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1 Introduction

The primary healthcare service provider is a person or an organization, who provides the immediate primary health service or consultation. PHC is narrated as essential health care which is based on scientifically acceptable methods and technology. The goals of PHC are defined by three major categories, "empowering people and communities, multisectoral policy and action; and primary care and essential public health functions as the core of integrated health services" (Wikipedia, 2022). Considering the definitions, the services of PHC is clear. PHC providers not only diagnose the patients and provide treatments to prevent such issues.

Primary healthcare is provided in a community setting, such as a General Practitioner in their specified field of the healthcare system, local community health center, or pharmacists. There is a basic concept that people of the country receive the bare minimum healthcare service which are essential for a good health. In the healthcare system of the most countries, there are major challenges to fulfil these essential care and South Asia is no exception. Factors behind this global trend are increasing health costs and decreased returns on investment for aging populations. Where the primary healthcare procedure is formally structured in the health system, and professionals are educated for their specific tasks, the performance of the system is often optimized. Primary health care services include early intervention, health maintenance, counseling, and diagnosis of acute and chronic diseases, etc.

1.1 Background

In Bangladesh, primary healthcare providers cover basic medicinal supports. A fresh graduate doctor in Bangladesh primarily provides services in the community clinics, medical colleges as a medical officer, or freelance doctors as a GP. An MBBS doctor will be the first one to diagnose a patient at the primary level and will provide treatment or counseling according to the needs of that patient and will refer to the upper-level providers when necessary. For diagnosis, some diagnostic centers also work alongside the primary healthcare providers where certified nurses, medical assistants, and pharmacists work together.

There is some basic diagnosis that are fulfilled by the primary healthcare providers. For example, some medical tests are advised to do to any person before marriage, which doesn't need any higher-level prescription to do. These tests can be done in any diagnostic center. In the Muslim community doing circumcision is a compulsory surgery. As the Muslim population in Bangladesh is 90 percent of Bangladesh's population as per the 2011 census, circumcision is provided as the primary health care service. Circumcisions are often done by local quacks called Hajams or Kalifa who takes this profession from their ancestor generation. And also, the vitamin A, D campaign is conducted by the primary health care providers. These campaigns in Bangladesh conducted by the community health clinics very successfully. These campaigns in Bangladesh has helped to create a great awareness about vitamin deficiency diseases among people. And similarly, in the maternity and child welfare organizations are creating an impact to educate village mothers to be careful about their pregnancy. This has reduced the statistics of child and maternal mortality rate in Bangladesh.

1.2 Motivation

In Bangladesh, the government tries to bring medical facilities to villages through programs to train medical assistants for rural subcenters. This effort is likely to remain inadequate for a long period of time. The most often mentioned obstacles are a large number of consumers the difficulty of communications in rural areas, particularly

during the monsoon; and the small number of health professionals and their ambivalence to rural posting, the low utilization of government health facilities by rural people, and their inadequate attention to the needs of women and infants (Joarder et al. 2018).

There are an inadequate number of doctors available to provide the facilities to carry forward to the rural places. As technology has no such boundaries, this can be revolutionary for the rural people to get the PHC through digital platforms.

1.3 Objectives

The general objective of this study is:

- To explore the primary health care facilities in Bangladesh.
- To study how digital technology can improve the primary health care system

2 Primary Health Care in Bangladesh

Bangladesh is a South Asian country with an estimated population of approximately 160million people according to the report of Bangladesh Health Bulletin 2015 (WHO, n.d.). PHC system in Bangladesh is one of the important sources to ensure that people can continue to receive essential health services, such as safe delivery process for women and proper vaccination for children and adults.

The country is virtually homogeneous in ethnicity, with a landmass of fertile plains and a large delta prone to flooding. On average there is a physician for 3000 people, but this can vary to 1:20 000, and 3.7% of GDP is spent on health. Through vertical public health programs and other societal interventions, the health indicators have substantially improved. However, to achieve PHC and address non-communicable and lifestyle diseases, there is still a long way to go (WHO n.d, 2016).

Unfortunately, private PHC providers overlook these, but 70% of healthcare spending are spent in this sector. Most people go to a hospital when they are sick and there is very little emphasis on prevention. This is very challenging for a country that already has shortage of skilled manpower. Even when there's no health crisis going on, fewer than 20% of people can access critical care.

This creates an increasing challenge in a country that already has a shortage of doctors and overcrowded health facilities. When there's not a health crisis, fewer than 20% of people can access critical care, which means a spike in COVID-19 cases can quickly overwhelm the health system.

2.1 PHC structure in Bangladesh

Bangladesh's healthcare infrastructure can be divided into three levels where medical college and specialty hospitals exist at the tertiary level, District level hospitals and maternal welfare centers are on the secondary level and, Upazila health complexes, union health & family welfare centers, and community clinics are considered the primary level healthcare providers (WHO, n.d.). There are also various NGOs and private practitioners who contribute to the PHC system in Bangladesh.

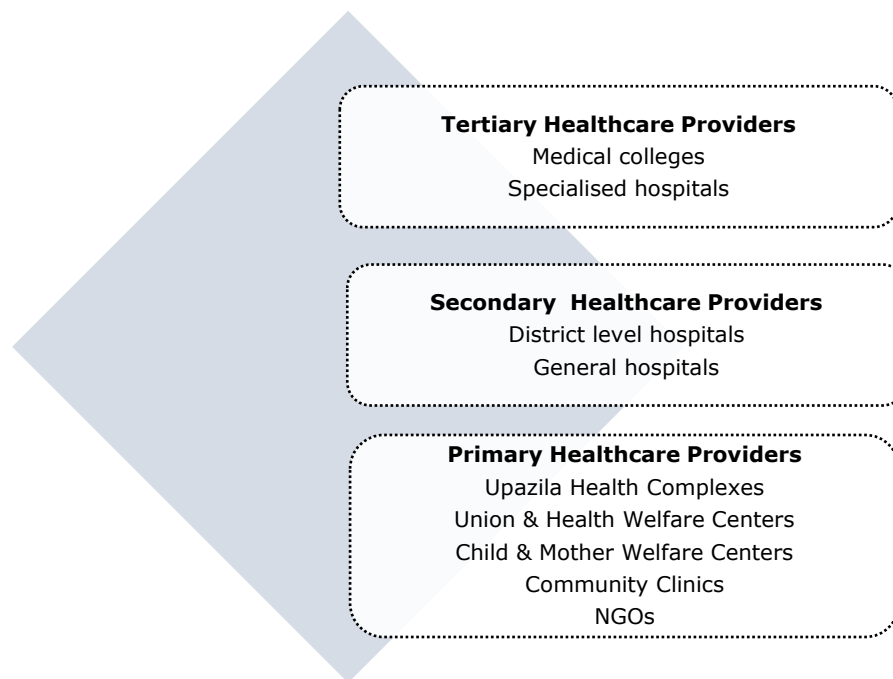


Figure 2-1 Healthcare system in Bangladesh

According to WHO, GDP per capita in Bangladesh is 1211\$ and total health expenditure as proportion to GDP is only 3%. Number of doctors and nurses per 1000 population is consecutively 0.26 and 0.14. In the structure of PHC in Bangladesh, the Upazila health complex and community clinics are depicted but in reality, these facilities are not very active in providing services. (WHO n. d.).

In the PHC system in Bangladesh, first service providers who are being asked for immediate treatment or for primary consultation. Here, the most GP doctors are specialized in Medicine, and provides treatment or consultation for primary diseases. In the rural places, there are community healthcare, where people go and ask for primary treatment and, in the maternity, and child welfare organizations in the upazila levels also works as PHC service provider. Community health complex and the NGOs are mainly focused on providing PHC to the poor people. These organizations are run by Government and global health funding's.

Financing of Bangladesh's health care system is out-of-pocket payments (Azhar and Chunhuei, 2017), meaning that the health expenses aren't insurance. The reason behind this is that most of the people specially who are below the poverty line cannot afford the health insurance cost. So, people go for out-of-pocket payment method for healthcare services. Though the government has made PHC free in most categories, for example, in vitamin campaigns for children and in teen vaccination. In the rural areas, the PHC is provided in the most nominal value and sometimes free if the specific individual is unable to pay. And the NGOs also collect funding from international sources and spent them on this sector.

2.2 Healthcare facilities

Good health is one of the fundamental humans right, and PHC is the first step to exercise this right in any country. Primary healthcare can address health needs throughout one's life, and is about caring for, not just treating specific diseases or conditions. In every domestic country, proper healthcare facilities are arranged and provided the government. The basic healthcare facilities include hospitals, clinical and medical offices, maternity and child welfare

centers, nursing homes, birth centers, mental healthcare centers, dialysis centers, imaging and radiology centers etc.

In particular, PHC facilities are health complexes at upazila level, maternity and child welfare centers and outdoor section of any medical college also provides primary health care. Besides health complexes in rural places there are non-governmental organizations that provides PHC to the village people who are not being able to reach to the health complexes for treatment.

As the structure of the PHC system depicts, there are community clinics for rural places and in Upazila levels. And for maternity and child welfare there are consultation centers available in villages areas. For the urban areas, there are private hospitals and medical colleges providing PHC. The NGOs are also working in both the urban and rural places by filtering out the poor peoples.

In the semi-urban areas, the GP doctors also provides PHC. They are mostly seen in pharmacies or in a sub-section of a pharmacy. Mostly in these areas doctors with specialty in specific sector are not seen that much. Mostly the MBBS doctors are seen providing PHC in the primary level of the system. In the urban areas, medical colleges have a unit called outdoor, which specially for providing PHC and if critical then refer to the specific department.

2.3 Problem Domain

Since the Alma Ata Declaration in 1978, PHC system in Bangladesh has made progressed a lot, still there are challenges to the establishment of the PHC system. Alma-Ata-Declaration depicted as the foremost milestone of the twentieth century in the arena of global public health (WHO, n.d.). It identified PHC as the key to get to the goal of healthcare system (WHO, n.d.). The objective of this declaration is the need for urgent action of all governments and world community of healthcare to promote the health for all people. This is the first declaration that underlined and has given importance on PHC (Wikipedia, 2022).

Recently WHO has published a case study of Primary Health Care System of Bangladesh. The study has pointed out many faults of the system management and system infrastructure design of PHC in Bangladesh. The study has been done considering some key features like demographic location, macroeconomic situation and health indicators of Bangladesh. The study shows that, though the government takes the lead responsibility of any planning, decision making and implementation of system design through the Ministry of Health and family Welfare (MoHFW), but they fail to implement PHC system in the country successfully. The case study published a chart which shows the result of healthcare system to support the study.

For urban PHC in Bangladesh, The Ministry of Local Government, Rural Development and Cooperatives (MoLGRDC) is in authority. The MoLGRDC does not have the capacity to build an urban PHC system. And MoHFW works separately from MoLGRDC, this creates a gap in the rural and urban PHC infrastructure of Bangladesh.

The key statistics points of the case study are given below:

Table 1 Case Study Result by WHO

Total Population	159.71 millions
Distribution of population (Rural/ Urban) respectively	66.5%, 33.5%
Total health expenditure as proportion of GDP	3% (GDP per capita is \$1211.7)
Public expenditure on health as proportion of total health expenditure	23.1%
Out-of-pocket payment as proportion of total health expenditure	63.3%
Voluntary health insurance as proportion of total health expenditure	0.1%
Number of doctors/nurses/ community health workers per 1000 population respectively	0.26, 0.14, 1.37
Geographical Distribution of doctors/nurses/community health workers and NGOs respectively	Doctors: 1.1/182, Nurses: 0.8/5.8, CHWs: 3.6/2, NGOs: 49.5/10.1
Maternal, Infant mortality respectively	176(per 100000 live births), 31(per 1000 live births)

As the statistics of healthcare system indicates, there are very much of shortage of doctors and nurses in the system. An estimated number of community health worker per 1000 population is only 1.37 (WHO, n.d.). There are also less skilled traditional healthcare providers in rural areas which keep the people away from modern science and technology in the field of medical science.

Another fact in the primary health care system in Bangladesh is that the system is decentralized. The controlling power of the system is shared by NGOs, the national government, and international welfare organizations (Anwar and Tuhin, 2015). This shared power has caused a considerable impact on the decision-making of the system. This has also caused many problems, including unequal treatment towards the elite and lower social classes.

There is a notion of mistrust in the service of primary health care service in Bangladesh that, it is the services that are compromised for the elite society and not equal for all. The standard of health care services is more likely compromised by the government health care providers than nongovernment health care providers. One of the major difficulties in providing the services is the lack of an automation system. Especially in the primary health care system, almost all the paperwork is still done manually which pulls the system speed slower. (Billah et al, 2017)

Lack of physicians and clinical equipment is one of the reasons that the system is not being able to work properly. There are only about 3.06 physicians available for 10,000 people (Tahsin S., 2020) and the number of nurses per 10,000 people is lower than that. Additionally, only one third of clinical health facilities in the country have more

than seventy percent of sanctioned staff working and the rest is vacant. There's also significant vacancy in alternative PHC provider. (Tahsin S.,2020).

In particular, people were most dissatisfied with waiting for time, cleanliness, and privacy of treatment, and the standard of in-patient food. (Mahdy, 2009) affirms that the health care system is still the same as the post independent period of Bangladesh in 1971. People are more interested in getting treatment from abroad and not satisfied with the country's PHC providers. This phenomenon known as health tourism (Mahdy 2009). In a study (Islam et al, 2019) of the rural health care system, paints a dismal picture of health care service delivery. Every Upazila is instructed and provided with the same amount of service equipment and same budget allocation rather than finding out the actual needs of that community.

In reality, there are uncertainties about how practical community clinics actually are in offering these services, mainly in light of inadequate employment and proficiency, drug convenience, and significant indication of low usage (WHO, n.d.).

All these issues are not being monitored properly and making the situation out of control day by day.

3 Methodology

To make digital health a reality in primary health care, the following apparatuses must take into deliberation. One is to build the physical infrastructure, second is to deploy the appropriate services. In medical science there's a huge area of studying and implementing technical stuff. In particular, PHC of any country faces the most challenges to handle the pressure. To improvise the services of PHC, there's no other better option than making the system digital from manual infrastructure.

In a country like Bangladesh, digital influence on rural people still is not fully covered. But as the internet has reached in the most part of country, it will not be a major challenge to bring attention to the following systems that will provide a better, secured and hassle free PHC services to the people, even in the rural areas.

3.1 Web-based service for PHC

A complete system that includes every possible feature of a primary health care service can solve most of these issues and can help the system to monitor everything digitally more accurately. Web-based healthcare system is not relatively new idea but there has been implementation based on this idea all over the world. But in Bangladesh, still there is lack of well implemented system in this domain. Here, in the proposed system is designed to include all the features of PHC into one system. The system suggests to integrate all the sub-module into one place for all. It also indicates to provide virtual service as long as the physical service is not needed. And when it is necessary, appointment taking feature will be activated.

A system diagram of the proposed system is given below to provide an idea of the system:

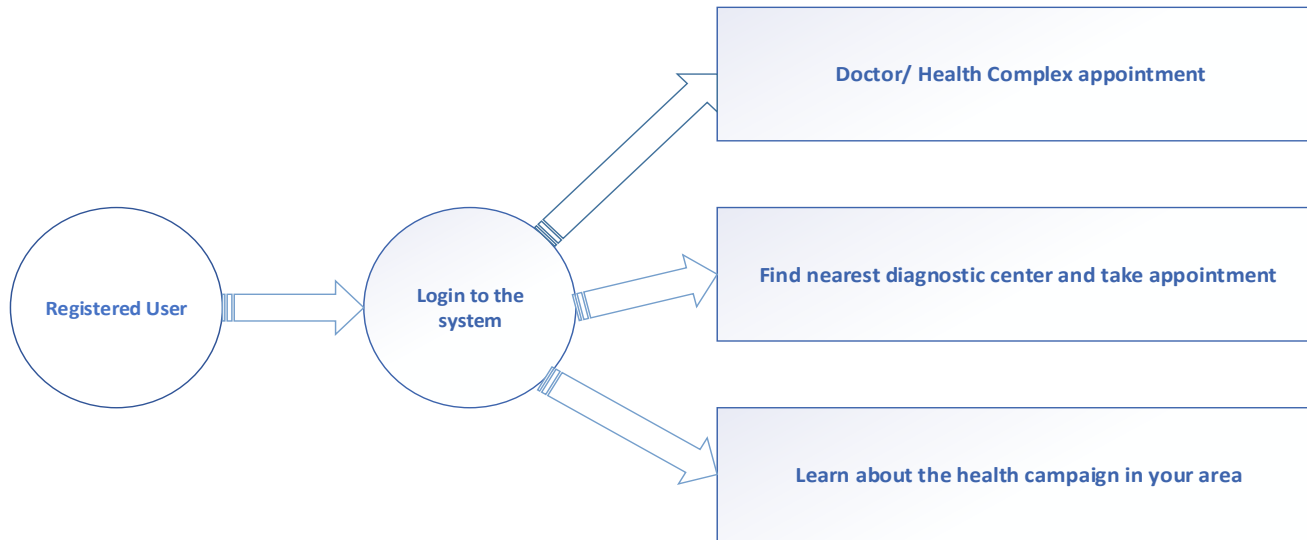


Figure 3-1 Web-based healthcare system structure

The system will offer registration to three types of users. One for patients, another for the Physicians/Diagnostic center, and the third one is for the admin panel of the system to maintain the back-end.

First type of users who are basically the mass people, for whom the system is built. Users will open a free account to enter into the system by providing some information in a form. The information will be stored in the database for further reference of that individual user. For child care health issue, parent of the child will be addressed. Users can seek help, do basic check-up digitally by providing some measuring information, or just ask for counseling from the experts. The users will also be able to book appointments for tests or doctor check-up from nearest service provider to their locations.

This system will help to get real data from users for further implementation of new technology on it.

3.2 Machine Learning approach

The next digital approach to the health care system is to implement Machine Learning into these data. Machine Learning is the future of digital technology. ML technology is growing fast with the increased amount of data and utilizing these data to turn into informational pieces. Reading and analyzing these data and their pattern, machines are being capable of providing suggestions as compared to a human expert. Sometimes, machines can do better than human as machines works faster.

With the humongous amount of data collected from the previously mentioned system, various types of machine learning models can be built to get insight into the data and pattern of disease or human tendency towards the system.

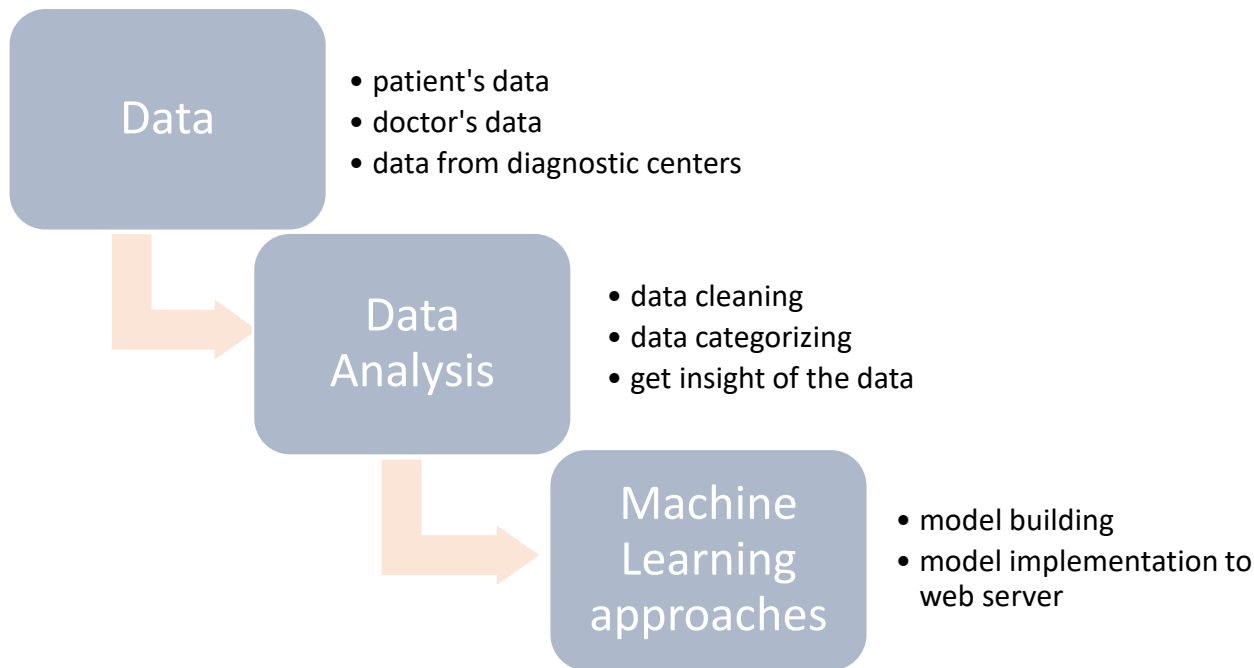


Figure 3-2 Machine Learning approach for Primary Healthcare

The ML models can be built based on various concept. Prediction model or virtual health assistant. Even the data used in the models can guide the system to take necessary steps in the future considering data patterns of the users. Such as, if the pattern shows that, people with normal flu are increasing in a specific cluster area, public awareness messages can be circulated to warn people to stay at home or suggest some primary medicines to cure the flu or book appointment to the nearest PHC provider.

ML models can be build considering various types of data pattern. Multiple model for multiple solution of different problems. ML model can be a virtual assistant, disease prediction model, analyzing patient's test report etc. And every PHC provider can build their own machine learning model with data of that specific region. This will help to improve the PHC services for that area.

In particular, self-learning neural network is a fast-growing technology in healthcare. This type of models is able to increase the quality of treatments by analyzing data from the previous server for an individual patient's condition. This takes into consideration the followings, patient's X-rays, CT-scan and other imaging data from diagnostic tests.

Models combining for all types of data or integrating different model into one system will bring a major difference in the whole healthcare system.

4 Discussion

The general purpose of the study is to finding out the system infrastructure of PHC system in Bangladesh and scope of digital technology implementation into it for betterment of the system. There has been many research and survey on this ground nationally and internationally. Problem domain of PHC in Bangladesh section elaborates the lacking of the system. And it is plain to see that there is no hint of effective digital technology infrastructure in the healthcare system. Though there are some government and private initiatives happening in the healthcare system of Bangladesh. But the approaches and methods are need to be more improvised. In an effort to solve the issues

and improvise the healthcare system digitally, two of the proposed methods can be coherent to the PHC system in Bangladesh.

4.1 Digital Technology in Healthcare

Digital technology in healthcare can be defined as a revolution in the global healthcare system. Starting from invention of smart devices to measure different health issues to combine the internet to organize a systematic approach to provide healthcare services equally to mass people, the digital technology has emerged a lot. And this is continuing to improvise and be more efficient day by day.

(Shah et al, 2017), has created an innovating MDSS (Marketing Decision Support System) system for the rural people's healthcare decision support and information distribution. This study is surely has made an effect to reach healthcare services to reach rural people. They named it 'Bhalo achi' meaning 'I am fine'. (Alam et al, 2018) however, noted that m-health in developing countries suffers from a range of barriers such as lack of infrastructure, cultural and social resistance, lack of education, and the role of medicine. Their case example of Bangladesh illustrates a developing country with a good digital infrastructure, but research attention in m-health is generally lacking in the developing countries context.

Maya- a Bangladeshi health tech company launches this app called Maya with a tagline 'It's okay to ask for help' mainly focuses on women and mental health issues. It is basically a digital assistant, which answers basic health related FAQs and take decision if the users need to refer to the experts. Virtual assistant like Maya app, uses NLP and ML technology.

4.2 Justification of the methodology

The proposed methodology is focused on building a strong community in digital platform to include rural people into the system. As many of village people are mostly not educated enough to use such platforms properly, this web-based service can be designed to be in the most user-friendly manner so that, people with less technology experience also can use this. This type of digital services is gaining popularity in all countries, especially during this recent COVID-19 pandemic situation. In particular, Bangladesh's healthcare system the PHC seeker has to go through a hazardous step to get to the specific service provider, as the system is not well-organized. And in time of emergency it gets very difficult to look for emergency help. A digital platform with automated booking system or alternate information provider like this system will reduce the process and will save time. And as it grows and collect data and learns patterns from the dataset, the machine learning approach of data analysis and prediction models will perform better providing a smooth experience to the users.

Web-based medical service for PHC in Bangladesh will be beneficial in terms of better and equal service, cost efficiency. As the system is designed as per step by step process, so the users do not need to go wrong places and do wrong diagnosis for multiple times. Here, the system will refer the users from one step to another. For example, the system will get what the user need. Based on the requirement, the system will show the users options available. Users will get to know the nearest locations of the health complexes or diagnostic centers. So, traffic management of the service provider centers will be managed. And, people will get to know about the capability of these centers before going there.

Machine learning and data science is the future of technology. Not only in medical science but in all branches of IT, data science is a very important part. Machine learning methods work with user's data, so studying previous data a ML model can make various prediction for that individual user. Users can ask for their previous history of disease which can be stored under that specific registered user's account. ML models can even predict if a user may have any chance of getting some specific disease just by reading that user's symptoms and tests data.

The implementation area of ML in the healthcare system is vast. Some of them are:

- Diagnosis and disease identification,
- Disease prediction,
- Diagnosis through image analysis,
- Personalizing treatment,
- Robot assisted surgery,
- Smart record of medical data,
- Virtual consultation services and,
- Drug discovery and development etc.

A great example of ML in the medical science is the implementation of Digital Image processing. During the Covid-19 period, ML and image processing has made a lot analysis and model building. Image processing works by diagnosis different radiology images of image data and feed them to the model for training. The output results show separate the confirmed cases based on their difference of the image patterns. The accuracy of these models is very high.

Machine Learning in Healthcare Informatics has strong analytical abilities. This is making the information provided to doctors much better and accurate. Because of that, doctors now can easily access parameters such as risk of disease like kidney failure, stroke or coronary artery disease. The machines learning approaches takes the patients' feature like blood pressure, gender, family history and latest chemical examination data. Afterward, related clinical insights are made to help doctors to compose a proper treatment plan. And as a result, the best healthcare is provided. Possible outcomes help them evaluate how much the process will cost — thus, making treatment more reasonably priced.

These digital services take off the load of the doctors and nurses by providing primary consultation and counselling. As Bangladesh has lack of doctors and community workers than necessity, these systems will be very much helpful for the government to manage the huge number of patient load.

4.3 Public awareness in rural area

The majority of the population in many developing countries live in rural areas having limited access to modern general facilities and to specialized hospitals. Obviously only a digital platform can not handle such huge pressure or even provide physical treatment, but educating people to use these technologies is as much necessary. In view of the fact that, world is growing advance in technology. Manual or paper-works are being replaced by the digital technology. So, it is very much needed to create awareness about latest medical scient technology among mass people including people living in rural places. According to (BTRC, 2021), mobile internet users in Bangladesh is

about 103 millions, which is approximately 61% of the population. Most of the internet users are on social platforms. These services can be promoted on social platform as well as offline platforms like doing seminars, social awareness programs to rural areas.

5 Conclusion

PHC service is one of the most important aspect of human life. So, people's involvement in health care service is very substantial in confirming health policy of any country. Digital technologies have already opened up a lot of potentials for shaping the future of primary health care and ensuring effective public health action.

A recommitment by governments to the goals of primary health care and its values is necessary for more changes to come, with digital technologies central to its vision and its realization. Engaging the private sector as a resource by assigning it specific, measurable tasks is a beneficial option, which will entail guidelines to help the Government, donor and private sectors work in more synchronized ways.

Healthcare is one of the fastest growing sectors in today's economy; more people require care, and it is becoming more and more expensive. Technologies like big data and machine learning have the potential to help both patients and providers in terms of better care and lower costs.

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List of Abbreviations

WHO – World Health Organization

PHC – Primary Health Care

GDP – Gross Domestic Product

COVID-19 - Coronavirus Disease 2019

NLP – Natural Language Processing

ML – Machine Learning

NN – Neural Network