 2009. The vision was to identify the objectives and established rural healthcare development to ensure quality healthcare to all citizens in Bangladesh. The key features of the National ICT policy in healthcare was (MOSICT, 2008):

- “Improve management of healthcare delivery system.
- Improve community awareness and access to health care facilities for all including difficult to access areas, with a special emphasis on child and maternal health.
- Ensure quality assurance of health care services.
- Enhance capacity of National Health Service Delivery System.”

The chapter also describes current e-Health solutions, issues and challenges between rural and urban health care system in Bangladesh.

4.1 Current Health Care Condition in City and Rural Areas

In this part, we have extracted the information from the World Health Organization (WHO) about the current health care system of Bangladesh. The country has done great progress in recent times particularly in health care sector. A major constraint identified towards reaching national health goals is the issue of shortages in the healthcare employees and the unequal skill mix (World Health Organization, WHO).

The Ministry of Health and Family Welfare (MOHFW) is responsible for providing primary health care services in cities, districts and village based rural areas in Bangladesh.

4.1.1 Problems in the Existing Health Care System

There are several problems in the existing health care system; few of them are given below:

- Lack of health professional and medical staff.
• Misuse, mismanagement and corruption in government and non-government bodies.

• Abuse of selling illegal medicine in the pharmacies.

• Patients have to wait long queue to visit with doctors and making diagnostic test for their health problems.

4.1.2 Impact of the Health Care Problems

Followings are the most common health problems especially in the third world countries like Bangladesh.

• Increasing death rate.

• Suffering various diseases.

• Increasing disabilities with new born babies.

• Increasing expenditure.

• Misuse of drugs.

4.2 Usage of ICT Facilities in Rural Health Care

Basically, health care information system is not in a proper shape in rural area of Bangladesh. There is very limited application of ICT facilities and the rural health care information system requires a lot of development. In health care system, there is not enough use of computer application and internet facilities. The hospital doctors and nurses always keep the patient information manually. They do not maintain any modern health care information system that contains database, software application, online medical training for nurses etc. Though using ICT in health sector is a major issue today and there is some projects going on which already started to use ICT. Some current projects are-

• First national e-Health project Integrated Rural Health Information System (IRHIS).

• Exploring the socio-cultural barriers and determinants of women's health status in rural Bangladesh the project funded by the international development research center.

• ICT pilot project for rural area in Bangladesh is a successful implementation of a sustainable ICT based project.

• Department for International Development (DFID) health systems resource center is working in partnership with Bangladesh Government in the improvement of the structure and operation of the health sector in rural and city areas.
4.3 Current e-Health Solutions

There have been many initiatives taken to develop e-Health solutions by using ICTs in Bangladesh. Some of the e-Health solutions used now-a-days are described by the following sections:

4.3.1 Mobile Phone Health Service

This service was launched in May 2009 in most of the upazila hospitals (418 Nos.) and district hospitals (64 Nos.) in Bangladesh. The service has been provided a mobile phone to act as a local call center for delivering medical advice 24 hour to the citizens who make calls to the mobile phone. The numbers of the mobile phones have been circulated in the communities using local channels. Doctors on duty in the hospital remain available to answer the phone call. The service is free of charge and has a number of benefits of wider coverage in the village that reaches to everybody everywhere. As a medical doctor is available within distance of a phone call all round the clock for free, people have a better option to avoid unqualified healers. This mobile phone health service also helps patients to avoid unnecessary visits to health centers, which indirectly benefits the health centers and doctors to provide better attention and support to the patients who physically visit the health centers. Being local the service is also culturally approachable and customizable to local situation. Due to the comfort of people in getting medical advice easily and quickly, local government is trying to roll out mobile phone health service will start up to community clinics (Directorate General of Health Services -DGHS).

4.3.2 Telemedicine

Telemedicine defines as the use of telecommunication technologies and interactive media to provide health information and services over long distances (T.L. Huston and J.L. Huston, 2000). Telemedicine can be used for remote diagnosis and treatment of patients in real time consultation and continuing medical education for health workers. Applications and technologies used in telemedicine such as video conferencing, audio, data exchange, store and forward technology and web systems. Infrastructure for telemedicine and differs from satellite communications, wireless communications for fixed lines (Debashish Das, 2005). Recently some organizations are working on telemedicine and e-Health by following some prospective manner to establish the facilities in Bangladesh. The telemedicine service providers offer the following services (Debashish Das, 2005):

- Commercial services focusing patient’s demand.
- Digital data storage for doctor’s usage.
• Medical video-conferencing to home or abroad.
• Various follow up cares for patients.

From the above services, following benefits can be accomplished:

• Overall Health care service (including treatment related travelling, accommodation, investigation and consultancy) would be cost effective.
• It offers friendly environment during treatment period.
• Prompt expert opinion served to all patients including from the remote and isolated areas.
• Remote area doctors do not feel helpless.
• Faculty development of the physicians by the expert.

So it is expected that people will remain in even better position about getting health care without need for traveling to long distance. The telemedicine dream of the Ministry of Health and Community clinic project is to expand the service up to community clinics in rural areas. For this purpose, it is planned to provide mini laptops to community clinics, where health workers will use those to help patients and consult upazila hospital doctors by video conferencing. The laptops in the community clinics will be used for multiple purposes, e.g. telemedicine, updating community health data, health education of people, training of health staffs, communication, and internet browsing (Debashish Das, 2005; Directorate General of Health Services -DGHS).

4.3.3 Patient Health Records

It is very important to keep all the patients’ health history records, but very few of them are using the system and mostly in the city areas. It started since 2-3 years and currently in the Dhaka city most of the private clinics and hospitals, e.g. Apollo Hospital, Square Hospital, Medinova clinic, Popular diagnostic center are using their own database system for patient health records to keep it for their future purpose to find out patient previous health records easily (Directorate General of Health Services -DGHS).

4.3.4 m-Health

m-Health can be defined as the application of emerging mobile communications and network technologies for health care systems. It involves the use of mobile computing, medical sensors, and communications technologies for health care. Successful implementation of m-Health makes the right information available at the right place, at the right time, and in the correct form.
The Directorate General of Health Services (DGHS), Bangladesh launched SMS based pregnancy advice m-health services in March 2010. On registration via mobile phone SMS, pregnant mothers would receive appropriate periodic antenatal, safe delivery and postnatal care advices through SMS. Currently four mobile operators TeleTalk, GrameenPhone, Banglalink, Aktel have developed and are working this service. Patients can make text message in Bengali and voice mail are also being considered to add to this pregnancy care advice. There are large numbers of health workers under the DGHS to carry out promotional activity for this service. The SMS advice for safe pregnancy will contribute through improving neonatal and maternal health. So we have found that m-Health has its broad-range of communications advantages which is potentially useful for life saving applications. Besides, wireless technology will play a vital role in the future health care delivery model for its increasing popularity, availability and flexibility (Directorate General of Health Services, DGHS).
Chapter-5

Proposed e-Health Card Architecture Design and Implementation

In this chapter we have presented the components of the proposed PDA based e-Health card system. We introduce to modern equipment such as smart card and PDA in the proposed system. Therefore we have stated how these two devices would influence to eliminate the limitation in the existing e-Health care system in Bangladesh.

5.1 Smart ID Card

A smart ID card combines integrated circuits, which can process data. The card has ability to receive inputs by the application and able to deliver an output, here we will consider a microprocessor cards and it will contain memory storage capacity. Integrated Database Management System (IDMS) is the heart of smart ID card; a smart ID card maintains the data repository and a software system. A smart ID card provides secure service to an organization to support identity based applications such as sign-on and authorization management. IDMS application has two modules: i) physical access-control and ii) logical access-control system. The smart ID card controls physical access to secure facilities and the logical access of Information Technology systems such as web servers, database servers and workstation, and application (Rick, Susan and Ramaswamy, 2007). Smart ID card is a fundamental device that allows information storage and processing. The micro controller has central processing unit, where RAM is used to store executing programs and data temporarily, while ROM is used to store the OS, fixed data and standard routines (Walid, Mohamed and Moncef et al., 2006).

5.2 Architectural design of Smart Card

Smart card technology mainly uses in four major areas e.g. banking, telecommunication, high security and social service. Based on the thesis nature the proposed idea will work under the social service, where the social service represents a set of branches of medical services, delivery service of professional medical history, etc. (Schubert, Michel & Reichl, 1996). Smart card is a plastic card embedded with microcomputer chip. Figure-9 represents the dimensions of a smart card regulated to ISO-7810 and 7816-2 standard which is also the same standard of other identification card such as National identification card, health card, driving license, etc. Our proposed e-Health card will consist of 3.375 inches wide by 2.125 inches high and the average thickness would be 0.76 mm or 0.02 inches. The card can easily be carried inside a wallet.
Some of the major fields of the e-Health card that includes (Klaus, 1992 & Smartcard News, 2010):

- Patient card number (not exceed 16 numbers)
- Date of birth (not exceed 08 numbers)
- Card control number (not exceed 06 numbers)
- Name (not exceed 26 characters, consist of 2 different field, e.g. family name and last name)
- Picture (shows the card holder picture)
- Bar code (works in some special cases)
- Extra data, such as signature field, validation date and information about the card provider.

There are three parts of the standards they are [ISO-8,9,10] at present they are published by the international organization for standardization and international electro technical commission are the basic reference of such kind of smart card" (Klaus, 1992). The card has magnetic stripe located into the opposite side of the card. The dimension of e-Health card is as same as credit card. Figure-9 represents the dimensions of the smart card as well as it's height, width, the chip, and other components. The proposed e-Health card electrical interface performed with 8 different contacts as C1-C8. In the figure 10, represents the electrical interface inside the smart card.
The card module will follow according to ISO/IEC 7816-2 standard that contacted with the VCC (Power supply), RST (Reset), CLK (Clock), RFU (Reserved for Future Use), GND (Ground), VPP (Programming Voltage) and I/O (Input/output) (Smart card News 2010). The smart card works based on the chip and the procedure runs between card and interface. Our proposed PDA based e-Health card is also followed with the above described architecture environment and it will consist most of the updated feature followed by the ISO standard.

5.3 Smart Card Based Health Care System

Now a day, smart ID cards are using various platforms. The use of ICT offers multiple accessibility and exchange essential medical information to make it more reliable to the patient care. But the ICT facilities in the health care system of Bangladesh have not been introduced yet. However a PDA based e-health care system with smart card can make significant change in the health care services. People can get access to the health care services very easily. Very few developing countries have such kind of e-health care system. Many developed countries such as UK, Germany, Bulgaria, and Austria have their own e-health care system based on smart card (Bernd and Peter 1996, e-Health News, eHealth Europe 2009). "These systems are highly autonomous in terms of their ability to integrate and share health information among medical staff in hospitals or clinics" (Walid, Mohamed and Moncef et al., 2006). Smart ID card as one of the ideal media, it has ability to store the critical medical records of an individual. This smart card will be used by the doctors and other medical staffs to access patient’s history.
5.4 Advantages of Smart Card in e-Health care

After evaluating the Smart ID card, we have found huge possibilities to reduce healthcare operating costs. Transparency using the smart card in health care system could achieve trust from the patients in terms of the treatment queue, expense, diagnosis diseases, doctors and pharmacist’s accountability, etc. Smart ID card facilitate the electronic transfer of the patient confidential information such as referral letters, patient records, different types of report, doctor prescriptions, and high-resolution digital images, appointment schedule, medicine history, patients records and so forth. Followings might be the advantages of using smart card in the proposed system:

- It is more secure to carry from one place to another
- Change public’s habits towards a wider use of electronic health card
- It will make a wall to reduce the abuse of medicine and corruption in health sector
- To motivate people to use the proposed e-Health card properly and take the advantages of it and easy to access to the patients more effective
- To enhance the quality of health care system through the proposed e-Health card technology
- It has ability to store data and to process the information
- The card provides sequential access to one machine by multiple users.

5.5 Personal Digital Assistant (PDA)

PDA is a handheld mini computer which can be carried easily anywhere. It has a small screen and keyboard. It has achieved popularity, since it supports maximum functionality of a laptop. In the proposed e-Health card system we introduce PDA instead of PC or laptop for accessing the e-Health card database. There are several reasons for choosing PDA which are stated below:
a. **Size of the device**: Size of the PDA is much smaller than an ordinary PC or laptop. Because of its size doctors or other relevant persons can carry it easily.

b. **Storage capability**: The latest PDA’s are offering enough space to implement in the proposed e-Health card system. Doctors can make their appointment calendar with patients and store patient’s information in the PDA. Moreover, doctors can also store patient diagnostic reports in PDA for analysis the patient diseases.

c. **Portability of the device**: Using PDA it doesn’t require to use paper for storing data. Users of PDA can access their data anywhere and anytime. For example, electricity failure is a common problem in Bangladesh and in that case using PDA one can easily access the patient and other relevant information.

d. **Communication with central database**: Most of the PDA supports all kinds of internetworking such as GPS, Wi-Fi, 3G, 4G etc. Therefore, it is comparatively easier for an entity (e.g. doctors, pharmacist, etc) based in remote area to communicate with the central e-Health card system.

e. **Security**: Data or information can be lost from the PC for malfunctioning of the software or hardware, and breaking or stealing the PC. In contrast PDA is carried by its holder, which means reducing the mentioned risks for loosing information.
f. **Expense:** Use of PDA in the proposed system is comparatively less expensive than PC or laptop, since PDAs are durable and maintenance cost is about zero. Therefore, we designed the proposed e-Health card system based on PDA.

### 5.6 Central Health Database Management System (CHDMS) of e-Health Card

The Central Health Database Management System (CHDMS) explores the connectivity with different service center, where the physician and other service units will have the rights to use on customer data through the e-Health card system. The platform performs several stages to provide a better e-Health card service to the citizens of Bangladesh. The aim of this thesis is to present a PDA based e-health care system which would reduce illegal selling of medicine and create transparency among the doctors, other medical staff as well as pharmacists. The proposal of the system has been designed for service based oriented platform. Each platform plays their unique role and maintains a connectivity chain network with the other e-Health service bodies. Each section has their own trained employees, where every employee/technician will take their own responsibility and work with the specific service section to provide a transparent health service to the citizens of Bangladesh. The e-Health card service center units are responsible for the customers inquires, uploading reports and giving emergency supports. In the design section we have suggest five different units of the service center, where each section has their own responsibilities and need to provide service to the customer. At the same time service center needs to upload the customer data in their database and restore it into central health database unit server. The e-Health card service center units perform their responsibilities which are as follows:

#### 5.6.1 Hospital Information Center Connectivity Unit

The hospital connectivity unit is one of the major units for the patient to get connected with the physician by checking either the patient’s e-Health card or with the card reader/PDA. It is notable that the patient needs to say the specific health disabilities to the information center. The information authorities choose the physician according to the patient’s disease. The service divided in two sections, an emergency service and the other one is normal service. It is one of the preliminary stages where patient have the opportunities to get communicated with the physicians. The patient need to contact with the hospital information desk (in figure-6) presenting the cycle of the information connectivity. The information desk authorities will take the card from the patient and check the patient identification with the e-Health card and
do the others official formalities to get a proper health service. The information desk authorities will update and upload the patient data in the hospital database.

5.6.2 Physician Connectivity Unit

Physician Connectivity Unit (as presented in Figure -6) is the second e-Health care unit where the patients get connected with their physicians. The patient will be informed from the information desk about their physician. The physician then confirms the patient’s identity by his/her e-Health card ID using either the card reader or PDA. After consulting with the patient about his physical problem, the doctor will upload an electronic health prescription into the central health database. If the patient needs any diagnosis, the physician will refer the patient to diagnostic center. Besides, physician can get the patients’ previous health information and disease history. According to the previous health data and current diagnosis data, physician prescribes the patient.

5.6.3 Diagnostic Center Connectivity Unit

Diagnosis is one of the important steps of any Health care system. This unit assured transparent and reliable experimental report of the patient’s health. The diagnostic center pathologist will check the physician’s suggested test for the patient. After confirming patients’ identity with the card reader or with the PDA, diagnostic lab technician will perform the test. In this case, when the lab pathologist accesses the patient database, he/she can see the physician’s instruction about the lab test. After finishing the diagnosis, the lab unit authority will report the test results (including the image) to the physician, as well as uploaded this report into the central health database server through the Diagnostic Center Connectivity Unit. Figure-6 represents how the diagnostic unit would work inside the e-Health card connectivity.

5.6.4 Pharmacy Connectivity Unit

“In reality, there is no mechanism or legislation exists in the country for assessing the competence of prescribing medical practitioners. No legal action is taken against them even if a serious mistake leads to a fatal outcome” (Islam, 2006). A developing country needs a better health care service for the patients, where the health documents can save in a secure database which will be accessible by the pharmacy. It will decrease the drug abusing and will reduce corruption and selling of medicines without prescription. In our proposed approach, when a patient comes to a pharmacy for buying the medicine, pharmacist will verify the patient with his/her e-Health card using the card reader or PDA and identify the patient. The proposed system would help the patients from buying low branded medicine, since the
pharmacist sell the medicine according prescription uploaded in the central database. Besides, the pharmacists will not have any access to the patient’s drug history from the central database and will be bound to sell the drugs suggested by the authorized physician. After giving medicines, the pharmacist will update the patient’s database stating name and quantity of the medicine. As a result Government would have the control over the pharmacist regarding their illegal drug selling and price tempering. Figure-5 illustrates the way of pharmacist connectivity unit and how it works inside the e-Health card service using card reader or PDA. This implementation will make a strong wall against the addicted people and save the young generation to stop taking illegal medicine.

5.6.5 e-Health Card Service Center Connectivity Unit

The e-Health card service center will help the citizens to learn the advantages of different type of health care services for the patients. The e-Health card service center will give the facilities to the citizens about their healthcare literacy. During the study period we have suggested a model service center in the Dhaka city of Bangladesh. From this healthcare service center people will know how they are working behind the technology and their connectivity with each other, and their responsibilities of different healthcare units. However, e-Health card information service center will provide the information to assist in accessing various public health resources. This service will make sure a better and secure healthcare service for every citizen. Here we have discussed some parts of e-Health card service center unit in the following:

5.6.5.1 Verifying National ID Card

After arriving at the e-Health card service center, the patients will be verified personally with his National ID card and proceeded to continue his/her queries regarding e-Health care services. After verification of the patient, e-Health card of the patient will be issued and made an appointment with the doctor for his/her treatment. The authorized personnel in the healthcare center can use either PDA or PC to perform this task.

5.6.5.2 Patient History

This unit ensures patient details and his/her health information (e.g. previous doctor’s prescription, drug history, diagnostic test result etc.). This service provides proper guidance about patient’s current disease.

5.6.5.3 List of Authorized Health Service Center

One of the advantages of e-Health card is that the patient will be informed about all the authorized service centers where the patient could get those services. All authorized service
center shared the Central health database. However service center does not cover all the area of the country, initially it covers limited area of the city.

5.6.5.4 Lost and Found
The e-Health card service center maintains their own lost and found database where the patients have the opportunities to collect or return e-Health ID card if found. If the patient will not come to the service desk to pick up his/her e-Health card, he/she will get a message on his/her mobile phone from the health service center. In that case the person needs to prove that he/she is the owner of this e-Health card. The lost of found database maintained by the healthcare service center which is secured and verified by the Ministry of Health central database server.

5.6.5.5 Patient Update Information
The e-Health card service center regularly updates patient’s information into central database server unit. Furthermore, if something need to change or update his/her information, the patient will have to contact with the health card service center personally and fill out a form in order to update those information into the central health database.

5.6.5.6 Assign Relevant Doctor
The e-Health card service center always cares about patient health. When a patient comes to the health card service center to consult about his/her health problem, the health card service center will assign registered hospital where the patient can get the treatment, book a time and refer to the relevant doctor or specialist for his/her health problem.

5.6.5.7 Input Basic Health Information
When a person or a patient comes to the e-Health card service center to register into their health database system then he/she need to identify by showing the National ID card. After registered with the e-Health card, health information center will add his/her basic health information by asking several questions. The authorized personnel in the service center will add patients’ previous health information into their database when the patient can prove it by any official documents, e.g. prescription, X-ray report or any diagnosis report etc.

5.6.5.8 Emergency Services
The e-Health card service center has the liability to take care patients’ health service when a patient comes an emergency basis. Afterword from health information center immediately issue an e-Health card, assign a relevant doctor and transfer the patient to the nearest hospital by ambulance or other services within short time.
5.6.6 Connectivity with the Ministry of Health

Ministry of Health containing Central Database server is the center point to control and to coordinate all other units of the proposed system located all over the country. Units of the proposed system in the hospitals, pharmacy, and diagnostic center are connected with this server and work as central data repository. For example, when a patient will take health care, all information about a patient such as diagnostic report, previous diseases history etc. will be stored in this server. In future if a doctor wants to check the patient’s health history, he will simply retrieve the relevant data from this server through the doctor’s module. Instead of maintaining server locally, we use this central server in the proposed system in order to manage the health care system efficiently, to secure the patient’s data, and to reduce the maintenance cost.

Figure 8: Central Health Database Management System of e-Health card.
5.7 Integrated Platform of Proposed e-Health Card

Through on this thesis, we need to give our opinion and suggestions to the Government how they can design a PDA based e-Health card system in a preliminary stage. It is important to have some structure of e-Health card and how it will work according to the user demands and what are the relations between e-Health cards with the consumer. "In the relatively short history of HIT, we have learned that a stand-alone component or service is limited in its usefulness, but integration of the component or service adds substantial value" (Janice, RN, & Deborah, 2006). The proposed e-Health card deals with four major components, from figure 7 we found that each section has different structure and work trend which are as follows:

![Diagram](image)

Figure 9: Major components inside e-Health card.

5.7.1 Clinical Observation

Observation of clinical experiment is a major concern of diagnosis, how the health care system will help the doctors, where they can review directly the patient diagnosis report inside the card memory. It does not require reviewing the paper based diagnosis report. After the laboratory observation the lab authority directly uploads the patient report to his/her card, also takes the opportunity to send the report to the doctor directly through updating the patient database. At the same time the technology offers to preserved and share the information with authorized persons.

5.7.2 Laboratory Documentation

Now a day’s paper based diagnosis and prescription is one of the old systems which are insecure. The proposed PDA based e-Health card system stored paper based medical records instead of digital format. To have further analysis of the patient, the health lab authority have the right to access on central health database to observe the patient’s clinical paper based data,
where the doctor can see the patients all medical history by the different doctors. This e-Health card have ability to exchange documents with other authorize health care center. The lab authority will directly update the patient’s diagnosis report in a digital image format and send it to central database. We have proposed an electronic health card system for developing countries, for that reasons the health authorities need to store the patients’ documents until the user needs to familiar with the process.

5.7.3 Security Module

"Collections of computerized personal health data present a very real threat to privacy" (Roderick, 2008). Security trend is one of the important sections of proposed e-Health card. There might be some questions: who will get access to the card information’s, how the security and privacy trend have designed and how the stored information will use? The answers of the above questions are: e-Health card will help the authorities as verify of person’s identity which enclosed the picture of the card holder and other necessary information. However e-health card offers a defensive wall for the patient’s security, because the card will create various security models with the authentication and authorization code.

The above figures 7 represent a documents exchange system of the proposed e-Health card. The e-Health card exchange station is a combination of different document exchange (DE) station and security management center monitoring information from DE station, where all the DE station responsible sending and receiving documents through the e-Health card reader. To observe a better security performance card reader need a cryptographic algorithm which provides security function. A smart card is very difficult to duplicate than magnetic strip
because cryptographic functions is already implemented inside these card, whereas the card itself protected by the personal identification number and locked automatically after attempts with wrong inputs (Yang, Ju S. & Rao, 1998).

5.7.4 Image Diagnosis

Medical diagnosis is one of the techniques to create images from the human body by examine diseases. When a patient verified by the PDA based e-Health card, the physician will connect with his authentication code to access the central health database. After that, the physician can analyze the diagnosis images of the patient, e.g. X-ray, MRI, Ultra scan etc. Finally, the physician will update current information directly to the central health database. This is one of the advance technologies of proposed e-Health card system. The advance technology offers a secure system where the physician can identify the proper reasons of the diseases.

5.8 Sample of Proposed e-Health Card

![Patient Health Card](image)

Figure 11: Front and back side view of patient health card
5.9 Security Measures for the Proposed e-Health Card System

Security is one of the important issue for designing any IT oriented system. We have proposed two kind of measures for ensuring security for this e-Health card system:

1. General level security measures
2. System level security measures

The former one is general security features that is visible to all, while the latter one is system level security which covers software, hardware, and network level security. To resolve these security issues, the security risks must be identified first in this regard. In the proposed e-Health card system, following risks have been identified and analysed.

5.9.1 General Level Security Risks

There are several common risks that may occur any time. Among them followings are significant:

1. Manipulation of user ID and access code
2. Manipulation of data
3. Data damage
4. System damage
5. Malfunctioning of the system
6. Lack of awareness
7. Physical security of the PDA

5.9.2 System Oriented Security Risks

1. **Manipulation of Data:** Data can be manipulated due to bugs in software or system configuration. For example, if the access control to the database (in the proposed case, Central Health Database Management System-CHDMS) is not properly configured for the right person, data in the CHDMS can be manipulated which might result in wrong health information of an individual.

2. **Malfunctioning of the Software:** Software malfunctioning is one of the weaknesses of any IT system, There are several reasons that may cause software’s malfunctioning. Most common reasons for software functioning have been lited bellow:
   - Malicious program such as virus, trojan, spywares etc.
   - Bugs in system and application programs.
   - Use of software from untrusted vendors.
3. Malfunctioning of Hardware and Network Infrastructure:
   • Misconfiguration or unproper configuration of hardware.
   • Misconfiguration or unproper configuration of network.
   • Hardware and network equipment from untrusted vendors.
   • Misconfiguration of servers.
   • Damage of hardware or network apparatus.
   • Damage of Server due to electricity failure.

4. Physical Security of the PDA
A PDA can be lost or damage by the patient. In this case the patient can face problem to take his/her emergency healthcare. Therefore there should be a easy way to re-issue a new card. Besides, user should be motivated to keep the PDA safe in order to avoid uncertainty for getting emergency healthcare. Therefore during the implementation of the proposed system the security measures about PDA can be taken according to International Telecommunication Union Standard [ITU-Rec. X.200 (1994); ITU-Rec. X.800 (1991); ITU-Rec. E.800 (1995)].

5.10 Possible Security Risks Measures for the Proposed System
To resolve the security risks mentioned in section 5.10, we have proposed several steps after analysing the e-Health card architecture, end user, possible threats, etc.

5.10.1 Solutions for General Level Security Risks
1. Train end user: In this proposed e-Health card system, end users may be doctors or other responsible medical personnel, report entry personnel in diagnostic center, salesman in the pharmacy, etc. and they should be properly trained how to deal with the new system. For example these end users should be trained properly how to maintain login information.

2. Creating awareness: Creating awareness among the users of the system is one of the ways to resolve security risks. Awareness can be created by conducting training for users, arranging seminars after certain period.

3. Provide necessary back up system for data and information: Measures should be taken up to back up important data from various servers, for example Central Health Database Management System. In this case, standard and widely recognized back up system can be deployed and recognized organization can be employed or skilled and experienced employees can be recruited for maintaining the system.
4. **Provide sufficient fund for recovery the system:** Donor organization should create a supplementary fund in order to recovery the system in case of any failure. Fund can be created during developing the system and by the donors. Besides, this fund can also be created by the Health ministry.

5. **Supply of uninterruptable electricity:** For a successful implementation of this system, uninterruptable electricity must be ensured with the functional unit of the system.

6. **Routine seminar for end user:** Such as e-Health card holder, doctor, diagnosistic center, salesman in the pharmacy, etc. This kind of seminar is useful for the new end user to learn how to operate the system while for other this will refress their learning about the system and create awareness.

### 5.10.2 Solutions for System Level Security Risks

In section 5.9.2, we have presented several security risks that may arise for a newly developed IT based security system. These risks can be prevented or reduced by taking the following measures depend on the adaptation to the location environment condition:

- Develop system by a certified organization.
- Necessary software supply from a certified organization.
- Necessary hardware supply from a certified organization.
- Setting up trusted anti-virus and firewall.
Chapter 6: Survey Results

6.1 Survey Meta Data

- **Survey location:** The survey location selected in four medical colleges Comilla Medical College (CMC), Mymensingh Medical College (MMC), North Bengal Medical College (NBMC) and Mawlana Bhashani Medical College (MBMC) in Bangladesh.

- **Survey period:** From January 10 to February 10, 2010. (1 month)

- **Targeted participants:** MBBS doctors, MBBS student, Internship doctors, Trained nurses, Local peoples, patients and pharmacist.

- **Financial support for survey:** The Swedish Program for ICT in developing region (SPIDER).

- **Survey documents:** All original survey documents have been submitted to Professor Louise Yngström at The Department of Computer and Systems Sciences, SU/KTH, Kista, Sweden. For validation or any query regarding the survey data (Ref: 2), please contact with Professor Louise.

6.2 Demographic Characteristics of the Respondents

The result of the survey showed (in Table-1) that, 67.5% of the respondent was male and 32.5% of the respondent was female and the average age of the respondent was 29 years old. The result of the study revealed that 81.25% of the respondent’s education level was MBBS doctor followed by MBBS student 18.75% (Table-1).

<table>
<thead>
<tr>
<th>Table 1: Demographic Characteristics of the Respondents (n=80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
</tr>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Education Level</td>
</tr>
<tr>
<td>MBBS Student</td>
</tr>
<tr>
<td>MBBS Doctor</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Occupation</td>
</tr>
<tr>
<td>Student/Internship student</td>
</tr>
<tr>
<td>Doctor</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
6.3 Problems and Lacking in Present Healthcare System

The survey result showed that there are many lacking and problems involved in case of present healthcare system in Bangladesh including lack of equipment, financial & technological support and proper drug supply 28.75%, corruption in health sector 7.5%, Incompatible healthcare system & communication problem 7.5%, followed by lack of skilled professionals or doctors throughout the country 20%, lack of knowledge among the people 10%, political enforcements 8.75% and tendency of doctors for private services 12.5% (in Figure-12).

![Figure 12: Pie chart of Lacking and problems of healthcare system (n=80)](Copyright © 2010 Introducing an e-Health card for Developing Countries: A case study of Bangladesh)

6.4 Idea about e-Health Card

The result of the study exposed that among the 80 respondents, 66.25% have an idea or concepts regarding the proposed e-Health card system and 33.75% of the respondents have no idea regarding the e-Health card system (Table-2).

<table>
<thead>
<tr>
<th>e-Health card idea</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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<td>66.25</td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>33.75</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>
6.5 Advantages of e-Health Card

The study showed that 57 respondents mentioned that the proposed e-Health card may brings about many advantages in the healthcare system of Bangladesh including proper use or distribution of drugs 10%, serial monitoring and evaluation is possible 10%, easy way of health service or emergency service 10%, followed by both of prevent illegal drug distribution and possible to reduce the use of papers 8.75%, both of improvement of healthcare system and doctors can prescribe the patients at any time 7.5%, can reduce corruption in health sector 5% and possible to store patient’s profile or data 3.75% and 23 respondents of the study had no comments regarding the question (Figure 13).

Figure 13: Bar chart of advantages e-Health card (n=57)

6.6 Necessity of Proposed e-Health Card

The result of the study showed that 95% of the respondents mentioned that the proposed e-Health card system is very essential for Bangladesh and 5% of the respondents mentioned that the proposed e-Health card system is not very essential for Bangladesh at present (Table 3).

Table 3: Necessity of proposed e-Health card (n=80)

<table>
<thead>
<tr>
<th>Necessity e-Health card</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>76</td>
<td>95</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>
6.7 Usefulness of e-Health Card for the Doctors and Patients

It revealed from the study that among the 80 respondents, everybody mentioned that the proposed e-Health card system will be very beneficial for the patients as well as for the doctors (Table 4), according the above data and during the interview time most of the responder realize the usability of e-Health card in a developing countries for doctors and patients, the figure was 100%.

Table 4: Usefulness of e-Health card for the Doctors and Patients (n=80)

<table>
<thead>
<tr>
<th>Usefulness for Doctors &amp; Patients</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

6.8 Possible Benefits of e-Health Card for Doctors and Patients

The study revealed that there are many benefits involved with the proposed e-Health card system for the doctors as well as for the patients including possible to store patient's profile 17.5%, followed by proper distribution of drugs 15%, access to doctors prescription 13.75%, both of reduce illegal drug selling and patients can get emergency service 10%, can create relationship between doctor and patients 7.5%, can evaluate future outcome of diseases and treatment 7.5%, basic health problems of the country can be identified 7.5%, can reduce doctor's working pressure 6.25% and doctors can easily recognize the patients 5% (Figure 14).

Figure 14: Bar chart of Possible benefits e-Health card for doctors and patients (n=80)
6.9 Possibility of Introducing e-Health Card

The result of the study revealed that among the 80 respondents, every respondent mentioned that it is possible to introduce the proposed e-Health card system in Bangladesh and the result was 100% (Table 5).

<table>
<thead>
<tr>
<th>Possibility of introducing e-Health card</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

6.10 Positive Changes in Healthcare System due to e-Health Card

The study showed that among the 80 respondents, every respondent mentioned that the proposed e-Health card system will bring about positive changes in the healthcare system of Bangladesh and the figure was 100% (Table 6).

<table>
<thead>
<tr>
<th>Positive changes in healthcare system due to e-Health card</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

6.11 Possible Ways to Reduce Problems in Present Healthcare System through e-Health Card

The result of the study showed that the proposed e-Health system may contribute through various ways to reduce problems in present healthcare system in Bangladesh including keeping records of patient's data properly 23.75%, followed by access to doctor's prescription by every individual 16.25%, proper distribution of medicine for patients 15%, to reduce and control illegal drug (medicine) selling 12.5%, both of reduce corruption in health sector and to prevent selling medicine without doctor's prescription 11.25% and to control abuse of selling medicine by doctors and pharmacy shops 10% (Figure 15).
6.12 General People’s Benefit from e-Health Card

The result of the study showed that 92.5% of the respondents mentioned that general people will be benefited through the proposed e-Health card system and 7.5% of the respondents mentioned that general people will not be benefited through the proposed e-Health card system (Table 7).

Table 7: General People’s benefit from e-Health card (n=80)

<table>
<thead>
<tr>
<th>General people's benefit</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>74</td>
<td>92.5</td>
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<tr>
<td>No</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

6.13 e-Health Card for Ensuring Quality of Healthcare System

It revealed from the study that among the 80 respondents, 95% of the respondents mentioned that the proposed e-Health card system will ensure the quality of healthcare system in Bangladesh and 5% of the respondents mentioned that the quality of the healthcare system will not be ensured through the proposed e-Health card system (Table 8).

Table 8: e-Health card for ensuring quality of healthcare system (n=80)

<table>
<thead>
<tr>
<th>Ensuring quality of healthcare system</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>76</td>
<td>95</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

The study showed that among the 80 respondents, 96.25% of the respondents mentioned that Government should introduce an e-Health card for every individual in Bangladesh and 3.75% of the respondents mentioned that it is not very essential to introduce an e-Health card for every individual by the Government (Table 9).

<table>
<thead>
<tr>
<th>Government should introduce e-Health card</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>77</td>
<td>96.25</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>3.75</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

6.15 Respondent’s Suggestions about Introducing e-Health Card

The result of the study revealed that many suggestions come out from the respondents about introducing the proposed e-Health card in Bangladesh including introduce e-Health card as soon as possible with the help of the Government 43.75%, followed by need international cooperation or foreign investment 13.75%, focus through mass media 11.25%, e-Health card concept should be accepted by the people 10%, both of experimental use by the government and not possible due to over population as well as poverty 7.5% and essential to introduce to prevent corruption 6.25% (Figure 16).
Chapter 7: Discussions

7.1 Healthcare Challenges and Cultural Effects

Our survey highlights that Bangladesh has the opportunity and willingness for move forward on ICT applications in the health care sector. The issues and challenges resolve to use of ICT in prerequisites of health care in the rural and urban areas by the following:

- To increase number of patients who have access and motivate mobile phones service.
- To make health service providers interested and feel them computerized records would benefit both their work and their patients.
- To encourage the Government initiating ICT based health care services at the national level, and installed computers in all upazila, thana and districts health complexes.
- To build computer network infrastructure and internet facilities in rural and urban areas.
- To increase computer literate trained doctors and medical staffs for quick service delivery.
- To motivate and maintain patient health records by using e-Health card.
- To develop a pilot project for ICT in health in remote areas, including both public and private sectors.
- Train health professionals in ICT application, specifically electronic patient records and e-Health card.
- To establish monitoring and supervision systems to ensure data validity and communication to the Ministry of Health.

After satisfactory implementation of e-Health card in the city and few urban areas, Government have to take the initiative to build ICT infrastructure to connect and to expand all the rural areas under this e-Health card project in Bangladesh. By the survey result we realize that if the project runs satisfactorily after few years, hopefully corruption will be decreased from the health care sector in different bodies, and all the citizens will understand what the benefit will get to use of this e-Health card which they claim for their health care security. The project framework will be helpful for doing future research for any developing countries to get an outline of the research.
7.2 Possible Trade-offs of the Proposed System

Like other system, the proposed system may have also some primary positive and negative aspects of an idea in different perspective scinerio. In this thesis work, we have taken these different scinerios into account and analysed them for developing and implementing the system.

7.2.1 Development and Implementation of the Proposed System

Most developing countries are corrupted in health care sector. Corrupted Government entity doesn’t want such system that could reduce corruption. Therefore they will try to hinder to introduce such system (like the proposed PDA based e-Health card system) by bureaucracy, by political issues or other negative activities. But willingness and coordination from different Government department or entities are required for successful implementation of such a system. On the other hand, introducing such a system is not so hard if the head of the state or Government has a strong control over its different entities.

7.2.2 Financial Conditions

The proposed PDA based e-Health-card system is a big project which would require huge amount of money. Most under developed country does not have sufficient fund to carry out such project. For this reason, fund must be provided from other sorts of sources such as World Bank, UNDP, ADB, WHO etc. Funding can be donation or loan, or a combination of both donation and loan. Since health is one of the most important and sensitive fundamental requirement, the terms and conditions for financing the project from other sources must be flexible enough so that the responsible Government can bear the cost. There are many examples in the third world countries that many development projects have been in hanging condition for many years due to the failure of the corresponding Government to fulfill donor’s terms and condition. In this case, donor’s can maintain proper monitoring during the project development and implementation instead of stop funding.

7.2.3 Implementation Time

Required time is an another important factor for this kind of project. Time requird to implement such system mostly depends on the total number of population, flow of funding, IT infrastructure, trained people, and Government initiatives. In our research we found that the required time for deploying such as system is proportional to these measuring entities. For
example, to implement this e-Health card system in a larger populated area requires more time than area with less people. Because, more people requires - more trained people to train them, more systems to be deployed in more hospitals, clinics, pharmacies diagnostic centers in order to serve them (the people on that area), and more data to be entered in the new system in order to update all necessary information. All these works consume time and fully depends on the number of population.

7.2.4 Education and Awareness

The requirement and benefit of a new system can easily be understood by the educated people than the illiterate or less educated people. For example, deploying a new technology based system in a european country is much more easier than a third world country. Because most of the people in european countries are educated and well aware of the technology. On the other hand, huge number of people are uneducated in the third world country. Thus they are not aware of their right as well as technological benefits. Therefore, additional time and funding are required for third world country for introducing e-Health card system.

7.2.5 Privacy for the Proposed System

It very important that before going to establish the proposed system, it has to be verify primary security privacy from the begining to end. The e-Health card system should be developed in such a way that the patient’s privacy must be protected in every interface of the proposed e-Health card system.

7.3 Human Computer Interaction (HCI) Approach

Now a-days Human-Computer Interaction (HCI) studies has experimented a speedy development over the last few years. By the observation we have found that there are many possible reasons for diffusion of personal computing among wide verity of users, large market with the human demands, miss alignment between human nature and technology, and a huge advantage for design a user interfaces of people with disabilities. In this section we have described some major components of HCI (incorporated in our proposed model) which are stated in the following (Carroll, 2001 & Julio, 2002):
7.3.1 Independence between the Interface and the Application

One of the important characteristics of HCI is that there should be a clear and transparent separation between the application level and the interface level. Based on our studies we have identified that the proposed system also needs the independency between the interface and the application. This approach will benefit the designer to develop interfaces in future without modifying the existing application.

7.3.2 User Interface Design Techniques

Interface designing is one of the important factors of the proposed application. User always expects user friendly and customized (according to the user requirement) application from the developer. During the development process, developer should use the real life data from the end users to verify how the proposed system would work finally. Interface should be designed in such a way that it would work as a translator between the user and the application. So the interface of the proposed HCI based e-Health card should be designed carefully especially considering the disable people.

7.3.3 User Needs Awareness

"To assess this trade off we introduce awareness as an evaluation metric to be used in conjunction with performance" (Findlater & McGrenere, 2010). In the Human computer interaction we need to define awareness of an unused feature in the proposed e-Health card system in order to increase the level of knowledge about the system. There should be a learning process to learn that the feature has developed intentionally. Awareness focuses on all the personalized interface of proposed e-Health card system and evaluates a the performance for its future improvement. User awareness is only one component that depends with the Performance of selected elements of graphical user interface. Performance and user satisfaction depends with various numbers and factors of layout; however we can say that awareness is one aspects of the different user’s experience that is particularly important for the modified approaches of user interface design (Carroll, 2001 & Julio, 2002).

7.4 Possible Funding Sources and Donors

Implementing such a large and complicated system like the proposed e-Health card system is very difficult and needs huge amount of money. Bearing such a big amount of money is difficult for a country itself. Alternatively, third world countries can take help as an aid or loan from the following financing organizations-
• World Bank
• UNDP
• ADB
• EUC
• USAID
• IDB
• JAICA
• AUSAID
• Individual organization such as Gates Foundation
Chapter 8: Conclusion and Future Works

The e-Health card has been successfully implemented in developed EU countries and most citizens are getting benefit by using this card for their health security, and thus they are saving time and money. The proposed e-health card system would be successful in Bangladesh when people will understand the actual benefits of this e-Health card system and about the necessity of this technology for upgrading the current healthcare situation. The health care service for the citizen of a developing country like Bangladesh needs to be cost effective for proper healthcare facilities. The goal of the thesis was to design a PDA based health care system to improve the health care condition in Bangladesh. In this regard we have set four questions in section 1.7 in order to achieve the research goal. According to our survey results we have identified problems in the existing health care system in Bangladesh. Problems and the impacts of the existing problems are answered in section 4.1.1 and 4.1.2. In this respect we have proposed a PDA based e-health care system in developing countries. Our analysis shows that the proposed system would resolve the current health care problems. In this respect we proposed the use of PDA for accessing the patient’s health data from Central health Database management system. As a handheld device PDA is more durable, portable, and comparatively safer than any other similar devices.

We also insist that the voluntary participation of the patients in the health card system with medical files; so that our proposed plan about the healthcare system can be extended into the electronic medical files. The service will ensure the health insurance for the potential card holding patient. Through this model, it will be possible to differentiate the patient’s healthcare information that can only be accessed by the Government health care services and by the other registered private organizations as well. It will also protect the corruption from different bodies of health care sectors. But implementation of this proposed project needs huge efforts. Our research result shows that successful implementation of this project depends on several issues such as financial arrangement, mass awareness, voluntary participation of the healthcare related people, etc. In return, benefit of this project is long term and wide on the national health care system. Implementation of the system as well as identifying its pros-cons has been left as an open research for future work.
References


Klaus V. (1992). Smart Cards, G A 0 Gesellschaft fiir Automation und Organisation mbH, 0-8186-2760-3/92$03.00 ©1992 IEEE.


Appendices

Appendix-1: Research Questionnaire

Research Questionnaire

Introducing an e-health card for developing countries

[This Questionnaire is only for partial requirement for the fulfillment of the course "ICT4D (Information and Communication Technology for Development) M.Sc Dept. of Computer and Systems Sciences, DSV KTH / SU
(Stockholm University), Kista, Sweden."]

Respondent ID

[ *** Please put tick □ mark on one or more boxes if needed]

1. Name of the Respondent:
2. Age:
3. Sex: □ Male □ Female
4. Address/Location:
5. Education Level:
6. Occupation:

7. What are the lacking and problems of present health care system in Bangladesh?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

8. Do you know about e-health (electronic health) card?
   □ Yes □ No
9. If yes, then what are the advantages of e-health card?
   ________________________________________________________________
   ________________________________________________________________

10. Do you think that the proposed e-health card is very essential for the Dhaka city nowadays?
    □ Yes □ No
11. Do you think that the proposed e-health card will be beneficial for the doctors as well as the patients?
    □ Yes □ No
12. If yes, what are the benefits they can take through e-health card?
    ________________________________________________________________
    ________________________________________________________________
13. Do you think that it is possible to introduce e-health in Bangladesh?
   □ Yes   □ No

14. Do you think that the proposed e-health card will bring about positive changes in the country's health care system?
   □ Yes   □ No

15. How can e-health card contribute to reduce present problems in health care system?
   □ To reduce corruption in health sector
   □ Proper distribution of medicine for patients
   □ Access to doctor's prescription by every individual
   □ To keep records of patients' data properly
   □ To control abuse of selling medicine by doctors and pharmacy shop
   □ To prevent selling medicine without doctor's prescription
   □ To reduce and control illegal drug (medicine) selling

16. Do you think that general people will get benefit from e-health card?
   □ Yes   □ No

17. Do you think that the proposed e-health card technology will ensure the quality of health care system throughout the country?
   □ Yes   □ No

18. Do you think that Bangladesh Government should introduce an e-health card for every individual?
   □ Yes   □ No

19. What is your suggestion about introducing e-health card in Bangladesh?
   ........................................................................................................
   ........................................................................................................

20. Would you like to add any other comment?
   ........................................................................................................
   ........................................................................................................

   (Thanks for your co-operation)

   Name of the interviewer.................................
   Date......................................................

Figure-1: Represents research questionnaire of field survey
Appendix-2 Example of Some Respondent’s survey feedback

Research Questionnaire
Introducing an e-health card for developing countries

[This Questionnaire is only for partial requirement for the fulfillment of the course “ICT4D (Information and Communication Technology for Development) M.Sc Dept. of Computer and Systems Sciences, DSV KTH / SU (Stockholm University), Kista, Sweden.”]

Respondent ID 23

[*** Please put tick □ mark on one or more boxes if needed]

1. Name of the Respondent:
2. Age: 39 years
3. Sex: ☐ Male  ☐ Female
4. Address/Location: North Bengal Medical College Hospital, Siliguri.
5. Education Level: MBBS BDS (Post-Grad)
6. Occupation: Physician

7. What are the lacking and problems of present health care system in Bangladesh?
   ☑ lack of modern technological equipment
   ☑ lack of experience about equipment handling and recent
   ☑ lack of training & about recent going method
   ☑ maintenance

8. Do you know about e-health (electronic health) card?
   ☐ Yes  ☑ No

9. If yes, then what are the advantages of e-health card?

10. Do you think that the proposed e-health card is very essential for the Bangladesh nowadays?
    ☑ Yes  ☐ No

11. Do you think that the proposed e-health card will be beneficial for the doctors as well as the patients?
    ☐ Yes  ☐ No

12. If yes, what are the benefits they can take through e-health card?
    ☑ Communication e specialized doctor consulted for
    ☐ Other

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13. Do you think that it is possible to introduce e-health Card in Bangladesh?
- Yes  - No

14. Do you think that the proposed e-health card will bring positive changes in the country's health care system?
- Yes  - No

15. How can e-health card contribute to reduce present problems in health care system?
- To reduce corruption in health sector
- Proper distribution of medicine for patient
- Access to doctor's prescription by every individual
- To keep records of patient's data properly
- To control abuse of selling medicine by doctors and pharmacy shop
- To prevent selling medicine without doctor's prescription
- To reduce and control illegal drug (medicine) selling

16. Do you think that general people will get benefit from e-health card?
- Yes  - No

17. Do you think that the proposed e-health card technology will ensure the quality of health care system throughout the country?
- Yes  - No

18. Do you think that Bangladesh Government should introduce an e-health card for everyone?
- Yes  - No

19. What is your suggestion about introducing e-health card in Bangladesh?
- [Handwritten text]

20. Would you like to add any other comments?

(Thanks for your co-operation)

Name of the interviewer: ........................................
Date: ..................................................

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Research Questionnaire

Introducing an e-health card for developing countries

[This Questionnaire is only for partial requirement for the fulfillment of the course "ICT4D (Information and Communication Technology for Development) M.Sc Dept. of Computer and Systems Sciences, DSV KTH / SU (Stockholm University), Kista, Sweden.

Respondent ID 2

[*** Please put tick □ mark on one or more boxes if needed]

1. Name of the Respondent:
2. Age: 30 years
3. Sex: □ Male □ Female
4. Address/Location: Bankura, Singrauli
5. Education Level: MBBS
6. Occupation: Physician

7. What are the lacking and problems of present health care system in Bangladesh?
   □ Supply of medicines
   □ Availability of health care providers
   □ Economic condition

8. Do you know about e-health (electronic health) card?
   □ Yes □ No

9. If yes, then what are the advantages of e-health card?

10. Do you think that the proposed e-health card is very essential for the Bangladesh nowadays?
    □ Yes □ No

11. Do you think that the proposed e-health card will be beneficial for the doctors as well as
    the patients?
    □ Yes □ No

12. If yes, what are the benefits they can take through e-health card?
    □ Reduces doctors work load
    □ Can evaluate patient's medical history and treatment outcome
13. Do you think that it is possible to introduce e-health Card in Bangladesh?
☑ Yes  ☐ No

14. Do you think that the proposed e-health card will bring about positive changes in the country’s health care system?
☑ Yes  ☐ No

15. How can e-health card contribute to reduce present problems in health care system?
☑ To reduce corruption in health sector
☐ Proper distribution of medicine for patient
☐ Access to doctor’s prescription by every individual
☐ To keep records of patient’s data properly
☐ To control abuse of selling medicine by doctors and pharmacy shop
☑ To prevent selling medicine without doctor’s prescription
☐ To reduce and control illegal drug (medicine) selling

16. Do you think that general people will get benefit from e-health card?
☑ Yes  ☐ No

17. Do you think that the proposed e-health card technology will ensure the quality of health care system throughout the country?
☑ Yes  ☐ No

18. Do you think that Bangladesh Government should introduce an e-health card for every individual?
☐ Yes  ☐ No

19. What is your suggestion about introducing e-health card in Bangladesh?
(Write your suggestion here)

20. Would you like to add any other comment?
(Write your comments here)

(Thanks for your co-operation)

Name of the interviewer

Date
# Appendix-3: Code Book of Data

## Code Book

<table>
<thead>
<tr>
<th>Variable Level</th>
<th>Ques.No</th>
<th>Variable</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>age of respondent</td>
<td>2</td>
<td>age</td>
<td>1=</td>
</tr>
<tr>
<td>age group of respondent</td>
<td>2</td>
<td>agegr</td>
<td>1=Male</td>
</tr>
<tr>
<td>sex of respondent</td>
<td>3</td>
<td>sex</td>
<td>2=Females</td>
</tr>
<tr>
<td>Name of Medical college</td>
<td>4</td>
<td>mlc</td>
<td>1=MMC 2=CMC 3=NEMC 4=MBMC</td>
</tr>
<tr>
<td>Education Level of respondent</td>
<td>5</td>
<td>edul</td>
<td>1=MBBS Student 2=MBBS Doctor</td>
</tr>
<tr>
<td>Occupation of Respondent</td>
<td>6</td>
<td>occup</td>
<td>1=Student/Internship Student 2=Doctor</td>
</tr>
<tr>
<td>Lackings &amp; problems of healthcare system</td>
<td>7</td>
<td>lap</td>
<td>1=Lack of equipment, financial &amp; technological support and proper</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>drug supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2=Corruption in Health sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3=Incompatible healthcare system &amp; communication problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4=Lack of skilled professionals/doctors throughout the country</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5=Lack of knowledge among the people</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6=Political enforcements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7=Tendency of doctors for private services</td>
</tr>
<tr>
<td>Idea about e-health card</td>
<td>8</td>
<td>ehealthcard</td>
<td>1=Yes 2=No</td>
</tr>
<tr>
<td>Advantages of e-health card</td>
<td>9</td>
<td>adecard</td>
<td>1=Proper use/distribution of drugs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2=Prevent illegal drug distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3=Possible to store patient’s profile/ data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4=Serial monitoring &amp; evaluation is possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5=Can reduce corruption in health sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6=Easy way of health service/emergency service</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7=Improvement of healthcare system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8=Doctors can prescribe the patients at any time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9=Possible to reduce the use of papers</td>
</tr>
<tr>
<td>Necessity of proposed e-health card</td>
<td>10</td>
<td>noecard</td>
<td>1=Yes 2=No</td>
</tr>
<tr>
<td>Usefulness of e-health card for doctors &amp; patients</td>
<td>11</td>
<td>usecard</td>
<td>1=Yes 2=No</td>
</tr>
<tr>
<td>Possible benefits of e-health card for doctors &amp; patients</td>
<td>12</td>
<td>benifi</td>
<td>1=Access to doctors prescription</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2=Reduce illegal drug selling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3=Proper distribution of drugs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4=Doctors can easily recognize the patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5=Patients can get emergency service</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6=Possible to store patient’s profile</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7=Can create relationship between doctor and patients</td>
</tr>
</tbody>
</table>
From the above figure showed about the code book and how it works during the data analysis. In the field survey we have collected several types of data based on the responder questionnaires. We have sorted comparable data according to the responder ID because of the repatriation of similar data during the input techniques in parallel, so we have given short name of our input data.
Appendix-4: Survey Data Input, Data Variables and Data Output by using SPSS.
The above data table presenting 80 responder data based on the field survey questionnaires.

Figure-3: Represents data input

The above data table presents some variable of data based on the 18 different codes, where each code is responsible for specific data input with their different activities of measurements and how the data would calculate.
The above figures presenting the output view of our thesis survey data. Each of the folder consists several types of data information where we can observe and visualize data in various way. In the analysis of results, we have reviewed data information according to our thesis nature e.g. – Data table, pie chat, bar chart, numeric data etc.