

**eHealth - Digital Healthcare Management System for
Bangladesh**

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How to bring patients and physicians closer together and improve treatment and consultation in Bangladesh by designing an eHealth digital healthcare system.

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Abstract

For the purpose of achieving universal health coverage with the goal of providing equitable access to all people regardless of their financial circumstances. Many of the issues discussed in the introduction have been considered while working on this project to achieve universal health coverage through the digitalization of the healthcare management system. Electronic health records play a critical role in the digital health care system in terms of storing, communicating, and passing medical records to other parties involved in health care delivery. Bangladesh's constitution declares that states have fundamental responsibilities to provide for their citizens' basic needs, such as food, clothing, shelter, education, and medical care. [IGS 2012] Addressing these issues and focusing on the factors that significantly influenced physician adoption of electronic health record systems will be a significant focus of this project. By establishing a direct link between individuals and doctors, it will be possible to demonstrate how the services meet the SDG's goal of ensuring healthy lives and promoting well-being for all people of all ages, which is critical for long-term development. As part of my Green ICT course, the project also aims to demonstrate how the proposed service meets the three pillars of sustainability: social equity, economic viability, and environmental protection. The proposal will also discuss the strategy's importance and how it will provide a common platform for the country to address existing digital health challenges like interoperability, cross-border data security, and proper data use.

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Chapter 1

Introduction

Nearly half of Bangladesh's population will have died before seeking health care. Non-communicable disease mortality is increasing as a result of non-communicable hospitals and health care.[154] In Bangladesh, there is no universally recognized healthcare emergency number, such as 911, 112, or 999. Each private hospital in Bangladesh and some of the larger national hospitals have a unique emergency number. Furthermore, individuals do not have a health profile that is dependent on the type of treatment they receive.

Even if the prescription is still written on paper and each report is printed on paper that is not stored digitally, they must still carry the printout paper with them whenever they see a doctor or visit a hospital.[185] Additionally, if immediate or necessary care is required, patients will not call a specific clinic or doctor's office if they do not know the phone number or do not have access to a nearby family or friend. Additionally, when people are aware that they must visit the hospital if they become ill, it is less likely that they will arrive on time due to the insane traffic that is typical for everyday use.[72] (traveling 3 kilometers on public transportation takes approximately 60 minutes on a typical day). Apart from that, almost every physician constructed a doctor's chamber in their home or used their personal doctor's chamber to see patients outside of the hospital, where they have more control. Many people who require treatment are unable to obtain it due to their lack of awareness of their location. According to the BMDC's (Bangladesh Medical and Dental Council) physician registration statistics, one physician is for every 1,847 people (public and private).[32] In Bangladesh, where it is difficult to see a doctor, digital healthcare services alleviate patient inconveniences.

In developing countries such as Bangladesh, the majority of patients are typically from rural areas. These individuals are typically from large geographic areas. This population is less educated and is generally unaware of their health rights.[7] They are content with what they received as a result of their low expectations. [27] A policy shift is necessary to ensure that people receive what they deserve. One of the prerequisites for attaining universal health coverage is ensuring equal access – equity in healthcare system utilization. Bangladesh's healthcare system is pluralistic, which means that a variety of actors play roles in medical treatment or practices. Four critical factors - public, private, non-governmental organizations, and donors - define Bangladesh's health system structure.[22]

Sustainable Development Goals By establishing a digital system, eHealth services contribute to the Sustainable Development Goals' goal of ensuring healthy

lives, promoting well-being, and reducing inequalities within societies. Additionally, the eHealth system demonstrates how it contributes to sustainable design by ensuring three sustainability pillars.

1.1 General Structure of the Report

The study began by describing the current state of health care and the individuals who face a system with fewer opportunities to exercise their rights. Though ICT usage increased significantly in Bangladesh in 2018, the convergent effect has not yet manifested in all systems, most notably healthcare management. The introduction chapter discusses the broad scope of the issue and other factors contributing to Bangladesh's demand for electronic healthcare management. Following that, in the State of the Art Chapters, various journals and articles are cited to illustrate what factors can motivate users to use or obtain expected improvements in health quality management. Additionally, the argument phase describes which factors significantly impair physicians' and other individuals' motivation to use such an electronic system. On the basis of the arguments and scenario presented in the preceding chapter, a primary objective of problem formulation was presented. Apart from that, the problem formulation process highlighted how the eHealth system deliberately addresses the other situation.

The methodology chapter describes in detail the method used. The methodology chapter described the process of analyzing the current situation, assessing user information, and designing the eHealth Content Management System. Additionally, the data collection process for user identification and general individual, physician, and pharmaceutical information was demonstrated in conjunction with a design overview of integrating into the eHealth system using other national database servers. The design chapter then explained and applied the eHealth Content Management system using the methodology described in the previous methodology chapter. Additionally, the technology is described in terms of why it was chosen and how it is used in conjunction with the eHealth CMS project to ensure security. This chapter also discusses content creation and design. Apart from that, it broadly describes how the system's design promotes sustainability and adheres to three sustainability pillars to ensure a more circular economy.

The requirements engineering chapter discusses how to connect the social and technological worlds in order to implement the eHealth system successfully and efficiently. Requirement engineering is one method for identifying new and more effective ways to align social, technological, and geographic alignment in order to stimulate global market development. Requirement engineering aims to streamline the process and lay the groundwork for developing a methodology for deriving engineering requirements from legal and regulatory requirements. It describes how the eHealth CMS tools should be used and summarizes the fundamental laws governing eHealth in Bangladesh while also providing an analysis and overview of pertinent legal rules. Additionally, it emphasizes compliance through design techniques and practices that aid in the facilitation of eHealth security engineering and business processes. Requirement engineering linked the contents of eHealth legislation and regulations to the aspects of eHealth technology and processes that can be engi-

neered into this system.

The following chapter is intended to assist the Ministry of Health and Family Welfare (MOHFW) and its partners in negotiating a digital healthcare system that benefits the entire Bangladeshi population. The purpose of this chapter on the current health segment profile is to illustrate how Bangladesh's health care system functions, not to criticize what did not occur in the past.

MOHFW is responsible for developing, implementing, managing, coordinating, and enforcing national policies and programs in the areas of health and family. Any new system must adhere to MOHFW regulations and policies governing general population access. MOHFW ensures that everyone has access to high-quality health care. District and Upazila education departments establish committees for this purpose. Additionally, these committees represent clinics run by members of the local community responsible for district and Upazila administration. MOHFW is responsible for administrative functions that contribute to ensuring transparency and effective service delivery to the public. While preserving professionalism, safeguarding the public's right to health, and enforcing standards, government agencies regulate a variety of professions in order to promote the development of a qualified professional workforce, ensure the quality and consistency of health services, and prevent power abuse. The MOHFW works closely with other statutory bodies such as the BMDC, the PCB, and the BNC to regulate the healthcare sector.

Chapter 2

State of Art

A point-of-care electronic health record system can help the doctor obtain better information and verify data, thus validating the quality of the test results and helping the doctor make appropriate treatment decisions.[166, 38] The population density of Bangladesh is one of the highest in the world.[179, 88] The estimated population of Bangladesh in 2021 is listed at 166.84 million.[88] A total of 663 hospitals are found in the rural sub-district and district headquarters region.[23, 186] There are 74,415 total beds available in both public and private hospitals; there are 1,860 people in Bangladesh for every bed. Furthermore, 90 percent of the total population inhabits rural regions where healthcare facilities and modern surgical and medical treatments are not readily available.[179, 88] Another problem is that most of the physicians are located in the city.[89, 123].

It can also be noted that implementing the electronic health record system in Bangladesh proves to be a rather tedious process.[53] Through telemedicine and eHealth, medical professionals and IT specialists find common ground, and concerned officials confront the challenges that eHealth adoption faces. ([183, 55, 124].

Overall, patients tend to prefer using eHealth systems in developing countries like Bangladesh rather than physicians. [34]

This earlier research indicated that physicians are less likely to use the new technology. [36, 54]

In a separate study, medical practitioners complained about the inefficiency and ineffective communication when patients have access to electronic health records systems.[34, 56, 157, 175]

In addition, physicians were also concerned about the disruption to their workflow and the potential for being pulled away from their work because of implementing an electronic health record system. [93]

While this pessimistic view of the eHealth system by physicians may be unnerving, it prevents it from being adopted.[152] Learning why physicians oppose the use of eHealth systems helps us understand why digital health portals have a greater chance of acceptance in the health care system. Another study discovered that personal values, facilitating conditions, and social influence are all highly influential in shaping physicians' behavioral intention to adopt electronic health record systems. Also, the study discovered that factors such as productivity, effort, and change resistance have no significant influence on success.[61]

The long-term progress that Bangladesh has made concerning MDG 4 and 5 has been steady, marked by declines in maternal and child mortality rates. When

compared to high-income countries, however, it is still high. It is critical to investigate the current quality of the healthcare system before putting in place a digital healthcare system. In 2015, two district and 12 sub-district hospitals were examined for their beliefs and patient satisfaction about medical quality and how satisfied patients were with the care they received in the regional district and sub-district regional hospitals.[148, 4] In half of the facilities, patients were not allowed to inquire about their health conditions and treatments. This project will also focus on establishing a system that can be accessed by both patients and physicians on the same case and using each individual's designated role of access. Patients are most satisfied with their overall experience when short wait times and lengthy consultation times with the doctor.[82]

Most of the patients in developing countries like Bangladesh are from rural areas and have a lesser understanding of their health rights.[27, 145] It appears that the people from this region are content with what they have. There needs to be a policy change to ensure health care support is made available to everyone in the area. The article [71] suggests that the patients in the study were pleased with the quality of care they received, even though the medical providers were unhappy with the service.

A study was completed in 2016 to investigate how socioeconomic groups distribute health benefits and how providers contribute to socioeconomic disparities in health benefits in Bangladesh.[87]

It was found that the health benefits in Bangladesh accrued most to the wealthy. Although public healthcare providers were causing minor inequality, private healthcare providers were making strides in addressing that problem. Because of this, the people who need healthcare the most receive fewer healthcare benefits than those who can afford it.

The number of patients bringing the electronic medical report to the consultation is on the rise, according to a 2006 paper in the journal of medical internet research[111]. However, the paper did not adequately cover physicians' perspectives on these documents. The research sought to discover how doctors who routinely use internet-based health information perceive it from a patient's perspective.

Chapter 3

Problem Formulation

Based on the arguments described in the state of art chapter, the proposal that formulated for the problem formulation is:

How to bring patients and physicians closer together and improve treatment and consultation in Bangladesh by designing an eHealth digital healthcare system.

The project will also identify:

- The majority of existing paper-based records' drawbacks, such as ambiguity, illegibility, incomplete data, and data disintegration.
- Efficient way to get treatment at a lower cost.
- A digital health profile that both patients and physicians can access on the same case, each with their own access role.
- Awareness-raising activity to teach patients about their healthcare rights.

Chapter 4

Methodology

To develop a product for healthcare management four things is important to consider: Software development; Safety; Protect from harm; Usage of the product.

4.0.1 Usage of the Products

It took a long time to standardize interaction between humans and computers. The ISO 9241 standard describes how input and output devices are designed and how they are interactive with software and the physical world.[120] The user interfaces of software show a variety of data. ISO 14915 defines professional interactions with text, graphics, audio, video and media.[34] IEC/TR 61997 specifies guidelines for not level-specific multimedia interfaces. ISO 15223 defines safety and effectiveness symbols for medical devices.[133]

4.0.2 Safety

Unreleased software can create value and destroy it. It can harm people, processes or cause fear. Medical device manufacturers must use the safety and performance standards to ensure the safety of patients. IEC 80001 defines the perspective of the care provider.[50] This job description defines the roles of risk management in the medical IT network. ISO 27000 defines system risk management as integrated.[146]

4.1 UX design for eHealth

It is all about interaction in the 21st century. So we no longer innovate for our customers. Users will abandon an application for e-health if it is not practical. If there is no alternative, the tool will be misused. When interactive products, infrastructures, and services are designed (UX). Many sources help us to understand the design of the experience. Trendsetters such as Nathan Shedroff, John McCarthy and Peter Wright, the cognitive scientist. These issues are explored as experience in their book Technology.[77] Some people call it "ludic" or "hedonist." Interaction design has used aesthetics for a long time. UX designers need to understand how interactive products and services interact with each other. They are essential to our culture.

What we know is what we do, see and feel (quoted)[177]. UX is a good book, a challenging game, or a lovely story. It includes memorable, satisfying, pleasant and

generous, impartial and genuine. McCarthy and Wright[94] emphasize the importance of combining new technology and personal experience. Experiences cannot be divided, they say, because they define one another. Interactivity interacts with people, technologies, activities, and their social and cultural contexts. The designers must first ensure that these elements are well meshed. The unexpected occurs. Individuals and groups have their own experiences that designers provide. Designers can understand and consider the overall impact of the features that provide a great user experience. UCD is the most popular. UX and UCD are not the same (UCD).[94] Our description of our job is UX design (as user experience practitioners). Most designers think that they have a design goal. It takes time, however. We (UX professionals) use user-centered design, which makes UCD a good user experience.

4.2 Justification for Utilizing the UCD Method

If the system is designed with the user in mind, it will be simple to obtain a prediction, an analysis, a demographic analysis, statistics on how the medication is being used, how many medications are required, and to have them distributed through a pharmacy. In the event of a pandemic, how many hospital beds will be required based on the number of patients who will be affected and who will consult with a physician.

4.3 User Centered Design Method

The term 'User Center Design' (UCD) refers to various design processes that allow end-users to shape the shape of a product or process.[80] The philosophy and methods employed are diverse. While users can participate in UCD in various ways, the most important thing to remember is that they are involved in development in some way. Typically, during the requirements gathering and usability testing phases, UCDs consult with users and participate in the design process. Because they collaborate with designers, user-centered design (UCD) methods significantly impact the design process.

Donald Norman's California San Diego University (UCSD) Research Laboratory coined the term "user-centered design" in the 1980s. After publishing a co-authored book entitled User-Centered System Design in 1990, it became well known.[135]

He provides four fundamental suggestions for how to design:

- It should be easy to determine at any time what actions are possible.
- Strengthen key system aspects, including the conceptual model, alternative actions and results of action.
- Make it easy to determine the current system condition.
- Use natural maps for navigating between the intentions and actions to be taken, the actions and the effects to be achieved, and the system state interpretation of the visible information.[20]

Users' attention is drawn to the design as a result of these suggestions. When designing a product, the designer's goal is to make the user's job easier by ensuring

that the product is used in the manner intended and that the user spends as little time as possible learning how to use it.[15] According to Norman[20], user-centered manuals that are too long, cumbersome, and incomprehensible are a source of frustration for many people.

4.4 Involving Users in Design

It is critical to consider carefully who a user is and how they are involved in the design process. Bangladeshi citizens will use the eHealth portal to accomplish a task or goal in this regard. However, there are additional users. Along with patients, users include those who manage the patients' needs and expectations. Eason[170] defined three distinct types of users: primary, secondary, and tertiary. Patients are the primary users of the eHealth system. Secondary users are those who use the artifact directly or indirectly—physicians, pharmaceutical companies, and tertiary users are those who are affected by eHealth or make decisions about eHealth practice. A successful product design must consider a diverse range of eHealth system stakeholders. While not all stakeholders must be represented during the design process, the impact of the eHealth system on them must be considered.[161]

4.5 Iterative Process

To understand the user's needs, generative method has been used in user-centered design – brainstorming and user experience assessment.[116] The term was coined in the 1970s. Later, Don Norman, a cognitive and usability science expert, incorporated the term into his extensive work on improving people's experience with objects.[135] Each iteration of the UCD approach is typically comprised of four dis-

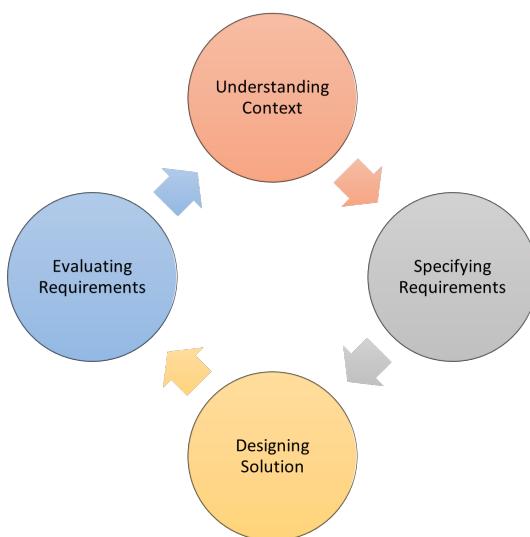


Figure 4.1: Process Iteration of User Centered Design

tinct phases. To begin, it requires attempts to comprehend how users interact with a system. Then identifying and specifying user requirements.[35] Following that, a design phase was conducted during time of creation of a design solution. Then an evaluation phase was started. The evaluation results were compared to the context

of users and requirements in order to determine how well a design functioned. More precisely, one can determine how close it is to an appropriate level for the users' context and requirements. The four phases thereafter were repeated until the evaluation results were satisfactory.(Figure: 4.1)

4.6 Broad User Experience Consideration

This project in UCD have been built around explicit user comprehension, tasks, and environments. The process is designed to capture and address the user experience in its entirety. As a result, data has been gathered from professionals from various disciplines (e.g., physicians, hospitals, and diagnostic clinics) and domain experts, stakeholders, and users. I did, however, recall two critical points. To begin, it required engaging users in a comprehensive evaluation of the user experience. Second, a long-term monitoring of usage needed to maintain.

4.7 User-Centred Approach to Web Design

The web portal is a term that refers to an application that enables internet access through a computer, laptop, tablet, or smartphone browser rather than through a native mobile application. Since the Bangladeshi people began using smartphones and personal computers in the last few years, businesses have recognized the benefits of web browser catering.[48] However, far too few businesses consider the end-user.[141] Few advantages to delivering a web browser eHealth system experience:

- Bangladesh offers an opportunity to address specific user needs at the right time and in the correct location.
- The standard web can be accessed in locations where other devices do not have easy access to the internet. Standard web development can be more affordable and even less expensive than developing a mobile application.
- There is the possibility of a much larger user base. In rural communities, more people in Bangladesh use PCs and laptops than mobile applications. This is because people in Bangladesh have community centers where they can go and get assistance with accessing a PC, whereas using a smartphone app requires specific devices and a limited amount of knowledge that most people are unfamiliar with.[69]
- There is the possibility of reaching a much larger geographical area (in developing nations, standard web browsers are often the only way for a user to access the internet).

4.8 User Centered Web Design Approach

After assessing the situation and it has been determined that the standard web portal should be used rather than the mobile application.[69] Then it has been determined what the Bangladeshi people required in terms of health care. Following that, the eHealth web platform has been prioritized , designed, kept the design consistent

with industry standards, and finally been reviewed and refined the design.(Figure: 4.2)

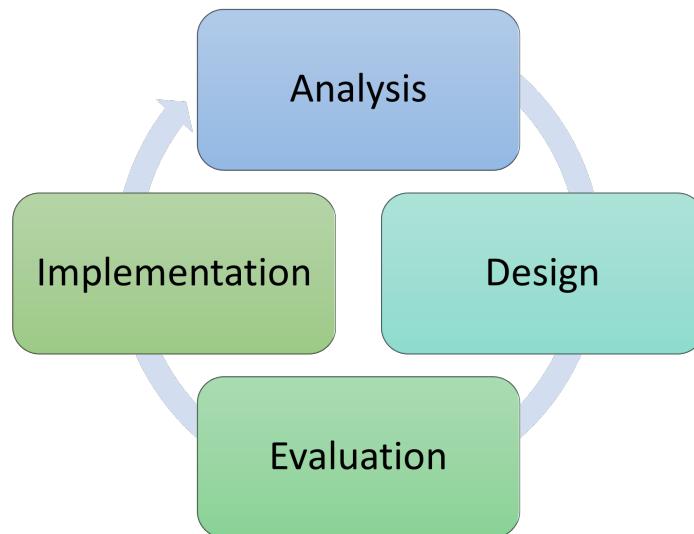


Figure 4.2: User Centered Web Design Approach

4.8.1 Assessing the Current Situation

Mobile applications are critical because smartphone and tablet users outnumber PC/Desktop users. Most people in Bangladesh (mainly in rural areas) lack the necessary knowledge and resources to use smartphones, and the majority do not own one.[69] After ten months of operation, only 7,43 percent of the country's mobile subscribers continue to use the fourth generation (4G) mobile telephone service.[23] Three mobile phone operators — Grameenphone, Robi, and Banglalink — launched the service on 19 February 2018 after receiving licenses from the Bangladesh Telecommunications Regulatory Commission. According to the latest BTRC statistics[67], 4G subscribers reached 1.17 crores in early December 2020, while the country's active mobile phone users totaled 15.70 crores.

Mobile phone operators blamed high prices on 4G-enabled devices on the slow growth of 4G penetration.[107] However, mobile phone importers stated that a lack of 4G-enabled products in their capacity contributed to the slow growth of 4G penetration.[70] In an interview with the National newspaper New Age, BTRC chairman MD Jahurul Haque stated that 4G is a significant barrier to 4G penetration in Bangladesh due to the country's mobile phone users' inability to afford 4G-enabled devices, including handsets. 40.54 percent or 6.35 crore of the country's total mobile phone subscribers use 3G internet service.[16] Apart from users of 3G and 4G services, the majority of people in Bangladesh access the internet via 2G services. 8.56 crore, or 54.48 percent, of the country's mobile phone subscribers, access the internet via a personal computer connected to a data modem.[70]

According to recent research, many users in Bangladesh use the mobile application for a limited set of functions such as email, a few apps, and social media and prefer to perform more complex tasks on their desktop computers.[107]

4.8.2 Understanding Users

Prior to designing or prioritizing features for eHealth, it was critical to gain a better understanding of the users in a web context.

When working on this project, it was necessary to know how they prefer to access the internet and discovered that the majority prefer to use a desktop web application rather than a mobile app, which requires compatible smartphones.[107, 70] Additionally, consider the time spent online via a mobile access point. The majority of people, particularly those living in rural areas of the country, prefer simpler mobile phones. BTRC, in collaboration with Grameenphone, launched a campaign in which desktop PCs equipped with a 3G internet data modem were distributed to the majority of the local community in order to teach residents how to use the internet for essential services.[67]

Quality education is available to anyone, anywhere, through the Online Teaching Excellence Center. Grameenphone enters the virtual education space with the launch of the Online Teaching Excellence Centre (OTEC).[5] Through the use of the internet, this knowledge-sharing hub expands its reach throughout the country. This platform connects educators from various reputable educational institutions who deliver lectures on a variety of subjects.

4.9 Obtaining citizen information/data

The information or data of a person or institution may be requested by a commission and shall be provided by the Commission unless otherwise requested.[117, 155, 37]



Figure 4.3: NID Information of Individual in Bangladesh

Each citizen may be on the electoral roll and therefore receive a National Identity Card. The Bangladesh Election Commission will issue a National Identity Card to each citizen. A national identity card will be issued to every citizen. (Figure: 4.3)

The following qualifications for NID registration are required by Article 122 of the Constitution of the Peoples' Republic of Bangladesh and Section 7 of the Electoral Rolls Act 2009:[44]

The screenshot shows a web-based application interface for the Bangladesh NID Application System. At the top, there's a red header bar with the text "Bangladesh NID Application System". Below it, the main content area has a light gray background. On the left, there's a navigation link "Home / Smart card status". In the center, there are two input fields: one for "NID or form number" and another for "Date of birth" which includes "Day", "Month", and "Years" dropdowns. To the right of these fields is a note: "If you want to know the information of smart card, give your NID number and date of birth". Below the input fields is a CAPTCHA image with the text "aneed" and a text input field labeled "Enter the code displayed in the image". At the bottom of the form are two buttons: "Canceled" and "Submit". At the very bottom of the page, there's a footer bar with the text "Bangladesh Election Commission. 2020 - 2021, all rights reserved."

Figure 4.4: NID Application System to authenticate users access to eHealth portal

- Is a citizen of Banladesh.
- Is deemed to a resident of an electoral area.

There are two phases in the data collection and integration process. The sample of data collection is between 300 and 400 people. The electoral board collects and adds voter data to the registration form. Alternatively, help complete the registration forms during the home visit. Once the registration form has been completed, voters will receive a registration slip. Voters can use this slip to visit the registration site and take pictures and data. Voters must arrive at the center of registration on time. The data collection and the local government representative check the voter's accuracy before approaching the data entry operator.

The data entry operator uploads the system with photos, fingerprints, and voting data. At home, people with disabilities, sick or elderly, have more flexibility. Data entry teams at the Registration Centers are stationed. When the data has been uploaded, the teams return to the server stations and start working again. After the place of registration has been confirmed, fingerprint checks are used to track and terminate the several registrations made by the same person at different places. The draft list is then printed, and people can claim or be removed from the final list for 15 days. The final list and the new national identification cards are updated to this database(Figure: 4.4). The information that can be collected form NID Citizen database:

- Full Name
- Date of Birth
- Blood Group
- Present Address
- Contact Information

4.10 Use of NID in Receiving Certain Services

Government notifications may be published either electronically or in the Official Gazette. After publication of such notices, the government may introduce a system to issue every citizen a National Identity Card and submit a copy when receiving services or civil facilities. This notice should however not be made public and the system should not be implemented until national identity cards have been issued throughout the country.[64] Citizens may not be obliged to display their ID cards or denied access, if they do not have them, to services or to civil facilities.

4.11 NIDWing Organizational Structure

The Secretariat of the Election Commission (ECS) oversees NIDW. Seventy-one employees report specific duties to the Director-General, each. It consists of three principal branches and nine units. The responsibilities are mentioned below;

4.11.1 The Objective of NIDW

- Issuing citizens a secure national identity card.
- Managing all activities related to this, including maintaining the national civil registration database and providing identity check services to qualified private and public organizations.
- Developing the Central, District, Upazila, and field data collection infrastructure to facilitate data collection, verification, and ongoing data management processes.
- Creating public awareness and attendance at registration centers on electoral registration and national identity cards.
- National ID card issuance and management.
- Encouraging the development of e-governance in Bangladesh by developing skills and sharing/distributing ICT equipment after electoral roll data collection is complete.[141]

4.12 Bangladesh Medical and Dental Council

The Bangladesh Medical Council was established in 1972 by the President of the People's Republic of Bangladesh adopted as Bangladesh Medical Council Act 1973 by Parliament.[32] Bangladesh Medical and Dental Council was formed in 1980 under the amended Bangladesh Medical and Dental Council Law. The 1980s began earnestly. Some of the amendments to the Medical and Dental Council Act of 1980 were adopted in 2010. In 2011 a new version of the Medical and Dental Council Act 2010 (Act. 61) was adopted.[32] The Council shall complete all of the above disciplinary measures. It shall cover all non-ordinary work, including complaints against doctors, preparation of undergraduate and postgraduate curricula, the accreditation of graduates awarded from outside countries, and the accreditation of journals. Moreover, other NGOs have graduate schools of dentistry and medicine.

Objective of BMDC

- Medical and dental qualifications awarded by Bangladeshi medical and dental institutions.
- Registration of medical practitioners and dentists.
- Medical Assistant Registration.
- Medical and dental intuitions inspection.
- Withdrawal of medical and dental institutions recognition and maintenance of medical and dental registers.
- Penalty for fraudulent registration claims.
- Action by registered medical and dental practitioners against the use of the false title, etc.
- Removal of names from medical practitioners' registers.
- Proceedings against persons not registered under the law.

The reason to select the BMDC Database server is to receive the name of the therapist. Every doctor should enroll in the council before practicing and informing them about their work area and time schedule. [32] (Figure: 4.5).

The screenshot shows the official website of the Bangladesh Medical & Dental Council (BMDC). The header features the BMDC logo and the text "Bangladesh Medical & Dental Council". Below the header, a green banner states: "We help to protect patients and improve medical education and practice in the Bangladesh by setting standards for students and doctors. We support them in achieving and exceeding those standards, and take action when they are not met." The main navigation menu includes links for HOME, ABOUT, DIFFERENT COMMITTEE, FORMS, REQUIREMENT OF DIFF. CERT., FIND REGISTERED DOCTOR, FIND REGISTERED MEDICAL ASSISTANT, and CONTACT. On the right side of the header, there are links for Useful Links, BMDC Webmail, Sitemap, and Search. Below the menu, there is an "ONLINE PAYMENT" section with the text "fast . secure . hassel-free" and a QR code. The central part of the page displays the "Find Registered Doctor" search form. It includes fields for "Registration No. *", "Doctor's Type *" (with options for Medical or Dental), and a "Captcha Code" field containing "72289" with a refresh button. A "Search Doctor" button is located at the bottom of the form. To the right of the form, there are instructions: "Only input Numeric Number, Without A-(like 1,2,3).", "* For Medical please search between 1 - 106000 & for Dental search between 1 - 11000", and "N.B.: Any mistake/ error for correction please send scan copy of BMDC Registration Certificate by email us using: info@bmdc.org.bd / admin@bmdc.org.bd".

Figure 4.5: BMDC Application to authenticate Physician's identity to access eHealth portal

4.13 Association of Physicians of Bangladesh (APB)

This group includes internal medicine specialists and medical science specialists (cardiologists, nephrologists, pulmonologists, dermatologists, hematologists, and psychiatrists/pediatricians). APB's history dates back to 1989. The Association of Physician Educators thrives on scientific and educational conferences. APB's program

has always included workshops and CME. APB is also a member of the United Forum Against Tobacco (UFAT). This group follows its rules. The APB constitution is unique. The 23-member E.C. meets here. Members are working hard to make this group a success. The Society currently has 406 life members. Bangladesh, a developing country, has made great strides in health. APB's work is vital in this regard.

4.14 Pharmacy Council of Bangladesh (PCB)

The Pharmacy Council of Bangladesh (PCB) is run by the Health Service Division, a separate entity within the Ministry of Health and Family Welfare.[fifteeneal, 164] It is governed by the Pharmacy Council of Bangladesh (PCB). Pharmacy education in Bangladesh is governed by the Pharmacy Ordinance 1976, which established the PCB as the official regulatory body. A professional registration certificate for pharmacists (Grade A), diploma pharmacists (Grade B), or pharmacy technicians (Grade C) is issued under the Pharmacy Act (Special Rule) of 2013 (PCB Regulations) (Previously known as The Pharmacy ordinance 1976). The Pharmacy Council of Bangladesh (PCB) is assisting academia, the pharmaceutical industry, community pharmacy, and hospital pharmacy institutions to improve pharmacy education, training, and practice in Bangladesh in general.

The Pharmacy Council of Bangladesh regulates the practice of pharmacy in Bangladesh.[164] The pharmacy council also does the following:

- Approve pharmacy exams for pharmacist registration.
- Maintain pharmacist and pharmacy apprentice registers (Figure: 4.6).
- To register pharmacists and issue registration cards.

The screenshot shows a web-based application window titled "Pharmacist Information Verification". At the top right is a vertical ellipsis menu icon. Below the title, there is a label "Select Grade:" followed by three radio buttons labeled "A", "B", and "C". Underneath this section is a field with a user icon and the placeholder text "Enter Pharmacist Unique Registration Number *". At the bottom right of the form area is a teal-colored button with the white text "FIND PHARMACIST >".

Figure 4.6: PCB Application to authenticate pharmacist access to eHealth system

The eHealth CMS divides the users' roles into specific categories, in which patient health information can be accessed through the BMDC and NID databases by doctors who are enrolled in APB and BMDC during verification. The NID database

must be verified by both parties to gain access to the eHealth Content (Figure: 4.7). Thus, the NID commission and BMDC must validate the eHealth system, which provides universal health coverage for Bangladesh.

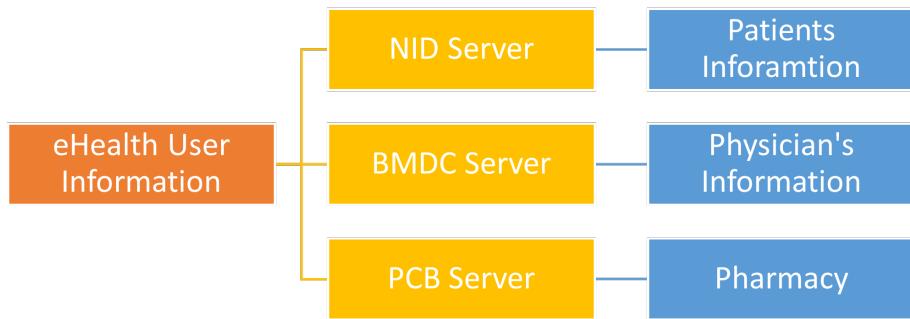


Figure 4.7: Collecting users information based on user role in ehealth system

Chapter 5

Design And Sustainability

Developing a conceptual design model of a health content management system is necessary for implementing a user-centered healthcare model. I am interested in designing a Healthcare CMS that can be launched online.

By using PhP and MySql along with HTML, CSS, and Bootstrap, the information and prescription can be sent to the server without reloading the page. Additionally, to access multiple patients and users to create multiple sessions, a different login method must be utilized. Patients will have a direct communication channel in the email directly addressed to the designated physicians. The user-centered health model structure is used in this report to design a health content management system. The research that this project will carry out will allow software developers to understand better the development of content management software and the various constraints and resources required for this type of software development. This design will show how application development will utilize web data in the eHealth digitalization system for maximum advantage. A health content management system, also known as a patient health record, incorporates data storage, processing, and information security, all tied together in one system. As new fields open computerized health data, a new technological environment is made available to solve the problem that computerized health data would have helped to solve before. To use a web browser, one does not need any specific technical skills. The dedicated health professional or delegates can administer the site interactively thanks to the content management tool.

From the architectural view, eHealth CMS has two part-front side representation for patients, individual, physician and pharmacy and the backside administrative part control by health regularization body.

When considered from an architectural standpoint, eHealth CMS has two distinct, yet interconnected, representations for patients, individuals, physicians, and pharmacies on the front side (their “visible side”) and on the backside (their “invisible side”).

To allow content to be updated separately from the container, such a tool is a fundamental component of the content management system. The process for designing a CMS for the digital health care system in Bangladesh will include conceptualizing the concept, applying it, testing it, and redesigning it if necessary.

5.1 Content

The content here is about everything in the health sphere which would be of use to the designated user, patients, physicians, pharmacies, and regulators. All the information about patients who will get treatment from their physician is included in the content of the prescribed medication documents, patients' reports, and diagnosis analysis results. Secondly, utilizing internet technology makes it possible to retrieve all of the health information data available and download it in a specific situation. There are many ways to collect health information data – either in a database or with a collection of documents. Content is composed of all Bangladesh-approved hospitals and lists of individual doctors and departments. Furthermore, patient health information is always up to date with current medications or new doctor's orders.

Because many pages on the site are critical and challenging to maintain relationships, static pages must be carefully managed. The design also necessitates advanced programming and computing skills because the site needs to be restructured throughout the design process.

5.1.1 Dynamic Page

Website width or depth, or having both, indicates the website topology. The revolution was intended to utilize a database that links various PHP, ASP, or Perl-based scripting pages. Because of the changing content, dynamic sites have advantages over static sites. (figure 5.1) Additionally, the Health content management system

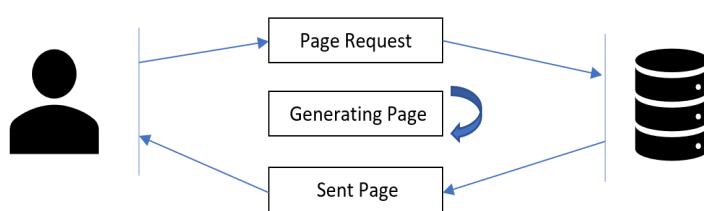


Figure 5.1: Dynamic Page from Server

tools separate the content into document, text, and image sections to manage each part independently. The figure 5.2 to the right illustrates the extent to which the content management system contributes to content management.

5.1.2 Optimization policy

The primary goal of cache use is to avoid making the same health values (both temperature and symptoms) re-calculated over and over again. When a patient or doctor logged in using a designated user's access, it was beneficial.

The function `ob_start()` creates an output buffer. A callback function can be passed to process the buffer content before the buffer is flushed. Flags can be used to allow or limit what the buffer can do.(Figure 5.3)



Figure 5.2: Content Creation

```
1 <?php ob_start(); ?>
2 <?php include "../include/db.php"; ?>
3 <!DOCTYPE html>
4 <html lang="en">
5
```

Figure 5.3: Buffer Functions

5.2 eHealth Application

This eHealth CMS project aims to build and maintain a database of health data and information related to patients with physicians and then index the data using keywords to generate good search results. The CMS will be run by a CMS administrator so that when people input information on the back end, it appears as a portal on the front. The eHealth website contains two sections; one section for everyone in Bangladesh who can log in to the portal using a national ID card (which was started in 2016 as the SMART Card and aims to finish delivery to every person in Bangladesh by 2022) and the other section for different designated individuals, such as information system managers and health institution administrators. In managing an information system, these aspects include but are not limited to, creation, publication, and validation of information by the software. (Figure : 5.4)

5.2.1 Development environment

The following software is being used to achieve the eHealth content management system.

- PHP version 8
- MySql version 8

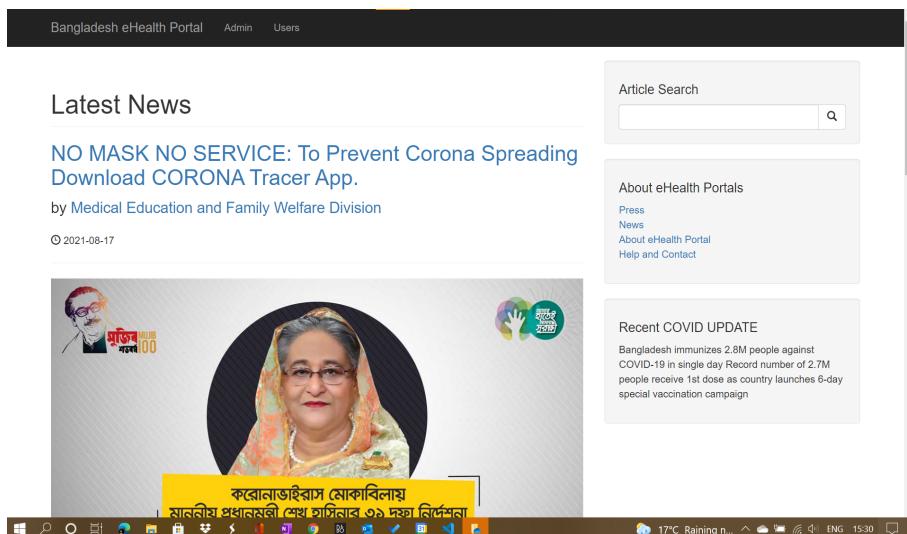


Figure 5.4: Home interface of eHealth Portal

5.2.2 Reasoning for Using Php and MySql

The first visible Digital Bangladesh demonstration took place in 2010 when the Honorable Prime Minister Sheik Hasina launched more than 4500 national digital centers from the Char Kukri Mukri region.[117]

Between 2007 and 2010, Bangladesh began to digitize. When the initial proposal of Bangladesh to start e-commerce for all possible solutions was supported by organizations and institutions, the company needed to develop software projects for its products and services.[48] However, Bangladesh required a highly skilled software developer to build an eCommerce platform and a content management system. Most organizations and institutions contracted foreign software developers to develop CMS products and services and ensure business-to-business communication via eCommerce platforms.[57] At that time, PHP and MySQL built most websites and CMS, as it was relatively popular with the developer at that time.

However, software development requires only maintenance and few internal changes. Furthermore, local software developers require government organizations and institutions to maintain the CMS with proper PHP knowledge after contract completion.[48, 57] With this in mind, most students in Bangladesh started their careers with PHP and MySQL in the expectation of a job in Bangladesh's competitive market.[155]

Digital Bangladesh's primary challenge was not to improve the Internet, facilitate e-commerce platforms, or introduce robots and AI. Instead, it was a question of designing digital solutions which would help masses and people without the Internet and smartphones bridge this "digital divide," which is certainly there and is threatening to expand.[117, 155, 44]

In the project, using PHP and MySQL is a preference and a valid reason for developing eHealth CMS. So, most developers in Bangladesh will need little knowledge of how the CMS works if it is implemented.

5.2.3 Importance of PHP in Web Development:

Using statistics[81] from different websites, the release of modern PHP web developers can be determined. Moreover, PHP is also more prevalent in its on-demand programming language than other programming languages. Today, almost 82 percent of websites use PHP as a programming language on the server-side. Below are several features describing PHP's importance in web development:

PHP is known to be the most frequently used programming language.

Open Source: PHP is accessible in every sense of the word. The big community of developers working with open source technology is crucial. They not only use PHP every day but also produce new positive changes and improvements. Programmers can get to know the latest solutions more quickly and implement them as soon as possible. In addition, unlike many other programming languages, PHP has its own support. These factors lead to the introduction of new PHP frameworks, components, and other tools. PHP is not surprisingly widespread.

Scalability: The creators are probably looking forward to the growth of the projects by building a website or web application. Scalability is therefore essential as the website should grow and handle increasing traffic. PHP-built sites can be expanded easily by adding additional servers when needed. More users = additional servers. Since PHP supports all major web browsers, scalability is not a problem.

High Speed: PHP uses its own memory to reduce workload as well as loading time. Therefore, the processing speed is relatively high, which benefits developers and their customers who receive the product earlier.

Cost Efficient: As PHP is open source, no additional costly software is needed to work with. One does not have to pay any additional licenses or royalty charges; there are no restrictions. Due to the various integration options, the use of PHP is free, and the development costs are reduced.

PHP improvements: Some languages of programming decrease in quality over time. With PHP, it is the other way around because demand is steadily increasing. New challenges require improvements, and these improvements can be achieved on an annual basis. Today, PHP does not only add a database to its front-end development. Many more diverse tasks can be done with PHP, such as data collection, redirection, mobile integration, etc.[81]

Database: PHP supports various database options, including MySQL, IBM, DB2, and Oracle OC18. It is better to manage and redirect data with more database options. Faster speed enables all embedded systems to function fluently and rapidly.

The choice of development language generally compromises the advantages and disadvantages of the available options. PHP can be used in 2021, from landing and simple WordPress websites to ending with complicated Web platforms such as Facebook to build any Website.

In the light of all the above, PHP should be made more efficient and able to handle a broader range of tasks while remaining user-friendly and cheap. Thanks to its light syntax and fast onboarding, PHP is the best choice for commercial projects.

PHP is used in this project because of its flexibility, nativity, multiple integration opportunities, and high speed.[81, 95]

5.2.4 PHP with a database system

PHP is famous as a scripting language among web developers because it can interact with database systems, including Oracle and MySQL. This section discusses the use of the MySQL database in the PHP scripting language. Any website may require different data or information to be displayed and recovered from the database.[95] This can include a simple list of website operations based on the data stored in the database. Website design can be modified using a few PHP scripts instead of each web page is changed and uploaded. The PHP script can access the MySQL database in order to retrieve all web page information.

5.2.5 Setting up the MySQL database

The procedure for establishing a MySQL database depends on the host. To access the database, each database would require a username and password.

Database management can be performed using PHP scripts or with a PHP-MyAdmin program.

The next step is to create the database tables to store information on the website. It is also easy to create a database table using PHPMyAdmin. Alternatively, the entire database can be created and configured using the following PHP script:

CREATE TABLE tablename {Fields}

Where the Fields are coded as *fieldname type(length) extra_in*

Example: *first varchar(15) NOT NULL*

In the PHP script, the following command is used to connect to the MySQL database:

mysqli_connect(localhost,\$username,\$password,databaseName);

where:

- localhost is the server address on which the web site is running.
- \$username is the user name for the database access.
- \$password is the password for the database access.
- databaseName is the name of the database, where the information is stored in table.

5.2.6 Executing PHP commands

After the MySQL database has been configured and connected, the server can start executing PHP commands. Below are the two ways to execute a PHP command:

- Entering the command in PHP using the following syntax:

mysqli_query(\$query)

This command form can be used to repeat the command by changing the variable.

- The command is defined as a variable. The operation result will be allocated to the variable.

5.2.7 Data input and output

The insertion of PHP data is identical to the HTML pages input procedure. The advantage of using PHP is that the script does not need to be changed for each new piece of data. Users can also enter their own web page data.

Following is an example of an HTML page with textboxes that can be used to enter data in a form: (see Figure 5.5)

```
<form action="insertValue.php" method = "post">
    <input type="text" label = "First Name" value = "ffirst">
    <input type="text" label = "Last Name" value = "last">
    <input type="text" label = "Phone" value = "phone">
    <input type="text" label = "Mobile" value = "mobile">
    <input type="text" label = "Fax" value = "fax">
    <input type="text" label = "Email" value = "email">
    <input type="text" label = "Web" value = "web">
    <input type="submit" name = "submit" value = "submit">
</form>
```

Figure 5.5: Data Entry Form in HTML

Alternatively, variables can be used to enter information in the database. Example:[95]

```
$first=$_POST['first'];
$last=$_POST['last'];
$phone=$_POST['phone'];
$mobile=$_POST['mobile'];
$fax=$_POST['fax'];
$email=$_POST['email'];
$web=$_POST['web'];
$query = "INSERT INTO contacts VALUES ('$first','$last','$phone',
'$mobile','$fax','$email','$web')";
mysql_query($query);
```

This script is saved to an HTML format in the insertValue.php file. The data entered in the webpage form is stored using this method in the defined variables, then passed on to PHP.

The following MySQL command can be used to display (or output) the input data using PHP, with the result assigned to the variable.

```
$query="SELECT * FROM contacts";
$result=mysql_query($query);
```

PHP provides two submission methods, GET and POST, to transmit data in a PHP script by form. The GET method displays the variables and data at the page address, while in the POST method, they are invisible. For example, a script can be created which displays various web pages according to the link clicked.

The government of Bangladesh requires each citizen to have a unique identification number to access the CMS. In 2016, the Bangladeshi government undertook the ambitious project to issue smart national identity cards to all under eighteen.[156] For people to be able to vote for their government, they must have the NID. While that may be the case, NIDs have proven to be an increasingly popular choice among various institutional bodies, such as those that provide additional services, such as passport and driving license verification.[44]

5.3 Structure of eHealth CMS

eHealth CMS consists of two parts, content delivery application (CDA) and content management application.

Content delivery application (CDA) - the back-end part for the code logic of a web solution and for transforming content into an end-user visual part. (Figure: 5.6)

Content Management Application (CMA) - front-end part or editors' user interface creates and updates content without any code touch. (Figure: 5.7)

These two components are closely connected, but Non-technical users work at the interface level and do not see the background that is the responsibility of developers.

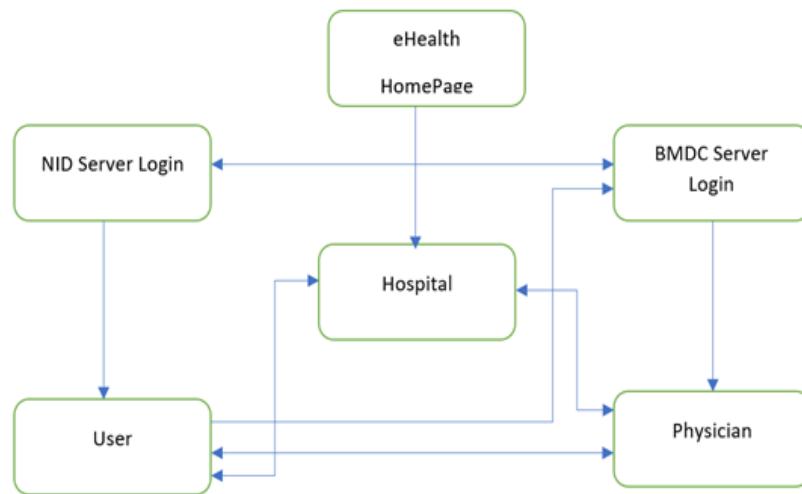


Figure 5.6: Flow Structure of eHealth CMS

5.4 eHealth CMS Functions

eHealth CMS provide out of box solution with the following function:

5.4.1 Content creation and publishing

Users can create content such as daily temperature recording, or food intake, health status for days to present during the consultation, or provide to the physician when necessary. Similar way, when the physician has a patient's report on a particular

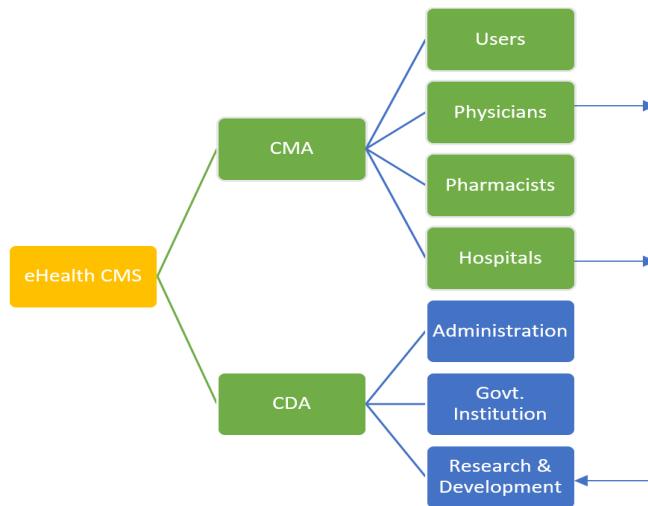


Figure 5.7: General Structure of eHealth CMS

case, content can be created from the physician's perspective. That can also be considered as a prescription for a certain situation. (See Figure 5.8)

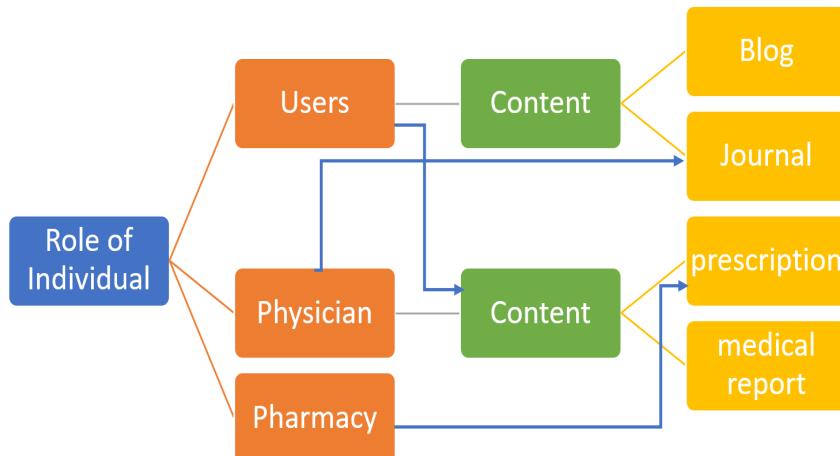


Figure 5.8: Content creation and publishing

5.4.2 Data Storage

eHealth CMS can store own information about the individual user in the server using its own database, where patients record can be created by their individual unique NID number. Physician's interaction with the database will also be with their personal NID number since NID will be the primary key in the database table to reference between tables. The table will be designated as Users, Physician, Pharmacy, and drug. Not to mention every table has its perspective objective to hold the data to correlate between other data or information. Since Businesses or organizations do not have any personal ID numbers like hospitals and administrative institutions in Bangladesh, the access of the public health record can be authorized

by the particular agencies that hold the responsibility in that local zone (see Figure 5.9). Detail role of administration was discussed in chapter 7 (Bangladesh Health Sector).

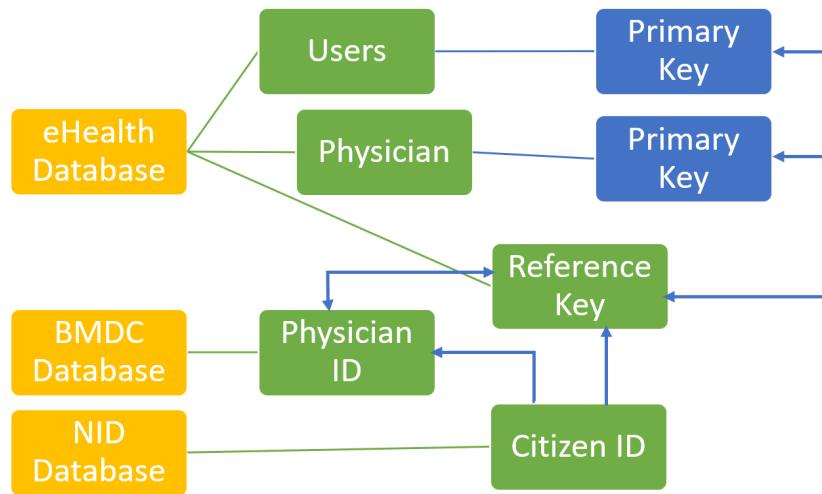


Figure 5.9: Data Storage Diagram

5.4.3 Content Indexing

Content was indexed on both the home page of the eHealth portal and users' profiles to sort it out and put it on display for the latest information. The content is collected from databases where every database from different government institution first come to eHealth own database and create indexing for display the latest information. It is because to get certain information from the certain database due to access limitation that will be applied for health record system.

5.4.4 Search and retrieval by various parameters

eHealth CMS was designed in such way when content was created or collected from other governmental institution and stored in the portal database, it will store it with a various keyword that is collected from the content itself and created based on the content. So when an individual searches with any keyword that species or relates to any post or content, it will present it with a last in first out manner. Also, when looking for physicians in any particular department, users can also choose to look for physicians into a particular department or hospital or search by department wise to collect physician information and address.

5.4.5 Content editing and deleting

Users can edit or delete any content that is created by them if and only if the content is not first shared with any physician. This is due to because when any content is shared between to individuals with different roles (e.g., patients and physicians), the content is stored in the database with an index referencing both different tables or particular roles of individuals. The only way to delete the content at that point

in time is to request for deleting from both sides. And the respective authority who administer the eHealth portal will take control of the content. If the content were a prescription or report for the consultation period or any medical report, then the content will be a reference to the eHealth portal from the source of destination server and can not be deleted by the individual will.

5.4.6 Access Control

When the user creates any content regarding health information to save it as a blog, the content can only be shared from the user to the physician as a format of the file that can be a read-only file for the other role of the individual. But when a physician is being appointed for patients, patients health data can be accessible by the physician without prior notification; this is because when patients book an appointment with any physician, consent will also be made at that point of time to access all health reports of that individual to get the complete overview of patients.

5.4.7 Security

eHealth CMS store personal content in the database with a password of every individual that first encrypted with sha256 and store it in the eHealth database. That is when users create any content and store it in their profile. User login was directed by the NID server, and the physician will access the eHealth database by login from Bangladesh Medical and Dental Council database server.

SQL Injection

By inserting SQL queries into the form data, the attacker attacks the database via SQL injection. When users create an account or log in to the eHealth database, they must enter their name and NID number in order to gain access to the database using their preferred password. However, if the form input text contains a SQL query and the username, it has the potential to modify or disintegrate the eHealth database's data or health information. To avoid this, the CMS makes use of the *mysqli_real_escape_string()* function (figure:5.10). This function accepts two parameters:

```
$username = $_POST['Username'];
$password = $_POST['Password'];
$NID = $_POST['NID'];
echo "<br>". $username . " ". $password ." ".$ID. " <br>";

$password = mysqli_real_escape_string($connection,$password);
$username = mysqli_real_escape_string($connection,$username);
```

Figure 5.10: real_escape function to prevent SQL injection

eters: the database connection and the value to escape into the string that passes

through the form data. The following is a sample of the code:

```
$password = mysqli_real_escape_string($connection,$password);
$username = mysqli_real_escape_string($connection,$username);
```

The function is used to escape the entire contents of the field and re-assign it to the user and password fields.

Password Encryption

To increase the security of the application form data, the crypt() function is used to encrypt and store the password in the database. This is to guard against malware software collecting usernames and passwords from the field without gaining access to the database. To enable password encryption, the database record was created with a password field of 200 characters.

Password varchar(200) NOT NULL

The objective is to create a password that is sufficiently lengthy in terms of numbers, characters, and symbols. The user's password will not change. However, when they create their profile for the first time, their password is encrypted and stored in an encrypted format in the database. Encryption is performed using the crypt() function. However, without the addition of a salt parameter, the crypt() function generates a weak password.

Although the *salt* parameter is optional, using salt in conjunction with the crypt() function results in strong encryption. The *salt* parameter contains a string of at least 22 characters. Any string could be used as the string in salt.

CRYPT-BLOWFISH was preferred for hashing algorithms. Blowfish hashing with the following salt values: "\$2a\$," "\$2x\$," or "\$2y\$," a two-digit cost parameter, "\$," and 22 alphabetic characters "./0-9A-Za-z." To begin, a hash format of the form \$2ys\$10\$ is created for use with the crypt() function. Ten after \$2ys\$ denotes the repetition of a particular round ten times. The salt parameter is a string of twenty-two characters in length. Crypt() accepts two parameters: the password entered by the user in the form data and the hash format used to encrypt the password. The following figure 5.11 is a snippet of code:

```
$hashFormat = "$2y$10$";
$salt = "ICTE3rdSemesterProject";
$hashF_and_salt = $hashFormat.$salt;
$password = crypt($password,$hashF_and_salt);
```

Figure 5.11: Using crypt() function with hash format

5.4.8 eHealth CMS offers

- **Usability:** An intuitive graphical interface that allows users to handle all information and collect necessary data about medication and creates easy communication with physicians and hospitals.
- **Accessibility:** The user can access health data anytime, anywhere when connected with the internet, which makes it hassle-free when visiting a hospital or visiting a doctor's chamber.
- **Collaboration:** A particular system that can be accessed by a whole nationwide community of people create collaboration between doctors to doctors, and individual users.
- **Scalability:** eHealth CMS was created in such a way where users can create or delete the content by themselves and store health data for a certain long period of time in an organized manner.

5.5 User-Centered Design Overview

An example of a software development life cycle that incorporates UCD philosophy is shown in below. (Figure 5.12)

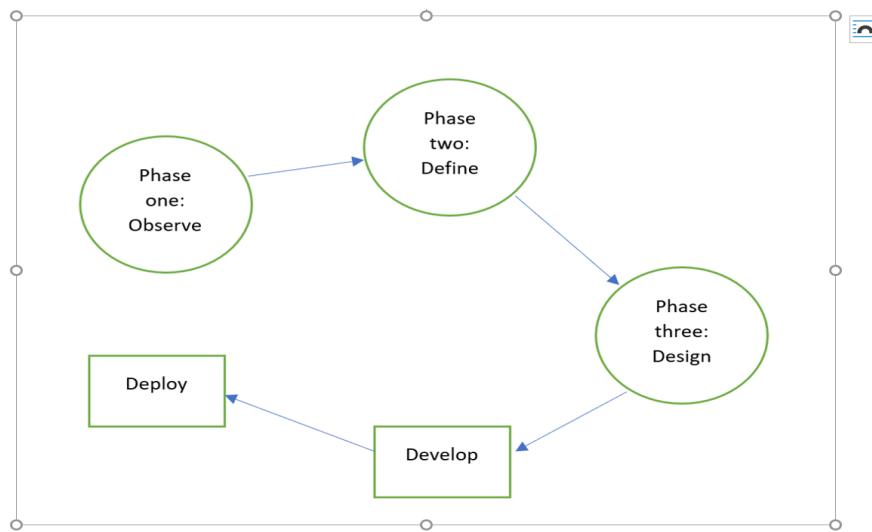


Figure 5.12: User Centered Design Model phases

5.6 First Phase: User Observation

Typically, the start of product development begins with a user-centric vision. However, to bring about real change, ideas must be coupled with action.[116] Products have different kinds of users. No matter how old the product, people's behavior is always in flux. Medical professionals, administrative and technical support staff, and patients are just some of the end-users of medical products. to better understand users, UCD conducts iterative user-focused research.[35] UCD only works with

the help of early end-user involvement. This first phase will examine the users, the work, and their requirements. The results of all user research are organized and summarized into profiles, work activities, and user needs.[30] The software will be implemented using user interfaces (figure: 5.13). The user will initially interact with

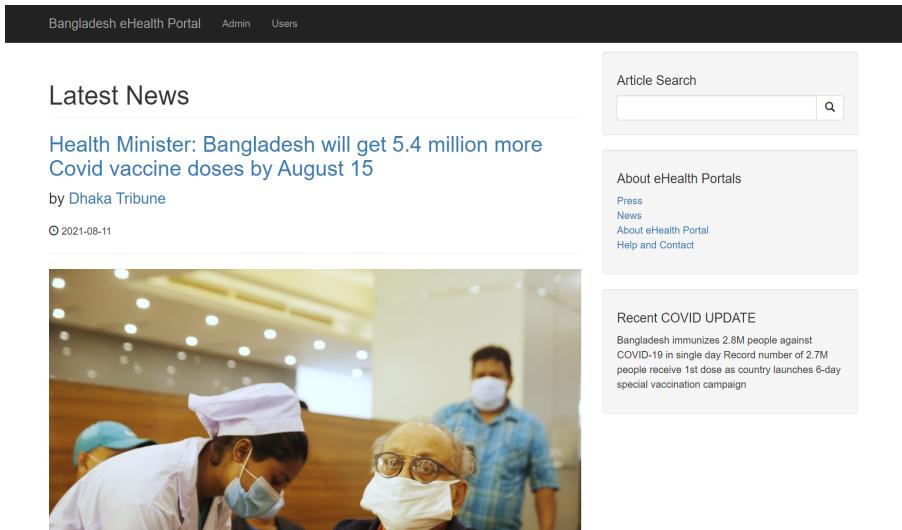


Figure 5.13: Portal Home Page

the eHealth system on the front page of the system's website. Regular users will be allowed to access government and ministry of health department and family welfare health news on the front page. The distinguished authority who will be in charge of updating the front page will manage the overall collection of health-related news. Bangladesh health sector profile discusses the administrative role of access in detail.

5.7 Second Phase: Defining Interaction

One of the most significant difficulties with using UCD is making user research findings appear in actual user interface design. Simple products need definition to succeed. The first step is to define the various interactions that the design should accommodate.[15] Use cases are concerned with how a product is used, which are the interactions between users. Work activities are first separated into logical groups and organized into a coherent, complete product with a high-level overview of the app's information flow.[116, 30] Only data definitions need to be specified in this phase, so there are no interface elements such as dialogs, buttons, or tabs. After identifying the intended user population, the use cases are evaluated and refined. Once the vision is realized and users understand the value, the campaign has been a success.

In this phase, the user logs in to the home page (first stage) using the elector Id card number that contains user information stored in the Bangladesh Election Commission Database. If the user clicks the user button, he will redirect to the login page of the NID server for confirmation of user identity (figure: 5.14). Similarly, a specific function can be accessed in Denmark via login NemID. Following a login with credentials, the user will redirect to the eHealth portal's user health profile page. The information on username, age, address, blood group, and contact number will

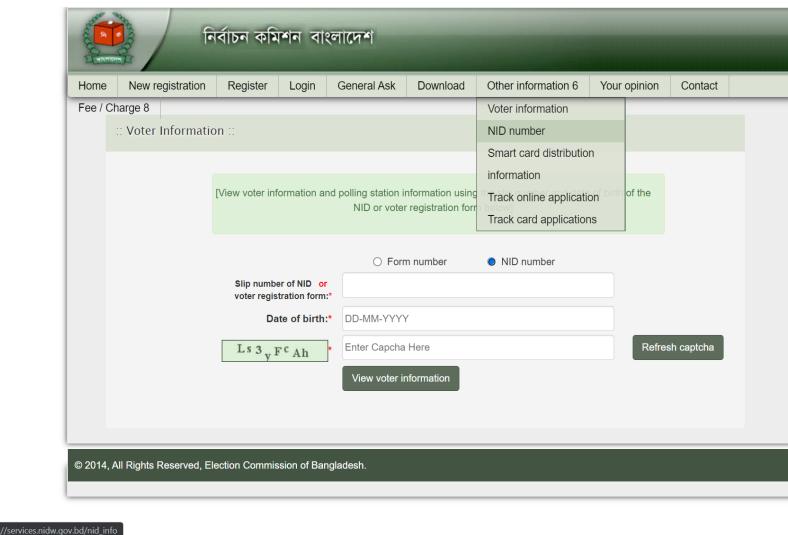


Figure 5.14: User Login Page through NID Server

be gathered from the database of the NID information board of electors. (figure: 5.15)

The user will view recent health information and report with a medical prescription or medical test report. If both parties use the same portal, users may receive

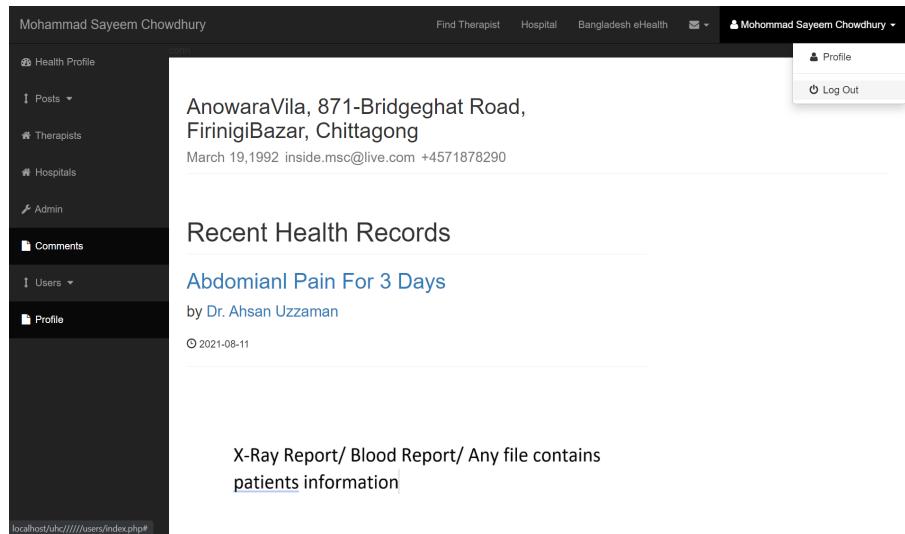


Figure 5.15: Users' health profile

a message from the doctor and the hospital. It is because the medical report or file must be sent to another doctor during consultation. (Figure: 5.16)

5.8 Third Phase: Designing the Interface

The UCD design process is centred around user-interface (UI) design, which is followed by interaction definition.[**ucd three**] Use case steps and data definition definitions can take precedence over high-level information organization. A software product's user interface enables users to interact with it.[30] UX design influences

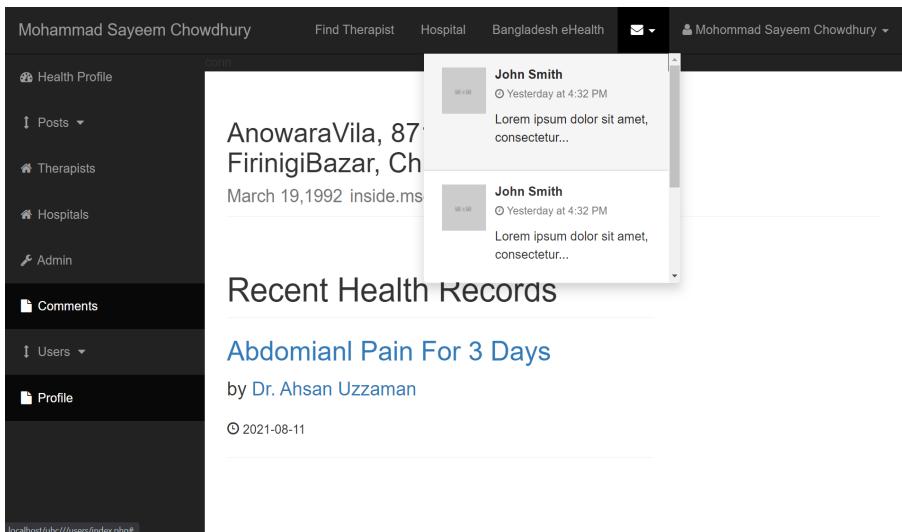


Figure 5.16: Communication through message between patients and physicians

the users' perceived usability and the user's actual usability.[15] Lavie and Tractinsky[100] state that interactive systems' aesthetics are either classical or expressive. Another significant influence on user perceptions of interactive systems is the ease of use. Content, services, and brand are also things to consider. Designers now have the job of creating the complete service, explains Gillian Crampton-Smith (p. 3)[26]. People utilize multiple touchpoints throughout their interactions with a service. To design well, these touchpoints must be visually and tactiley consistent. Provider-to-provider interactions are resources for service designers. Service levels are amenable to adjustment and are intangible—relevant results, not services. Customers and service providers negotiate about services. Accommodating schedules is crucial to dependable service. Future touchpoints for the next generation are distributed around time and space. Saffer emphasizes the value of service moments and suggests devising a service strategy to help one's organization meet these expectations.[80] Service strings group together instances of work with similar characteristics. These strings are known as process paths. Every organization requires that an individual have an interface and history of interactions so that service quality, security, privacy, and experience are never compromised.[35] For the service to know what is mine, what I'm interested in, who I'm willing to share with, and how this changes based on my mood, it must know all of this.

The user interacts with services at that last phase, makes a physician appointment, and checks the physician's or medical department's address to contact and communicate with physicians via email. (Figure: 5.17) On the top panel, users will view all names and addresses of the therapist and the hospital where the therapists work. When clicking the therapeutic section, the user receives all the names and addresses of the therapist from the Bangladesh Medical and Dental Council database (see chapter: Methodology for obtaining physician information from BMDC). Moreover, all physicians have unique access to the homepage's eHealth portal to keep their information updated so that the user knows about the current workplace position. Therefore, the eHealth portal maintains its own database to store additional information on profiles of doctors and user profiles from medical reports to doctor's prescriptions.

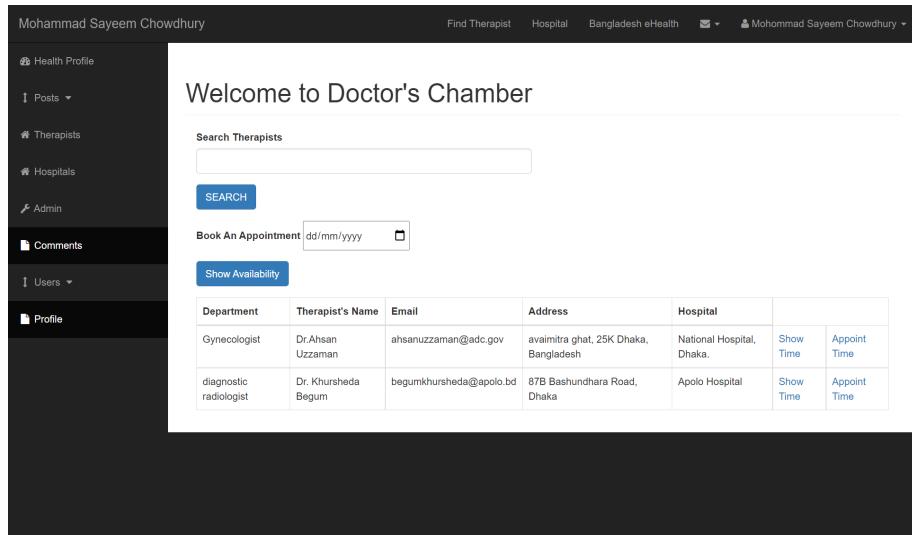


Figure 5.17: Yellow page for collecting information about physicians

Users can also look for the hospitals near the top navigation panel to see the hospital address and the hospital doctors. An appointment may be booked directly with the hospital or a time for consultation with the therapist can be appointed. The details of the consultation period can be found in a report that the doctor can publish, together with medication and medical reports, on the patient profile page. (see Figure: 5.18).

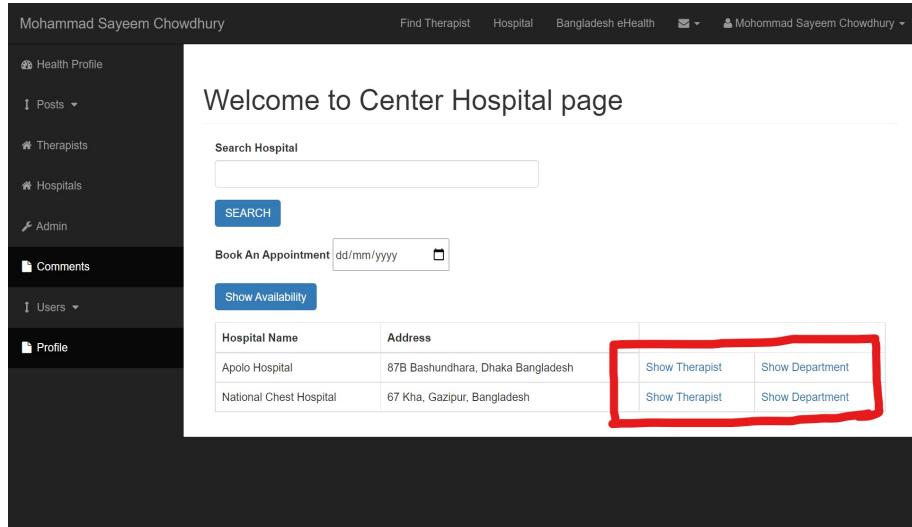


Figure 5.18: Information about List of Hospital

5.9 Sustainability and Sustainable Development

The definition of sustainability is far from straightforward; similarly, the definition of sustainable development is far from straightforward. This is best demonstrated by the fact that there are over 200 distinct definitions of sustainable development.

However, the Brundtland Commission defined sustainable development as follows in 1987:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[150]”

In order to live sustainably, we must take care of our planet, resources, and people. In addition, we can truly sustainably pass on our planet to our children and grandchildren.[160]

5.9.1 The Three Pillars of Sustainability

If we only achieve two of three pillars, we will end up with the following three pillars: (Figure 5.19)

- Social + Economic Sustainability = Equitable
- Social + Environmental Sustainability = Bearable
- Economic + Environmental Sustainability = Viable

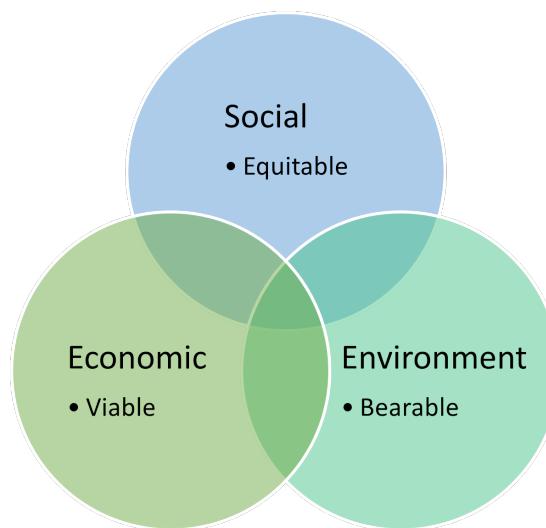


Figure 5.19: Three pillars of sustainability

We cannot achieve true sustainability and a genuinely circular economy without balancing economic, social, and environmental considerations.[171]

5.10 eHealth CMS-Sustainable Design

Interruption of treatment continuation: eHealth CMS was created to address the current situation. Throughout the design process of the eHealth digital care system, it was taken into account how each individual in Bangladesh currently deals with the current situation of seeking treatment from physicians and hospitals. However, one of the primary concerns was prioritizing the health concern. Nevertheless,

with the existing barrier in mind, the designing phase was developed to consider the issues that patients face as a result of the existing system.

Lost and missing prescription: Patients face a difficult situation with all prescriptions and medical reports due to the existing paper-based medical prescriptions from various physicians with varying treatments.[148] When patients are required to visit a physician or have chosen to change physicians and visit another district or hospital, they must carry all required prescriptions from a different timeline. It is the physician's responsibility to learn about and obtain information about his or her patients in order to provide future treatment. However, the physician reports that patients frequently miss some or all of their prescriptions due to improper storage. When questioned, the majority of patients agree that they stopped considering keeping the prescription for future use once they were cured of one disease.[148, 152] However, it is critical for the physician to diagnose a patient.

Additionally, when physicians recommend a medical test, patients receive the results from the diagnostic chamber or clinic, not directly from the physician. Mentioning the same reason as above, the physician frequently recommends repeating the medical test due to the loss of the medical report, which is required once a year or half. Additionally, people are frequently averse to repeating the medical test due to the high cost and time commitment.[4]

As mentioned in the introduction, each physician sees more than 25 patients per day, based on the physician-patient ratio of 1846 patients per physician.[151] Additionally, patients frequently struggle to obtain an appointment. According to the UN report[129], people in cities and rural areas frequently spend more time obtaining an appointment with a physician than they do consulting with one. Often, physicians do not have enough time to read through all of the paper prescriptions to get a sense of the patient's profile. Physicians at Bangladesh National Hospital in Chittagong report that they must spend considerable time learning about patients' profiles before continuing treatment.[82] As a result, they are unable to provide consultation time to an increasing number of patients each day.

The insecurity associated with obtaining an appointment with a physician is another issue created by the current system.[82] In most national hospitals, physicians are assigned an assistant clerk who is recruited directly from the ministry to assist patients in obtaining appointments with doctors. Thus, corruption is ingrained in every national hospital, with the assistant individual acting in his or her self-interest and that of the doctors. As a matter of system policy, physicians authorized to practice in government hospitals are required to charge a minimal fee, and treatment in a national hospital is frequently free.[152, 43] However, physicians in those hospitals are highly qualified and are hired following competitive examinations conducted by the ministry. Take note that in Bangladesh, individuals performing public services for the national commission are considered to be well compensated due to additional benefits provided by the government (most of the time, all fundamental rights are free for public services).[98] In a 2007 journal article[12], it was stated that physicians who practice outside of national hospitals earn a comparatively high visiting fee for each patient. With this in mind, most patients are forced to bribe the assistant clerk to obtain an appointment with the doctors. As a result, people face significant disruption and uncertainty when seeking medical consultation.

Assuarance of continual treatment: Patients will have access to their health profile via the eHealth system, including all prescribed medications and descriptions

of each physician visit. Patients can access all of their health information about themselves using their NID number and the database stored in eHealth CMS. Because the database design considers the NID of each individual as the primary and referenced key for obtaining or collecting information from various servers. When all information is connected, physicians can quickly assess a patient's health profile and administer treatment. As a result, each physician can consult with more than the average number of patients per day, ensuring that every patient receives proper care. From the patient's perspective, it is not necessary to describe what occurred previously in the event of prescription loss or inability to access the health profile on his own.

The eHealth system also alleviates the difficulties that each patient faces in obtaining an appointment to see a doctor. Patients can schedule their own appointments with the doctors they desire without involving a third party. Additionally, remote individuals who must travel long distances with the uncertainty of receiving an appointment on time can now manage their time effectively to travel with a confirmed appointment. Patients can communicate with doctors via messages for further instructions if necessary during the next consultation or continued treatment of a disease. Individuals who live in rural areas and cannot travel to or visit the physician's chamber are appointed to call the physician in an emergency using the information collected through the eHealth system.

System Contribution to Environment: On average, 88 out of every 100 people use a prescription to obtain medication from a pharmacy or other health care provider.[186] Additionally, when people are cured of a disease, they frequently lose sight of the importance of keeping the prescription in a secure location. Additionally, it is lost for a variety of other reasons. However, with a population of 163 million, people who rely on paper prescriptions and medical test results have a significant negative impact on the environment caused by deforestation.[118] Paper pollution, on average, consumes 42% of harvested wood.[76] When living in a densely populated country, forest and tree planting are critical components of balancing the social environment against pollution and other natural disasters. Nitrogen dioxide, sulfur dioxide, and carbon dioxide are released into the air during the paper manufacturing process, contributing to pollution such as acid rain and greenhouse gases.[76, 163]

Additionally, due to a lack of environmental education, rural and urban residents are unaware of the importance of maintaining a green environment.[138] Frequently, the question that comes to mind is how a seemingly innocuous act contributes to far more serious consequences.[132] Each year, Bangladesh is hit by floods caused by torrential rains that flow through the city's drains and rivers to the ocean. However, the flood lasted more than a month due to the accumulation of paper, plastic, and other debris that could clog the drainage system. The eHealth system can contribute to reforesting the country and ensuring a clean society in every way possible.

On average, ten people out of every twelve visit a physician every six months for a variety of reasons, ranging from flu to more serious problems.[43] To see doctors on time, people must travel long distances, and due to heavy traffic, they must stay much longer on the road.[72] When fossil fuels such as gasoline and diesel are burned, carbon dioxide is released into the atmosphere as a greenhouse gas. Numerous greenhouse gases, including carbon dioxide (CO₂), nitrous oxide (N₂O), and hydrofluorocarbons (HFC), are causing the Earth's atmosphere to warm, resulting in climate change.[105] Each year, a typical car emits 4.6 tons of CO₂. This calculation

is based on the assumption that today's average gasoline vehicle gets 22.0 miles per gallon and travels 11,500 miles per year. Each gallon of gasoline emits 8,887 grams of carbon dioxide. In addition to carbon dioxide, automobiles emit methane (CH₄), nitrous oxide (N₂O), and hydrofluorocarbons (HFCs) (CO₂).[105, 173] While these gases emit less than CO₂, their impact is significant because they have a higher global warming potential (GWP) than CO₂. Even a single-vehicle emitting a significant amount of CO can generate a CO plume (cloud). Following an old vehicle and driving through the plume can be hazardous to specific individuals. Not all automobiles emit the same level of pollution.

According to a recent University of Toronto study[134], approximately 25% of vehicles measured generated approximately 90% of total traffic-related air pollution. Carbon dioxide (CO₂) pollution is a well-documented cause of climate change. On the other hand, Automobiles and buses emit pollutants that have been linked to lung cancer, respiratory disease, and heart disease.[105] The researchers discovered that approximately a quarter of cars were responsible for the majority of particulate and carbon monoxide emissions in the area.[173, 163] Jonathan Wang, the study's lead author and a Ph.D. student in chemical engineering, explained that older vehicles in need of repair were the primary polluters.[174] According to article [72], all of Bangladesh's public buses are modified and refabricated in India before being used in the country. As a result, the contribution of heavy traffic to air pollution is also a significant concern when developing the eHealth system. When patients communicate with physicians to obtain the necessary information or are prescribed continuous medication, they contribute to the reduction of air pollution in the environment. Additionally, saving money on transportation and avoiding long periods of heavy traffic contribute to the sustainable design's economic viability.[39, 169]

Incomplete data, and data disintegration: Almost all physician prescriptions are written by hand,[82] except for a few exceptions(Figure:5.20). According to the United Nations,[7] the number of older people illiterate in Bangladesh has increased from 27 million in 1991 to 30 million in 2019, growing at an annual rate of 12.19 percent. With such a large number of people in the country's market, it is extremely difficult to decipher what the prescription states in order to obtain the proper medication for the patient.

Ambiguity: *Ambiguity* is a term that refers to a word or expression that can be interpreted in two or more different ways. Handwritten prescriptions frequently contain ambiguity due to the loss of information due to deteriorating paper quality or ink fading away with usage. As a result, individuals who rely on what they get from the pharmacy without knowing what doctors prescribe risk serious health consequences[186, 43](Figure:5.20). This also creates a demand for social awareness activities to be integrated into the eHealth system.[136] Using the eHealth system to obtain medication from a pharmacy requires identifying the individual in order to collect the appropriate prescription from the physician. Each time they use the system, they develop social awareness. This is because when patients use the same eHealth system for multiple prescriptions and services, they will develop an understanding that their data is secure due to their identification and storage in the eHealth system.

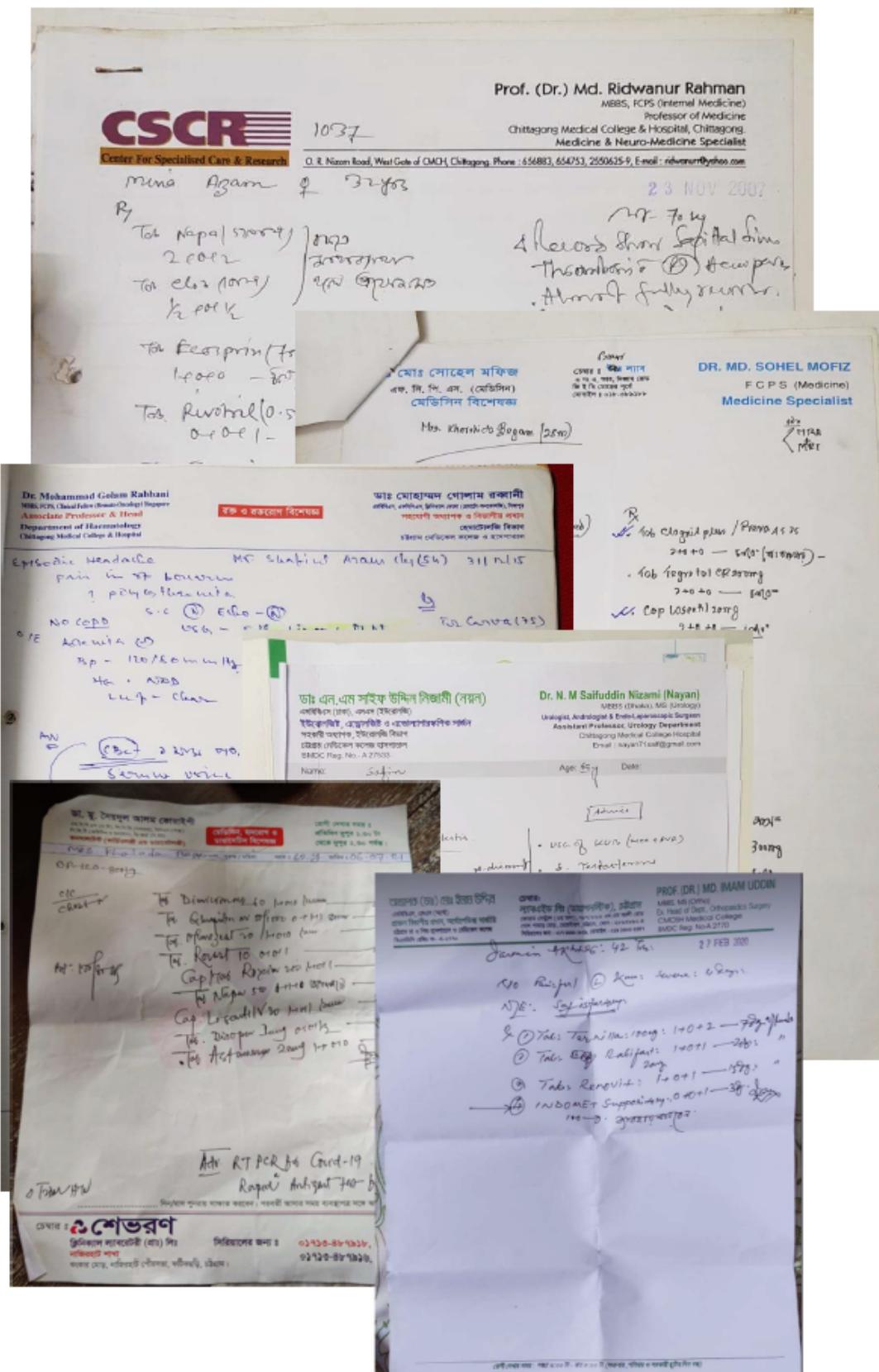


Figure 5.20: Handwritten prescription from Physicians

Chapter 6

Requirement Engineering for eHealth System

When it comes to healthcare, the models are changing, which causes a shift in technological needs. To perform a requirement engineering of a digital health care system, it is imperative to put patients in the middle (figure: 6.1) . Over the last 16 centuries, almost all governments have run public health care systems that were hospital-based and based on the guidance of knowledgeable doctors. Patients were at the system's periphery with a clear requirement focus, as demonstrated by their strategic alignment with the state or dedicated wealthy class. Completing the treatment with advanced information communication technology such as a high-speed broadband connection, a mobile health application, and super-fast connectivity is essential for overall recovery.

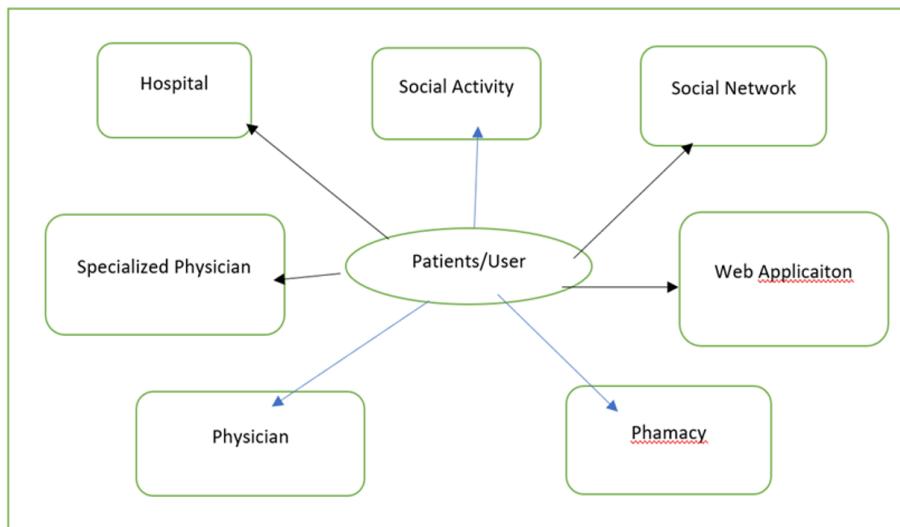


Figure 6.1: Health care system based on patients in the center of the model

6.1 Digital Health

Health care management is defined by the concepts, technologies, and terms that have no specific meaning and can be used in any way regarding healthcare, all summarised with the use of information technologies within the healthcare system.

Finally, using the term "digital health" best describes how ICT applications are being used in the healthcare system. Other terms, eHealth and mHealth, also have the same meaning, but that also suggests telemedicine or telehealth. Nevertheless, technological advancement is making it easier for video conferencing tools like Skype or Google Hangout to connect doctors and patients worldwide. Due to the digital health technology limitations in Bangladesh, digital health's evolution does not occur linearly. When technological advancement, socio-economic engagement, and political factors increase, individuals will race at varying paces, each getting a slower and steadier pace.[126]

6.2 Socio Technological Alignment

The state of ICT has grown considerably, and new technologies are widely accessible. However, reports indicate that while these technologies have been received more favourably in other industries, penetration has been modest in healthcare, wellness, and assisted living domains than financial, manufacturing, and logistics sectors.[52, 21, 143] Thus, clinical workflows lack necessary technology and are not executed and integrated.[79, 14, 13] In order to fulfil the rising health care demands without raising taxes, the overall efficiency and efficacy of medical systems must improve significantly.

Requirements engineering in healthcare is challenged by the necessity of finding new and more effective ways to galvanize social, technological, and geographic alignment to stimulate colossal development potential in global markets.[113, 147]

Controversial discussions on innovation and social context have existed since the 1970s.[45] Many say that innovation is driven by technology, and they refer to it as technological determinism.[101, 172] However, others claim that innovation is a social process, and they believe it involves society. Technology is totally under society's hands, whether to accept or reject it (social determinism).[104, 17, 74, 125] It looks that none of the supporters of the opposing extreme ideas has been able to sway the evidence so far. New technologies, such as new computer and software programs, are often introduced to society by a small number of visionaries and entrepreneurs.[2]

A society shift and, in many circumstances, a later technical change could occur to this belief. Because the evolution of innovation is a social process driven by a reciprocal dialogue between technology and society, we might call it "social innovation." [187]

6.3 Challenges in eHealth System

Requirements engineering is striving to connect the social and technological worlds. For successful and efficient implementation, requirements engineers who are well-versed in the healthcare industry will require a considerable amount of healthcare-specific knowledge. We have seen how the different dimensions of healthcare—political, historical, demographic, and socioeconomic—have changed with the advent of digital health.[25, 128, 131, 68, 19] This shift in strategy for this sector, known as application strategy, has the following implications for project participants in the

healthcare wellness or ambient-assisted living domain: What tasks do they perform? In other words, what can they realistically expect?

Requirements engineering is most commonly associated with the software industry, especially with its technical side. All engineers share the same vocabularies, except the technologist, who sees things from a different perspective. Many processes are known and well understood, and those processes are entirely deterministic. To meet these criteria, an applicant must demonstrate a strong understanding of the inter dependencies of technology and economics while also having relevant expertise in the healthcare market, where government regulation and a controlled market coexist.

To achieve a new technology, people must be comfortable with it. In order to ensure maximum interoperability and compatibility, we must ensure that we have common goals. Approval of new technology depends on thoughtful, ethical reflection and consistent adherence to laws and regulations as interpreted by the five individuals that comprise an individual, organizational, regional, national, and international system of ethical codes.[189, 109] Health technology assessment may raise ethical concerns relevant to these focus areas: benefits and harms, autonomy, equity, stakeholder values, acceptability, quality of life, and impact on family and caregivers.

6.4 Best Practice

Requirement's engineering had no one approach.[114] While most projects use only a handful of techniques, for example, workshops, some use only a few techniques. This result shows how requirements engineering is done in many ways.[114] Projects elicited requirements almost every time. As is often the case with projects, stakeholder workshops, researching existing systems, and reusing specifications were among the top options. The workshop was the preferred approach for eliciting requirements.[165] Ethnography, surveys, and data mining were just a few of the projects that used observation, ethnography, and surveys.[115, 137, 83, 33] These techniques are applied only in situations where other methods are not effective.[84] To manage projects, almost everyone plans to develop the product, often with prioritizing requirements. Many techniques of planning were combined. All the techniques were utterly equal. A requirements analysis has been performed on nearly every project. One way in which this often occurred was through using both informal modelling, prototyping, and object-oriented analysis. There was no single analytical technique that predominated. Generally uncommon (historically) are various techniques, such as decision trees and domain-driven development, in addition to quality function deployment and structured analysis.[gtwos, 28]

6.5 Laws and Regulation in eHealth

eHealth system, mobile healthcare, personalized prescription, and social media are shifting traditional health care into digital health care. Hospitals and doctors are tightly regulated due to the vast potential consequences of inadequate medical care. Therefore, eHealth solutions should be designed and implemented with the medical-legal structure in mind. It is possible that translating legal norms into the design

and implementation features will be difficult. This section seeks to facilitate this process and lay the groundwork for establishing a methodology for creating engineering requirements out of legal and regulatory rules. The strategy of integrating laws and regulations into eHealth technologies and processes is demonstrated throughout this chapter. The report provides the eHealth stakeholders with a toolkit to map, analyse, and apply the laws and regulations to achieve compliance. In this chapter, a taxonomy is used to describe the different methods of descriptive research employed in law and technology. Following this, it outlines how the tool should be applied and outlines the essential laws related to eHealth in Bangladesh while providing a non-exhaustive analysis and overview of the relevant legal rules. Additionally, it highlights the vital compliance-by-design techniques and practices that help facilitate eHealth security engineering and business processes. Compliance in the eHealth marketplace is encouraged as a means of providing evidence of conformance with the regulatory landscape.

6.6 Recommendation to healthcare stakeholders

Several recommendations for stakeholders of eHealth— developers, sellers, service providers, etc.— when implementing integrated approaches presented in this chapter for compliance requirements engineering is now possible due to the findings of this chapter's research. Every country and region has different eHealth laws and regulations. eHealth guidance states that stakeholders should consider where they want to market or use an eHealth solution and then identify and apply any relevant legal rules.[40, 49] Despite intensive harmonizing laws worldwide, laws in different countries can vary sufficiently to influence technology design. There are different contexts in which eHealth laws and regulations operate. Use settings and users could have a significant impact on applying the rules when using eHealth. No legal or regulatory matrix can be applied to everyone. To get legal advice, one should understand and investigate laws and regulations. The rules should be translated as early as possible in the development process. If design features are modified, continuous monitoring and auditing should be employed to ensure the changes conform to the design specifications. It can help to protect personal data. Standardized legislation serves to bridge the gap between actual technology design choices and existing law.

6.7 Laws and regulation in design and implementation

Many problems has been discovered while researching the legal and regulatory landscape of eHealth have remained ignored by government agencies and researchers. Complying with design norms requires understanding the full scope of norms so that we can deduce specific requirements for technology.[18, 112] Neither was an easy task.

Regulatory approaches incorporating legal and other regulatory rules into electronic health records are a cost-effective, preventive approach. Privacy by design will likely become a requirement for health IT systems that process personal information under forthcoming data protection laws.[1] The laws and regulations are not always

well translated into policy or software rules. The process is more complex than rule-based representation and rule transformation. There are many legal requirements that software developers must account for, which can be overwhelming.[11, 159]

Recognizing that both domain-specific and general security policies are possible, Koops and Leenes highlight three of these challenges that could be included in-laws soon: They can be both domain-specific and general at the same time.[96]

- 1.Rules that regulate the use of personal data have different consequences in different systems. The system, runtime, and language requirements all go into this.
- 2.Data protection is built on fundamental principles such as purpose specification and use limitation.
- 3.Any purpose given in natural language is open to interpretation, though any data processing task is defined in a computer program.

This section has laid the groundwork for a bridge that connects the content of eHealth laws and regulations to the aspects of eHealth technology and processes that can be engineered into these systems. The first step was to develop a taxonomy of research to locate the regulatory framework in the specific field. The eHealth taxonomy concept was demonstrated through a high-level overview of eHealth laws and regulations. The laws and regulations in this area focus on patient rights and safety and eHealth application and platform performance specifications.[106, 6] In this chapter, various compliance by design approaches to assist with compliance demonstration is also outlined.[153, 178] The section contained suggestions for stakeholders involved in the eHealth domain who are engaged in mapping rules and compliance by design and regulators in the eHealth sector. Finally, a few issues that might arise in the future have been recognized. Research has shown that following regulations and laws do not always produce desired results before writing this chapter.[110] One reason for this is that health care delivery using eHealth solutions introduces new vulnerabilities and threats.[102, 130] For consumers, the impact of eHealth apps on their health remains unclear.

6.8 Ethical Issues

Technology and the Internet have allowed digital health technologies to spread through our lives. Patient-provider communication, storing, transmitting, and retrieving medical data is improved by digital health technologies such as EHR, ePrescriptions, eReferrals, PDA, wearable devices, and telemedicine. As a result, the ethical questions raised by technological health and social care services revolve around the programmers' responsibilities. Health and social care can offer new technologies and their associated ethical and privacy concerns. It will require determining ethics and which code to follow to design, develop, and deploy digital health technologies and applications. Digital technologies have influenced many different aspects of our society. Requirement engineers must follow engineering ethics codes about software requirements.

As the Internet becomes a more significant part of medical practice, the need for a deeper understanding of the legal, ethical, and social implications for using that

technology also grows. It's dedicated to advocating for ethical medical guidelines, therapeutic options, clinical research, e-commerce, and writing for medical websites.

The law, which generally upholds widely accepted moral standards, is rarely employed to enforce ethical principles. Weaker norms take precedence over stronger laws. As new health technologies and applications are introduced, however, they introduce new issues as well.[85, 86, 75, 188] Security, privacy, and confidentiality are issues to consider.[182, 46] The information that follows provides more information on each of the topics below.

6.8.1 Privacy, security of personal healthcare data

It is a privacy concern because of the volume of personal healthcare data transferred between devices and healthcare information systems. Additionally, media exchanges between multiple devices and across systems are increasing. Patient documents might include images and video for diagnosis. EHR can re-identify patients by illegal means, which carries security risks, and it also removes privacy because people's identities are removed. It cannot be assumed that all patients are open to receiving automatic EHR data sharing. It is possible to gain personal health information about a person online without their consent if the website contains cookies and web beacons that gather the information while they are surfing the internet. In order to meet these same criteria, electronic records must adhere to the same standards as paper records for storage, use, and transfer. A healthcare provider and developer must have detailed knowledge of patients' personal health information, keep meticulous records of personal health information, gain patients' consent to any data collection, and make appropriate use of electronic health records.

6.8.2 Access equality in healthcare services

Equitable healthcare access is also an ethical concern tied to medical technologies and applications in a digital world. Rural people, racial and ethnic minorities, and immigrants are often financially struggling. Patients with multiple chronic illnesses, disabilities, mental illness, and children are particularly vulnerable. Others are too poor to afford the technology, do not have the necessary technical skills, or want to use the Internet, mobile devices, and digital health technologies. Universal healthcare should include digital health technologies and applications in order to better the health of the population.

6.8.3 Quality of healthcare information system

Online health information can be challenging because there is a massive amount of information available, and the poor quality of that information poses a problem. International governmental organizations (such as the World Health Organization) should not be search-engine indexed because their names include specific words that could lead to their sites. Other facts bear this out: In addition, many lack the information and skill to assess the credibility of the information. These individuals do not possess the medical knowledge required to examine the validity of medical information. Social media connectivity is available in many digital health apps.[149] While supporting patients serves to reduce their feelings of isolation, it also brings

about privacy invasion.[24] Patients are reluctant to share information and feelings online when reasonable and appropriate security measures are not in place.[176] Information on the internet is rarely reliable. Even with digital health technologies and applications on the rise, many users find these applications daunting. The crux of the problem is that the digital health technologies to trust are many, confusing, and frequently incorrect. While strict national regulations govern the health sector, it is difficult to enforce online privacy laws. Ethics, unlike the law, is more than just law. The nationality fallacy occurs when a nation adopts legal requirements for ethics to follow the law. It is also dangerous to move medical research to another state because no similar laws are prohibiting similar actions. One may improve the overall health and well-being of its population by empowering its citizens with digital health technologies and online health information.

6.9 Standardization bodies

Interoperability essentially means that patients from different health systems can send and receive health data without any obstacles.[41] All levels of interoperability require technical, semanticized, and clinical standards. The Mandate M403:2007 coordinated by CEN, 2 CENELEC, 3 and ETSI of the three European Standards Development Organizations (SDOs) recommended a case-by-case approach to e-health interoperability standards process organization.[51] The methodology includes the creation of profiles to accommodate several projects and standards. Clinical needs are defined by DICOM, HL7, W3C, and security standards. Radiology, pharmacy, laboratory, and EHR workflow were among the uses discussed. The IHE SWF can meet a clinical need (Scheduled Workflow).[180]

6.9.1 List of main standard organizations relevant for the ehealth sector

- 1. HL7 Inc. (Health Level 7): This non-profit organization was established in 1987 to improve clinical eHealth practice, management, delivery and assessment.
- 2. DICOM (Digital Imaging and Communication in Medicine): In 1983, the National Association of Electricity Manufacturers (NEMA) established the DICOM committee. DICOM publishes Service-Object Pair Standards which extend beyond data transfer and object identification.
- 3. IEEE (Institute of Electrical and Electronics Engineers): The mission of the Institute is to advance technology. Standard 11073-X family (Personal Health Device Communication) allows the communication of personal health devices and other devices.

Chapter 7

Bangladesh Data Protection and Health Profile

7.1 Bangladesh - Data Protection Overview

Bangladesh has a unique history of starting on the wrong foot when it comes to data privacy, digital development, social networking, cybercrime, artificial intelligence, electronic communication, and increasing awareness of users/consumers. Data protection aims to shield privacy by regulating how organizations collect, store, and disseminate personal data.[99] Personal data generally refers to information or data related to a person, regardless of who collects it.[78] The constitutional rights of privacy are combined with the Information Communication Technology Act of 2006 (the only legal text available in Bengali), the Digital Security Act of 2018, and the Constitution of Bangladesh (in the original Bengali) to explain the framework of such data protection and privacy.[140, 9]

7.1.1 The Technology Act

One example of the Act in action is the Electronic Filing Act[127], which allows government agencies to use electronic methods to submit documents. As a result of the new law known as the Technology Act, anyone who has or handles sensitive personal data or information is legally liable. All companies must implement and maintain reasonable security practices to prevent wrongful loss or gain, as mandated by the Technology Act.[60]

In Bangladesh, the government has the authority to monitor individuals' private data if certain conditions are met. Data interception is permitted in Section 46 of the Technology Act when the state's sovereignty, integrity, or security is at risk and to keep relations with foreign states friendly and prevent harm.[65] The federal government may mandate that any federal agency monitor, intercept, or decrypt any information stored, generated, transmitted, or received in any computer resource. Section 46 of the Technology Act outlaws the encryption of personal information. The publicly beneficial information is available. The government may require information on this to be disclosed. This incorporates details on national security issues, law enforcement transgressions, and financial crimes.[119]

When the controller tells a subscriber to extend interception, decryption, and monitoring capabilities, it means the following scenarios: Section 69 of the Technol-

ogy Act covers interception, monitoring, and decryption. To designate a particular computer, computer system, or network as a protected system and authorize authorized people to secure access to that protected system, the controller may declare the computer, system, or network a secure system.[119]

7.1.2 The Digital Security Act

The Digital Security Act was passed to ensure data security, and it also introduced several data crime-related laws, including detecting, preventing, suppressing, prosecuting, and trialing cybercrimes. The following provisions from the Digital Security Act pertain to security: The General's jurisdiction is vast and includes digital media, so if a published or propagated data or information in that media threatens data security, the General can ask that it be removed or blocked.

7.1.3 The Telecom Act

Only the Telecommunications Act, 2001 governs telecommunications between two parties. An interception of a radio or telecommunications without the consent or approval of the sender or recipient is a violation of Section 67(b) of the Telecommunications Act. The most severe penalty is a three-year prison sentence or a BDT 300,000 fine (approximately €3,540).[168]

Section 97(Ka) of the Telecommunications Act permits the government to track personal information to a telecommunications service. This provision has been broadly drafted and is used for interception. A telecoms operator that supports the empowered authority must also provide full support. There are no limits on these capabilities in the Telecom Act. Thus, the duration of an interception is dependent on the implementing agency.[168]

Section 97(Ka) of the Telecommunications Act stipulates that the government may compel a telecommunications company to keep records relating to a specific user's communications. The government agency must examine the operator's technical resources and retention capabilities when deciding whether to request retention.[168]

In the public interest, the government may, by Section 96 of the Telecommunications Act, assume control of any telecommunications system and all necessary hardware and facilities. Employing the operator and his employees for the entire period of their possession of the apparatus or system guarantees that he and they will be employed. To the extent that a government acquires a radio apparatus or telecommunications system, it must compensate the owner or controller of that radio apparatus or telecommunication system.[168] Any person who unlawfully taps or intercepts private communications between two people is breaking the law under Section 97(Ka) of the Telecommunications Act.[168]

Incur or authorize another person to incur a significant expense for their benefit or for the benefit of someone else who is not authorized to use the expense. Until a legal proceeding initiated by the Bangladesh Telecommunication Regulatory Commission (BTRC) gives the staff member or operator permission to receive the message; unless otherwise authorized by the BTRC. Except with explicit permission from the BTRC, no one can obstruct or get information about the sender, recipient, or content of a message.**[threeseccsec]**

7.2 Data Protection and Regulatory Authority

7.2.1 Main regulator for data protection

Data protection guidance is issued as needed by the NDSC, which the Digital Security Act empowers. The DSA, the director of which answers directly to the Executive Cabinet, can use its power to block content completely or decrypt encrypted data sources.[47]

7.2.2 Personal data

Data belonging to the individual are not clearly defined. When "identity information" is defined as "any information that can uniquely or jointly identify a person (including corporations) or system," then it becomes clear that the legislation covers every potential means of identity.[73]

7.2.3 Data Controller

Data controller, joint controller, and data processor have not been defined in Bangladeshi law.[144] Neither the data controller nor the data processor distinguishes between data. Someone who gathers, sells, acquires, supplies, or uses data is known as a data user.

7.3 Patients' Rights to eHealth Care

7.3.1 Data transfers

The use of Bangladeshi data protection laws to demand the transfer of data or localization is explicitly excluded unless otherwise agreed between the data user and the data subject. Data transfer rules exist for some industries, such as banking and telecommunications, which have foreign jurisdiction restrictions.[3]

Additionally, in the health care setting, specific data protection rights are protected. The right of patients to be protected during, after, and during the investigation of eHealth solutions which are medical devices must be upheld. The term cross-border health care refers to a system where health information is shared across multiple healthcare organizations. This comes into play next when international health requirements are enforced.[62]

7.4 Current Overview of Bangladesh Health Sector Profile

It is an actual picture of what is going on in Bangladesh's health sector today, with details about its structure, assets, strategy, procedures, and structure. This report provides an overview of the current health profile situation based on publicly available reports and statistics. This extension aims to assist the Ministry of Health and Family Welfare (MOHFW) and its partners in negotiating a healthcare system that is beneficial to the entire population of Bangladesh. My goal in showing the

current health segment profile is to depict how the health care system functions, not lament what did not happen in the past or express expectations for the future.

7.4.1 Gender equity in health sector

The first gender equity strategy of MOHFW was adopted in 2001. To assist in designing and executing health policy, the method was created to expose gender equity challenges.

7.4.2 Health Sector Organization

AArticle 15 of the Bangladesh Constitution guarantees each citizen the right to food, education, and health care.[seveheal] To fulfill this obligation, the government has developed and implemented a variety of strategies aimed at ensuring universal health coverage and rural access to medical care. While the Health and Population sectors in Bangladesh began in the early 1970s, integrating Health and Family Planning took two steps. The first was the incorporation of the Family Planning Program into the Ministry of Health and Family Planning, where it now functions as part of a broader whole.[66] In 1976, the government declared population growth to be the country's most serious problem, resulting in the establishment of a National Population Policy. The government established a President-led National Population Council and a Minister-led Central Coordinating Committee. [31] A Family Planning Directorate was established to oversee the implementation of the family planning policy and program. Between the 1980s and the early 1990s, Bangladesh implemented a series of aggressive population growth initiatives. However, significant efforts were made in the early 1990s to initiate functional integration of health and family planning services at the village and sub-administrative levels. This is summarized in the National Health Policy 2000 and the first South-West Asian Programme (HPSP). The decision was reversed in 2001, and the current MOHFW structure was restored. [31]

The Ministry of Health, Family, and Social Affairs is responsible for the implementation of national health and family policies.[58]

MOHFW rules and policies apply to the digital eHealth care system.

7.4.3 Roles and responsibilities of MOHFW

The MOHFW is responsible for implementing, managing, coordinating, and regulating national health and family planning activities, programs, and policies.[63, 58] Management refers to these critical functions regardless of whether the term is used explicitly in a sentence. The overall public sector health provider structure is based on the national government, with divisional, district, Upazila (subdistrict), union, and ward administrations following. There is no single organogram that accurately depicts the structure of MOHFW.[63, 58]

Within the overall structure of the Bangladesh Public Administration, the MOHFW management organization is split into two divisions:

- 1. The secretariat with eight wings, reporting to a joint secretary or chief, is responsible for policy development and administration. (Figure: 7.1)

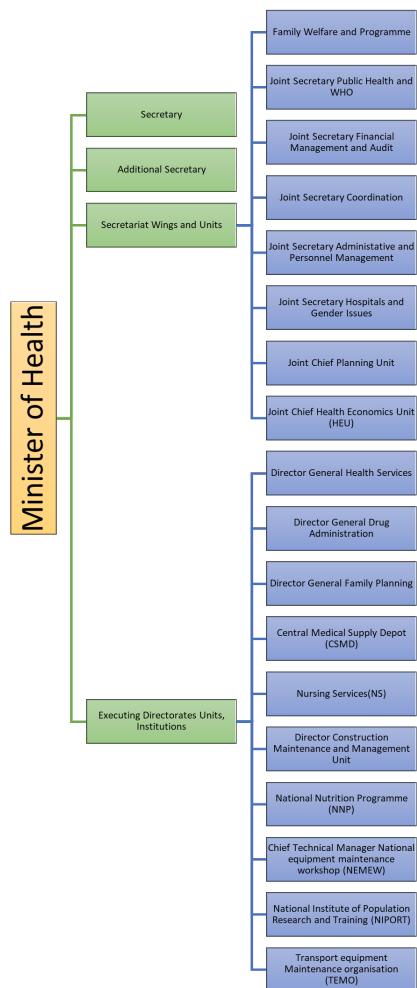


Figure 7.1: Roles and responsibilities of MOHFW[8]

- 2. In a well-ordered hierarchy MOHFW consists of directorates and institutions run by 10 separate entities.

Additionally, the country is divided into six administrative divisions, each of which contains 64 districts. Wards and unions are administrative units; in this case, the minor portion is referred to as unions. Typically, villages with wards and unions have a population of 1,000-1,500 people.[162]

Through a \$500 million public-private partnership, the Asian Development Bank is assisting Bangladesh in expanding and improving urban primary health care services. UPHCP-ii, the project's second phase, began in 2005. Additionally, the third phase of the initiative began in 2012. Additionally, the ADB will fund this project until 2020. The project's primary objective is to increase access to health care for the poor, women, and children. Additionally, the project revealed an increase in PPP restrictions, particularly in local governments, resulting in the adoption of new PPP regulations.[122]

7.5 Governance Structure and Institution

The Parliamentary Standing Committee on MOHFW is responsible for ensuring that everyone has access to high-quality health care. Additionally, district and Upazila

education departments establish committees specifically for this purpose. These committees are composed of members of the local community who are responsible for community clinics and members of the local community who are in charge of district and Upazila administrations.[8]

7.6 Directorate General of Health Services

The Directorate General of Health Services (DGHS) operates at the national, divisional, district, and lower administrative levels through administrative structures and institutes.[142] On a national level, the head of a federal agency and the second-and third-level managers who report to him are referred to as director-generals.(Figure: 7.2)

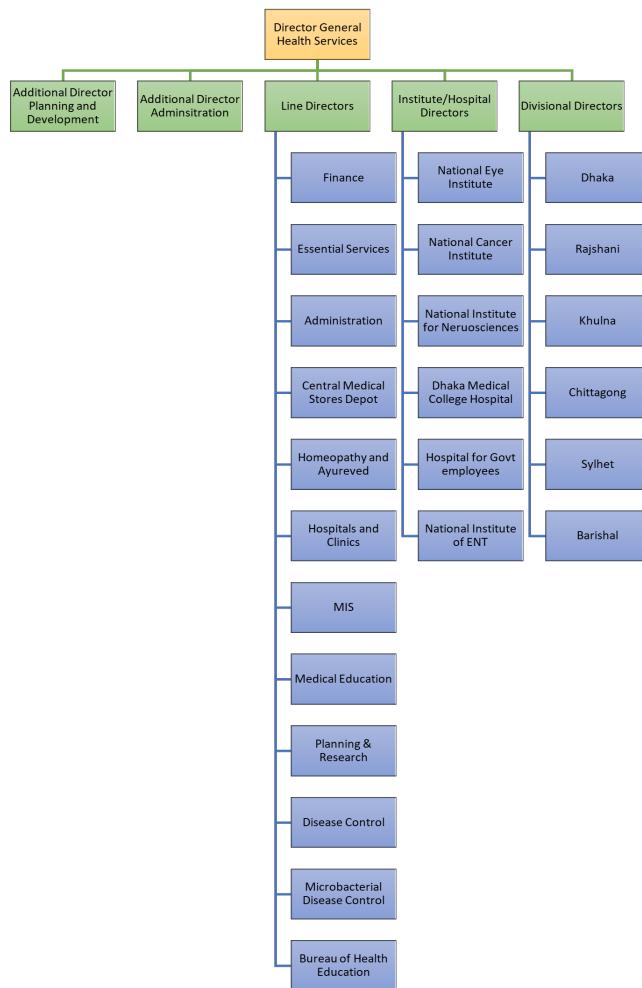


Figure 7.2: Administrative Structures of Directorate General of Health Services[8]

7.7 Directorate General of Family Planning

The Directorate General of Family Planning (DGFP) is responsible for administrative tasks at the national, divisional, district, and local levels.[142] Departmental

directors, regional directors, director generals, sector directors, and hospital directors are all available at the national level (figure below). DGFP is responsible for nine of the HNPSP's 38 operational plans.(Figure: 7.3)

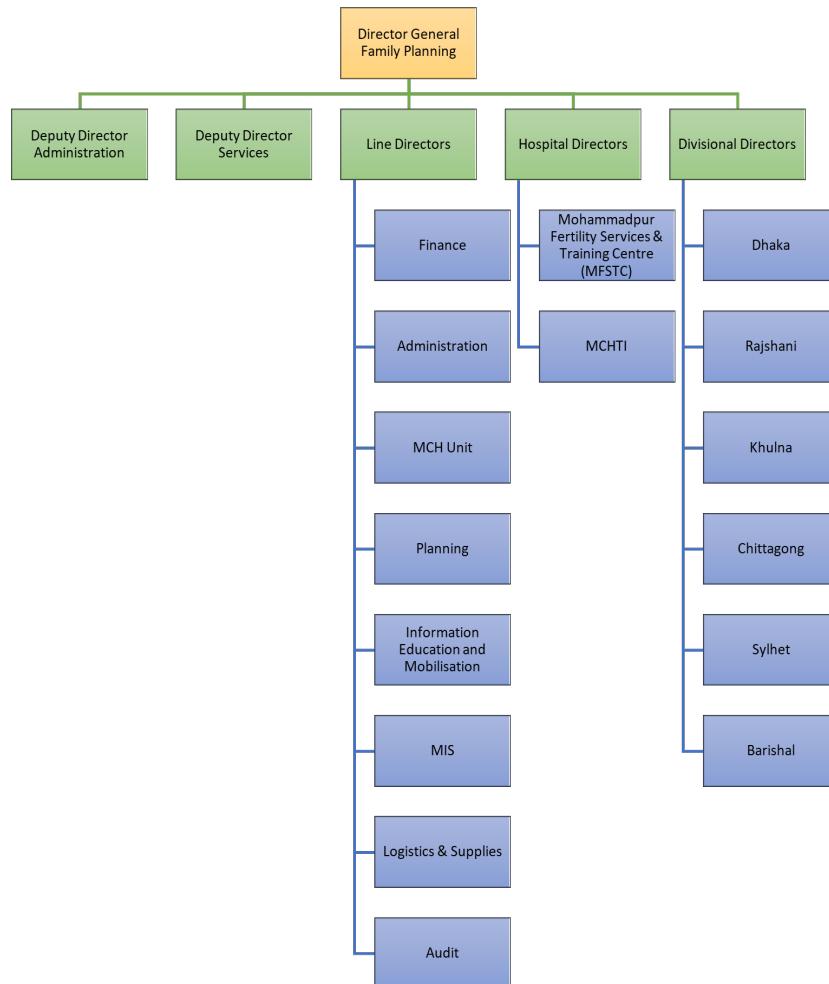


Figure 7.3: Operational plan of Directorate General of Family Planning[8]

7.7.1 Other government ministries and agencies involved in the health sector

The Ministry of Local Government, Rural Development, and Cooperatives (MOL-GRD) have partnered with provinces to provide health care in urban areas.[59] These rules, which date back to the 1970s and 1980s, reflect a well-established division of labor. It is encouraging that various sources can fund these programs and that a robust health insurance system can be implemented with the help of diverse sources. UPHCP was founded in 1998. The UPHCP II's second stage began in mid-2005 and concluded in 2011. A third stage was added in June 2012.[58]

7.7.2 Non State health service delivery

The non-state health sector in Bangladesh reflects the population's diversity in several ways. Existing pharmaceutical and private health specialists, private clinics,

non-governmental organizations (NGOs), pharmacies, and other types of health care providers are constantly evolving in their skillsets, involvement, and practice modes. Non-state health promotes overall growth in an administratively immature environment. Our objectives can be achieved with limited information on the association, structures, range, and quality of care. Because non-state administration is not uniformly announced, it is not easy to assess its scope. Determining the validity of existing data is difficult because new information complicates the situation.

7.7.3 Public health, and research and development

Several specialist agencies are usually associated with DGHS, working in the areas of public health research and development.[8] This list includes:

- National Institute of Preventive and Social Medicine (NIPSOM)
- Institute of Epidemiology, Disease Control and Research (IEDCR)
- Institute of Public Health (IPH)
- National Institute of Population Research and Training (NIPORT)
- Bangladesh Medical Research Council (BMRC)
- Centre for Medical Education (CME)
- Institute for Child and Maternal Health (ICMH).

These are the leading organizations and agencies that will have access to the database as a result of their role and ability to implement policies via the system.

7.8 Governance structures and institutions

The MOHFW mandates entrust the Committee with the critical responsibility of supervising administrative functions that ensure public health care delivery transparency and effectiveness.[42] Government agencies regulate various professions to promote the development of a qualified professional workforce, ensure the quality and consistency of health services, and prevent power abuse. The bodies will ensure sector transparency and accountability. Each district and Upazila has committees to oversee facility and program service delivery. Local residents serve on committees with representatives from local governments, the private sector, and community clinics.[42, 103]

Bangladesh's health policies and laws delineate roles and responsibilities. Previous legislation included the 1880 Vaccination Act and the 1980 Medical and Dental Council Act. A lot of codes and ordinances are updated to reflect societal changes.[181] Most MOHFW rules concern medical licenses. Several statutory bodies, including the BMDC, PCB, BNC, MOHFW, and the Medical Faculty, collaborate to regulate the healthcare sector.[8]

Regulators in Bangladesh face numerous challenges, including the rise of private medical colleges, diagnostic centers, and pharmaceutical companies. The 1940 Drug Act, 1946 Drug Control Ordinance, and 2005 National Drug Policy govern

Bangladesh's pharmaceutical industry. A significant regulatory body in Bangladesh is the Bangladesh Pharmacy Council, which is a part of the Ministry of Health and Family Welfare.[8] The DDA regulates pharmacy cadre education and registration, while the BPC regulates pharmaceutical product quality. MOHFW proposes revising regulatory bodies' mandates and structures, as well as building capacity. To improve supervisory performance and institutional capacity, the MOHFW directorates DGHS, DGFP, and DDA must be reassessed and strengthened.[8, 181, 90]

7.8.1 Regulation through information

One of the critical components of community empowerment is ensuring that the community's voice is heard and that service provider are held accountable. Accountability for service providers and improved service quality are made possible when community members communicate their legitimate claims and concerns to authorities and service providers.[91]

7.8.2 Small- and community-level planning

Small communities, resource management, and local needs are incorporated into this HPSP planning strategy. They are responsible for supervising their subordinates. Locally, the focus was on training and toolkit development. Insufficient supervision and capacity to assist Upazila (county) local planning administrators hampered the planning process. Many program managers misunderstand the goal of local planning. Ongoing pilot programs for local decision-making and budgeting in six districts and 14 Upazilas The Ministry of Health and Family Welfare has set up a national committee and six district committees.

During the HPSP's early implementation stages, community-based stakeholders from pilot unions and Upazilas formed the National Stakeholder Committee (NSC). The pilot committees were formed to increase client and stakeholder transparency and involvement in HPSP implementation and monitoring.[92] Conversely, health service users were rare. The National Stakeholder Committee offered no official assistance to local groups. The lack of attention to the consultative process made developing a stakeholder engagement strategy difficult.[92, 59]

The HNPSP is currently considering several activities to improve community and stakeholder consultations, particularly with the poor and women. A citizens' charter of rights was proposed to ensure community input.

7.8.3 Health Advisory Committee

In 2002, the community voice promotion system was implemented to maximize community involvement while maintaining service providers' accountability. Members of Parliament presided over health advisory committees that included elected and non-elected officials, community organizations, and local government officials. Under the Secretary's supervision, the committees were tasked with delivering hospital services and making recommendations to line managers and the Secretary. These committees have been underutilized due to membership, information, and resource constraints.[66, 31, 42]

7.8.4 Citizens' Charter of Rights

This initiative was spearheaded by the MOHFW[8], which prioritized citizens' rights to health. The charter, which was updated in 2007, was made public in 2004 through a government campaign. The charter codified clients' rights and established a uniform set of healthcare services. Additionally, individual charters have been developed for various medical college hospital services, district hospital services, UHC services, and union sub-centers. A disadvantage of charters is that they lack a legal and institutional framework that would enable citizens and government to use them and broad public awareness, including service providers.[162]

7.8.5 Information flows in the health Sector

The data management process is organized into sections that flow naturally. On behalf of the service or program administration, service providers must report and administer data. Using the consolidated data, a final report is generated and sent to a higher authority. Finally, the data from these reports are shared nationally to help program and service managers assess their overall effectiveness.[65, 47, 59] Program and line directors are generally more concerned with the impact of their programs and activities. However, a holistic view is complex because the system is composed of vertically integrated data processing systems.

When analysing routine data, the primary sources are MIS DGHS and its sub-systems, including:

- Geographical Reconnaissance Information System
- Personnel Management Information System
- Logistics Management Information System
- Information communication technology status and use in the field.

The DGFP has its electronic recording, analysis, and reporting system (ERAR). The system provides information on personnel and logistics management. While software systems deal with data flow, each of the three systems handles data differently. A web-based UPCHP II Health Management Information System includes a data approval mechanism. This application helps users optimize data flow and processes related to quarterly progress reports—transparent data routing and verification.[8]

7.9 Health Financing Overview

MOHFW accounts for nearly 97% of all government health spending. It accounts for roughly 66.7 percent of total public spending, while development funding accounts for 41.2 percent, with development partners accounting for 50%. [122, 103, 31]

In a similar study in Bangladesh, nearly two-thirds of health spending is out-of-pocket[10], meaning individuals pay for healthcare services directly. While the wealthy spend more money, those on the lower economic rungs spend more of their income. According to the International Journal of Public Health, approximately 13% of Bangladeshi households spend over 10% of their income on health, considered

catastrophic. Financing medical treatment is a significant barrier for many people [29]. Costs were cited as a reason for not seeking care by 25% of those who became ill.[63]

Bangladesh has a large number of NGOs. Contracting with NGOs to provide nutrition and HIV/AIDS services is one example of a typical public-private partnership (among others). NGOs' roles are changing as donors fund them directly. Between 1997 and 2007, nearly 80% of donor funds went to NGOs.[10] Nongovernmental organizations play a more prominent role in service delivery, except for the Ministry of Health and Family Welfare, which does not collect or report data on NGO health services.

7.10 Pharmaceuticals regulation

Formed in 1982, the National Drug Policy aims to remove harmful, unnecessary, and even useless drugs from the market while ensuring affordable access to essential drugs through a well-managed administrative process. This measure aimed to legalize and regulate both traditional (Unani, Ayurvedic, and homeopathic) and allopathic medicines. The policy is being updated.[158, 103, 91] The Directorate of Drug Administration (DDA) was established in 1976 by the Ministry of Health to regulate medication manufacturing and distribution. It oversees and manages the pharmaceutical industry. It oversees the health and safety of various manufacturing, quality control, storage, distribution, sales, post-marketing surveillance, and drug import and export facilities. It also regulates drug manufacturing, importation, and retail sales.[97, 8, 122]

The DDA oversees national drug surveillance, quality assurance, drug testing labs, and rational drug use.[97]

7.10.1 Pharmaceuticals manufacturing

The Bangladesh Association of Pharmaceutical Industries (BAPI) represents over 150 member companies in government lobbying. Due to the high concentration of market shares among the top ten firms, the remaining 25% is controlled by two companies, Beximco and Square.[184, 167] This demonstrates the extreme disparities in firm size, innovation, and marketing capability and raises the question of why they exist.

7.10.2 Pharmacies and drug retail outlets

If a drug dealer exceeds the volume threshold, there is no additional oversight of the number of outlets or sales volume. However, current estimates [121] of pharmacists and drugstore salespeople put the ratio at around 200:1.[139] Most patients get their medication from pharmacies or retail drug stores before going to the doctor. To avoid a doctor's visit, 92 percent of patients go to a pharmacy or retail drug store, according to the [108].

While primary health care and autonomy decentralization are important in providing care to vulnerable populations, addressing demand and supply issues is also important. They provide social safety nets for the poor, cost-sharing by the wealthy,

and open, participatory government. Encouraging a supply-side environment encourages public-private partnerships to deliver better and complementary health services and to increase overall available funds[122]. Service to the poor and vulnerable must be addressed.

Chapter 8

Limitation And Conclusion

8.1 Limitation

Numerous variables can come into play when developing an eHealth system. While many factors are taken into account, one that can have an effect on the system is the financial transaction. Because it denotes a session's conformity. Due to time constraints, the financial impact of activities was not included in the project. Another significant consideration when designing the eHealth CMS data storage is security. The majority of information about individuals is gathered from various database servers in order to compile comprehensive health profiles and necessary information about other organizations such as hospitals, physicians, and pharmacies. However, security concerns were discussed in the design section, including the importance of protecting the eHealth database system, which stores patients' health information in conjunction with information from other user databases. If financial responsibilities for activities are included in the project, an additional layer of identification and authentication appears necessary for establishing secure financial transactions and information.

8.2 Conclusion

When implemented with proper planning and strategy, the emergence of digital health services has the potential to have a significant impact on Bangladesh's growing economy. The pandemic has had a negative impact on the economy of Bangladesh, but it has also provided an opportunity for the development of a cutting-edge digital platform. Customer relationships must be strengthened in order to foster a strong digital bond between patients and doctors, which will have an impact on the entire health care system. This initiative would include the implementation of a customer relationship management tool to provide more accurate patient history monitoring and scenario analysis in order to provide a more incredible experience. This would also assist the medical institution in analyzing patient trends and requirements in order to improve services and expand its business projections in the future. If the healthcare system can be digitalized and equipped with cutting-edge technology, the entire economy will stand to gain significantly. Also, every year, a large number of patients from Bangladesh travel to India, Singapore, and Thailand for better treatment, and if our health services can be made available on a digital platform, this outflow of patients and money can be curtailed. There has never

been a time when the need for digital health has been more visible and acute than now, following the outbreak of the COVID-19 virus, which has forced health care providers and patients to use alternative methods of accessing and delivering health services. The development of a digital health strategy will also enable the country to progress in a more structured and planned manner in terms of developing infrastructure, connectivity, quality, and validation of digital applications in the healthcare ecosystem. Bangladesh has already advanced to a more advanced stage in terms of applying digital technology across all sectors. It now provides opportunities for the general public to gain access to digital solutions that will enable the advancement of socio-economic development.

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