

Exploring the Barriers to Access Feminine Healthcare among Marginalized Women in Bangladesh and Design Implications

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A thesis submitted to the Department of Computer Science and Engineering
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B.Sc. in Computer Science

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Declaration

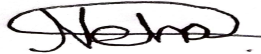
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Approval

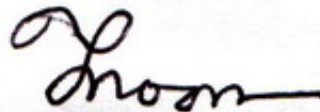
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Abstract

In today's era of information and technology for promoting and maintaining both physical and mental health, high-quality healthcare services are crucial. Telecommunications service creates an opportunity to close the digital gap between marginalized women and mobile healthcare services. In a developing country like Bangladesh, people here still face deprivation of fundamental necessities. Individuals from low-income backgrounds typically cannot access private healthcare systems due to their financial constraints. Moreover, due to a lack of knowledge, they are unable to avail many public healthcare services as well. In Bangladesh, the healthcare system is financed by the supply side, allowing low-income households to receive medical treatments or at least basic healthcare. Also, in this study, we acknowledged underprivileged women are less aware of their physical as well as mental health. Even if they are aware, individuals may not receive medical aid or correct treatment due to a lack of basic medical assistance access. Besides, women have distinct healthcare difficulties than men, and they are also more likely to catch certain illnesses and diseases. In this paper, we are particularly focusing on deprived women who face various healthcare difficulties, including menstruation, gynecological, and mental disorders in Bangladesh. To address these challenges, we propose the use of voice bots in the telecommunication sector as a potential solution.

Keywords: Women's healthcare, Menstrual healthcare, Gynecological healthcare, Data Analysis, Human-Computer Interaction (HCI), Artificial Intelligence, Fuzzy String Matching, Voice Bot

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Chapter 1

Introduction

The World Health Organization (WHO) emphasizes ensuring access to both mental and physical health care for all women [37]. However, in many parts of the world, women, especially marginalized women are deprived of this right to a significant extent. Besides, talking about menstrual and gynecological health issues is still considered taboo in many places which eventually results in women hiding their gynecological problems and thus endangering their health a great deal. Although some aspects regarding the healthcare of women have improved substantially in the past few decades, there are still important unmet needs [44]. A considerable amount of research has also been done focusing on the unmet healthcare needs of women and facilitating their access [50]. However, a paucity of research has been done on facilitating healthcare services to marginalized or underprivileged women keeping their current socio-demographic, cultural, and other factors in cognizance.

In the literature, we see many proposals incorporating technology to ease healthcare access for people [65]. Just like any other problem in this world, technology can definitely play a vital role in availing healthcare services or aiding in getting quality health services even in the remote part of the world. Harnessing the power of technology, many countries are taking initiatives to ensure health care services to people of all walks. Some examples include telemedicine, chatbots, voice bots, etc [73]. Therefore, in our study, we focus on exploring the barriers to healthcare for marginalized women in Bangladesh and proposing technological solutions to facilitate their access.

In Bangladesh, marginalized women are those who are most susceptible to poverty, prejudice, and abuse. Here, rural and slum-dweller women are frequently the most marginalized group, and the political and economic climate of the nation only makes matters worse [63], [66]. They experience a variety of forms of discrimination, such as violence against women, and lack of access to healthcare, education, and employment prospects [6]. On the contrary, privileged women benefit from social and economic advantages, such as easier access to resources and opportunities including jobs, healthcare, and education. They have greater representation in decision-making processes and are less likely to encounter prejudice or violence. In our study, to get a sense of the health disparities between privileged and underprivileged women, we collected data from both groups and make a comparison that makes the disparities evident. Different aspects of our study are described in detail below.

1.1 Importance of Finding Out Healthcare Barriers for Marginalized Women

There is a growing body of research focusing on finding the barriers to accessing healthcare for people from different races, ethnicity, etc. [85]. Understanding the barriers is very crucial as they direct us on how and where to start an intervention program to eradicate these barriers. However, such research studies focusing exclusively on women are very few in number. As healthcare needs differ in males and females, therefore focusing on them separately is important. Especially, we have not found any such study focusing the marginalized women in Bangladesh. As the barriers differ based on geographical location, race, ethnicity, etc., therefore, such studies should be conducted on different communities separately to uncover their unique problems and needs. Thus, we find it necessary to focus exclusively on marginalized women of Bangladesh to better understand their context. The research findings in this paper reveal the ways in which women gather information on feminine healthcare matters and enhance the understanding of the effectiveness of utilizing healthcare services to address these issues. The study found that many women, particularly those from underprivileged backgrounds, face significant barriers in accessing healthcare information and services. These barriers include limited access to technology and the internet, lack of transportation, and cultural and linguistic barriers. Moreover, our study also found that there is a lack of awareness and knowledge about healthcare-seeking behavior and healthcare services among women from marginalized communities than that from privileged women communities. This paper discusses significant disparities in feminine healthcare access and care quality between privileged and marginalized women in Bangladesh. The survey that we collected was to understand the community gap and analyze how they will get healthcare access and how technology might be a way for mitigating their sufferings since we also need to keep in mind that these underprivileged women have several barriers and limitations.

1.2 Importance of Technology in Healthcare

Technology is crucial to the healthcare sector since it benefits it in so many ways. Through better access to medical records and cutting-edge imaging technologies, it improves patient care. It is easier for healthcare providers to communicate and work together, which improves outcomes. Telemedicine and remote patient monitoring allow for distant care and cut down on hospital visits. Additionally, in an emergency, we can access technology-based healthcare right away rather than going to the hospital. [50] The research aims to bridge the feminine healthcare divide for marginalized women by leveraging Information and Communication Technology (ICT). Through telemedicine, health education, and communication platforms, ICT can overcome barriers and improve healthcare access for marginalized women. The findings of this research can contribute to empowering marginalized women to take control of their health and well-being. Furthermore, this research can contribute to the body of knowledge on m-health and telemedicine, particularly in the context of addressing feminine healthcare disparities for marginalized populations. We are in the era of advanced technology and we should make the best use of it. Artificial

intelligence (AI) will profoundly revolutionize medicine and healthcare. By incorporating AI into the healthcare system, benefits such as the automation of procedures and the ability to analyze large amounts of patient data to provide improved and more efficient healthcare at a lower cost can be achieved, which could save patients valuable time as well as make their consultation easier for them.

1.3 Technology Based Design Proposal

We have noticed the transforming influence of technology in enhancing numerous aspects of life through our study of related works. Technology has been crucial in aiding growth and efficiency across numerous disciplines, from improving communication and enabling worldwide connectivity to digitalizing livelihood through automation and data analysis. [35] Being motivated by that we considered offering a tech-based design that can lessen their hurdles in order to provide our targeted demographic with the correct solution to their difficulties to obtain healthcare for menstruation and gynecological problems. Our suggested design is a mobile voice bot that may offer women basic advice and solutions to their gynecological and menstrual problems and direct them to take the right action and visit a doctor on schedule. The bot won't openly advise them to take any medication because this is such a delicate subject. The bot will be accessible to the targeted group around-the-clock. Women can use this service by simply dialing a hotline and speaking with the voice bot about their difficulties. The mobile voice bot will automatically recognize their health-related queries and will give suggestions in Bangla according to that. Although the topic of discussion is the health services that women can get with the aid of AI the main emphasis of this paper is the underprivileged women, who don't always have the opportunity to have a health checkup often every few years. Because they occasionally lack the financial means to visit a doctor for treatment or perhaps because there isn't a healthcare facility close to their homes, these disadvantaged women occasionally go without treatment or health aid in some truly dangerous instances. They get chronic or serious ailments as a result of this.

1.4 Problem Formulation and Research Challenges

The purpose of the study is to help women with a primary solution to their different gynecological and menstrual problems at an early stage. So, they can get treatment for it from the beginning and not have to suffer more in the future. Our study evolved keeping three research questions in mind. They are presented below.

RQ1 What are the barriers to accessing healthcare facilities among marginalized women?

RQ2 How technology can help facilitate their access to healthcare?

RQ3 Can a 24/7 Voice bot service eliminate the barriers?

However, while conducting research which directly connected to humans and their personal health issues, is a bit challenging for the researchers to get their desired findings. Since our target audience was marginalized women it was tough to seat with

them, getting their consent to participate in our surveys. Moreover, the questions were a bit private because our survey questionnaire includes questions regarding gynecological and menstrual health, and a lot of women showed unwillingness to participate.

Since we live in a society full of taboos and social constraints it is challenging to talk about these sectors (gynecological and menstrual) openly. Many women feel shy and uncomfortable talking about their health issues. Some of them think it is inappropriate to talk about these in an open manner.

Besides, due to a lack of education, we found their technological skills are still very novice, some of them do not even know how to use a mobile phone properly. We found in marginalized communities most of the women lack smartphone usage. Thus, it is challenging to propose a technology-based solution for them.

1.5 Our Research Contributions

The main contributions of our study are as follows.

- Our study uncovered the barriers to access health services for marginalized women in Bangladesh.
- Our study pinpoints the impact of socio-economic, cultural, and geographic factors that influences the access to feminine healthcare for marginalized women in Bangladesh.
- Our study establishes the acceptability of the m-healthcare service among marginalized women.
- Addressing the barriers to healthcare, we propose a design of a 24/7 voice bot to facilitate availing primary healthcare services for marginalized women. We built such a prototype, detailed the workflow, and evaluated its performance formally.

1.6 Thesis Organization

The following chapters of this paper are organized as follows In Chapter 2, we reviewed some related literature that is similar to our research topic and got some insights from the papers. Chapter 3, contained our research methodology where we planned our study and made progress accordingly. Then Chapter 4 contained all the results and findings from our data analysis. In Chapter 5, we proposed a system that could reduce the gynecological healthcare difficulties that marginalized women often face and described a prototype of a voice bot system which we created initially as a solution to the problems from the findings. In Chapter 6, we gave a detailed discussion of the insights from the previous chapters. Furthermore, in Chapter 7, the limitations and future work of our study were discussed. Lastly, in Chapter 8, the conclusion remarks had been discussed.

Chapter 2

Related Works

In this chapter, we have explored different studies which are connected to our research. We conducted a range of studies, including those on women's healthcare and empowerment, e-health for rural people, identifying women's potential health risks and reasons behind it, data collection and analysis in women's healthcare, and medical assistance using chatbots and voice bots.

2.1 Women's Healthcare and Empowerment

Studies [77], [76], [79] all relate to the importance of women's health and empowerment in improving maternal and reproductive health outcomes in marginalized communities. The first paper highlights the prevalence of birth maltreatment in public healthcare facilities and identifies a significant correlation between abuse during childbirth and socio-demographics, health services, and women's empowerment. The authors suggest that promoting women's empowerment through measures such as preventing domestic violence, including them in household decisions, providing social support, and enabling financial independence can help prevent mistreatment during childbirth.

The second paper focuses on the importance of maternal health for a child's cognitive development and emphasizes the need to allocate healthcare spending wisely and enhance the quality of medical facilities and qualified personnel. The third paper examines the role of women's empowerment in abortion and family planning, and decision-making among marginalized women in Nepal and suggests that empowering marginalized women by increasing their education, economic opportunities, and decision-making power can improve their access to these services. The study concludes that empowering marginalized women is crucial for improving their access to abortion and family planning services and ensuring they can make informed decisions about their reproductive health. Overall, these papers demonstrate the importance of empowering women and investing in women's health in order to improve maternal and reproductive health outcomes in marginalized communities.

In both the context of Bangladesh and outside it is common to observe that women face a variety of challenges that somehow affect their mental as well as physical health and well-being. There are many researches and observations regarding these. In many cases, it is seen that these challenges restrict women from accessing education, social and economic opportunities, and healthcare services. In study [58], [26], [17] it is mentioned that before marriage women face gender inequalities in their own

families including less food and education than their brothers. After marriage, they become their husbands' property and totally dependent on their husbands. According to the study [26] self-esteem is low among rural women in Bangladesh and they have limited access to basic needs because of social taboos, norms, and religious restrictions and this leads women to affect their empowerment and decision-making abilities about their life and health, etc. They lack much knowledge about their health and well-being. According to the research [25], [17], women regardless of location, require information on health, food and nutrition, family planning, and child education; however, rural women face similar challenges due to a lack of access to information, and resources and an inability to use information and communication technology. Also, in their research, they found that 75% of their participants from rural areas of Bangladesh need health information [25]. In study [17], it was found that women may become more empowered if they engage in ICT in an active and in-depth manner in terms of learning and education.

According to the study [48], adolescent girls in low-income and middle-income countries lack support and appropriate facilities to manage their menstrual hygiene practices. They are often unprepared for their first menstruation and lack the necessary resources to manage it. This highlights the need for greater attention to menstrual hygiene management and education to ensure their health and well-being. Females in rural Bangladesh lack proper sanitary facilities, resulting in poor menstrual hygiene practices. 86% of adolescent girls use old cloth during menstruation, of which only 12% wash it properly with soap and dry it in the sun. 40% of female students in Bangladesh skip school during menstruation due to poor toilet infrastructure. [36] According to the research [9], there is growing concern about the lack of attention given to female hygiene practices, from adolescence to menopause.

Girls and women often do not take these practices seriously, including related hygiene factors. As a result, taboos and misconceptions regarding menstruating girls and menstrual hygiene have developed, leading to gender inequality and the degradation of women's empowerment. Because of this problem the study [56], suggests that media can be successful in creating social awareness about menstrual hygiene practices in Bangladesh and how it can help break down taboos and promote positive attitudes towards menstruation. It also discusses the potential for media campaigns to improve menstrual hygiene management and increase access to menstrual products and facilities for women and girls. Also, in a report by the World Health Organization (WHO) in 2011, it was suggested that almost 89% of Bangladeshi adults are under mobile phone coverage [20]. Bangladesh has the world's lowest mobile phone call rates [15], providing an opportunity to develop mobile health services for its citizens. These services could enable users to seek medical advice, make doctor appointments, access medical test results, and access personal health information [35].

2.2 E-health for Rural People

Even though the HCI community is trying its best to make a bridge between the marginalized and healthcare providers, it is also important to find out what influences them to not accept those services. According to study [61] some demographic features like age, gender, education, and monthly family expenditure have an impact on end users' acceptance of e-health. It is very difficult for rural people to go to any

hospitals or clinics as those are far. According to the research [71] most people in rural areas are illiterate, they are unable to accurately articulate their problems or recall their previous medical history. The villagers' treatment costs can be reduced by using an e-health system that stores their medical history, reducing the possibility of miscommunications. Also, famous doctors will not want to stay in rural areas because of a lack of services and a lower standard of living. The e-health system can connect rural residents with urban doctors. The authors of the study [50], [35] also suggest that the use of mobile phone-based technology has the potential to improve the delivery and accessibility of health, population, and nutrition services in rural Bangladesh, and may contribute to the achievement of the Sustainable Development Goals related to health and well-being.

2.3 Data Collection and Analysis on Women's Health-care Sector

The studies [85], [87], [88] analyzed in the given reference explored various aspects of menstrual hygiene management (MHM) among adolescent girls in different settings. Study [85] investigated the socio-cultural factors related to knowledge, attitudes, and menstrual hygiene practices among adolescent girls in Junior High Schools in the Kpando Municipality of Ghana. Study [87] conducted a systematic review to examine the challenges faced by women and girls in managing their menstrual hygiene during humanitarian crises and/or public health emergencies. Study [88] aimed to understand the menstrual experiences of girls enrolled in monastery schools in the Magway Region of Myanmar and to examine the link between their reported unmet menstrual health needs and school absenteeism. All studies found that the lack of access to menstrual supplies and facilities, as well as the stigma and taboos surrounding menstruation, affected the menstrual health and well-being of adolescent girls. The studies suggest that addressing these issues requires providing age-appropriate instruction, ensuring access to menstrual supplies, and WASH facilities, and challenging taboos and shame surrounding menstruation.

These studies [62], [12], [83] focus on maternal health outcomes and healthcare access in South Asian countries. They all highlight the importance of socioeconomic factors in determining health outcomes, with lower socioeconomic status associated with poorer maternal and child health outcomes, less access to healthcare services, and increased risk of pregnancy-related complications. The studies also emphasize the need for targeted interventions to address the underlying social and economic factors that contribute to poor maternal health, such as improving access to healthcare, nutrition, education, and addressing chronic health conditions. While progress has been made in improving maternal healthcare service utilization in India, disparities still exist, particularly among marginalized populations. The studies collectively suggest that more attention needs to be given to addressing the social determinants of health in order to improve maternal and child health outcomes in South Asia.

The studies [84], [22], [10], [40], [86] share a common focus on marginalized communities and the challenges they face in accessing healthcare services. They highlight the importance of addressing social determinants of health, such as poverty and lack of education, and the need for community-based interventions to improve health outcomes in underprivileged communities. Additionally, the studies emphasize the

importance of involving marginalized communities in the development and implementation of healthcare programs to ensure cultural appropriateness and responsiveness to their specific needs. The studies also recommend targeted interventions to improve access to maternal and mental health services for marginalized women, including increasing awareness, improving transportation, and addressing cultural and social barriers. Finally, the studies suggest that policies should prioritize the health needs of marginalized communities to ensure that no one is left behind in terms of healthcare services.

The studies [58], [54], [45], [4], [19], [34], [30] cover a range of topics in Human-Computer Interaction (HCI) and healthcare. Several studies examine the social and cultural context of technology design, including the challenges and opportunities of designing technology for low-income rural women in Bangladesh [58] and the need for technology to be inclusive and culturally sensitive to diverse knowledge systems when designing for community health [54]. Other papers focus on healthcare, such as the impact of undesirable events on patients and recommendations for improving patient safety [45] and the challenges of carrying out fieldwork research in healthcare and how HCI researchers can improve their methods [30]. Additionally, a study examines the impact of a women’s development program on gender inequality within households in Bangladesh [4], while another study discusses using design as a tool for self-reflection in immigrant women’s health and wellness management [34]. Lastly, a study examines the challenges of designing and implementing technology in developing communities, highlighting the crucial role of intermediaries [19].

These four studies [46], [72], [64], [69] share a common theme of exploring the use of technology in addressing various health and sanitation issues in low-resource settings. The papers highlight the importance of taking a human-centered approach to design, considering local contexts and social norms, and addressing issues of equity and inclusion. They also emphasize the need to go beyond health literacy and provide social support, community, and access to health information. Overall, the studies provide valuable insights for those working in the fields of healthcare, technology, and sanitation in low-resource settings.

2.4 Identifying Women’s Potential Health Risk and Reasons Behind It

These papers [52], [24], [18], [67] discuss the challenges of healthcare provision and pregnancy risk identification in disadvantaged communities in different parts of the world. The first paper proposes using an artificial neural network technique to represent the Poedji Rochjati Score Card (PRSC) to assess pregnancy risk factors, while the second paper proposes using a prognostic machine to predict a patient’s physiological condition. The third paper analyzes the self-rated health of women in disadvantaged communities in Beirut, Lebanon, while the fourth paper discusses the challenges of providing wellness support in a low-income rural community in Bangladesh. Both papers highlight the limited access to healthcare and the mistrust of healthcare infrastructure in disadvantaged communities. The papers emphasize the need for technology to improve healthcare access, but they also acknowledge that technology design should consider the conflicting interests and beliefs of various parties, such as care providers and care-seekers.

2.5 Medical Assistance Using Chatbots

Studies [90], [65], [59], [57], and [81] all focus on the use of chatbots in the healthcare industry, particularly for women’s health and adolescent health. The studies aim to address the gaps and difficulties faced by people in accessing healthcare information and services, especially in underdeveloped countries like Bangladesh. The authors propose the use of chatbots as a feasible solution to provide virtual healthcare services that are accessible, accurate, and efficient.

In [90], a chatbot is created to cover a narrow range of functions, including symptom-based disease diagnosis for women, home remedy recommendations, and food advice. Similarly, in [65], “Chat-a-bot” is developed to serve as a virtual healthcare professional, delivering responses in a conversational and easy-to-understand way for pregnant mothers during their prenatal journey. In [59], an AI-based chatbot is created to assist and support expectant mothers, and families with young children, providing quick and practical advice in case of emergencies and answering questions on disease prevention pathways, lifestyles, and other health-related issues.

In [57], a personal assistant or chatbot is developed using artificial intelligence and an artificial neural network to gather health information from users and advise on whether or not to see a doctor or provide healthcare suggestions like exercise routines or diet programs. In [81], the focus is on the evaluation of the effectiveness of a chatbot called “AdolescentBot” in helping teenagers access reproductive and sexual health information in Bangladesh.

Overall, the studies show that chatbots have the potential to provide cost-effective and efficient healthcare services, especially in areas where access to healthcare information and services is limited. Chatbots can also help in reducing the social stigma associated with discussing health-related issues, particularly for women and adolescents. The studies highlight the need for further research on chatbots in healthcare and the ethical and societal implications of their usage.

2.6 Medical Assistance Using Voice Bots

The studies described in the reference all incorporate voice bots or conversational agents to improve healthcare. In study [89], the authors discuss using voice bots to provide quick and accurate responses to patients. They used Naive Bayes Algorithm to determine the likelihood of diseases, which serves as the main point. In study [73], the authors focus on providing primary healthcare education, information, and counseling to chronic patients, specifically in rural India. They developed a multilingual conversational bot called “Aapka Chikitsak,” which is based on Natural Language Processing and hosted on the Google Cloud Platform. The bot is designed to provide interactive antenatal and postpartum healthcare, general healthcare information, and preventive measures for common diseases and ailments in India in a user-friendly language.

Study [74] explores the use of voice bots for daily tasks for ADHD child patients. The bot is designed to help children do their daily tasks by using a goal-plan-do-check cycle, based on self-instructional learning. The voice bot is developed based on Raspberry Pi and uses the Dialog Flow API. Study [80] focuses on delivering interventions to females diagnosed with metastatic breast cancer through a smart speaker system called “Nurse AMIE”. The system uses voice interactions to reduce

barriers for this demographic to interact with remote intervention technologies. The system records the patients' daily status and symptoms, suggests self-management interventions, and uses the Alexa Skills Kit SDK, Echo Show devices, the Alexa Presentation Language, and AWS Lambda service for deployment and data storage. The authors plan to conduct a Randomized Controlled Trial to further evaluate the acceptability and effectiveness of "Nurse AMIE".

2.7 Robot-based Medical Health Assistance for Women

The paper [55] describes the development of a low-cost healthcare robot named "Mini Nurse-Bot", which is designed to assist elderly individuals with taking their medication on time. The robot comprises three components: the transmitter system, the receiver system, and the control system. The transmitter system is connected to the elderly person and emits a signal to the robot, while the receiver system monitors the signal. The control system manages the movement of the robot and the medicine container.

Similarities can be drawn between this study and other studies that involve the development of healthcare robots for elderly individuals. The main focus of the study is to address the challenges faced by elderly people, their relatives, and caregivers in providing care, particularly in low-income countries. The development of these robots aims to provide affordable and accessible healthcare services for elderly individuals, enabling them to live more independently. Additionally, the use of technology, such as voice or video data tracking, is being explored to make the robots more autonomous.

In summary, the study in paper [55] developed a low-cost healthcare robot to assist elderly individuals with taking their medication on time.

Chapter 3

Methodology

In this chapter, we will explain the methodology for conducting our study. Figure 3.1 presents the pipeline of our adopted methodology. To explore the overall condition of healthcare opportunities and find the factors hindering access to healthcare, we collected data in several phases and several mediums. Then we performed a mixed-method analysis i.e., both quantitative and qualitative analyses of our collected data. Based on the findings from our exploration, we present our design proposal in detail with a working prototype.

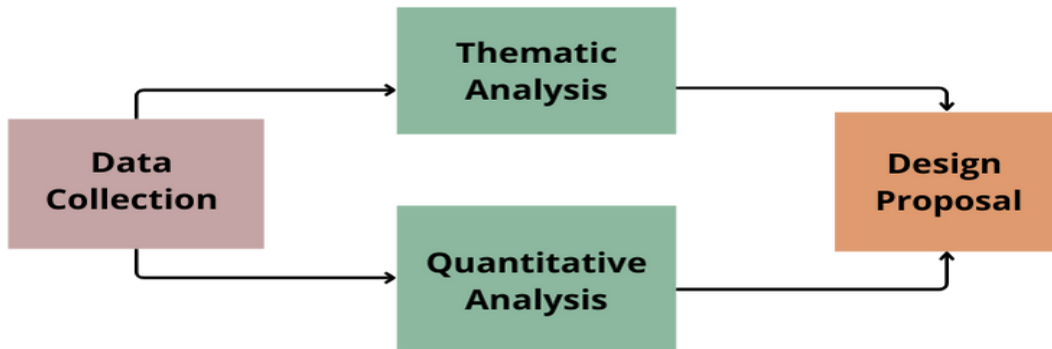


Figure 3.1: Methodology

3.1 Data Collection

For the primary hypothesis of our research purpose, we wanted to explore how marginalized women deal with their health problems, how available the healthcare

facilities are to them, and how much technological help they are getting. After creating the questionnaire for the survey, we took appointments to find a doctor who can review the survey form. So we mailed them and they gave us their valuable time. It took us around one month to reach the doctors, discuss with them and seek approval. Finally, we were able to receive approval from two doctors and then distributed it to collect data from women in different occupations. We divided our survey participants into two groups : (1) Privileged and (2) Marginalized. First, we distributed the survey form to the privileged people using an online survey and received 44 responses. Later we interviewed 15 marginalized women within two days from some housemaids and their neighborhoods. Moreover, we collected 15 more data by doing a field visit at a slum in the city of Dhaka known as Korail Slum. Some of them were unemployed, some were garment workers and most of them were housemaids. After collecting the data we started our first phase of data analysis.

3.1.1 Questionnaire Design

For conducting the survey, it is important to set up an adequate questionnaire that will be simple, precise, and informative. In order to do that, we created a questionnaire with questions about the necessary information we needed to get from our target audiences. The questionnaire was created using an online survey regarding the health issues women regularly deal with, this includes chronic, gynecological, and mental distress during pregnancy and menstruation so that we get an idea about which diseases women are more prone to. Our questionnaire also includes some personal information as in demographic data such as age, family member count, education level, employment status, marital status, and total income of the family although the questionnaire was kept anonymous, we collected this data for our preliminary research. Moreover, we kept some questions to get an idea about how many of the women have the tendency of hiding their gynecological issues because of shyness, and societal, religious, and cultural constraints. We also kept some questions regarding how many of them used any sort of app or mobile-based services, if those services were helpful or not, and if we propose any service will they be willing to use.

Both [1] and [38] papers highlight the importance of gathering and analyzing data related to women’s health for effective healthcare delivery. They emphasize the need to collect data from large groups of women, including physiological, psychological, and economic factors that influence women’s health. Additionally, both papers stress the significance of data governance and standardization for effective analysis and utilization of healthcare data. [1] also specifically mentions the importance of understanding a woman’s educational background as a factor contributing to her health concerns. Thus, we kept some questions regarding existing healthcare services provided in our country to know how many women are aware of it, how the provided services are, and what they lack.

We kept questions in both qualitative and quantitative manner. The majority of the survey questions were quantitative, allowing us to gather numerical data and statistical information on the subjects. However, a small number of questions were designed to collect qualitative data, such as opinions and personal experiences, which provided a deeper understanding of the subjects. The quantitative data allowed us to understand the general trends and patterns in the survey responses, while the

qualitative data helped us to gain a more nuanced perspective on the subjects. Together, these two types of analysis provided a comprehensive understanding of the survey results, giving us a more complete picture of the subject matter.

Total Responses	44 (p) + 30 (m) = 74
Total Questions on Personalised Information	9
Total Questions on Opinion-based Information	16
Total Questions on Mental Health based Information	9
Total Questions on Health-based Information	10

Table 3.1: Table of questionnaire overview where p=privileged and m= marginalized

Afterward, we visited the densely populated slum area of Dhaka known as Korail Slum to conduct a survey on the women living there. Our sample comprised 15 women of various ages, with the majority falling between 15-30 years old. We encountered women who were unmarried, married, and widowed, with most being housewives and only a few engaged in work. Our data revealed that all the women owned a personal mobile phone, and were hesitant to seek male doctors for gynecological issues. We also learned about the menstrual products they used and their perspectives on period shaming and creating a period-shaming-free society. Through this survey, we gained insight into their backgrounds and needs. Thus we collected another 15 responses and our total response of marginalized women turned out to be 30.

3.1.2 Data Collection Through Online Survey

Initially, we implemented phase-1 of data collection by utilizing an online survey through the use of Google Forms. After designing the questionnaire, we distributed it to our female acquaintances, family members, colleagues from academic institutions, and educators, and asked them to forward the questionnaire to other women they knew. The survey form was distributed mainly to the educated women of our country to gather an idea of which diseases women are more prone to, this includes chronic, gynecological, and mental distress during pregnancy and menstruation. The participants were eager to take part, and as a result, we were able to obtain 44 responses from 8 January to 11 January 2023 within a period of just three days. When we distributed the questionnaire, we provided the participants with a general overview of the survey and the reason for conducting it. Many of them expressed a keen interest in our proposal of a technology-based solution to their problems.

3.1.3 Data Collection through Interviews with Marginalized Women

We collected data from marginalized women in two rounds. First of all, we collected data from our housemaids and their neighborhoods. Then we collected data from slum dweller women by visiting a slum. Below we present the details of both of these rounds.

Housemaids and Their Neighborhood

For our phase-2 data collection, on 12 January 2023, we conducted our fieldwork in the buildings where we live and could find seven housemaids and took their interviews. We asked them the same set of questions present in our survey in Bangla for their better understanding. Then on behalf of them, we gave input in our Google form to collect their data. Moreover, we asked them if we could go to their locality and collect some more data. Two of them were really happy to welcome us and thus we went to their house and from their neighbors we collected a little more data. From their neighborhood, we could collect data from six housewives and two garment workers. The duration of the interview sessions ranged from 10 to 15 minutes. It took two days to take the survey from the housemaids and one full day to take the survey from their neighborhood. Additionally, we approached around 19 women to participate in our survey but only 15 of them gave their consent to take part.

Data Collection from Slum Dwellers

On 25th February 2023, we visited Korail Slum to survey the women living there. It was around 10.30 am when we arrived, and we started going from house to house, asking if they would be willing to participate in our survey (Figure 3.2). Some of the women were hesitant, but most of them agreed and were very humble.

We asked them questions from our questionnaire A.1, which focused on their health and well-being. Many of them shared their experiences with us, including the disparities they face in accessing healthcare facilities in Bangladesh. They also expressed their reluctance to visit male doctors for gynecological problems and menstruation-related issues.

We explained to them about the system we are planning to implement, which would provide them with primary suggestions through a voice bot. They seemed interested and appreciated our efforts to improve their healthcare access.

During our visit, we had the opportunity to interact with the women and learn about their lives. Some of them even gossiped with us, which made the atmosphere more relaxed and friendly. We stayed in the slum for about one and a half hours and managed to survey 15 participants.



Figure 3.2: Taking interviews from shops and households of Korail slum

3.1.4 Participants' Demography

We provide a highlight of the demographic characteristics of our participants in Table 3.2. It is clear from the table that our participants have diversity in them regarding age, occupation, marital status, etc. However, as expected, we see that the privileged women are all highly educated whereas, the marginalized women had barely completed high school. Similarly, the monthly family incomes of the privileged women are much higher than the other group and this is also in line with our expectation.

	Categories	Count(n)(p)	% (p)	Count(n)(m)	% (m)
Age	<18 years old	1	2.3%	2	6.7%
	18-30 years old	38	86.4%	16	53.3%
	31-44 years old	5	11.4%	11	36.7%
	45-54 years old	0	0.0%	1	3.3%
	55 & over	0	0.0%	0	0.0%
Marital status	Prefer not to answer	0	0.0%	0	0.0%
	Widowed	0	0.0%	3	10.0%
	Single	27	61.4%	2	6.7%
	Divorced	1	2.3%	2	6.7%
	Married	16	36.4%	23	76.6%
Occupation	Unemployed	1	2.3%	7	23.3%
	Housewife	1	2.3%	7	23.3%
	Student	22	50.0%	1	3.3%
	Employed	18	40.9%	15	50.0%
	Business Woman	2	4.5%	0	0.0%
Education_level	Did not attend school	0	0.0%	12	40.0%
	Primary School	0	0.0%	13	43.3%
	Secondary School	0	0.0%	4	13.3%
	College	19	43.2%	1	3.3%
	Graduate	11	25.0%	0	0.0%
	Post Graduate	14	31.8%	0	0.0%
Family income	Between 0-10,000 BDT	0	0.0%	3	10.0%
	Between 10,000-20000 BDT	0	0.0%	17	56.7%
	Between 20,000-30,000 BDT	1	2.3%	10	33.3%
	Between 30,000-40,000 BDT	10	22.7%	0	0.0%
	Above 40,000 BDT	33	75.0%	0	0.0%

Table 3.2: Demographic table of privileged and marginalized women participants (p = privileged and m = marginalized)

3.2 Overview of Quantitative and Qualitative Analysis

Based on the data we collected from our target groups and to justify the research questions, we chose to conduct both qualitative and quantitative analyses of the data. In the following sections, we are going to explain how these analyses were done.

3.2.1 Quantitative Analysis

We conducted our quantitative analyses using SPSS software. We did Multinomial Logistic Regression, Factor Analysis, GLM Analysis, and One-Sample T-test. These were the four types of analysis we conducted. To determine the differences between the two groups, we performed these four types of analysis on the data gathered from marginalized women as well as data from privileged women separately. We needed to examine the data we collected from our target group's various responses

utilizing a variety of analysis techniques in order to draw out some useful analysis components.

3.2.2 Qualitative Analysis

From our interviews with marginalized women, we received a handsome amount of open-ended responses from them. During the interview, we made an effort to discuss their struggles and the reasons behind their lack of concern for routine medical examinations. We transcribed their responses into text and performed thematic analysis [39] on them. To perform thematic analysis, we went through the responses several times and got familiar with the data. Then we tried to extract the codes from each response. Upon generating the codes, we compare them and reiterate the responses to have a consistent codebook. We further organize and taxonomize our codes and gave appropriate names which eventually conclude the themes.

3.3 Sampling Size and Sampling Strategy

We focused on the healthcare gaps and difficulties experienced by women in Bangladesh, particularly those who are marginalized and privileged. The paper aims to identify the knowledge gaps among these women regarding self-care and general healthcare and highlights the significant disparities in access to feminine healthcare and quality of care between privileged and marginalized women.

The sample size for this study was determined after careful consideration of various factors, including feasibility, available resources, and research objectives. Given the scope of the research and practical constraints such as time, budget, and resources, a sample size of 74 women from Bangladesh was deemed appropriate.

The sample of 74 women was considered sufficient to achieve the study's objectives, as it allowed for in-depth data collection and analysis. We stopped at 74 because after getting responses from both privileged and underprivileged groups, it was concluded that the saturation point had been achieved given the nature of the research aims and the data gathered. When additional data collection does not produce new or noticeably different knowledge or insights, saturation has set in. In our situation, the participant's comments and experiences started to repeat themselves, indicating that the data had become redundant.

As for the sampling strategy, we used stratified sampling along with convenience sampling. We at first reached out to the housemaids and their neighborhoods who are easily accessible by us and represent marginalized women which stands for convenience sampling. And at the same time, we ensured that women from different demographic groups get included in our study. Thus, the sample was made up of individuals who represented a variety of demographic groupings and a wide spectrum of opinions which represents stratified sampling.

The technique of stratified sampling was deemed appropriate since it allowed for the inclusion of a variety of perspectives and ensured that the sample was representative of the population of interest. By involving participants from various social strata and acquiring a comprehensive understanding of the healthcare gaps and issues faced by disadvantaged women, we hoped to convey the variability in healthcare access and quality of care experienced by women in Bangladesh.

On the other hand, convenience sampling offered a feasible and adaptable strategy for participant recruitment due to the marginalized position of the target population and the related limitations of carrying out a random sample. With the help of this sample strategy, the research team was able to get beyond obstacles including a lack of funding, a short timeline, and the requirement to build rapport and trust with the participants.

Despite the fact that convenient sampling does not ensure a representative sample in the strict sense of statistics, it did enable the deliberate selection of participants who may offer insightful information on the healthcare gaps and challenges encountered by underprivileged women in Bangladesh. Within the limitations of the time and resources at hand, the emphasis was on recording a variety of viewpoints and experiences. We planned to collect in-depth qualitative information using this method in order to develop a thorough knowledge of the feminine healthcare disparities among marginalized women.

To combine representativeness and practicability, a combination of stratified and convenient sampling techniques was used. A stratified sample made it possible to include a variety of women from various socioeconomic and geographic origins, ensuring a thorough understanding of healthcare inequities. Contrarily, convenient sampling made it easier to put ideas into practice by taking into account the limitations imposed by time and resource restrictions. While understanding the practical constraints entailed in conducting research within this demographic, the sampling technique used in this study attempted to offer insightful information about the feminine healthcare difficulties experienced by underprivileged women in Bangladesh.

3.4 Ethical Approval

In this study, we aimed to investigate feminine health-related issues among both privileged and marginalized groups. To ensure the ethical conduct of the study, we obtained approval from the institutional review board (IRB) and obtained informed consent from all participants.

To protect the privacy and confidentiality of the participants, we implemented a number of measures. For example, we collected personal information through an anonymous online survey and ensured that data was stored securely. Additionally, we provided participants with detailed information about the study, including their rights to withdraw at any time and the potential risks and benefits of participation. We also took special care to ensure that the rights of marginalized groups were protected. For example, we made sure that our recruitment methods were inclusive and that marginalized groups were not disproportionately represented in the study. Additionally, we provided extra support and resources for participants from marginalized groups, such as language support as well as also defined some terms (period, gynecological terms, medical terms, etc.) to them so that they could understand our questions.

Overall, we believe that these efforts helped to ensure that the study was conducted in an ethical and responsible manner and that the rights of all participants were respected.

Chapter 4

Findings from Interviews and Online Survey Form Responses

We performed a mixed-method analysis i.e., both qualitative and quantitative analysis of the data collected from the survey and interviews. In this chapter, we are going to discuss in detail the findings from these analyses.

4.1 Findings from Statistical Analysis

The primary goal of statistical analysis is to extract meaningful insights from data by summarizing key findings, simplifying complex information, and making necessary adjustments to pave the way for further investigation. In the context of our study on women's health issues, we conducted a comprehensive survey of women from both privileged and underprivileged backgrounds in our country, representing diverse socioeconomic and cultural backgrounds. By comparing and contrasting data from marginalized and privileged women, we sought to identify disparities and differences in their health experiences, coping strategies, and preventive measures. Through various quantitative analyses using SPSS software, our objective was to uncover the gaps in healthcare access and utilization among marginalized women and gain a deeper understanding of their unique challenges and needs.

The studies [5], [68], [2], [14], [78], and [82] all provided valuable insights and guidance for data analysis in various statistical contexts. Specifically, [5] provided guidance on selecting appropriate Goodness-of-Fit tests for the logistic regression model, [68] offered statistical methods for understanding correlates of child stunting using Generalized Linear Mixed Models, [2] provided insights on the robustness of the Two-sample T-test for ordinal scaled data, [14] discussed the appropriate selection of statistical tests for data analysis, [78] provided practical guidelines for choosing between the Two-sample T-test and its alternatives, and [82] discussed the use of Factor Analysis as a tool for survey analysis. These studies contributed to a more robust, reliable, and comprehensive data analysis approach in their respective areas, ensuring accuracy, validity, and evidence-based analysis in research projects.

Multinomial Logistic Regression

The Multinomial Logistic Regression Analysis of Table.4.1 shows that all independent variables, except “period_1_stat”, have a significant effect on the dependent

Effect	Chi-Square	df	Sig.
comfortable_stat	25.897	4	0.000
period_1_stat	7.480	4	0.113
menst_prob	12.984	4	0.011
shy	37.902	4	0.000
menst_desc	37.928	16	0.002
psfc_desc	47.164	4	0.001

Table 4.1: Multinomial Logistic Regression analysis if “comfortable” is affected by other variables in privileged women participants

variable “comfortable”. The variable “comfortable” was the dependent variable, and “menst_desc” and “psfc_desc” were the factors, while “period_1_stat”, “comfortable_stat”, “menst_prob”, and “shy” were the covariates. These variables were used to show the significant reason for the menstruation problems due to discomfort and shyness. The Model Fitting Information indicates a significant improvement and provides a better fit in the model fit $\chi^2(52) = 112.360$ and p -value $0.000 < 0.05$. This suggests that the factors and covariates included in the final model have a significant effect on the dependent variable “comfortable”. Additionally, the p -value of both Pearson and Deviance is higher than 0.05, indicating that the model is a good fit for the data. The variables “comfortable_stat”, “menst_prob”, “shy”, “menst_desc”, and “psfc_desc” have significant Chi-Square values and low p -values, indicating their strong association with the dependent variable.

The pseudo- R^2 model including the factors “menst_desc”, “psfc_desc”, and covariates “comfortable_stat”, “period_1_stat”, “menst_prob”, and “shy” is a good fit for predicting the likelihood of the dependent variable “comfortable” (Cox and Snell = 92.2%, Nagelkerke = 96.9%, and McFadden = 84.5%). The variables “period_1_stat”, “comfortable_stat” and “menst_desc” also have high beta values, indicating their importance in predicting the dependent variable. The model fit is good as indicated by the Low -2 Log-Likelihood values for both the reduced and final models and the high 2 value for the final model with a low p -value, indicating a significant difference between the observed and expected values. For the “menst_prob” variable, $\chi^2(4) = 12.984$ with p -value $0.011 < 0.05$ which is statistically significant, the “comfortable_stat” variable, $\chi^2(4) = 25.897$ with p -value $0.000 < 0.05$ which is also statistically significant. Additionally for the “shy” variable, $\chi^2(4) = 37.928$ with p -value $0.000 < 0.05$, the factor “menst_desc” variable, $\chi^2(16) = 37.928$ with p -value $0.002 < 0.05$, and the factor “psfc_desc” variable, $\chi^2(20) = 47.164$ with p -value $0.001 < 0.05$. Overall, these results suggest that the factors and covariates included in the analysis are important predictors of women’s comfort in the privileged healthcare service. Therefore, these findings may have implications for healthcare providers who aim to improve women’s comfort in healthcare environments.

The Multinomial Regression Likelihood Ratio Test of Table.4.2. indicates a significant improvement and provides a better fit in the model fit $\chi^2(30) = 51.471$ and p -value $0.009 < 0.05$. This suggests that the factors and covariates included in the final model have a significant effect on the dependent variable “comfortable”. Additionally, the p -value of both Pearson and Deviance is higher than 0.05, indicating that the model is a good fit for the data.

The variables “comfortable_stat”, “menst_prob”, “shy”, “menst_desc”, and “psfc_desc”

Effect	Chi-Square	df	Sig.
comfortable_stat	4.865	3	0.182
period_1_stat	1.046	3	0.790
menst_prob	3.819	3	0.790
shy	6.592	3	0.086
menst_desc	18.868	9	0.026
psfc_desc	13.588	9	0.138

Table 4.2: Multinomial Logistic Regression analysis if “comfortable” is affected by other variables in marginalized women participants

have association with the dependent variable. The pseudo- R^2 model including the factors “menst_desc”, “psfc_desc”, and covariates “comfortable_stat”, “period_1_stat”, “menst_prob”, and “shy” is a good fit for predicting the likelihood of the dependent variable “comfortable” (Cox and Snell = 82%, Nagelkerke = 92.5%, and McFadden = 78.8%). The variables “period_1_stat”, “comfortable_stat” and “menst_desc” also have high beta values, indicating their importance in predicting the dependent variable. The model fit is good as indicated by the low -2 Log-Likelihood values for both the reduced and final models and the high χ^2 value for the final model with a Low p -value, indicating a significant difference between the observed and expected values. In the Likelihood Ratio test table, only the factor “menst_desc” variable, $\chi^2(16) = 18.868$ with p -value $0.026 < 0.05$, is statistically significant. However, the other factors were not significant as all their p -values were greater than 0.05. Therefore, these findings may have implications for healthcare providers who aim to improve marginalized women’s comfort in healthcare environments.

Effect	Chi-Square	df	Sig.
shamed	5.251	4	0.262
education_level	10.801	4	0.029
shy	6.089	4	0.193
comfortable	4.246	4	0.374
psfc_desc	20.128	20	0.450

Table 4.3: Multinomial Logistic Regression analysis if “menst_desc” is affected by other variables in privileged women participants

A Nominal or Multinomial Logistic Regression was conducted on the privileged women participants where the dependent variable was “menst_desc” while “psfc_desc” is a factor and its covariates are “shamed”, “education_level”, “shy”, “comfortable”, and “psfc_desc”. The results from the Likelihood Ratio Tests, Table.4.3, indicate that the effects of the covariates on the dependent variable, “menst_desc”, are not statistically significant except for “education_level”. The effect of “education_level” on the dependent variable is statistically significant, as shown by the lower -2 Log Likelihood value and the higher Likelihood Ratio Tests Chi-Square value with a significant level of $0.029 < 0.05$. However, the effects of “psfc_desc”, “comfortable”, “shy”, and “shamed” on the dependent variable are not statistically significant as their respective Likelihood Ratio Tests Chi-Square values have high p -values greater than 0.05. This suggests that “education_level” is the only significant predictor of the dependent variable in this Multinomial Logistic Regression or Nominal Regres-

sion model. The Chi-Square of Pearson and Deviance is both large and the degree of freedom is also large, which is expected for a model with many variables. However, the p -values for both tests are high, indicating that the model is not significantly different from the expected values. Therefore, we can conclude that the model fits the data well and the covariates are not significant predictors of the dependent variable. The pseudo- R^2 measures for Cox and Snell, Nagelkerke, and McFadden are 58.4%, 61.9%, and 30.4% respectively, indicating the Goodness of Fit of the Multinomial Logistic Regression or Nominal Regression model in explaining the variation in the dependent variable, “menst_desc”, with the given set of covariates, “shamed”, “comfortable”, “shy”, and “education_level”, and the factor, “psfc_desc”. Therefore, the model has a moderate to a good fit in explaining the variability of “menst_desc” based on the given set of covariates and factors.

Effect	Chi-Square	df	Sig.
shamed	9.282	3	0.026
education_level	16.137	3	0.001
shy	8.051	3	0.045
comfortable	0.249	3	0.969
psfc_desc	26.674	9	0.002

Table 4.4: Multinomial Logistic Regression analysis if “menst_desc” is affected by other variables in marginalized women participants

The Multinomial Logistic regression model with dependent variable “menst_desc”, factor “psfc_desc”, and covariates “comfortable”, “shy” and “education_level” of marginalized women participants showed a significant improvement in model fit when compared to the intercept-only model. The final model had a -2 Log-Likelihood of 36.233, which is lower than the Intercept-only Model’s 75.437. The Likelihood Ratio Test also showed a significant improvement in model fit with a ($\chi^2(21) = 39.204$) with a significance level of $0.009 < 0.05$. Therefore, the final model provides a better fit to the data (Chi-Square of Pearson(54) = 32.554 and significance was 0.991 from Goodness-of-Fit) and suggests that the factors and covariates included in the model are important predictors of the dependent variable, “menst_desc”, for underprivileged women’s healthcare.

The pseudo- R^2 measures for the Multinomial Logistic Regression model with dependent variable “menst_desc”, factor “psfc_desc”, and covariates “comfortable”, “shy” and “education_level” indicate a moderate to a high level of Goodness of Fit (the Cox and Snell R-Squared = 0.729, indicating that the model explains 72.9% of the variation in the dependent variable, the Nagelkerke pseudo- $R^2 = 0.785$, indicating that the model explains 78.5% of the maximum possible variation in the dependent variable, and the McFadden R-Squared measure is 0.493, indicating that the model explains 49.3% of the variation in the dependent variable relative to a null model). These measures suggest that the model is a good fit for the data and provides useful information for predicting the dependent variable for underprivileged women’s healthcare data. The likelihood ratio tests show the effects of “comfortable”, “shy”, “education_level”, “shamed”, and “psfc_desc” on the Multinomial Logistic Regression model significant predictors of the dependent variable “menst_desc”. The results from Table.4.4, show the effect of “comfortable” had a

non-significant value of 0.969 while the effects of “shy”, “education_level”, “shamed”, and “psfc_desc” had significant p -values of 0.045, 0.001, 0.026, and 0.002, respectively. These results suggest that the model is statistically significant and has a good fit for the data and provides useful information for predicting the dependent variable for underprivileged women’s healthcare.

Factor Analysis

	Component 1	Component 2
education_level	0.770	0.101
occupation	0.857	0.075
employment	0.627	-0.266
health_checkup	-0.199	0.570
family_income	-0.192	-0.837

Table 4.5: Factor Analysis on privileged women participants

A Factor Analysis was conducted to explore the relationship between five variables, including “education_level”, “occupation”, “employment”, “health_checkup”, and “family_income” on privileged women participants. The Correlation Matrix showed that all variables had a fairly strong correlation, with a Determinant value of 0.597. The KMO measure of Sampling Adequacy (0.607) indicates that the sample size is adequate for conducting Factor Analysis. Moreover, Bartlett’s Test of Sphericity result shows that the Correlation Matrix is not an Identity Matrix and there is a significant relationship between the variables ($\chi^2(10) = 20.914$ with p -value $0.022 < 0.05$). These results suggest that the data is suitable for Factor Analysis. The factor variables “education_level”, “occupation”, “employment”, “health_checkup”, and “family_income”, “mobile_service” can be used for Factor Analysis to identify the underlying factors that may influence privileged women’s healthcare outcomes. In this analysis, the Communalities between the initial extraction of “occupation” have the highest extraction measure of 0.722, indicating that it shares the most common variance with other factors and also “education_level” and “family_income” have relatively high extraction measures of 0.581 and 0.690 respectively, while “employment” and “health_checkup” have lower extraction measures of 0.513 and 0.398 respectively. Overall, the results suggest that these factors share some common variance and may be useful in understanding privileged women’s healthcare behaviors. For analysis and interpretation purposes we are concerned only with Initial Eigenvalues and Extracted Sums of Squared Loadings. The requirement for identifying the number of components or factors stated by selected variables is the presence of Eigenvalues of more than 1. For the 1st component, the value is $1.841 > 1$, and for the 2nd component is $1.063 > 1$. Further, the Extracted Sum of Squared Loading% of variance depicts that the first factor accounts for 36.819% of the variance features from the stated observations, the second 21.261%. Thus, 2 components are effective enough in representing all the characteristics or components highlighted by the stated 5 variables.

Moreover, The factor loadings obtained from the Pattern Matrix Table.4.5, represent the relationship between the original variables and the identified factors. In

this analysis, the two identified factors are represented as Component 1 and Component 2. The factor loadings for component 1 indicate that “occupation” has the strongest relationship with this factor, followed by “education_level” and “employment” which also have relatively high loadings. The factor loadings for component 2 indicate that “health_checkup” has the strongest relationship with this factor, while “family_income”, “employment” have a negative loading on this factor, indicating an inverse relationship. Overall, this suggests that the identified factors of Component 1 and Component 2 may represent different aspects of privilege or socioeconomic status among the study population.

	Component 1	Component 2
education_level	-0.019	0.591
occupation	0.959	0.006
employment	-0.963	0.001
health_checkup	-0.061	0.882
family_income	0.098	0.678

Table 4.6: Factor Analysis on marginalized women participants

A Factor Analysis was conducted on the marginalized women participants to explore the relationship between five variables, including “education_level”, “occupation”, “employment”, “health_checkup”, and “family_income”. The Correlation Matrix showed that all variables had a fairly strong correlation, with a Determinant value of 0.162. Additionally, The KMO measure of Sampling Adequacy of 0.549 indicates that the dataset is marginally suitable for factor analysis. Moreover, Bartlett’s Test of Sphericity was significant ($\chi^2(10) = 48.212$ with p -value $0.000 < 0.05$), suggests that the Factor Analysis was appropriate. The Communalities measures of the factor variable “occupation” has the highest extraction measure at 0.923, followed closely by “employment” at 0.928, and “health_checkup” at 0.746. Here, only the variable, “education_level” has a lower value than 0.5. This suggests that “occupation”, “employment”, and “health_checkup” are the most relevant factors in the analysis, while “education_level” may have less impact on the healthcare outcomes for underprivileged women. For analysis and interpretation purposes we are concerned only with Initial Eigenvalues and Extracted Sums of Squared Loadings. The requirement for identifying the number of components or factors stated by selected variables is the presence of eigenvalues of more than 1. For the 1st component, the value is $2.322 > 1$, and for the 2nd component is $1.131 > 1$. Further, the extracted sum of squared holding% of variance depicts that the first factor accounts for 46.447% of the variance features from the stated observations, the second 22.616%. Thus, 2 components are effective enough in representing all the characteristics or components highlighted by the stated 5 variables. The Factor Analysis results for the variables “education_level”, “occupation”, “employment”, “health_checkup”, and “family_income” show that each variable has a different level of correlation with the identified factors. The Pattern Matrix of factor analysis from Table.4.6 shows that the factor loadings for Component 1, “occupation” have the strongest positive relationship with this factor. The factor loadings from Component 2 indicate that “health_checkup”(0.882), “family_income”(0.678) and “educational_level”(0.591) have a stronger correlation. This suggests that “occupation” and “family_income” may have a greater impact on the overall health status of marginalized women, while “education_level” and

“health_checkup” may be more closely related to a specific aspect of healthcare.

Generalized Linear Model Analysis

Parameter	B value	Std. Error	Hypothesis test(Wald Chi-Square)	df	Sig.	Exp(B)
education_Level	-0.061	0.2251	0.072	1	0.788	0.941
comfortable	0.184	0.1411	1.707	1	0.191	1.202
shy	0.206	0.1970	1.095	1	0.295	1.229
menst_prob	0.544	0.5048	1.163	1	0.281	1.724

Table 4.7: GLM analysis if “PMS_stat” is affected by other variables in privileged women participants

We conducted a Generalized Linear Model on the privileged women participants where the dependent variable was “PMS_stat” and covariates were “education_level”, “comfortable”, “shy”, and “menst_prob” to analyze if “PMS_stat” has significance on the other variables. The Scaled Pearson Chi-Square (39) = 44.000 indicates that there may be some discrepancies between the observed data and the expected data based on the model. The Deviance of Goodness of Fit of 65.124% with 39 degrees of freedom and a value/df of 1.670 suggests a similar conclusion. However, the Pearson Chi-Square (39) = 65.124 with a value/df of 1.670 indicates that the model is still reasonably good. Overall, these results suggest that the model may not be a perfect fit for the data but is still adequate in describing the relationship between “PMS_stat” and the covariates “shy”, “education_level”, “comfortable”, and “menst_prob” for privileged women in healthcare.

The Omnibus Test in this Generalized Linear Model measures the Likelihood Ratio ($\chi^2(4) = 3.106$) and a p -value of $0.540 > 0.05$. This indicates that the model as a whole is not statistically significant at the 0.05 level, suggesting that the model may not be a good fit for the data.

The Tests of Model Effects in the generalized linear model for “PMS_stat” with covariates “education_level”, “menst_prob”, “shy”, and “comfortable” show that none of the variables have a significant effect on the dependent variable at the conventional level of significance ($\alpha = 0.05$). The Wald Chi-Square Test statistics and their associated p -values from Table.4.7, indicate that “education_level” ($\chi^2(1) = 0.072, p = 0.788 > 0.05$), “comfortable” ($\chi^2(1) = 1.707, p = 0.191 > 0.05$), “shy” ($\chi^2(1) = 1.095, p = 0.295 > 0.05$), and “menst_prob” ($\chi^2(1) = 1.163, p = 0.281 > 0.05$) do not contribute significantly to the model. Therefore, we fail to reject the null hypothesis that these covariates do not have a significant effect on “PMS_stat”. For the model with the dependent variable “PMS_stat” and covariates “education_level”, “menst_prob”, “shy”, and “comfortable”, the results indicate that none of the covariates have a statistically significant effect on “PMS_stat”, as their corresponding Wald Chi-Square measures and p -values are all above the threshold of 0.05. The B values and Exp(B) values show the direction and magnitude of the effect of each covariate, respectively. However, since none of the covariates are statistically significant, the interpretation of these values is not meant for this particular model.

In our study, in Table.4.8., we utilized a Generalized Linear Model on marginalized women participants to analyze the impact of various covariates on the dependent variable, “menst_prob”. The covariates included “education_level”, “menst_hide”, “shy”, “comfortable”, and “gyno_prob”. The Goodness-of-Fit measures Deviance,

Parameter	B value	Std. Error	Hypothesis test(Wald Chi-Square)	df	Sig.	Exp(B)
education_level	0.027	0.1245	0.045	1	0.831	1.027
comfortable	-0.068	0.0749	0.825	1	0.364	0.934
shy	0.102	0.1780	0.327	1	0.568	1.107
menst_hide	-0.057	0.0593	0.936	1	0.333	0.944
gyno_prob	-0.027	0.0867	0.100	1	0.752	0.973

Table 4.8: GLM analysis if “menst_prob” is affected by other variables in marginalized women participants

and Pearson Chi-Square ($\chi^2(24) = 6.595$) indicated that the model fit the data well. The Omnibus Test result further suggested that the model did not have a significant effect on “menst_prob”, as the p -value was $0.756 > 0.05$. Therefore, the covariates included in the model did not have a significant impact on the likelihood of experiencing menstrual problems among marginalized women.

Additionally, the Tests of Model Effects also indicated that none of the predictor variables are statistically significant, as all of their Wald Chi-square values have p -values greater than 0.05. Thus, Table.4.8, suggests that there is no evidence to suggest that any of the predictor variables (“education_level”, “shy”, “comfortable”, “menst_hide”, “gyno_prob”) have a significant effect on the likelihood of experiencing menstrual problems among marginalized women. It appears that the covariates “education_level”, “shy”, “comfortable”, “menst_hide”, and “gyno_prob” do not have a statistically significant effect on the dependent variable “menst_prob”. This is indicated by the relatively low Wald Chi-Square measures and the high p -values. The B values and Exp(B) values indicate the magnitude and direction of the relationship between each covariate and the dependent variable. However, since the covariates are not statistically significant, their coefficients and Exp(B) values are not meaningful in this context.

Parameter	B value	Std. Error	Hypothesis test(Wald Chi-Square)	df	Sig.	Exp(B)
education_level	-0.001	0.1305	0.000	1	0.996	0.999
shy	-0.105	0.1147	0.844	1	0.358	0.900
comfortable	0.307	0.0820	14.051	1	0.000	1.360

Table 4.9: GLM Analysis if “gyno_prob” is affected by other variables in privileged women participants

We conducted another Generalized Linear Model on privileged women where the dependent variable was “gyno_prob” and covariates are “education_level”, “shy”, and “comfortable”. The Pearson Chi-Square and Deviance of Goodness of fit measures for the Generalized Linear Model with “gyno_prob” as the dependent variable and covariates including “education_level”, “shy”, and “comfortable” are both 55.3% and the Scaled Pearson ($\chi^2(40) = 44.000$) indicating an acceptable level of fit between the model and the data. Overall, the model appears to fit the data well, suggesting that the covariates included in the model are important predictors of “gyno_prob” for privileged women in healthcare. The Omnibus Test measures the Likelihood Ratio ($\chi^2(3) = 16.100$) and a p -value of $0.001 < 0.05$, indicating that the model is statistically significant. This means that the predictors, which include “education_level”, “shy”, “”, and “comfortable” are significantly associated with the dependent variable, “gyno_prob”. Therefore, the model is a good fit for the data. The Tests of

Model Effects show that “education_level” and “shy” do not have a significant effect on the dependent variable “gyno_prob”, as their Wald Chi-Square measures are not significant. On the other hand, “comfortable” has a significance of 0.000 which is lesser than the p -value threshold. Since its Chi-Square value is the highest of all the variables so, this indicates that privileged women in healthcare who feel comfortable may be more prone to discussing their feminine healthcare problems with healthcare providers. The above Parameter Estimates, Table.4.9 shows the estimates of the regression coefficients for the covariates “education_level”, “shy”, and “comfortable” in the model predicting the dependent variable “gyno_prob”. The Wald Chi-Square measures and their associated p -values in the Tests of Model Effects indicate that only “comfortable” is a significant predictor of “gyno_prob”, with a positive B-value coefficient of 0.307, meaning that as comfort levels increase, discussion regarding gynecological problems also tends to increase. The Exp(B) values indicate that a one-unit increase in “comfortable” is associated with an Exp(B) value of 1.360 increase in the odds of having a discussion on “gyno_prob”. The non-significant Wald Chi-Square measures for “education_level” and “shy” suggest that these variables do not significantly predict “gyno_prob” in this model.

Parameter	B value	Std. Error	Hypothesis test(Wald Chi-Square)	df	Sig.	Exp(B)
education_level	0.615	0.2366	6.763	1	0.009	1.850
shy	0.164	0.3723	0.194	1	0.659	1.178
comfortable	-0.329	0.1411	5.432	1	0.020	0.720

Table 4.10: GLM Analysis if “gyno_prob” is affected by other variables in marginalized women participants

We also conducted the Generalized Linear Model on the same variables (dependent variable: “gyno_prob” and covariates: “education_level”, “shy”, “comfortable”) on the marginalized women participants. The Goodness of Fit measures indicates that the model is marginally suitable and fits the data slightly better (The Scaled Pearson ($\chi^2(26) = 30.000$), while the Deviance(26) is 29.268.) The Omnibus Test of the Generalized Linear Model with “gyno_prob” as the dependent variable and “gyno_prob”, “shy”, and “comfortable” as covariates resulted in a likelihood ratio ($\chi^2(3) = 8.892$) and a p -value of $0.031 < 0.05$. This indicates that the model as a whole is statistically significant and that the covariates included in the model have a significant effect on the “gyno_prob” of marginalized women in healthcare.

The Tests of Model Effects measure the significance of individual predictor variables in the model. For this generalized linear model, the predictor variable “shy” has a Wald ($\chi^2(1) = 0.194$) and a sig. value of $0.659 > 0.05$, indicating that it is not statistically significant. However, the predictor variable “comfortable” has a Wald ($\chi^2(1) = 5.432$) and a sig. value of $0.020 < 0.05$, suggesting that it is a significant predictor. The predictor variable “education_level” has a Wald ($\chi^2(1) = 6.763$) and a p -value of $0.009 < 0.05$, indicating that it is a statistically significant predictor of the dependent variable “gyno_prob” for marginalized women. The Parameter Estimates table above, Table.4.10 provides information on the strength and direction of the relationship between the dependent variable and each of the covariates in the model. For the marginalized women healthcare data analysis with “gyno_prob” as the dependent variable and covariates as “education_level”, “shy” and “comfortable” the results indicate that “education_level” and “comfortable” has a significant relationship with “gyno_prob”, with a Wald ($\chi^2(1) = 6.763$), and a significant value of $0.009 < 0.05$

and a Wald ($\chi^2(1) = 5.432$), and a significant value of $0.020 < 0.05$. This suggests that an increase in higher education and feeling comfortable when sharing gynecological problems with others is associated with “gyno_prob”. The Exp(B) values indicate that a one-unit increase in “education_level” is associated with an Exp(B) value of 1.850 increase in the odds of having a discussion on “gyno_prob” without hesitations. However, only “shy” does not have a significant relationship with “gyno_prob”. Additionally, the B and Exp(B) values from the 95% Wald Confidence Interval show the strength and direction of the relationship between each covariate and “gyno_prob”.

Parameter	B value	Std. Error	Hypothesis test(Wald Chi-Square)	df	Sig.	Exp(B)
mobile	1.737	0.4288	16.408	1	0.000	5.679
health_checkup	0.316	0.1969	2.571	1	0.109	1.371

Table 4.11: GLM Analysis if “mobile_service” is affected by other variables in marginalized women participants

The study conducted a General Linear Model to analyze the data on marginalized women’s healthcare. We wanted to know whether the marginalized women participants have done their health checkups using any mobile healthcare service. The dependent variable was “mobile_service”, and the covariates were “mobile” and “health_checkup”. The results indicated that the Goodness-of-Fit measures were not very satisfactory, with values of Scaled Pearson Chi-Square, Deviance, and Person Chi-Square measures being 30.000, 14.737, and 14.737, respectively, with 27 degrees of freedom. The Omnibus Test, however, showed that the overall model was a good fit for the data, with a Likelihood Ratio ($\chi^2(2) = 13.999$) and a significant value of 0.001. The Tests of Model Effects revealed that only “mobile” had a significant effect on the likelihood of using mobile services among underprivileged women. The Parameter Estimates table above, Table.4.11, provides information on the strength and direction of the relationship between the independent variables and the dependent variable. In this case, the covariate “mobile” has a significant effect on the dependent variable “mobile_service” with a Wald Chi-Square value of 16.408, a B value of 1.737, and an Exp(B) value of 5.679. This suggests that for every unit increase in the mobile variable, the odds of having mobile service are about 5.7 times higher. On the other hand, the covariate “health_checkup” is not significant with a Wald Chi-Square value of 2.571 and an Exp(B) value of 1.371, and a significant value of $0.109 > 0.05$. This suggests that there is no significant effect of health checkups on mobile services.

Parameter	B value	Std. Error	Hypothesis test(Wald Chi-Square)	df	Sig.	Exp(B)
abortion	1.751	0.3072	32.479	1	0.000	5.760
marital_status	-0.043	0.0662	0.425	1	0.515	0.958
menst_prob	0.116	0.1798	0.418	1	0.518	1.123
period_1_stat	-0.049	0.0448	1.220	1	0.269	0.952

Table 4.12: GLM Analysis if “distress” is affected by other variables in privileged women participants

From Table.4.12, For the given Generalized Linear Model with the dependent variable as distress and covariates model as “marital_status”, “abortion”, “menst_prob”, and “period_1_stat”, the Parameter Estimates table shows that only the covariate abortion has a significant effect on distress as indicated by a high Wald Chi-Square

measure and a low p -value. The $\text{Exp}(B)$ value for “abortion” is 5.760, suggesting that the odds of experiencing distress are approximately 5.8 times higher for women who had an abortion compared to those who did not have an abortion. The other covariates, including “marital_status”, “menst_prob”, and “period_1_stat”, were not found to have a significant effect on distress. The Scaled Pearson Chi-Square measure and the Pearson Chi-square measure both have values/df below 1, indicating a good fit between the model and the data for the privileged women’s healthcare data analyzed in this study. Additionally, the Likelihood Ratio ($\chi^2(4) = 30.597$) of the Omnibus Test, and its significance level is $0.000 < 0.05$, which indicates that the model as a whole is statistically significant. Therefore, we can conclude that the covariates “marital_status”, “abortion”, “menst_prob”, and “period_1_stat” have a significant impact on the dependent variable “distress” for privileged women’s healthcare data analysis. Moreover, the Tests of Model Effects indicate that “abortion” is a statistically significant predictor of distress with a Wald ($\chi^2 = 32.479$) and a significant level of p -value $0.000 < 0.05$, while “marital_status”, “menst_prob”, and “period_1_stat” are not significant predictors since significant levels of p -value are above 0.05. This suggests that the experience of abortion has a strong association with distress levels among privileged women in the healthcare data analysis.

Parameter	B value	Std. Error	Hypothesis test(Wald Chi-Square)	df	Sig.	Exp(B)
abortion	2.682	0.2074	167.171	1	0.000	14.616
marital_status	0.037	0.0983	0.142	1	0.706	1.038
menst_prob	-0.295	0.2335	1.593	1	0.207	0.745
period_1_stat	0.096	0.1051	0.829	1	0.363	1.100

Table 4.13: GLM Analysis if “distress” is affected by other variables in marginalized women participants

The aim of this study was to use a General Linear Model to investigate the relationship between “distress” and several covariates, including “marital_status”, “abortion”, “menst_prob”, and “period_1_stat” for marginalized women. The Parameter Estimates Table 4.13, shows that only the covariate “abortion” has a significant effect on “distress” as indicated by a high Wald Chi-Square measure and a low p -value. The $\text{Exp}(B)$ value for “abortion” is 14.616, suggesting that the odds of experiencing distress are approximately 14.6 times higher for women who had an abortion compared to those who did not have an abortion, which is higher than that of privileged women. The other covariates, including “marital_status”, “menst_prob”, and “period_1_stat”, were not found to have a significant effect on “distress”. The likelihood ratio ($\chi^2(4) = 61.533$) and a significant p -value of $0.000 < 0.05$ suggest that the overall model is a good fit for the data of the Omnibus Test. It indicates that the covariates included in the model, “marital_status”, “abortion”, “menst_prob”, and “period_1_stat”, have a significant effect on the outcome variable, “distress”, for marginalized women in the healthcare data analysis. Since only “abortion” is a statistically significant predictor variable, this suggests that having had an abortion is associated with higher levels of distress among marginalized women. However, none of the other predictor variables (“marital_status”, “menst_prob”, “period_1_stat”) have a statistically significant effect on the likelihood of experiencing distress.

	Mean	t	df	sig.(2-tailed)	Mean Difference
mobile_service	3.86	4.968	43	0.000	0.864
comfortable	3.43	2.016	43	0.050	0.432

Table 4.14: One-Sample T-Test analysis for the variables “mobile_service” and “comfortable” in privileged women participants

One-Sample T-Test Analysis

The Descriptive Statistics, including Mean, Standard Deviation, Standard Error Mean, and sample size, for the variables “mobile_service” and “comfortable”. The results indicate that the average value for “mobile_service” is 3.86 (M=3.86; SD=1.153) and for “comfortable” is 3.43 (M=3.43; SD=1.421) among the 44 privileged women participants.

The results of the T-Test, Table.4.14, indicate that there is a statistically significant difference between the Mean scores of the mobile service and comfortable variables and the assigned Test value of 3 for “neither agree nor disagree”. For the “mobile_service” variable, the T-value is 4.968 with a *p*-value of 0.000, indicating that the Mean score is significantly higher than the assigned Test value. The Mean Difference is 0.864 with a 95% Confidence Interval of 0.51 to 1.21, which further supports this conclusion. For the “comfortable” variable, the T-value is 2.016 with a *p*-value of 0.050, which is marginally significant. The Mean Difference is 0.432 with a 95% Confidence Interval of 0.00 to 0.86. These results suggest that women who participated in the study were more likely to agree with the statement about mobile service and slightly more likely to agree with the statement about being comfortable with healthcare services compared to the assigned test value of 3 for “neither agree nor disagree”.

	Mean	t	df	sig.(2-tailed)	Mean Difference
mobile_service	4.50	9.127	29	0.000	1.500
comfortable	1.90	-4.557	29	0.000	-1.100

Table 4.15: One-Sample T-Test analysis for the variables “mobile_service” and “comfortable” in marginalized women participants

The Descriptive Statistics, including Mean, Standard Deviation, Standard Error Mean, and sample size, for the variables “mobile_service” and “comfortable”. The results indicate that the average value for “mobile_service” is 4.50 (M=4.50; SD=0.900) and for “comfortable” is 1.90 (M=1.90; SD=1.322) among the 30 participants. The T-Test analysis from Table.4.15, reveals that the Mean of “mobile_service” is significantly higher than the Test value of 3 (assigned test value of 3 for “neither agree nor disagree”), with a T-value of 9.127 and a *p*-value of 0.000, indicating a positive perception of mobile service by marginalized women in healthcare. The Mean Difference is 1.500 with a 95% Confidence Interval of 1.16 to 1.84. In contrast, the results for “comfortable” show a significant difference between the sample Mean of 1.90 and the Test value of 3, with a T-value of -4.557 and a *p*-value of 0.000. The Mean Difference is -1.100 with a 95% Confidence Interval of -1.59 to -0.61, indicating that marginalized women in healthcare do not feel comfortable in their healthcare environment.

4.2 Findings from Thematic Analysis

The interview session with marginalized women revealed several challenges that impact their ability to access healthcare and seek treatment for their health issues. Several important themes emerged from our thematic analysis of the collected responses of marginalized women. In the remainder of this chapter, we describe each theme in detail.

4.2.1 Misconceptions Regarding Symptoms

Among marginalized communities, misconceptions regarding health symptoms are very much prevalent. These misconceptions play a vital role in deferring their health checkups and hospital visits. In our study, we found that some women have incorrect beliefs about the symptoms of certain illnesses, leading them to delay seeking treatment or using ineffective remedies. Misconceptions about symptoms arise from cultural or traditional beliefs, lack of proper education, or limited access to healthcare information. For example, some women believe that certain symptoms are a normal part of aging or a result of their lifestyle and therefore do not require medical attention. Others rely on home remedies or alternative therapies based on traditional beliefs, even if these remedies may not be effective in addressing the underlying health issue. In this regard, one participant shared,

“While I was pregnant, after a few months I started to bleed but when I consulted elders they told me it was normal and didn’t allow me to seek any medical care. After some days I faced excessive abdominal pain, thus I lost my child.”

These misconceptions about symptoms lead to delayed or inappropriate treatment, resulting in worsened health conditions or even complications. For instance, a woman might dismiss persistent abdominal pain as a normal part of her menstrual cycle, when in fact it could be a symptom of a severe underlying condition such as ovarian cysts or endometriosis. By not seeking timely medical attention, the disease may progress and result in serious health consequences.

Addressing misconceptions about symptoms requires targeted health education and awareness programs that provide accurate information about common symptoms of various illnesses, debunking myths and misconceptions. It also involves promoting open and non-judgmental communication about health issues and encouraging women to seek medical care without fear of stigma or shame. Empowering women with accurate information about symptoms can help them make informed decisions about their health and seek timely medical attention when needed, improving their overall health outcomes.

4.2.2 Lack of Knowledge

From our field visit and statistical analysis we got to know that marginalized women mostly lack education. In our survey, 43.3% participants did not attend school, and around 40% participants only went to primary school. Due to a lack of education, women may not have access to information about healthcare, making it difficult for them to understand the importance of seeking medical attention. Due to their extremely low literacy rates, many members of the marginalized group lack even the most basic understanding of gynecological, menstrual, and reproductive health. As a result, when individuals experience any symptoms or issues related to these

health conditions, they also struggle to make the best decisions. For example, one participant shared,

“I got married when I was 13, suddenly my period stopped and after several months my neighbors told me that I was expecting.”

From this response, we can understand that participant was expecting but due to lack of knowledge, she was unable to understand. Also, she was missing her periods for the long term but did not take any steps regarding it as she didn’t know it might be a symptom of pregnancy.

Moreover, we found some of them don’t even have knowledge about their own identity. This lack of knowledge about their own identity can have serious consequences for their health outcomes. Women may not be able to assert their rights, seek timely medical attention, or make informed decisions about their health, leading to delays in diagnosis and treatment, increased health risks, and poorer overall health outcomes. One participant shared,

“I think my age is 42. I lost my parents in childhood. My neighbors said I got married at the age of 20 and it’s been 22 years of my marriage thus I am assuming that my age is 42.”

In addition to that, marginalized women also face barriers to accessing healthcare information. Lack of access to healthcare facilities, and limited availability of healthcare resources can further exacerbate the lack of knowledge about proper medication and healthcare providers to consult. For example, One participant shared,

“My period is not regular but I feel shy to talk about it and don’t know which doctor to consult.”

4.2.3 Trust Issues Rooted from Bad Experiences

We acknowledged from our interviews that previous negative experiences with healthcare providers lead to a lack of trust and reluctance to seek treatment in the future in these communities. This lack of trust then becomes a significant barrier to seeking healthcare services, as women may feel anxious or apprehensive about engaging with healthcare providers due to fear of similar negative experiences.

Moreover, trust issues also stem from the perception of being judged or stigmatized by healthcare providers due to their marginalized statuses, such as their socioeconomic status, gender, or ethnicity. Marginalized women already face discrimination or bias in their daily lives, and this can extend to their interactions with healthcare providers as well. For instance, one shared her experience,

“I still remember the day when a guy came to our slum with a bag full of medicines, claiming they would help us with our pain. Since we are poor people, we accepted the offer of free medicine without a second thought. Little did we know that we were in for a big shock. My son is educated he later found out that the medicine had expired a long time ago, and he immediately forbade all of us from taking it. It was a terrible feeling, knowing that we had been taken advantage of just because we were poor and vulnerable. It’s as if people think they can do whatever they want with us, feed us whatever they want, just because we are not rich.”

These trust issues further perpetuate a cycle of avoidance and delay in seeking healthcare, as women may choose to avoid healthcare services altogether or delay seeking care until their conditions worsen due to the lack of trust in the healthcare system. This can result in delayed diagnosis, untreated health issues, and poorer

health outcomes for marginalized women.

Addressing the issue of trust requires building strong doctor-patient relationships based on mutual respect, empathy, and cultural sensitivity. It also requires addressing any underlying biases or discrimination within the healthcare system and ensuring that marginalized women feel safe, respected and heard in their interactions with healthcare providers. Building trust through positive experiences and effective communication can play a crucial role in encouraging marginalized women to seek timely and appropriate healthcare, thus improving their health outcomes.

4.2.4 Patriarchy, Domestic Violence and Lack of Power

From the findings of our statistical analyses and interview sessions, we found that women in marginalized communities are mostly unemployed. They lack decisive power because of being unemployed as they are financially handicapped and unable to make financial contributions to the family. Besides, the patriarchal society aggravates this situation further. Due to these reasons, women in marginalized communities are been subjected to violence at home, making it difficult for them to seek medical attention or disclose their symptoms to healthcare providers. Domestic violence causes many health issues among marginalized women. We found many women complaining that they are beaten up very frequently which often causes serious injuries to them. However, their health care needs are ignored as society is mostly male-dominated, and domestic violence followed by injuries is pretty common here. One of our participants reported,

“I was pregnant for 5 months but lost my child due to domestic violence. My husband beats me almost every night.”

Another participant expressed her remorse in this regard as follows.

“I got bald because of the continuous torture of my husband, he pulls my hair so often also I got a severe leg injury because he recently beat me up, he doesn’t even let me go to doctors after beating me so bad.”

Addressing domestic violence requires a comprehensive approach that includes not only healthcare providers but also community leaders and policymakers.

4.2.5 Shyness and Discomfort

From our exploration, we found most women from marginalized communities feel uncomfortable discussing their health issues, particularly with male healthcare providers. Many of them shared their uncomfortable nature sharing gynecological issues with a male doctor. In many communities especially in our subcontinent, women are taught from a young age to keep their health concerns private and not to speak openly about them, especially with male healthcare providers. While interviewing, we asked them why they feel uncomfortable sharing their issues with a male healthcare provider. One participant replied,

“When I first got my period I told my father about it since I didn’t know anything about it. My mother and grandmother slapped me and told me not to share anything about this topic with any male member of my house. Since then I feel hesitant to talk about it with male healthcare providers as I never shared these issues with any male person.”

This cultural conditioning can lead to shame and discomfort when it comes to seeking medical attention, further exacerbating the challenges faced by marginalized women in accessing healthcare services. This highlights the importance of ensuring that women have access to female healthcare providers who can provide a safe and comfortable environment for discussing health concerns.

4.2.6 Lack of Affordability

In our exploration, we found that healthcare services are often expensive for marginalized communities due to their low income, making it difficult for women to afford them. With their income, most people live in a hand-to-mouth fashion and many find it hard to manage their daily meals or proper shelter. Therefore, spending money for medical treatment when the disease is not very severe or in a critical condition, seems somewhat luxury to them. In some cases, healthcare providers may be available in the community, but they may not be properly trained to diagnose and treat certain illnesses. Moreover, from our survey, we found that marginalized women often lack awareness of the healthcare services provided by the government at affordable rates, which can create a significant barrier to accessing much-needed medical treatment. One of the participants elaborated on this situation as follows, *“As a poor woman from Bangladesh, I am the sole provider for my family and have recently been experiencing severe abdominal pain. I’ve been trying to find affordable healthcare options but have found none that I can afford. Government hospitals and private clinics are too expensive and the local quack doctors may not be properly trained. I have no choice but to wait it out and hope my symptoms improve. My situation highlights the difficulties faced by low-income households in accessing healthcare services, despite government hospitals and programs being in place. The cost of healthcare remains a barrier for many and there is a need for more affordable and accessible healthcare options for marginalized populations like mine.”*

4.2.7 Taboo Regarding Reproductive Health

We noticed in our field research that some women have a limited understanding of menstruation and reproductive health, leading to misconceptions and stigma. The lack of knowledge about menstruation can also impact women’s ability to effectively manage their reproductive health. Women have a limited understanding of their menstrual cycles, fertility, and contraception methods, which can lead to unintended pregnancies or reproductive health issues. A lack of knowledge about safe and hygienic menstrual practices may also result in the use of unhygienic materials during menstruation, leading to health risks and discomfort.

The stigma associated with menstruation can also further isolate marginalized women, as they face discrimination, exclusion, or even violence during their menstrual cycles. This can impact their mental health, self-esteem, and overall well-being.

“I was twelve years old when I first got my period. I remember being in school when I felt a strange sensation in my lower abdomen. I didn’t know what was happening to me, but soon enough, I started bleeding. I was scared and confused, and I didn’t know who to turn to for help. My mother never talked to me about it. I felt embarrassed and ashamed of what was happening to me. I tried to hide it by using old clothes and rags as makeshift pads and also, sometimes I used to wear multiple pajamas so

that my clothes don't get blood-stained. However, it was uncomfortable and messy. I didn't want to go to school or leave my house. I was afraid that someone would find out and make fun of me. I felt isolated and alone. After struggling in silence for several days, I was relieved when my mother finally noticed something was wrong and asked me why I had been avoiding school and people. Summoning the courage, I confided in her about my first period and the confusion and fear it had caused me. To my relief, she patiently explained what had happened to me and taught me how to manage my periods. Thanks to my mother's guidance, I was able to overcome my fear."

Cultural beliefs and practices can create stigma and shame around menstruation, making it difficult for women to seek medical attention or discuss their menstrual health. In many cultures, menstruation is still considered a taboo topic, and women may receive limited or no information about it. This lack of knowledge can lead to myths, misconceptions, and stigma surrounding menstruation. For example, many women believe that menstruation is a shameful or dirty process, leading to feelings of embarrassment or discomfort when discussing it or seeking information about it. This results in a lack of awareness about menstrual hygiene practices and can even lead to health issues such as infections or other menstrual-related complications.

4.3 The Households

On January 12th, 2023, our study team executed fieldwork as a component of the second phase of data collection. In this phase, we obtained 15 responses from marginalized women residing in the vicinity. The initial step involved conducting interviews with 7 domestic workers from various residential buildings in which team members reside. For the remaining respondents, we had to venture out to one of the domestic worker's local areas, which was predominantly populated with tin shed houses at Kamalapur, Dhaka. During this field visit, we were able to interview 8 additional respondents, comprising 6 housewives and 2 garment workers. Tin shed houses at Kamalapur in Bangladesh, as observed through our fieldwork, are a form of low-cost, informal housing constructed from corrugated tin sheds. These housing units are typically small in size and may lack proper sanitation or electricity facilities. They are commonly found in slum areas and are considered inadequate housing. Due to their informal nature, these houses may not possess proper permits or legal ownership. Additionally, they are often overcrowded and located in areas prone to natural disasters or flooding.

On February 25th, 2023, our research team executed fieldwork for data collection in Korail Slum (Figure 4.1). Korail Slum is a stark reminder of the harsh reality of poverty in Bangladesh. The houses are made of rusty corrugated metal and scraps of wood, with thin walls that barely provide any protection from the elements. Inside, families huddle together on makeshift beds, trying to find comfort in the cramped quarters. Outside, the streets are narrow and cluttered, with laundry hanging from every available space. Clotheslines are strung across the alleys, and residents put their washed clothes out to dry in the open air. The smell of smoke and burning trash fills the air, making it difficult to breathe.

The lack of proper sanitation and hygiene is also evident in Korail Slum. Trash is piled up on street corners, and raw sewage flows in open gutters, posing a significant health risk to the residents. The unhygienic living conditions make it challenging

for people to stay healthy, and diseases such as diarrhea and respiratory infections are prevalent. Despite the challenging living conditions, the people of Korail Slum carry on with their daily lives, trying to make the best of what they have. Children run barefoot on the dusty roads, playing with makeshift toys made from scraps of metal and plastic. Women cook over open fires, and men gather in groups to chat and share a cup of tea. Korail Slum is a testament to the resilience and spirit of the people of Bangladesh, who despite their struggles, continue to find joy in the simple things in life. It's a reminder that everyone deserves a safe and decent place to call home.



Figure 4.1: Households of Korail slum

Chapter 5

Design Proposal

Through our field study and mixed-method analyses, we were able to identify the barriers to accessing healthcare for marginalized women which answers our RQ1. Next, to answer RQ2 i.e., to find out whether technology can facilitate the current difficulties of marginalized women, we need to analyze a few things such as - the limitations of current Govt. and non-govt. Initiatives for these people, the feasibility of technologies to bridge the gap, and at the same time the capability and willingness of marginalized women to use technology. In this chapter, we will reflect on these points, and upon finding out the answer to RQ2, we will discuss the feasibility and design of a 24/7 voice bot service as a primary healthcare provider to answer RQ3.

5.1 Technology for Bridging Healthcare Gaps

The barriers that were uncovered by our study hampering the access to healthcare faced by marginalized women cannot be eradicated overnight. For example, poverty, low literacy, and misconceptions - we need a considerable number of efforts and initiatives from the government to eradicate these barriers. In a developing country like Bangladesh, it is likely to take a long time to eradicate them and ensure no disparity in healthcare access for everyone. However, the current world is dominated by technology, and availing healthcare to marginalized people through technology could be a good alternative. The literature also provides us with ample evidence to ease healthcare access to underprivileged people through technology [55], [76], [85]. Thus technology can play a pivotal role in bridging these gaps and improving healthcare outcomes for women in Bangladesh.

The use of technology in addressing feminine e-health issues can have several advantages. Firstly, technology can facilitate access to information and knowledge about self-care and general healthcare, especially for underprivileged women who may have limited access to formal healthcare services. Through digital platforms such as websites, online forums, and educational videos, women can learn about important health topics, including menstruation, gynecological health, and mental health, which can empower them to take better care of their health.

Technology can help bridge the gap in healthcare availability between rural and urban areas in Bangladesh. As the majority of the population lives in rural areas where access to healthcare is limited, technology can be utilized to provide telehealth services, such as remote consultations and tele-diagnosis, to reach underserved communities. This can help overcome geographical barriers and enable women in remote

areas to receive timely medical advice and support. Telemedicine, which involves the remote delivery of healthcare services using technology, can overcome the limitations of distance and provide access to healthcare for women in rural areas where access to healthcare is limited. Telemedicine can facilitate remote consultations, diagnosis, and treatment, thereby improving women's access to specialized care, including gynecological consultations and mental health services. This can be particularly beneficial for marginalized women who may face financial constraints in traveling to urban areas for healthcare services or have limited mobility due to social or cultural norms.

In addition, technology can facilitate the development and use of healthcare apps that provide relevant information and education on self-care and general healthcare. These apps can be designed to be culturally sensitive and accessible to women with low literacy levels, providing them with essential knowledge about menstrual health, gynecological disorders, and mental health issues. Healthcare apps can also provide reminders for health screenings, medication management, and other preventive measures, empowering women to take control of their health and make informed decisions. This can be particularly helpful for underprivileged women who may have limited access to formal education or health literacy resources.

Furthermore, technology can enable data collection and analysis to better understand the healthcare needs of marginalized women. Through electronic health records (EHRs) and data analytics, healthcare providers and policymakers can gain insights into the specific healthcare challenges faced by underprivileged women and develop targeted interventions to address them. For example, analyzing data on healthcare utilization patterns, disease prevalence, and treatment outcomes among marginalized women can help identify trends, patterns, and gaps in healthcare services. This can inform evidence-based policy-making and resource allocation to prioritize healthcare interventions for marginalized women, who may be more vulnerable to healthcare disparities.

Moreover, technology can facilitate communication and collaboration among healthcare providers, policymakers, and communities to address healthcare gaps. Digital platforms, such as online forums, social media, and messaging apps, can enable the exchange of information, knowledge sharing, and advocacy for healthcare issues pertaining to marginalized women. This can empower women and other stakeholders to raise awareness, voice their concerns, and demand improvements in healthcare services. Technology can also facilitate remote training and capacity-building programs for healthcare providers in underserved areas, enabling them to deliver better care and address healthcare gaps effectively.

Technology has immense potential in addressing healthcare gaps for women in Bangladesh from privileged and marginalized individuals' perspectives. Telemedicine, healthcare apps, data analytics, and digital communication platforms are examples of technological interventions that can improve access to healthcare, provide health information, enable evidence-based policy-making, and empower marginalized women. By harnessing technology effectively, we can work towards narrowing the healthcare disparities and improving healthcare outcomes for underprivileged women in Bangladesh. Thus, all these findings answer our RQ2.

5.2 Our Proposal: A 24/7 Voice Bot Service

Based on our research, we discovered that Bangladesh, as a developing country, still has several gaps in its healthcare sectors. Furthermore, our findings revealed that marginalized women are more deprived in their own communities due to numerous barriers. Although, in Bangladesh, there are many NGO initiatives that work for the betterment of the marginalized community, they are often out of reach for them. While exploring the answer to our RQ1, we found some significant barriers to accessing feminine healthcare among marginalized women that include illiteracy, lack of internet access, unawareness of existing healthcare initiatives, financial constraints, societal taboos, and norms. From exploring literature reviews related to healthcare services for remote or rural communities, the studies [76], [85], [81], [55] all have a common focus on healthcare difficulties and the use of technology to overcome them. The study [81] investigates the usefulness of a chatbot in providing reproductive and sexual health information to youths in Bangladesh, and the study [55] introduces a low-cost healthcare robot developed to aid the elderly in medication adherence. Despite their disparate issues, all of these studies illustrate the potential of technology to improve healthcare services. In the instance of the chatbot [81] and healthcare robot [55], technology enables the cost-effective and efficient transmission of healthcare information and help, particularly in places where healthcare resources are few. These projects aim to address healthcare concerns and improve the general well-being of the target communities by harnessing technology.

Our target group is marginalized women, from our findings, we have seen that, most of these women are illiterate, hence it is impossible for them to integrate themselves with chatbots or any text-based technology. Therefore, we are proposing a voice-based system so that they can input their queries via voice rather than text. Additionally, most of the marginalized women do not use smartphones, that's why, when proposing our 24/7 voice proposal, we wanted our system to be a button mobile-based voice service rather than a smartphone app.

Since 90% of the people we questioned own mobile phones and can make calls to anyone using the standard mobile phone dialing system, we chose a mobile voice bot to address the issues with women's access to healthcare. There were few smartphone users, and while privileged women were accustomed to using mobile apps for assistance, the majority of the marginalized lacked this knowledge. As a result, we decided to create a voice bot healthcare service rather than approaching a smartphone app. Additionally, every participant in the surveys expressed their readiness to use healthcare services provided by mobile voice bots and their belief that using such services will benefit them. Furthermore, the main focus of our mobile voice bot service is menstrual, gynecological, or reproductive health because we received unfavorable feedback in this area since most people are not particularly knowledgeable about menstruation hygiene. Additionally, the majority of them are not worried about the health problems they are developing. Even when it is necessary, very few women are likely to go for a health examination. The majority of them are reluctant to discuss their health problems with others.

A 24/7 voice bot service that can provide users with healthcare problem-related primary solutions will be able to eradicate a lot of healthcare disparities in our country. Because it can work like a virtual health assistant and will be able to bridge the gap between patients and healthcare professionals. The patients especially those

who are female and live in rural areas will be able to seek feminine healthcare facilities remotely through the service.

Our analysis suggests that marginalized women are unaware of the low-cost healthcare options available to them as well as the hospitals or clinics closest to them where they can receive treatment for certain health issues. If we can provide our suggested voice bot with more comprehensive functionality, that would be feasible for them. We want to update our voice bot so that it has a feature that enables users to provide information about doctors affiliated with local hospitals. In addition, if a user provides their present location in an emergency, the bot can quickly connect them to local medical facilities or provide a list of nearby public clinics along with their operating hours. Additionally, we want our bot to provide details about the affordable services offered by those public hospitals.

Here, Figure 5.1 shows the design of our proposed 24/7 voice bot service.

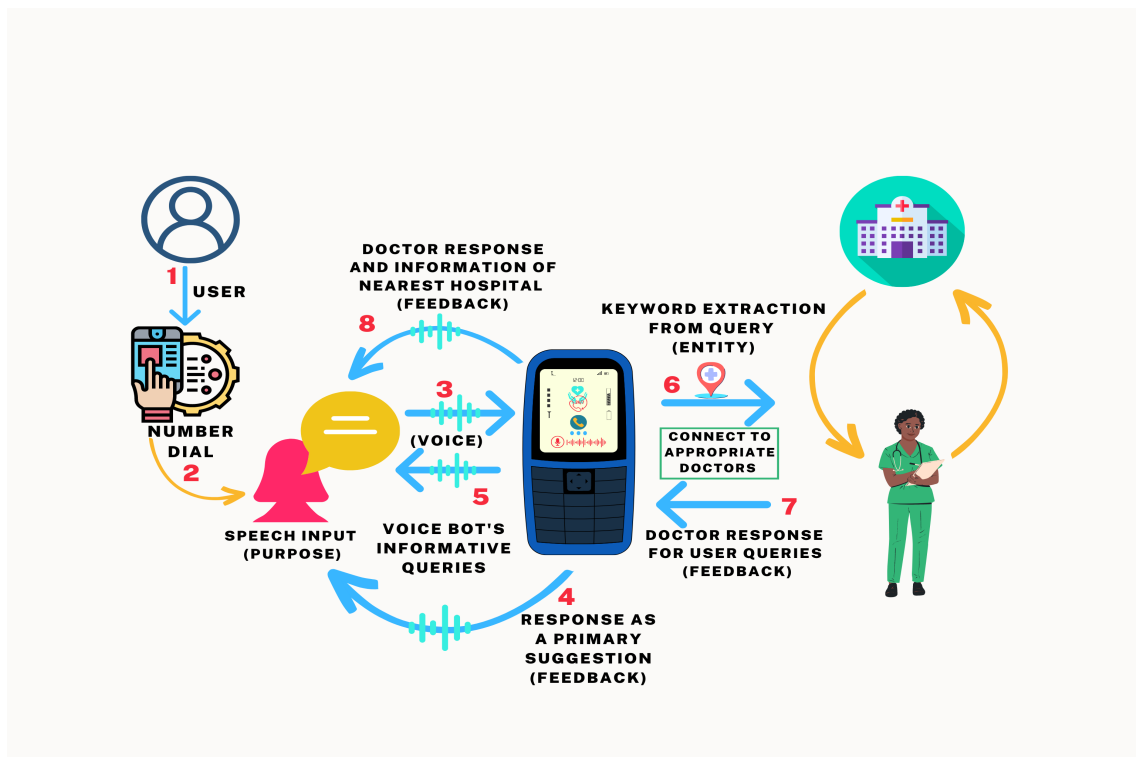


Figure 5.1: Proposed 24/7 voice bot service

5.3 Architecture of Our Developed 24/7 Voice Bot Prototype

As our research’s target population is marginalized women, we opted to create a voice bot rather than a chatbot after taking into account all the elements from the findings stated in our Chapter 4. We employ a Python library that uses string-matching algorithms to create a voice bot prototype for the initial phase of development. Our voice bot prototype accepts user input in Bangla and responds with a voice in Bangla. The workflow of our voice-bot prototype is presented in Figure 5.2.

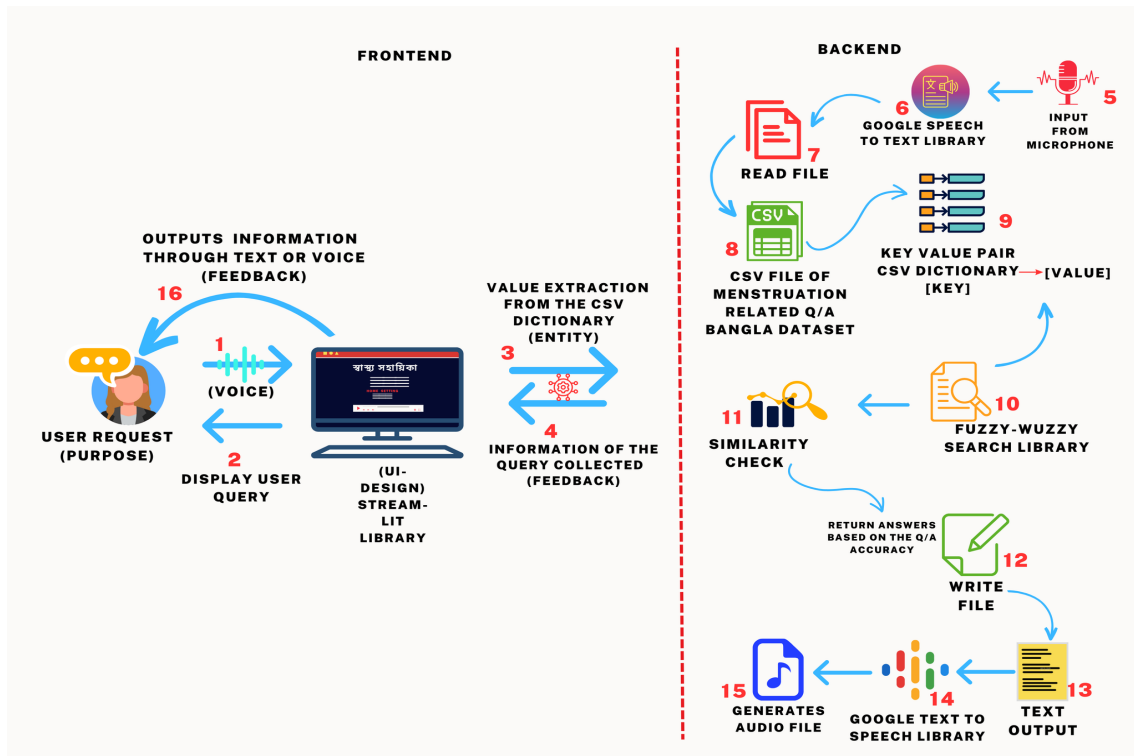


Figure 5.2: Workflow diagram of the prototype

5.3.1 Preparing Questionnaire for The Prototype

As our voice bot would respond to health-related queries, therefore we needed to prepare a questionnaire database. However as these questions and answers are related to healthcare, therefore, we took help from some Govt. doctors to prepare and finalize it. We are going to elaborate in detail on the questionnaire preparation steps in the following subsections.

Field Research to Understand the Common Gynecological Issues

On 9th February 2023, our research team conducted a field research study to understand the most common gynecological issues faced by underprivileged women who visited a gynecologist. We arrived at the location at 9:30 AM and began our study at 9:45 AM (Figure 5.3). During the one-hour survey, we observed that most patients were between 35 and 47 years old, while some were as young as 17, 23, or 30 years old.

Our findings revealed that the most common issue reported by the patients was pain and discomfort in the uterus. Many of them reported feeling like their uterus was going to fall out, which caused them severe pain frequently. Additionally, some patients reported that they had tumors in their uterus, which caused them inflammation and pain, and they wanted to get it removed by operation.

Moreover, we found that many patients were experiencing heavy bleeding during their periods. The doctors asked them about their menstruation cycle and whether their menstruation was regular or not. They also asked whether it was painful or not. The doctors prescribed some necessary medicines and suggested taking ultrasonography and pregnancy tests.



Figure 5.3: Field research at Government hospital

We also observed that some patients reported itching problems in their vaginal area. There were other issues such as pain during intercourse, pain during urination, dizziness, and headaches. For these types of cases, the doctors suggested taking urine tests, and for those who reported headaches and dizziness, and muscle pain in the leg, they were asked to visit medicine specialist doctors since these were not gynecological problems.

Moreover, many patients often came a lot later when the disease became severe. We believe that this could be due to the lack of awareness about gynecological issues and the stigma attached to discussing them.

Overall, our study highlights the urgent need for increased awareness about gynecological issues among women. We recommend that more awareness campaigns be conducted to educate women about gynecological problems and the importance of seeking medical help in a timely manner. We hope that our research findings will help healthcare professionals develop better treatment strategies for women suffering from gynecological issues.

Questionnaire Overview

After this fieldwork, we were able to notice that the root cause of all gynecological issues is menstruation. Moreover, we asked the duty doctor what sort of problems women are more likely to have. The duty doctor was kind enough to give us her time and told us most women come with menstruation-related problems. When a woman is having regular periods and maintaining menstruation hygiene she is less prone to catch any gynecological problem. So we created our own dataset of the questionnaire of health queries and their primary suggestions using books and relevant articles. We kept all the questions regarding menstruation as our primary dataset. In the dataset, we have 408 Bangla questions and their relevant answers. We kept the questions in a similar way the patients were approaching the doctor in that Govt hospital. Also, we kept our wording simple and easily understandable. After creating the dataset we took approval from a gynecologist that our questions and suggestions are adequately prepared. Lastly, we integrated our dataset into the prototype-making.

5.3.2 Query and Response

We tried to keep our system simple, informative, and precise. When a user asks for a query, her question is first converted using speech to text then the bot performs pre-processing (e.g., string matching, language localization, Text-to-Speech conversion, etc.) on the user’s text and analyzes them. For each query text, the bot tries to find the best possible answer. The bot tried to identify two things, firstly which menstrual problem the user is referring to and what type of problem that person is facing. For each condition, we respond to four different types of requests such as:

Problem define: What can be the reason behind the ask menstrual or gynecological problem?

Symptoms: What signs or symptoms indicate the gynecological or menstrual issue?

Reason: What is the cause of this problem?

Recommendation: How do I prevent this problem?

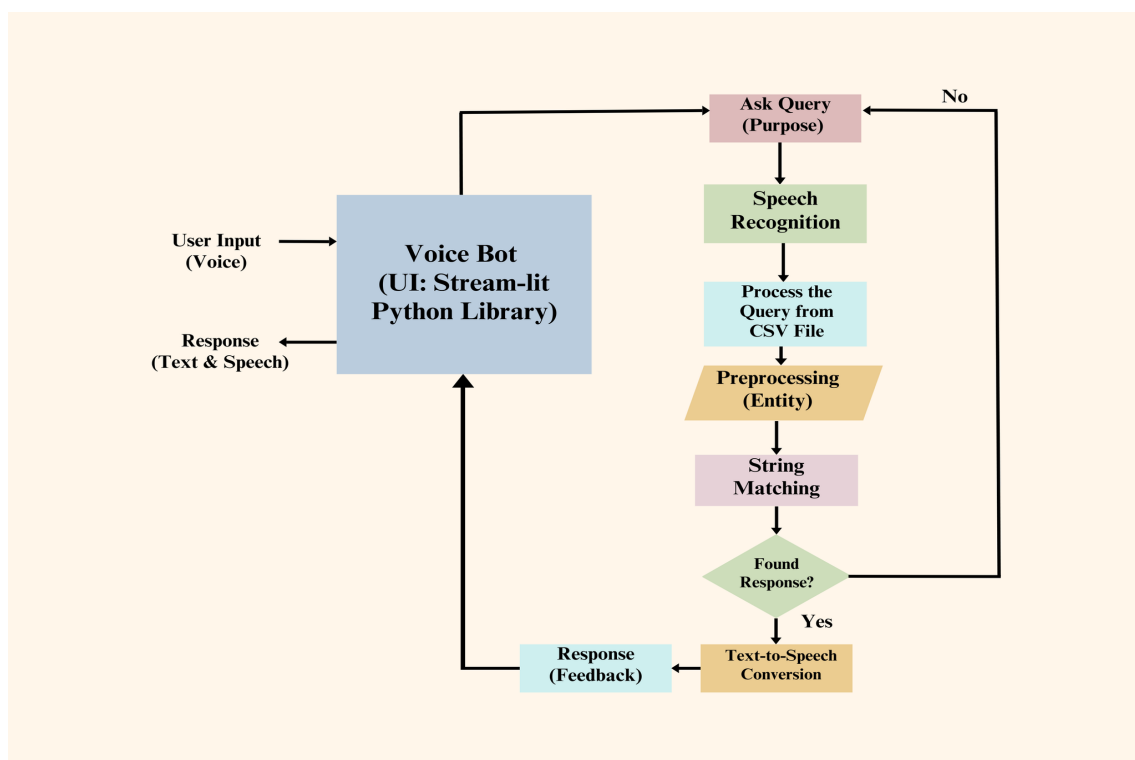


Figure 5.4: Design architecture

Our model mainly focuses on three main hypotheses : (1)Purpose, (2)Entity, and (3)Feedback. The purpose is basically stated in the user input message, such as resolving a conflict or requesting a service, as a purpose or objective. The entity is basically extracting the main keywords from the user input message for instance if a user is saying “I am suffering from abdominal pain” here in this user input message “abdominal pain” would be the main keyword. Therefore, after extracting the keywords the Voice bot will generate feedback to provide the user a primary solution. The following Figure 5.4 shows the design architecture of our created prototype.

5.3.3 Frontend Development

For the front end, we did the work of the user interface using the Streamlit package. For data science and machine learning projects, the open-source Python package Streamlit makes it easier to create interactive web apps. Streamlit helps developers quickly design user-friendly UIs because of its beginner-friendly syntax, rapid prototyping capabilities, interaction with well-known libraries, and simplified deployment procedure. It includes data caching and optimization, provides interactive visualizations, easily interfaces with well-known data manipulation frameworks, and makes sharing and deployment simple. The active community support and expanding ecosystem of Streamlit make it a powerful tool for creating interactive web apps in the fields of data science and machine learning, despite its potential limits in advanced UI customization. In our UI we have two tabs. Tab 1 has boxes where users can ask questions to be transformed into text by speech-to-text technology. A second box is then presented with the answer, and users can hear the bot's response because text-to-speech functionality is included. Tab 2 has two things: One is the Threshold and the other thing is the option of reading out answers. Using the threshold, we can compare its value with the required similarity score for the query and response to be considered relevant. By the option of reading out answers, we can enable the option of listening to the voice bot's reply.

5.3.4 Backend Development

The voice bot system's basic functionality is provided by the code's backend. It is in charge of processing user queries, matching them with relevant information from a dataset, and generating relevant responses. The backend comprises several vital components and functionalities that contribute to the overall functioning of the voice bot.

These libraries, modules, and APIs collectively provide functionalities such as CSV file handling, fuzzy string matching, user interface creation, time, text-to-speech conversion, speech-to-text, speech recognition, and audio playback, enabling the code to process user requests and provide suitable responses in the form of text and speech output. The libraries, APIs, and modules used in the backend code are explained here.

Libraries & Modules

'CSV': A Python module is used for reading and writing comma-separated value(CSV) files. It enables the code to access data stored in a CSV format.

'FuzzyWuzzy': A Python library for fuzzy string matching algorithm, using Levenshtein Distance to calculate the differences between sequences. It is used to compare strings and calculate similarity scores. In our code, performed string matching between user queries and questionnaires in the dataset, calculated similarity scores, and generated best matches.

'Streamlit': A Python library that is used to build interactive web applications with a user interface and simplifies the process of creating and deploying a web-based user interface. It allows the code to display information and interact with the user. To develop the voice bot system, the Stream-lit library provides some functions such

as- `st.title()`, `st.subheader()`, `st.spinner()`, `st.slider()`, `st.checkbox()`, and `st.audio()` for constructing different UI elements and interactions.

‘Time’: A built-in Python module that provides functions for time-related operations. In the code, it is utilized to introduce delays using the sleep function. It helps in simulating the loading or processing time for a better user experience.

‘OS’: A Python module for interacting with the operating system. In the code, it is used to handle file operations. It is utilized to specify the file path and name for saving the generated audio file.

‘Pyaudio’: A Python library that is used for audio input/output operations such as capturing audio from a microphone or playing audio via speakers.

‘gTTS’: A Python library for converting text to speech. The gTTS (Google Text-to-Speech) library is a Python interface for the Google Text-to-Speech API which allows converting text into speech in different languages. In the code, the gTTS library is utilized to generate an audio output of the matched response.

‘Speech-Recognition’: A Python library for executing speech recognition. The speech recognition library is a Python package that provides speech recognition abilities. It delivers support for multiple speech recognition APIs, including the Google Cloud Speech-to-Text API. In the code, the `speech_recognition` library is utilized to take and convert user queries from verbal language to text format.

APIs

‘Google Cloud Speech-to-Text API’: The ‘`speech_recognition`’ library uses this API to recognize the voice. In order for the code to process the user’s input, it is utilized to translate the spoken questions of the user into text format. The `recognize_google` function from the `speech_recognition` library is used in the code, which uses the Google Cloud Speech-to-Text API.

‘Google Text-to-Speech (gTTS) API’: This API is used indirectly through the ‘gTTS’ library. It is applied to the search result of the code to convert text, especially, into speech. The API generates an audio file containing the spoken output.

Backend Workflow

The voice bot system’s main functionality is provided by the backend of the programming. By importing the necessary libraries, it is in charge of processing user inquiries, matching them with relevant information from a dataset, and producing appropriate responses. The voice bot’s backend has a number of important components and functionalities that are essential to its general operation. The following Figure 5.5 shows the Backend design flowchart.

Dataset Handling: A dataset is loaded into the backend from a CSV file called ‘`bangla_dataset.csv`’. The dataset consists of a number of Bangla questions and their accompanying responses. This questionnaire was made to focus on menstruation-related queries and responses. Additionally, the questions function as keys and the responses as values in a dictionary that is created by reading and processing this dataset. Therefore, this makes it possible to efficiently search and get responses to user requests.

Threshold Setting: A threshold option is added to provide the minimum similarity score required for a query to be regarded as a match. Through slider control in the

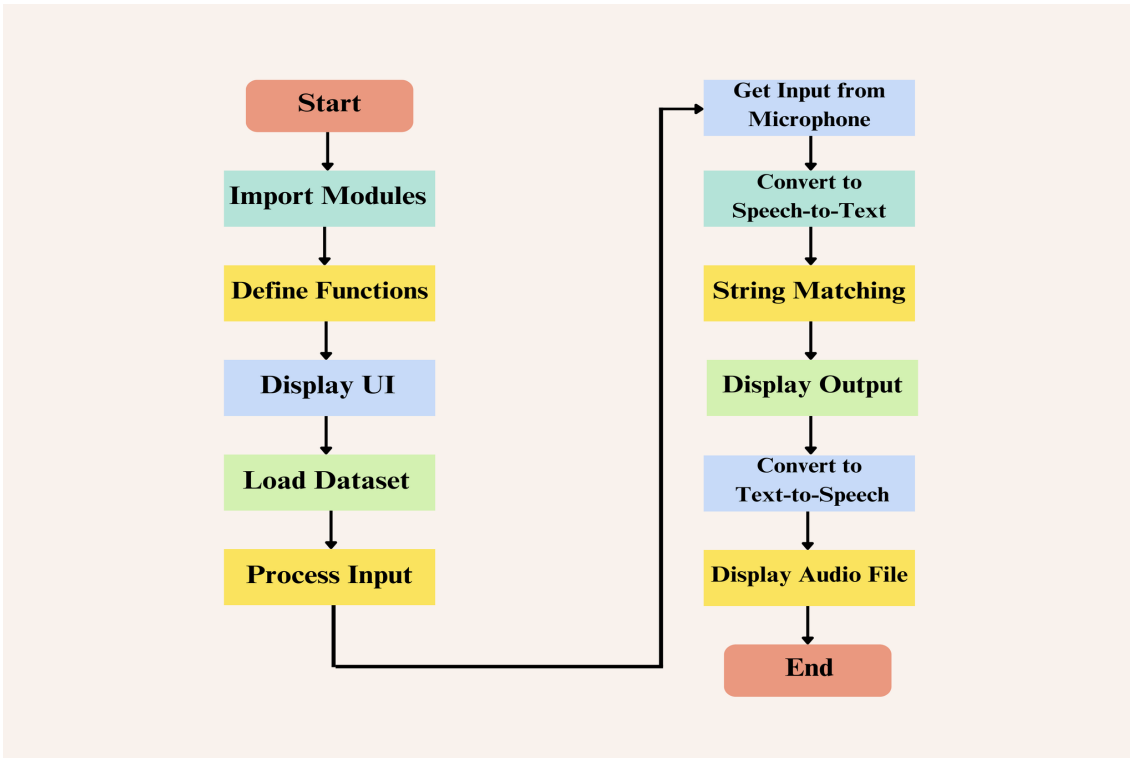


Figure 5.5: Backend design flowchart

user interface, the user can modify this threshold. Raising the threshold can make the matching process more stringent and perhaps reduce false positive matches. The system's sensitivity may be precisely adjusted by individuals to meet their particular requirements.

User Input Processing: The speech recognition library is incorporated into the code for enabling user input through the microphone. It uses the Recognizer instance to record audio and then utilizes Google's speech recognition API (`recognize_google()` method) to convert the spoken query into text. The query that has been processed is then utilized for further processing.

Voice Recognition: The speech recognition library is integrated into the backend to provide voice recognition features. It makes use of the recognizer object to use a microphone to hear user inquiries. The voiced questions are then translated into text format for further processing utilizing speech recognition techniques, particularly the Google Cloud Speech-to-Text API's (`recognize_google()` function). The method uses a parameter that specifies that the speech should be transcribed in Bangla.

Query Processing and Result Retrieval: Once the user question has been obtained, the backend processes it by passing it to the `return_result()` function along with the dataset and the threshold value. By comparing the user query with each question in the dataset, this function executes the matching algorithm. It then calculates similarity scores and chooses the best matching result depending on the threshold. The user inquiry is responded to by retrieving and returning the relevant response.

String Matching Algorithm: The backend uses a Fuzzy matching algorithm to match user queries with the dataset. The fuzz and process modules of the fuzzy-wuzzy library are used to compute string similarity scores between the user query and the questions in the dataset. The fuzzy matching method makes it possible for a more reliable and accurate matching mechanism by supporting variances, typos, and partial matches in user requests. Based on the given query, the matching algorithm tries to locate the best matching entry. The dataset, user question, and threshold are the inputs for the `return_result()` function, which is defined in the code. It conducts fuzzy string matching using the fuzzy-wuzzy library and the `ratio` function to determine the degree of similarity between the query and the dataset items. The items that have scored over the threshold are sorted and filtered. Thus, the highest-scoring item is selected as the search result. The following Figure 5.6 shows the String Matching Algorithm flowchart.

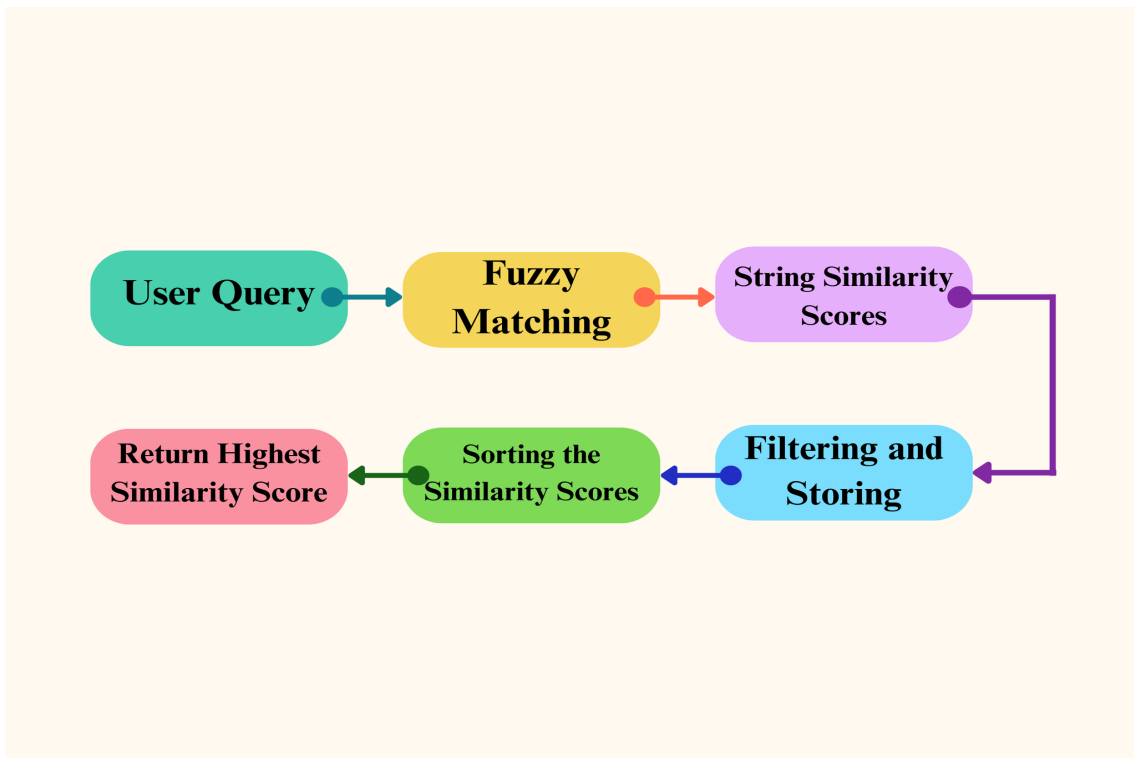


Figure 5.6: String Matching Algorithm flowchart

String Similarity Scores: The code determines how closely the user query and the dataset's questions resemble each other. The query is compared to each dataset entry using the `fuzz.ratio()` method to calculate the degree of similarity.

Return Result Function: The dataset, user query, and threshold are the input parameters for the `return_result()` function, which is defined in the code. Using the fuzzy-wuzzy library, it executes fuzzy string matching inside the method. Moreover, it computes the similarity score for each dataset item and stores it with the index.


Filtering and Storing: The code uses similarity scores to filter the dataset items. It selects the items whose scores are higher than the

predetermined threshold. The results of this filtering are then sorted in descending order based on the scores, ensuring the best matches appear at the top.

Selecting the Search Result: The maximum-scoring item is selected by the code to be the outcome of the search. Using the index of the selected item, it obtains the matching value from the dataset.

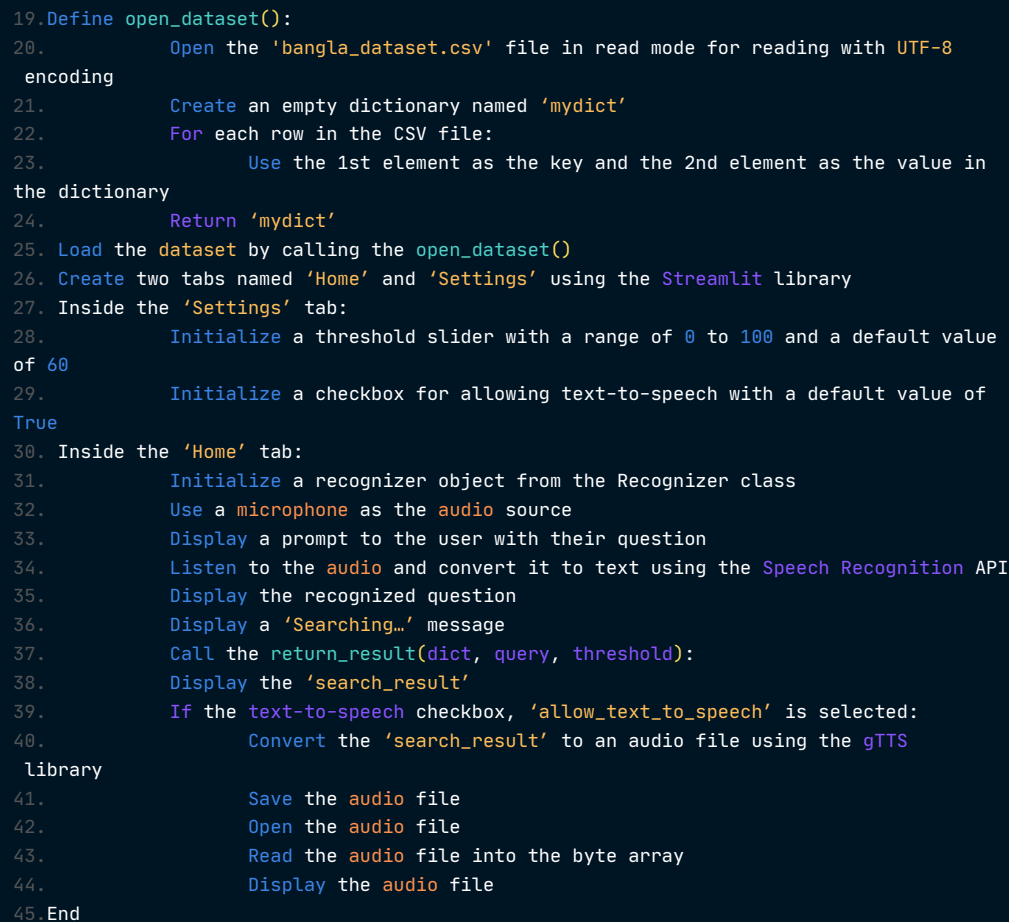
Text-to-Speech Conversion: The Google Text-to-Speech (gTTS) module is applied by the backend to enable text-to-speech features. If the ‘Read out answers’ checkbox is selected by the user in the user interface, the backend sets up an audio file of the matched response in Bangla using the gTTS library. The user then gets to listen to the response rather than reading it by having the audio file played back to them using the `st.audio()` method and the resulting audio is saved as an audio file in MP3 format.

5.3.5 Pseudocode



```
1. Start
2. Import required libraries and modules (CSV, Fuzzywuzzy, Streamlit, time,
gTTS, os, speech recognition)
3. Display the title and subheader of the application
4. Initialize a variable called 'search_result' as an empty String to store
the value
5. Define return_result(dict, query, threshold):
6. Try:
7.     Pause the program for 3 seconds
8.     Create an empty list named 'scores' to store the similarity scores
9.     For each key-value pair in the dictionary:
10.        Calculate the similarity score between the query and the value by
the fuzz.ratio() function
11.        Append the score along with its index to the list named 'scores'
12.        Filter the scores list to keep only the items with scores above
the threshold
13.        Sort the filtered scores in descending order based on the score
14.        Get the index of the highest-scoring item from the sorted scores
15.        Get the corresponding value from the dataset dictionary using the
index
16.        Return 'result'
17. Except:
18.    Return a predefined error message
```

Figure 5.7: Pseudocode of prototype (part1)



```

19. Define open_dataset():
20.     Open the 'bangla_dataset.csv' file in read mode for reading with UTF-8
    encoding
21.     Create an empty dictionary named 'mydict'
22.     For each row in the CSV file:
23.         Use the 1st element as the key and the 2nd element as the value in
    the dictionary
24.     Return 'mydict'
25. Load the dataset by calling the open_dataset()
26. Create two tabs named 'Home' and 'Settings' using the Streamlit library
27. Inside the 'Settings' tab:
28.     Initialize a threshold slider with a range of 0 to 100 and a default value
    of 60
29.     Initialize a checkbox for allowing text-to-speech with a default value of
    True
30. Inside the 'Home' tab:
31.     Initialize a recognizer object from the Recognizer class
32.     Use a microphone as the audio source
33.     Display a prompt to the user with their question
34.     Listen to the audio and convert it to text using the Speech Recognition API
35.     Display the recognized question
36.     Display a 'Searching...' message
37.     Call the return_result(dict, query, threshold):
38.     Display the 'search_result'
39.     If the text-to-speech checkbox, 'allow_text_to_speech' is selected:
40.         Convert the 'search_result' to an audio file using the gTTS
    library
41.         Save the audio file
42.         Open the audio file
43.         Read the audio file into the byte array
44.         Display the audio file
45. End

```

Figure 5.8: Pseudocode of prototype (part2)

5.3.6 Prototype Testing

In our CSV file, we have 408 questions. We tested our prototype manually. We tried to determine whether our bot was providing us with the same precise reply by asking it the identical question that was contained in our CSV file in a variety of different formats. We looked for a pattern to see if it was consistently providing the same right response by testing 100 questions from our CSV dataset. According to the test results, 76 percent of the 100 questions were correctly answered.

After manually testing our dataset using the voice bot, we discovered that the voice bot we developed is approximately 24% of the time not responding appropriately. We identified a trend explaining why the bot is not answering appropriately after studying and testing 100 questions with various wording. It was observed that the bot is unable to properly match the string and provides an inaccurate answer if the query does not have at least three words that match the question in the dataset. Then we examine how raising the threshold can at least partially resolve the issue for most of the concerns. The purpose of the threshold is to control the level of

similarity required between the user's query and dataset entries. Moreover, since the similarity score is compared with the threshold value, setting the right balance is important to ensure relevant responses. When the calculated similarity score is lower than the threshold, it means that it did not get accurate matching, hence it ends up providing irrelevant answers or returns an error message.

To showcase the accuracy of our voice bot, we are utilizing various metrics commonly used in natural language processing (NLP) and machine learning.

Here, All the values we obtained have a term. Let's go over them one by one:

In the cases in which we asked the bot questions in a passive way and not matching any keywords from our dataset, our bot answered them incorrectly and these are called False Negatives(FN). For our matrix, False Negatives = 13.

The cases in which we exactly asked the questions like our dataset and our model predicted them correctly are called the True Positives(TP). For our matrix, True Positives(TP) = 37 (Example given at 5.9, 5.10, 5.11). The overview of all the matrices is given in 5.1.

স্বাস্থ্য সহায়িকা

আপনার মাসিকজনিত সমস্যাগুলো নির্দিধায়ে আমাদেরকে বলুন

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আপনার প্রশ্ন :

প্রশ্নটি: মাসিকের সময় কি কি মেনে চলা উচিত

প্রয়োজনীয় পুষ্টিসমৃদ্ধ একটি সুষম খাদ্য মাসিক চক্র নিয়ন্ত্রণ করতে এবং মাসিকের লক্ষণগুলি কমাতে সাহায্য করতে পারে।
প্রাথমিক চিকিৎসা ভিত্তিক সমাধান: মাসিকের স্বাস্থ্য বজায় রাখতে, একজনের উচিত: ফল, শাকসবজি, গোটা শস্য এবং চর্বিহীন প্রোটিন সমৃদ্ধ খাদ্য গ্রহণ করুন পিরিয়ডের সময় আয়রনের ঘাটতিজনিত রক্তাধ্বতা প্রতিরোধ করতে আয়রন সমৃদ্ধ খাবার যেমন মাংস, মুরগি এবং শাক-সবজি অন্তর্ভুক্ত করুন ক্যাফেইন, অ্যালকোহল এবং প্রক্রিয়াজাত খাবার সীমিত করুন প্রচুর পানি পান করে হাইড্রেটেড থাকুন প্রয়োজনে প্রতিদিন মাল্টিভিটামিন নিন

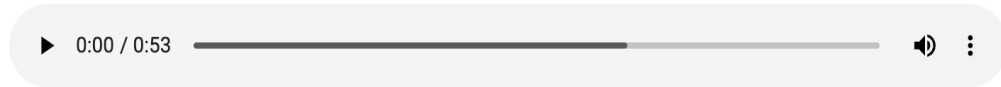


Figure 5.9: Example 1 of the bot answering correctly.
(screenshot from prototype)

স্বাস্থ্য সহায়িকা

আপনার মাসিকজনিত সমস্যাগুলো নির্দিষ্টধায়ে আমাদেরকে বলুন

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আপনার প্রশ্ন :

প্রশ্নটি: আমি পিএমএস সম্পর্কে শুনেছি এটা আসলে কি

প্রাথমিক রোগ নির্ণয়: পিএমএস, বা পি-মেনস্ট্রুয়াল সিনড্রোম হল শারীরিক এবং মানসিক লক্ষণগুলির একটি গ্রুপ যা একজন মহিলার মাসিকের আগে বা তার সময় ঘটে। প্রাথমিক চিকিৎসা ভিত্তিক সমাধান: PMS-এর উপসর্গগুলি মহিলা থেকে মহিলার মধ্যে ব্যাপকভাবে পরিবর্তিত হতে পারে, তবে ফুলে যাওয়া, ক্লান্তি, মেজাজের পরিবর্তন, মাথাব্যথা, পেটে ব্যাথা এবং ক্ষুধার পরিবর্তন অন্তর্ভুক্ত থাকতে পারে।

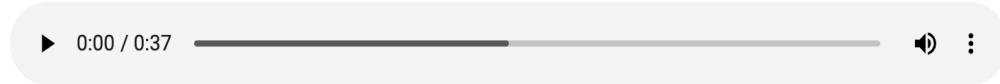


Figure 5.10: Example 2 of the bot answering correctly.
(screenshot from prototype)

স্বাস্থ্য সহায়িকা

আপনার মাসিকজনিত সমস্যাগুলো নির্দিষ্টধায়ে আমাদেরকে বলুন

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আপনার প্রশ্ন :

প্রশ্নটি: আমার মাসিক ঠিক করতে আমি কোন ওষুধ গ্রহণ করতে পারি

প্রাথমিক রোগ নির্ণয়: অনিয়মিত মাসিক চক্র হরমোনের ভারসাম্যহীনতা, থাইরয়েড রোগ, পলিসিস্টিক ওভারি সিন্ড্রোম (PCOS), মানসিক চাপ, ওজন পরিবর্তন এবং কিছু ওষুধ সহ বিভিন্ন কারণের কারণে হতে পারে। ফার্স্ট এইড-ভিত্তিক সমাধান: আপনার মাসিক চক্র নিয়ন্ত্রণ করতে, আপনি স্বাস্থ্যকর খাবার খাওয়া, নিয়মিত ব্যায়াম করা, মানসিক চাপ কমানো এবং ক্যাফিন এবং অ্যালকোহল এড়ানোর মতো জীবনধারা পরিবর্তন করার চেষ্টা করতে পারেন। যদি এই পরিবর্তনগুলি সাহায্য না করে তবে ডাক্তারের সাথে পরামর্শ করা ভাল। আপনার ডাক্তার আপনার হরমোন নিয়ন্ত্রণ করতে এবং আপনার মাসিক চক্র নিয়ন্ত্রণে সাহায্য করার জন্য ওষুধ লিখে দিতে পারেন।

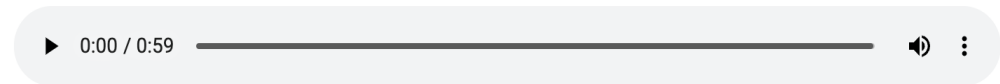


Figure 5.11: Example 3 of the bot answering correctly.
(screenshot from prototype)

True Positives(TP)	37
True Negatives(TN)	39
False Positives(FP)	11
False Negatives(FN)	13

Table 5.1: Table 1

Accuracy	0.76
Precision	0.77
Recall	0.74
F1 score	0.7536

Table 5.2: Table 2

However, there are some cases where we have asked the bot questions in a different way but we kept some keywords matched with the questions from our dataset but our bot answered them correctly and we call the values True Negatives(TN). For our matrix, True Negatives(TN) = 39 (Example given at 5.12, 5.13, 5.14)

Similarly, there are some cases where we have asked some questions in a different way but very few keywords matched with the dataset and we saw the bot answered them incorrectly, and we call the values False Positives(FP). For our matrix, False Positives(FP) = 11

So, here we are applying precision and recall metrics first.

Precision: Precision is the ratio between the True Positives and all the Positives [75]. We know, the formula of precision [70]

$$\text{Precision} = \frac{\text{True Positives(TP)}}{\text{True Positives(TP)} + \text{False Positives(FP)}} \quad (5.1)$$

$$= \frac{37}{(37 + 11)} \quad (5.2)$$

$$= 0.77 \quad (5.3)$$

Recall: Recall is the measure of our model correctly identifying True Positives [75]. We know, the formula of Recall [70]

$$\text{Recall} = \frac{\text{True Positives(TP)}}{\text{True Positives(TP)} + \text{False Negatives(FN)}} \quad (5.4)$$

$$= \frac{37}{(37 + 13)} \quad (5.5)$$

$$= 0.74 \quad (5.6)$$

Now if we want to calculate the accuracy, we know, the formula for Accuracy [60]

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \quad (5.7)$$

$$= \frac{(37 + 39)}{(37 + 39 + 11 + 13)} \quad (5.8)$$

$$= 0.76 \quad (5.9)$$

Here, TP denotes True Positives, TN denotes True Negatives, FP denotes False Positives and FN denotes False Negatives in the above formula.

The precision and recall metrics here are equally important. So we need to calculate the F1 score. The F1 score is a metric that is frequently employed in classification tasks to assess the accuracy of the model by accounting for both precision and recall.

It shows the performance of the model as a single value and is the harmonic mean of recall and precision.

The F1 score is calculated using the following formula [70]:

$$\text{F1 score} = \frac{2 \cdot \text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}} \quad (5.10)$$

$$= \frac{2 \cdot (0.77 \cdot 0.74)}{(0.77 + 0.74)} \quad (5.11)$$

$$= 0.7536 \quad (5.12)$$

A model that performs better overall, with precision and recall being balanced, has a higher F1 score. An F1 score of 1.0 indicates that the model's precision and recall were both perfect. The model appears to have a decent balance between precision and recall in our situation, where the F1 score is about 0.7536, although there is still an area for improvement. Depending on the individual issue domain and the required precision/recall trade-off for that application, the F1 score will either be interpreted as good or bad. The results calculated above is been showed in 5.2.

স্বাস্থ্য সহায়িকা

আপনার মাসিকজনিত সমস্যাগুলো নির্দিধায়ে আমাদেরকে বলুন

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আপনার প্রশ্ন :

প্রশ্নটি: বয়স বাড়ার কারণে কি মাসিক অনিয়মিত হতে পারে

একজন মহিলার বয়স বাড়ার সাথে সাথে মাসিক চক্র কম নিয়মিত হয়ে যায় এবং অবশেষে মেনোপজের সময় বন্ধ হয়ে যায়। ফার্স্ট এইড: নিয়মিত গাইনোকোলজিকাল চেক-আপ মাসিক চক্রের পরিবর্তনগুলি নিরীক্ষণ করতে এবং যে কোনও সম্ভাব্য স্বাস্থ্য সমস্যা চিহ্নিত করতে সাহায্য করতে পারেন.

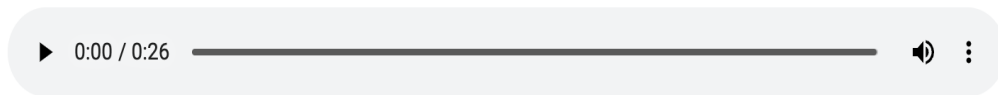


Figure 5.12: Example of the true negative (screenshot from prototype)

স্বাস্থ্য সহায়িকা

আপনার মাসিকজনিত সমস্যাগুলো নির্দিষ্টধায়ে আমাদেরকে বলুন

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আপনার প্রশ্ন :

প্রশ্নটি: বয়স বাড়লে কি মাসিক অনিয়মিত হয়

একজন মহিলার বয়স বাড়ার সাথে সাথে মাসিক চক্র কম নিয়মিত হয়ে যায় এবং অবশেষে মেনোপজের সময় বন্ধ হয়ে যায়। ফাস্ট এইড: নিয়মিত গাইনোকোলজিকাল চেক-আপ মাসিক চক্রের পরিবর্তনগুলি নিরীক্ষণ করতে এবং যে কোনও সম্ভাব্য স্বাস্থ্য সমস্যা চিহ্নিত করতে সাহায্য করতে পারেন।

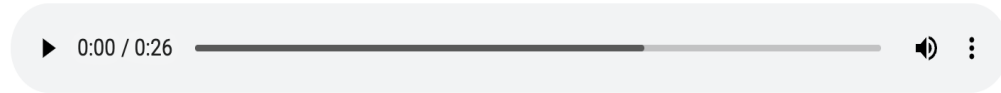


Figure 5.13: Example 1 of the true negative (screenshot from prototype)

স্বাস্থ্য সহায়িকা

আপনার মাসিকজনিত সমস্যাগুলো নির্দিষ্টধায়ে আমাদেরকে বলুন

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আপনার প্রশ্ন :

প্রশ্নটি: আমার বয়স 40 আমার মাসিক আগের মত হয়না সবাই বলে বয়সের জন্য বয়স বাড়লে কি আসলেই মাসিক অনিয়মিত হয়

রোগ নির্ণয়: একজন মহিলার বয়স বাড়ার সাথে সাথে মাসিক চক্র কম নিয়মিত হয়ে যায় এবং অবশেষে মেনোপজের সময় বন্ধ হয়ে যায়। ফাস্ট এইড: নিয়মিত গাইনোকোলজিকাল চেক-আপ মাসিক চক্রের পরিবর্তনগুলি নিরীক্ষণ করতে এবং যে কোনও সম্ভাব্য স্বাস্থ্য সমস্যা চিহ্নিত করতে সাহায্য করতে পারেন।

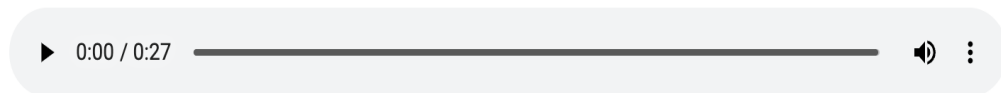


Figure 5.14: Example 2 of the true negative (screenshot from prototype)

5.3.7 Benefits of a 24/7 Voice Bot Service

A voice bot service providing primary health care 24/7 would serve a great deal to help marginalized people, especially women with their health issues. The details are discussed below.

Accessibility: A voice bot system can be accessed through a mobile phone, which is a common and easily accessible technology in Bangladesh. Moreover, according to the study [51] only 5.4% of the population of Bangladesh are smartphone users. Since the voice bot service can be easily accessible on button phones as well, this could increase access to healthcare resources for women who may have difficulty traveling to clinics or hospitals.

Cost-effective: Implementing a voice bot system could be a cost-effective solution for improving healthcare access and reducing disparities, particularly in low-income areas. Those who hesitate to visit doctors due to financial constraints will easily get primary suggestions through this.

Personalization: A voice bot system can be developed to provide personalized healthcare advice and guidance, which can be particularly useful for women who may have unique healthcare needs and concerns.

Privacy: Women may feel more comfortable discussing sensitive healthcare issues with a voice bot system, which could improve privacy and confidentiality. During our surveys, we found a lot of women feel hesitant to share their gynecological issues with others, especially male doctors. It will be lessened too through this.

5.3.8 Limitations and Drawbacks of a 24/7 Voice Bot Service

In spite of the immense potential of a voice bot service, there are some challenges and drawbacks entailing such a system. Below we discussed those limitations.

Limited capabilities: A voice bot system may not be able to provide comprehensive healthcare services, such as physical exams or laboratory tests, which may limit its effectiveness in addressing healthcare disparities.

Technical issues: Many may be unable to use the voice bot system due to connectivity and technical challenges, which might also reduce its effectiveness.

Language barriers: While the voice bot can be programmed in Bangla, it may not be able to provide assistance in other languages, which could limit its usefulness for some women in Bangladesh because the country has around 42 native languages, some are from ethnic minorities and some are from non-ethnic.

Lack of human interaction: Some women may prefer to receive healthcare advice and guidance from a human healthcare provider, which can be because of a lack of trust, rather than a voice bot system, which could limit its effectiveness for those individuals.

Chapter 6

Discussion

In the sections above, we attempted to provide a clear context of privileged and marginalized women and their financial status, households, family members, health issues, and awareness among themselves. In consideration of the study's focus on feminine healthcare, we carefully explained how accessing healthcare for marginalized women is difficult due to the high cost and their low level of education and awareness. Additionally, we presented in-depth findings from thorough field research we conducted on privileged and marginalized women.

6.1 Understanding The Context of Privileged and Marginalized Women

Urban Bangladesh and many other South Asian nations are inextricably linked with underprivileged women. While the HCI community gives homeless and related populations a lot of attention, [21], our research work in this paper tries to do so in the context of a developing country with a high population density. Our findings in this research on healthcare, social support, and economic analysis can have significant effects on future designs of ICTD (Information and Communication Technology for Development) interventions for a broad class of economically disadvantaged people. Our data from both the privileged and marginalized women further show that there are differences in many aspects of their life between them. Accessing the healthcare system, awareness and concerns are much dependent on the literacy level and financial conditions. It is clear that privileged women are way ahead in these terms than marginalized women [12]. From our survey, we have seen that marginalized women generally lead unstable life and they even lack to fulfill their basic needs.

6.1.1 Malnutrition and Food Insecurity in Marginalized Communities

When we visited underprivileged community we saw that food insecurity is a big problem there. Only a very small percentage of women consume food that is balanced and maintains a healthy physique. Research carried out on women from Bangladesh reveals that blue-collar workers, such as those employed in the garment industry, and women whose spouses work in blue-collar jobs have a greater likelihood of being exposed to underweight [53]. Some of the local women are very ill-health

and incredibly frail. The local populace lacks the financial ability to provide a good standard of living for their family. They have had numerous physical and mental issues as a result of their constant hunger and poor nutrition. Malnutrition had a negative impact on physical development, particularly in women. The situation for women there has gotten worse as a result of social inequities. Additionally, married women remained to have children while experiencing starvation and other physical and psychological issues. Additionally, they were not given appropriate nutrition even while they were pregnant [62]. This results in maternal fatalities, stillbirths, and baby deaths within the first week of life. In low-income areas like this, infectious diseases are easily disseminated due to poverty, inadequate housing, high population densities, and inadequate living circumstances paired with environmental factors that favor vector breeding [8].

6.1.2 Lack of Education

While we visited underprivileged neighbourhood we could see the literacy rate was very low there. There, only 43.3% percent of adults crossed primary school 3.2. A cycle begins of illiteracy because parental education levels influence whether or not their kids go to school, Children from low-income homes are frequently forced to quit school early in order to find employment or care for younger siblings. Even for those who are able to attend school, access is a challenge. There are much fewer schools nearby than in other parts of the city. Due to all of these issues, children in high-poverty populations are unable to attend and remain in school.

6.1.3 Unhygienic Household Environments

We have seen underprivileged households that most of the households have a very unhygienic and unhealthy environment. The narrow paths were crowded, and the rooms were without ventilation, resulting in the overflow of water, sewage, and waste during the rainy season. There was a high incidence of skin infections in the area. While interviewing young women, I observed rats and cockroaches scurrying across the ground. These women owned only a few belongings, such as a jute mat to sleep on and cooking utensils. Electricity was available, but there was no gas for cooking, which meant that many women resorted to using mud stoves and burning materials such as paper, cloth, plastic, or wood to cook their meals. Deplorable conditions prevail there. People there frequently reside in unsafe, subpar housing with little access to necessities like sanitization. Insufficient availability of better-quality water and sanitation has been acknowledged as a cause of the existing health problems, specifically the high occurrence of infant mortality in underprivileged urban regions [13]. The lack of proper sanitation was a significant issue, particularly for women and adolescent girls. As men had greater mobility, they could walk to a distant location to defecate and could also use trees for this purpose. However, women faced greater difficulties and expressed feelings of shame and insecurity due to the lack of adequate facilities. They are among the most socially isolated populations in the nation and receive little social protection.

6.1.4 Poverty

Most women work hard in the underprivileged community in their day-to-day life but they do not usually get paid what they deserve [11]. According to our research, women often have limited authority over their finances, as men usually make economic decisions that women are expected to comply with and follow. Women participants in the survey have a lower income level than men because they have limited opportunities to access the urban labor market due to their lower level of training and skills. Moreover, the existence of negative attitudes towards female employment also contributes to this disparity [3]. Thus Financial distress is a general case for everyone living there. In this case, cost savings, convenience, and the ability to provide care to those with mobility issues or those living in remote areas without access to a local doctor or clinic are some benefits of using technology to deliver health care.

We strongly believe that a technology-driven system could prove extremely advantageous for numerous South Asian countries that share similar cultures, such as India, Sri Lanka, and Pakistan. These countries have a large population of disadvantaged women, and their governments prioritize cost-effective healthcare solutions. However, while creating the system, it is crucial to consider the cultural norms that are deemed acceptable within these regions.

6.2 Challenges During Data Collection

During data collection since most of the questions of our questionnaire were personal, many of the women were unwilling to participate. Some possible reasons for their unwillingness may include fear of judgment, lack of trust, shame or embarrassment, lack of access to information or resources, societal or cultural pressure, or past negative experiences. Additionally, some women may have a lack of knowledge or awareness regarding their health or may have a lack of access to healthcare services. Moreover, one of the significant challenges encountered during the data collection phase was the limitation of time. This limitation hindered the ability to acquire a comprehensive dataset. In future endeavors, it would be advantageous to allocate more time for data collection in order to facilitate more in-depth analysis.

6.3 Durability and Participation of Relevant Stakeholders

Governmental organizations in Bangladesh have launched numerous initiatives to enhance everyone's access to healthcare. The DGHS, as part of the overall government Digital Bangladesh strategy, has launched four major programs to strengthen its management information systems using ICTs. It has invested resources to make sure that all upazila health facilities receive access to computers and the Internet, and it is developing a website that will serve as a repository for data on health organizations, services, and projects. Considering the constraints of resources, user skill, and attitude, the DGHS seeks to establish its management information system in health as the quickest information gathering and delivery source for Bangladesh for use in evidence-based decision-making. A mobile phone health service has been

developed as part of the government's ambition to create a health system informed by ICT. In order to provide this service, district hospitals and upazila health centers operated by the government use mobile phones as a 24/7 local call center. In order to raise awareness and let people know the pertinent numbers, local communication channels are being utilized. Residents can call for free and receive free medical advice from the available doctor.

Plans are additionally in place to increase the use of telemedicine in hospitals and to offer quality control, regulatory supervision, disease surveillance, and other services. In March 2010, a pregnancy advice service using Short Message Service (SMS) was also launched, providing tips for a secure pregnancy. In order to obtain prenatal, birth, and postnatal advice, expectant mothers must register. Data on the scheme's usage or impact are scarce at the moment, however one small-scale evaluation, [32] was mostly positive. The Ministry of Health and Family Welfare (MOHFW) provides online platforms for user inquiries, the Directorate of Family Planning operates a call center for newborn care, the Directorate General of Health Services (DGHS) operates a contact center for the general public, and so forth. While admirable, these efforts mostly target literate individuals with access to digital tools. Additionally, there has been a recent rise in private e-health programs, which are once more concentrated on populations with access to digital tools and, in some cases, also presume social media use. Marginalized women, however, do not fit into these categories.

6.4 Exploration of Current Health Initiatives

The rapid expansion of ICT and telecommunications in Bangladesh has the potential to allay worries about a shortage of healthcare services nationwide. Additionally, most of the Bangladeshi individuals have access to a mobile phone. Although there have been several m-health projects in Bangladesh, the country's health sectors still need a lot of improvement.

A number of m-health activities have been started in Bangladesh, including the provision of primary healthcare, disease surveillance, the gathering of routine data, and programs for health promotion and illness prevention. NGOs, the government, the private sector, and mobile phone providers all run the present projects [29].

Even after taking this many initiatives from different platforms, using and normalizing the use of m-health is still challenging in Bangladesh. In Bangladesh, using m-health services was found to be difficult due to technical limitations, lack of literacy, poor English language skills, a lack of trust, and other factors [43]. The m-health system continues to encounter a number of difficulties and limitations despite the government of Bangladesh's significant initiatives in the area of health information and communication technologies [7]. Among these include the need to define the service, standards across various organizations, financial viability, the availability of technical staff, the absence of common standards for health information and communication technologies, which makes it difficult to manage and share data across various databases, and interoperability. Another obstacle to the deployment of m-health services is the widespread lack of high-speed internet access in rural areas, as well as the expensive cost of infrastructure and integrated software development. Bangladesh and other developing nations must overcome a number of challenges in order to promote and implement m-health. Bangladesh's infrastructure develop-

ment for healthcare and ICT faces a number of obstacles. The country's progress in digital connection is hampered by the poor ICT infrastructure, which is characterized by constrained internet networks and insufficient electricity [27]. The necessity for increased economic independence is highlighted by the country's considerable reliance on industrialized nations, foreign investors, and international institutions like the World Bank and WHO [47]. Lack of support and desire to introduce and embrace new ICTs leads to resistance to change, which stifles innovation [49].

Challenges with usability and user acceptance are caused by things like unfamiliarity, ignorance, lack of trust, and lack of understanding, highlighting the value of educating and fostering trust in technology [41]. Modern legal frameworks against cybercrime and rules for electronic authentication are meaningless due to a lack of policy and regulations, necessitating the need for thorough governance in the digital sphere [27]. In addition, recent misleading reports in the healthcare industry and a lack of technological expertise all contribute to a lack of trust and impede growth [23].

Due to a lack of standardization and a single database that citizens can access, interoperability between systems suffers, making harmonization efforts necessary [31]. The lack of a generally agreed operational framework for e-health or m-health creates leadership and governance issues that call for a cohesive vision and efficient governance [33]. The disregard for good eating, lifestyles, education, and research that results from inadequate health information highlights the necessity for all-encompassing health programs and awareness efforts [16]. Transparency and integrity are required because corruption permeates the profession, harming the purchasing of medical supplies and eroding public confidence [42]. The need for coherent policies is highlighted by the emergence of policy incoherence when projects started by the government are shelved for political reasons and donor-driven reforms fall empty with the general population [23].

Strong oversight and accountability procedures are needed because there aren't enough effective mechanisms for monitoring and accountability [23]. Limited promotion opportunities and the acceptance of doctors' private practices are two characteristics of the personnel system crises that underline the need for reform and career advancement [31]. The problems are made even more difficult by poverty because those who are less fortunate have a harder time paying for healthcare and don't know how to practice good hygiene, nutrition, and sanitation [42]. To address these issues and develop a sustainable and equitable healthcare and ICT ecosystem in Bangladesh, extensive efforts across all sectors are needed.

We have used an m-health service to check and test the drawbacks. It was "Shastho Batayon", a govt initiative. It basically connects people directly with doctors over the phone. The patients share their problems and doctors send them prescriptions accordingly through text. The first drawback here we have found is, the system is critical and not user-friendly for everyone. Users need to dial multiple buttons in order to connect to the doctor which is not suitable for marginalized people. Then again, users sometimes need to wait for the doctor for a long time. So, any instant advice or suggestion can not be taken.

6.4.1 Government Initiatives

National initiatives in Bangladesh such as ‘Shastho Batayon’ by DGHS which gives everyone access to free healthcare information, are wonderful programs, but they are of limited use to communities where no one can read print or has access to modern technology. Even if they manage access to a device and a call, there are mostly male doctors, and even if there are females the marginalized women feel shy or hesitant to talk about gynecological or any other health issues through it. The lives of marginalized women may be directly impacted through focused programs/helplines, infomediaries with technology access, and similar experiences.

6.4.2 NGO Initiatives

The MAMA Bangladesh initiative, operating under the brand name ‘Aponjon’, aims to improve healthcare outcomes on a national scale by using mobile phone technology to provide a financially sustainable health information service. Innovative financing models will be utilized to achieve this goal. The initiative is officially supported by the Ministry of Health and Family Welfare (MoH& FW) and the Access to Information (A2I) program at the Prime Minister’s Office (PMO), both of which are government partners. The initiative is based on existing maternal-child health and family planning programs established by USAID and the Government of Bangladesh (GoB) and is being implemented through the Maternal and Child Health Integrated Program (MCHIP). The main objective is to provide pregnant women and new mothers with behavior change and communication (BCC) messages through mobile phone technology [28].

6.5 Designing Technologies Fitting to Context

In Bangladesh, there is a gap in feminine health issues between privileged and marginalized individuals, where privileged individuals have better access to healthcare, education, and resources while marginalized individuals face a lack of access to healthcare facilities, education, and resources, resulting in issues such as lack of access to safe menstrual hygiene products leading to health problems and lack of knowledge and education about gynecological, physiological and psychological health leading to higher rates of different types of diseases 3.2. Addressing this gap requires increased access to healthcare and resources as well as efforts to educate and empower marginalized individuals about their own health.

Designing technology that fits the context is critical to ensure its effectiveness and sustainability in addressing societal challenges. In the case of healthcare for marginalized women in Bangladesh, our survey findings suggest that a mobile phone-based solution may be more appropriate than an app-based solution. While the majority of participants owned mobile phones, none of them had used any apps, indicating a potential lack of digital literacy and limited access to smartphones with sufficient memory and processing power. Therefore, a mobile phone-based solution that leverages basic dialing features and SMS messaging could be a more feasible approach for improving healthcare access and awareness among marginalized women. These findings highlight the importance of conducting user-centered research to identify technology-driven solutions that are tailored to the local context and user

needs. By designing solutions that are accessible, affordable, and easy to use, we can bridge the gap between privileged and underprivileged women in healthcare and contribute to improving their overall well-being.

Chapter 7

Limitations and Future Work

There are several limitations to consider when conducting research on healthcare gaps in both privileged and underprivileged women communities in Bangladesh. Firstly, due to the sample size, the survey might not have captured the full extent of the healthcare challenges faced by marginalized women, as some women may not have been able to participate as we could not reach them due to time constraints and many other aspects. Additionally, the survey might not have accurately reflected the views and experiences of all participants, as social desirability bias and self-reporting limitations could have influenced responses.

We were unable to reach the rural communities because our study is still based in metropolitan areas. It is likely that women living in remote or rural areas are more deprived of healthcare facilities than those living in urban areas. Due to our inability to access remote areas, we were unable to contact a sizable community of underprivileged women. We, therefore, lack their insights on the healthcare inequities they experience as well as their opinions on our suggested technology. Therefore, we wish to make this our future project. Furthermore, we are interested to explore further how cultural and societal factors, such as gender norms and social stigma influence healthcare access and utilization among marginalized women.

In terms of future work, it is critical to explore and implement practical solutions that address the healthcare challenges faced by marginalized women. For example, community-based healthcare initiatives that focus on awareness-raising and providing basic healthcare services in rural areas could be implemented. Additionally, there is a need to build the capacity of healthcare professionals, particularly in rural areas, and provide them with the necessary resources to improve the quality of care. Moreover, further research could focus on exploring the potential of telemedicine and other innovative technologies to improve healthcare access and utilization among marginalized women in Bangladesh.

Also, our dataset's modest sample size suggests that fewer data variance has been identified. In order to uncover more solutions for their healthcare inequities, we want to collect more data in the future to enrich our dataset with more variations. Moreover, Bangladesh is a small nation with a diverse population. This country is home to over 44 indigenous languages. Since the target audience for our suggested design is marginalized women, the voice bot component of it needs to be able to recognize every native language. We want to provide our bot with the ability to do that. Since we want our bot to be reachable 24/7, this bot will be integrated with a telecom system. There are six telecom companies in Bangladesh. We intend to

present them with our idea in the future so that we may make our bot available through all of the national telecom providers.

Since our focus group is primarily the community of marginalized women, we aim to work with NGOs and governments to reduce the cost of operating the voice bot system around the clock. We want our Voice bot system to provide personalized recommendations based on the user's specific information such as age, symptoms, and medical history. Also, it can ask questions to users regarding their personal information if needed. Then the bot can offer suggestions and advice accordingly. We wish to upgrade our voice bot so that it includes a function that allows users to get information about doctors from hospitals in their neighborhoods. Moreover, if the user informs their current location in an emergency, the bot can easily connect them to their neighboring medical institutions or give a list of nearby government clinics and their open hours. Furthermore, we want our bot to provide information about the low-cost services provided by those government hospitals.

Overall, while our study sheds light on the healthcare gaps between privileged and underprivileged women in Bangladesh, there is still much work to be done to address these disparities and ensure equitable healthcare access for all women, regardless of socioeconomic status.

Chapter 8

Conclusion

Our study underscores the key barriers for marginalized women to access and avail of healthcare opportunities which are crucial to pinpoint for taking necessary initiatives to improve their situation. From our findings, we have found that underprivileged women either ignore their health issues due to a lack of knowledge or misconceptions or have a tendency to hide their gynecological issues due to shyness or discomfort. Overall they are unwilling to visit and take medical services unless the health issue becomes critical because of financial constraints or social taboos, etc. Identifying the gaps between privileged and marginalized women's healthcare in Bangladesh is crucial for promoting equitable access to healthcare services and improving the well-being of all women. By understanding these challenges and addressing them through targeted interventions and solutions, we can reduce healthcare disparities and ensure that all women have equal opportunities to lead healthy and productive lives.

Considering their overall situation, we found that technology can play a vital role in this regard as the underlying factors such as poverty, illiteracy, etc. cannot be eradicated overnight whereas technology can help these people access healthcare in spite of the current barriers. Therefore, we proposed a 24/7 voice bot service to facilitate their barriers and presented the design of such a prototype in detail with performance analysis. We have also elaborated pros and cons of such a system in the current context. Our goal is to ensure that a technological intervention creates a simpler m-healthcare system for women by letting them know when they should actually go to the doctor, making a primary suggestion that can help them with some of their health issues, and suggesting the best doctors in the area through that health assistant. This will prevent major health damage and financial waste. We hope that our study will contribute to the design of more effective healthcare solutions to help marginalized women access healthcare.

Appendix A

Appendix Title

For our better understanding we created short forms of our questions and using those we did further data analysis. Those are given in the table below:

Questions	Short form
1. What is your age?	Age
2. What best describes your marital status?	marital_status
3. What is the total number of members in your family?	family_member_count
4. How many children do you have?	child_count
5. Have you ever experienced any miscarriages or abortions?	abortion
6. Did you happen to experience any mental distress before or after your pregnancy?	distress
7. What is your occupation?	occupation
8. Please select the employment area you are involved in.	employment
9. What is the highest level of education you have completed?	education_level
10. Do you have a sensory, physical, or mental disability?	disability
11. If yes, then which category does your disability fall into?	disability_type
12. Would you say your health is generally:	health_status
13. At what age did you have your first period?	first_period
14. Were you comfortable sharing about your first period with other people?	comfortable_stat
15. Is your period regular? (predictable within one week)	period_1_stat

Questions	Short form
16. Are you aware of PMS (premenstrual syndrome)? Select any of the options below.	PMS_stat
17. What do you think about people who menstruate and are discriminated against?	menst_desc
18. What do you think can be the most important benefit of a period-shame-free society?	psfc_desc
19. Have you ever been period shamed in school or college or university?	shamed
20. Are you currently facing any menstruation problems?	menst_prob
21. Are you willing to share your gynecological problems with others?	gyno_prob
22. Do you feel shy talking about your menstruation health?	shy
23. Are you comfortable sharing about women's health issues with a male doctor or male person?	comfortable
24. What do you use during periods?	napkin_type
25. Did you ever try to hide your menstrual problems?	menst_hide
26. Have you ever been abused by your partner?	abuse_stat
27. Have you experienced any problems with having sex?	prob_sex
28. How often do you get a health checkup?	health_checkup
29. From the list below please mark whether you have had any of the following conditions and the age you were first diagnosed.	diagnose_stat
30. Did you consult any doctor for the above-mentioned problems at an early stage or were you hesitant?	doc_issues
31. Did you get any emergency medical help through any healthcare service or app?	service_usage
32. Have you been prescribed for a different disease that you didn't have?	wrong_presc
33. Was the above-mentioned condition arose because you didn't know which doctor you should consult?	doc_choose_mistake

Questions	Short form
34. What is the total income of your family?	family_income
35. Do you have your own mobile phone?	mobile
36. How many mobile phone users are there in your family?	mobile_user
37. Do you use any healthcare service app if yes, then what is/are the name of the app?	healthcare_app
38. If you have used any healthcare service app, share your experience about what were the benefits or drawbacks of the app.	healthcare_app_desc
39. What do you think of using a healthcare service app? Will it be helpful for others?	app_useful_stat
40. Do you think an app regarding women's medical health can be able to eradicate a lot of problems?	app_solve_issues
41. Will you be willing to use that tool?	tool_usage
42. Will you be willing to use any 24hrs mobile voice service for discussing your health issues?	mobile_service
43. Have you taken help from any 24hrs mobile voice service?	help_mobile_service
44. If you chose yes then share your experience. (Was that mobile voice service helpful or not?)	mobile_service_experience

Table A.1: Survey questions and their short forms for data analysis

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