SmartSheba: Enhancing Elderly User Experience with LLM-Enabled Chatbots and User-Centered Design

Sharfuddin Khan Chisty
sharfuddin.khan.chisty@g.bracu.ac.bd
BRAC University
Dhaka, Bangladesh

Anika Tahsin Miami
Computing for Sustainability and Social Good (C2SG) Research Group, BRAC University
Dhaka, Bangladesh

Jannatun Noor
jannatun.noor@bracu.ac.bd
Computing for Sustainability and Social Good (C2SG) Research Group, BRAC University
Dhaka, Bangladesh

ABSTRACT

The elderly population constitutes a significant segment of the world's population, and this ratio is expected to increase in both developed and developing countries. However, in the information age, the elderly face a new challenge of dependency on others for soft skills. Despite the widespread availability of technology, their interaction with it often relies on younger family members, which frequently discourages them from using technology at all. Large corporations typically focus on providing technology solutions to experienced users, often overlooking the elderly who are consequently deprived of these advancements. This paper examines these approaches and proposes a unique solution. It identifies critical areas where technology is essential for the elderly, with a particular focus on e-health services. The paper demonstrates how the use of a Large Language Model (LLM)-enabled chatbot, designed with a User-Centered Design (UCD) approach, significantly improves the System Usability Scale (SUS) score. Based on these findings, the paper concludes with a UCD-based Inclusive Design Strategy, offering a practical solution to the problem of technology dependency among the elderly, thus ensuring they can fully realize the potential of the information age.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

HCI, elderly, E-Health, UI design, UCD, LLM

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1 INTRODUCTION

In the rapidly digitizing world, all modern technology interfaces are designed using user-centric designs that adhere to human-computer interaction (HCI) principles. Although UCDs meet the needs of any end user, the graphical user interfaces (GUI) of common smart technologies are largely hostile towards the elderly age bracket (people above 55 years of age). As people age, many require medical assistance quite often. Hence, this paper focuses on building an e-health application that will be elderly-friendly and will specialize in assisting healthcare services. The crux of the paper is to assess the feasibility and efficacy of leveraging UCDs while building an e-health application to tailor elderly-friendly GUI designs that can be implemented across other smart devices or applications to make them elderly-friendly. Furthermore, in this paper, we have tested the use of an assistant chatbot for seamless and human-like customer care service powered by a Large Language Model, from a Natural Language Processing (NLP) system built on Artificial Intelligence (AI), to study the effectiveness of using virtual chatbots to generate informational prompts.

Elderly individuals constitute a significant portion of the global population, with 10% being over 65 years of age in 2022 [20]. Despite this, many existing user interface designs are perceived as intimidating by older adults. Research [53] indicates a need for further studies focused on designing for this demographic. Addressing cognitive challenges is crucial when developing graphical user interfaces (GUIs) for the elderly [14]. Cognitive load, which measures the total burden on working memory during task performance [8], is a key factor to evaluate. Additionally, considerations should include other aspects of gerontology, such as autonomy, visual impairments, and cognitive limitations [61]. Hence this research aims to answer two crucial questions in the realm of Human Computer Interaction for the elderly.

- **RQ1:** How to design assistive graphical user interfaces for the elderly population that serve the purpose of inclusivity in design?
- **RQ2:** How do Large Language Models affect the usage experience of the elderly?

The main goal of the study is to ultimately free the elderly from dependence on others in various degrees while they use smart devices such as smartphones in healthcare sectors. In doing so, the elderly population will be able to enjoy the benefits of modern technology without feeling left out. This study will test the efficacy of inclusive designs and the effectiveness of using LLM chatbots through an application named SmartSheba. Finally, This paper meets the third and sixteenth goals of Sustainable development goals set by the United Nations to ensure healthcare for all ages and the creation of an inclusive society by building effective institutions.

2 RELATED WORK

As populations age, their reliance on medical care increases significantly [4]. Cultural perspectives also significantly influence attitudes towards aging [67]. Research underscores the critical role of accommodating physiological, geographical, cultural, and generational variations in the design of user interfaces (UI) to enhance adoption among the elderly [6]. For instance, Yasuka and Mika noted that while the Dutch elderly readily adopt IT solutions, their Japanese counterparts tend to resist digital transformations in their lifestyle [77]. Further studies by Xiaolei Zhou and Wei Shen have shown that elderly individuals generally have slower movement times compared to younger people [81], and they struggle more with technological tasks, which can be attributed to gaps in technological fluency [9].

2.1 Role of HCI in Elderly-Friendly Technology

Human-Computer Interaction (HCI) is pivotal in developing accessible technology interfaces, particularly for the elderly. John Millar highlights HCI as essential for integrating physiological, social, and computational aspects to enhance interface usability, making it crucial for elderly-friendly designs [47]. Studies like that by An Fan et al. have proposed a 'senior mode' for mobile applications, reflecting a targeted approach to elderly user behavior [25]. Similarly, Chengmin Zhou et al.'s work uses scenario-based designs to tailor smart home interactions for the elderly, improving their engagement with technology [78]. Research by Ortiz on Alzheimer's patients underscores the need for consistent and visible aids, enhancing memory retention with the use of animated avatars [48]. A comprehensive review of 25 studies by Cole et al. reveals the effectiveness of codesign in developing electronic healthcare tools (EHTs), emphasizing collaborative learning and participation to optimize elderly user experiences [17]. This includes addressing cognitive and speech impairments, which are particularly challenging for those with Alzheimer's [24]. Further studies advocate for integrating advanced technologies like AR for spatial awareness and Human Activity Recognition (HAR) to support elderly autonomy and health monitoring [15, 33]. Gamification emerges as a promising approach to enhance elderly health engagement, though its adoption in emerging markets remains limited [37, 59, 68]. This highlights the ongoing need to improve the functionality and user-friendliness of health-related apps to better serve the elderly population.

2.2 Cognitive Barriers in Elderly Technology Use

Older adults often experience an inferiority complex and "high-tech phobia," which can hinder their integration into digital environments, a phenomenon supported by flow theory. Research highlights the need to address loneliness and isolation in the elderly by designing IT solutions that enhance social connectivity [64]. The design elements like layout, color choice, and content relevance significantly affect their user experience [79], and their struggles with VR tasks underscore a gap in technological fluency [9]. During COVID-19, studies showed that mental health and reduced isolation are crucial for improving the quality of life among the elderly, advocating for increased use of Information and Communication Technology (ICT) [45]. In rural Bangladesh, economic barriers prevent the elderly from accessing modern services, with technology designs often perceived as unaffordable [65]. Usability studies, such as SMASH, reveal frequent issues among the elderly with smartphone use, particularly in memory load and realistic system matches [57]. Innovations like personalized TV user interfaces consider cognitive and psychosocial changes, enhancing engagement for older adults with chronic conditions [46]. Cognitive load theory emphasizes the importance of tailoring educational platforms to the elderly's learning capacities, suggesting a balance of intrinsic, extraneous, and germane loads to optimize interface designs [69, 70]. These principles are also vital in developing e-health apps, where complex systems like web-based conversational agents must consider data transfer and rendering challenges [44].

2.3 Design Strategy

Enhancing health outcomes and promoting healthy aging for the elderly can be effectively achieved through smartphone-based applications designed with persuasive elements, as these platforms bridge significant gaps in accessibility and usability [43]. Currently, most applications are tailored for younger demographics, neglecting the unique needs of the elderly, which necessitates a dedicated design strategy for this population [12]. Psychological factors such as loneliness, suspicion, and fear must also be considered in software design, as they significantly affect the elderly's technology usage [40, 50]. The interface design for elderly users should prioritize simplicity to minimize cognitive load, avoiding superfluous elements that could hinder usability [23]. Studies have indicated that optimal readability on small screens can be achieved by balancing text size and scrolling; specifically, using a font size of 16pt in Arial Unicode MS and adhering to a 50x50 pixel standard for button sizes facilitates better interaction [51, 58, 63].

Reducing interface complexity is crucial, as simplified navigation aids in accommodating the declining skills of elderly users [7, 55]. Incorporating emerging technologies such as voice user interfaces (VUIs) and wearable sensors can significantly improve accessibility, requiring designs that consider the elderly's specific speech rates and feedback needs [5, 42]. Furthermore, studies show that older adults with higher educational backgrounds adapt more readily to new technologies, suggesting a capacity for more complex interface designs within this subgroup [74]. Effective design for the elderly must also address issues of trust, personal integrity, technology acceptance, and E-health literacy, all while accommodating the sensory declines associated with aging [4, 21]. Collaborative efforts among stakeholders are vital for developing technologies that enhance older people's quality of life, providing accessible and user-friendly solutions [80].

2.4 Integrating Technology and Artificial Intelligence in Elderly Healthcare

EHealth, utilizing technology to enhance health and well-being, is undergoing a paradigm shift driven by an aging population and an increase in chronic conditions. Various studies highlight the complexity of integrating technology into healthcare for the elderly, emphasizing the importance of user-centered design (UCD) to enhance accessibility and patient empowerment [3, 73]. For instance, challenges such as safeguarding personal information, technology reliability, and maintaining personal interaction with healthcare providers have been identified as significant barriers [3]. Cultural values also play a crucial role in the acceptance and use of technology among the elderly, as discussed by Alsswey and Al-Samarraie, who apply models like the Theory of Planned Behavior and the Technology Acceptance Model to evaluate user acceptance [6].

Moreover, technology like the Internet of Things (IoT) is pivotal for enabling smart living solutions that enhance the social life and safety of elderly individuals [60]. Studies like that by Holzinger et al. on user interface designs for the elderly further demonstrate successful applications in real-world settings [35]. The role of Artificial Intelligence (AI) in healthcare is also expanding, with systems like AI-driven Decision Support Systems (DDSS) improving diagnostic accuracy and patient-doctor relationships. AI's potential to reduce cognitive biases in diagnostics is further corroborated by research from Harada et al. [32].

Additionally, the importance of transparent explanations in AI systems has been emphasized to foster trust and ensure ethical use, as discussed in studies by Eiband et al. and Guidotti et al. [22, 31]. Moreover, technologies that support autonomy among the elderly, such as systems integrating smartphones and hospital information systems with Bluetooth technology, are crucial [71]. The importance of incorporating feedback mechanisms that allow elderly users to understand and trust AI recommendations is critical, as described by Panigutti et al. [11, 49]. This inclusion is vital for mitigating mistrust and enhancing the usability of technology in elderly healthcare. Finally, the engagement of end users in the design process of eHealth applications, as explored in Roberta's study, underlines the need to consider the elderly's particular challenges and preferences to improve the overall effectiveness and acceptance of technological solutions [30]. This holistic approach to designing and implementing healthcare technology ensures that it is both practical and trusted by its elderly users, aligning with broader healthcare goals and improving quality of life.

3 ADVANCING AGE-SENSITIVE DESIGN IN HEALTHCARE

Technological advancements have transformed elder care by providing seniors with essential healthcare resources through E-health applications. These applications enhance social connectivity and personalize care, significantly improving seniors' quality of life. User-configurable interfaces that adapt to the elderly's sensory and cognitive needs boost their independence and overall well-being [72]. Such technologies also offer better health monitoring, improved communication with healthcare providers, and fewer medical visits. Liljeroos and Arkkukangas' work on telemonitoring for older adults highlights the positive outcomes of enhancing patient empowerment and active health management [41]. Additionally, economic evaluations of eHealth platforms show a growing focus on their cost-effectiveness [66]. Despite many health apps targeting younger users, there is a significant gap in solutions designed for the elderly. Research by Conway et al. reveals that older adults are interested in technologies for health management, such as medication reminders, but often underutilize these tools due to design and accessibility barriers [18]. This issue highlights the necessity for interfaces that are simple, familiar, flexible, and easily recognizable [2]. Integrating smart environment technologies and age-friendly services can make daily healthcare more accessible and effective [7]. Clara Li notes that current mobile health applications often do not meet elderly users' needs [39].

This situation presents a substantial opportunity to enhance these technologies, ensuring they are accessible and appealing to older demographics. By focusing on user-friendly designs that seamlessly integrate into elderly lifestyles, we can significantly increase their engagement with technology, promoting a healthier and more empowered aging population.

4 METHODOLOGY

In this research, we employed a mixed method [28] while doing this research. We gathered data from the elderly, and caregivers of the elderly repeatedly in Phase I and Phase II. In phase one, we focused on finding answers to our first question, where we focused on finding out the type of design strategy that meets the cognitive needs of the elderly. For this, we focused on qualitative and quantitative data. In the qualitative segment, we focused on the feedback of both the elderly and the caregivers. To ensure diversity and representativeness in our study, we utilized stratified sampling to categorize elderly participants by age and literacy, and purposive sampling for caregivers based on their interaction frequency with elderly technology users. This methodological approach allowed us to gather data reflective of the broader population, enhancing the validity of our findings and supporting our study's goal to explore technology adoption variations effectively. We performed a Thematic analysis on the feedback of both the elderly and the caregivers. Along with this we also parsed the categorical data and performed data visualization to gain a bird's eye overview of the responses [16].

Since this research focused on various features we also conducted a field interview with the health care professionals who are involved in appointment booking to understand if such features are required or not. Additionally, we collected numerical data such as demographic data, access to smartphones, and technology usage of the elderly. In addition to that we collected demographic data of the caregivers and the frequency of the caregivers helping them in using smartphones. From our understanding in the context of Bangladesh in the usage of technology caregivers are an essential helping hand for the elderly. Hence considering the factors of the caregivers was crucial [1]. After performing a comprehensive analysis of these data we subtracted the features that are frustrating to the elderly population [76], found out the appealing color patterns, and identified the barriers that are restricting the elderly in their technology usage. Once the identification of the barriers is done we prepared a design that mitigates the cognitive barrier of the elderly in technology usage. We named it Smart Sheba. We included the solutions in the Homepage of Smart Sheba by making it the most simplistic design that mitigates the cognitive barrier by the elderly in their technology usage [76].

At Phase II of our research, we focused on developing a design strategy to address the information retrieval challenges faced by the elderly, making the design more inclusive. We employed a user-centered design approach in combination with a large language model to promote digital autonomy, integrating OpenAI's Assistant

API and Chat Completion API to enhance this strategy. Smart Sheba, primarily designed as a native mobile application but adaptable for other devices, utilizes OpenAI's API to interact with GPT-3.5, enabling seamless conversational exchanges powered by advanced language models. The integration of OpenAI's Assistant API ensures efficient data handling and user interaction, allowing for smooth data retrieval and autonomous digital engagement. This AI-driven system enhances the application's functionality, making it a valuable tool for promoting digital inclusion among elderly users [36].

After this, we tested our combined approach of the application to determine if it enhances the user experience of the elderly for this we collected numerical data using the Likert scale to find out the usefulness of our application and the system usability scale to compare between the versions of our application. Along with this, as we used an LLM in our research we performed a performance accuracy analysis for our application in Bangla and English responses. Additionally, we collected feedback from the elderly and the caregivers and performed a thematic analysis of the data to understand their overview of our design strategy. This finally led us to a conclusion of an inclusive design strategy that enables autonomy for the elderly. This study was designed as an exploratory pilot aimed at identifying variations in technology adoption among elderly individuals categorized by age and literacy levels. Here in Figure 13, we can see the statistical result of usefulness of the smart desk, a feedback from the elderly. Moreover, the study adheres to ethical guidelines, prioritizing transparency, respect for autonomy, and responsible data management. Securing ethical approval from the university's Institutional Review Board demonstrates our dedication to ethical practices, reinforcing the research's integrity [56] and validity while building trust within the elder community in Bangladesh. The findings from our study are intended to inform larger-scale research and contribute to hypothesis generation in the field of geriatric digital inclusion. User-Centered Design, an iterative and flexible design process, was employed during the second phase of our research for the development of Smart Sheba. While the detailed steps of UCD for this specific application are not included, its principles were rigorously followed throughout the process. The primary focus of this paper is on the outcomes of the UCD approach and the insights gathered from its application in Smart Sheba's development. These findings are highly relevant for researchers exploring inclusive design strategies and aim to contribute to the growing body of knowledge on senior care and digital inclusion. Here, in the Figure 1, we have shown the study pipeline of our research.

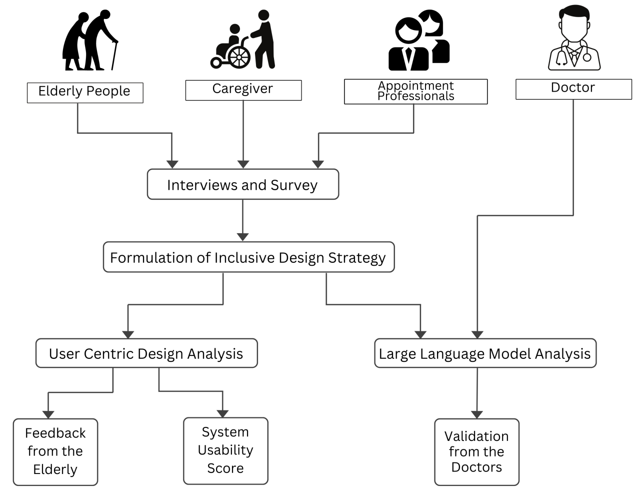

Figure 1: Study pipeline of SmartSheba

5 FINDINGS

We now present our research findings for older adults and caregivers to identify the obstacles older adults encounter when using smartphones.

5.1 The outcome of the interview with the elderly

5.1.1 Demography of the elderly. We interviewed elderly people between 55 and 80. Among the elderly, 50% (16 out of 32) were between 65 and 74, 43.8% (14 out of 32) were between 55 and 65, and 6.3% (2 out of 32) were between 75 and 80. Age is an important factor in smartphone usage because the elderly, who are younger, have a better chance of getting in touch with smartphones and technology. We also categorize the elderly based on their education. If the elderly had completed 10 years of schooling or more, we considered placing them in literacy. Less than 10 years of schooling to more than 5 were considered semi-literate, and less than that were considered illiterate. Literacy serves as a pivotal measure to comprehend how older individuals engage with smartphones. By categorizing the elderly, we would be able to identify how technology or smartphone usage varies and what their effects are. Also, from the data we collected, we can see that 6 males and 2 females were literate, which means that they had completed 10 years of schooling or higher. Most of the elderly interviewed—precisely 11 males and 9 females—were semi-literate. Lastly, only about four elderly people were illiterate.

5.1.2 Elder's background. We have collected the data from different places. But a lot of the elderly data came from the elderly, who are situated in the Dhaka Mohakhali area. Most of the participants that we interviewed came from different places. They all came to Dhaka to earn their livelihood. These seniors pursued various professions throughout their lives. A lot of the elderly were businessmen and salarymen. Many of the elderly are retired and spend their time at home. From the data we collected, the majority of the elderly were Muslims, and they all spoke the same language, which is Bengali. As the majority of the elderly in Bangladesh. Currently, we possess limited knowledge about the backgrounds of elderly individuals. Therefore, we inquired whether they have prior experience with smartphones to identify those who are more acquainted with the smartphone interface. Now, among the 32 elderly, only 4 did not have any prior experience. Two of the elderly responded that they do not understand smartphones very well; one of the elderly thought it was very expensive, and the last elderly thought it was too complex for him. An elderly person shared with us, *"I am too old for a smartphone; it is too complex for me and I just use my phone for communication so I don't need a smartphone"*

Moreover, a common theme among these respondents is the perception that smartphones are too intricate for their use. To better understand the preferences of elderly people, it is important to know what type of activities they perform on their smartphones. Here in Figure 2 we can see the activities performed by the elderly. We found that about 100% of the elderly use their smartphones for communication, while 84.4% use them for social media, and 40.6% use them for entertainment. This data will serve as a foundation for building the UI layout of our design to best suit our user base.

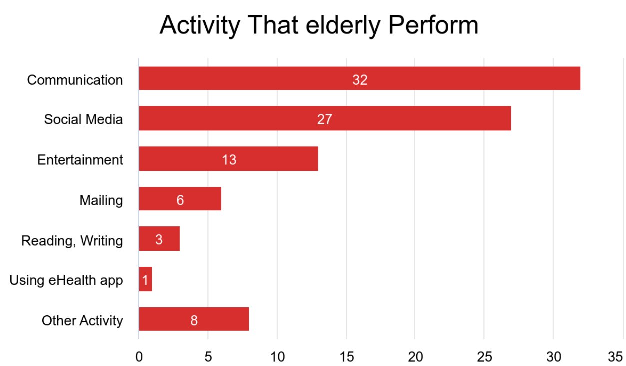

Figure 2: Activities performed by elderly

5.2 Barriers the Elderly Face

The color and color contrast also affect the elderly when they interact with the interface of the smartphone. Because the color text is not clear enough, it can hamper their smartphone experience. We found that the majority of the elderly—about 84.4% of the elderly—wanted vibrant colors, and 16.6% of the elderly wanted black or darker colors. As almost all the apps have icons, to confirm if icons and numbers are necessary for the navigation button, we asked them If the elderly felt it was easy to navigate and everybody replied positively, this indicates that if there are fewer icons, it can increase the cognitive load. Besides, we wanted to find out what frustrations the elderly face when using smartphones. It is a qualitative question, as we want to evaluate the problems the elderly face. So we did a thematic analysis of the data, and we used codes and their frequencies to analyze the data. The results found that 68.8% (22 out of 32) of elderly people complained about icons and text being too small. This means that because of this problem, a lot of the elderly cannot use the app very well. Another barrier elderly people face is forgetting the steps to use the app's functionality. 19 (59.4%) of the elderly face this problem. It is also a problem that will increase as the elderly get older.

This can be a significant problem as applications these days have a lot of features. So it would be very hard for the elderly to remember them, which would negatively impact the elderly's psychology. Approximately 46.9% of the elderly found that too many buttons were very frustrating. Which can be very confusing for the elderly, due to this, the elderly would make more mistakes while operating a

Theme	Frequency
I cannot understand the function of different icons	7
Forgetting the steps to use app functionality	19
Too many buttons and information	15
The icon and text are small and hard to understand	22
Other Functionalities	13

Table 1: Elder's frustration

smartphone. These problems are the main factors that lead to elderly cognitive barriers. To further investigate, we wanted to have a different viewpoint, which is that of the caregiver. As they spend more time with the elderly, they know much more about their needs.

5.3 Caregiver's Viewpoint of the Problems the Elderly Face

Even though caregivers are secondary participants in our study, they are one of the crucial pieces to understanding the perspective of the elderly. First, we took data for their age. The age range of the caregivers was between 25 and 45. There were 11 males and 8 females among the caregivers that participated in the interview. Out of the caregivers, 6 were literate, 8 were semi-literate, and 5 were illiterate. Then we wanted to figure out how much the elderly rely on caregivers for their technological needs. This would provide us with key insight into the dependence of the elderly on technology. A caregiver shared,

"I need to help my father regularly, as he calls my brother abroad and usually helps him send pictures in Messenger."

The interview results show that 26.3% (5 out of 19) of the elderly take regular help from caregivers. In addition, the majority of caregivers, or, to be precise, 57.9%(11 out of 19), help the elderly quite often. This shows how much the elderly are dependent on caregivers. And caregivers help with their technological needs.

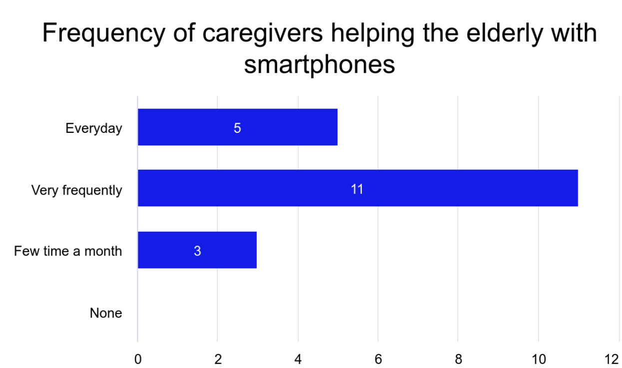

Figure 3: Frequency of caregiver helping the elderly

Caregivers also shared many different problems that the elderly face when alone on their smartphones. By thematically analyzing them, we found the codes.

Theme	Frequency
Navigating through complex interface	4
Using different features of social media	6
Changing smartphone settings	3
Forgetting the functionalities of an app	2
Booking an appointment	2

Table 2: The challenges observed by caregivers in the elderly population

Connectivity is very important, and to connect with other elders, you need to use a social media app. 6 out of the 19 caregivers told us elders facing problems with this social media means that many of the features of the app are very complex for the elderly. It also tells us that a lot of the elderly find it very difficult to navigate through complex interfaces. So we can say that the complex is one of the big problems that the elderly face. Similarly, as three of the caregivers explain to us, the elderly face problems in changing settings; it can also be due to complex layouts. Lastly, forgetting apps' different functionality can be credited to older age. Through in-depth thematic analysis, we can see that complex navigation is the biggest problem that the elderly face. Now we will look into the obstacles that the elderly face in the e-health sector so they can use smartphones to get assistance in the healthcare industry.

5.4 Barriers that the elderly face while using E-health apps

While conducting interviews with the elderly about their smartphone usage we wanted to get a clear picture of what the elderly think about e-health apps. And also find out if they face any kind of problem with the e-health sector. Though many of the elderly are familiar with telemedicine they are not that familiar with e-health apps. One of the elderly was not even interested in talking about it. He explained,

> *" I don't care about these apps and am not even interested because all the doctors are either quacks or money grubbers so I Don't trust them at all."*

We identified a few crucial insights that the elderly are very used to just calling doctors' offices and booking an appointment or they go to doctors' offices physically to book the appointment. Out of 32 elderly 31 (96.9%) of the elderly call a doctor's office for an appointment, 25 (78.1%) of the elderly use just book appointments physically, and only 6.3% of the elderly use other methods.

So to test whether the elderly have problems or not, we let them test an appointment booking app and took their feedback about what they found difficult to use. Out of the 13 elderly (N= 9) which is the majority of the elderly found It was too complex for them. One elderly shared,

> *"It is too hard for this old man just to make an appointment it is too much work and What would happen If I make a wrong appointment."*

This indicates that the elderly are facing problems in applications that navigation is complex and have nested layouts. Moreover, 7 of the elderly voted that they found the icons and text are too small to understand and the search bar is difficult to use. These can be an important reason why they do not use an application for appointment

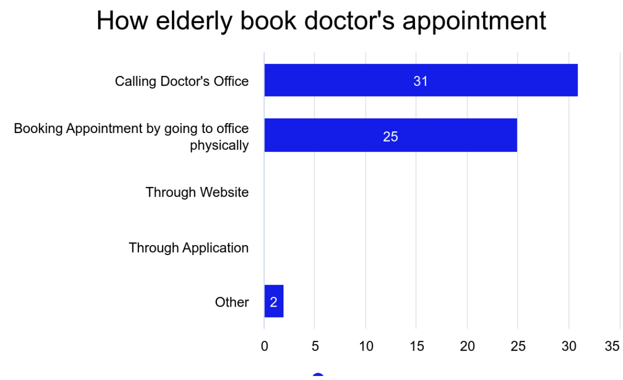

Figure 4: Method of appointment booking by elderly

booking. We also found that the majority of the elderly (76.9%), of the elderly, never used video consultation features. Most of the comments elderly shared,

> *" It is just a waste of money because I don't even know If the the doctor can really understand my problem let alone cure it"*

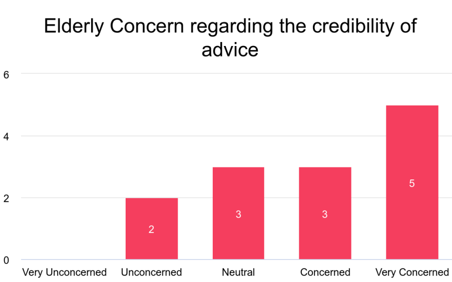

Figure 5: Usage of video consultation

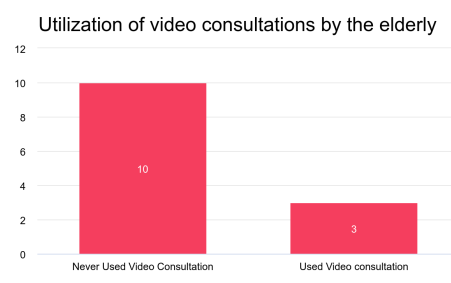

Figure 6: Concerns on video consultation

We observe from Figure 5 and 6 Among the elderly surveyed about video consultations, 15.4% expressed no concerns, 38.5% were highly concerned, and 23.1% had moderate concerns. This distribution indicates a predominant lack of trust in video consultations among the majority, potentially affecting their usage of such services..

5.5 Elderly Barrier from the viewpoint of caregiver

We have identified various barriers that the elderly face in accessing E-health services, and to obtain more detailed insights, we also explored caregivers' perspectives. Caregivers, who are intimately involved with the daily care of the elderly, provide crucial insights into their needs. From our interviews, it was revealed that caregivers predominantly use two methods to schedule doctor appointments for the elderly as presented in figure 7. All caregivers reported using telephone calls to arrange appointments, while nearly 95% (18 out of 19) also reported making appointments through in-person visits to the doctor's office.

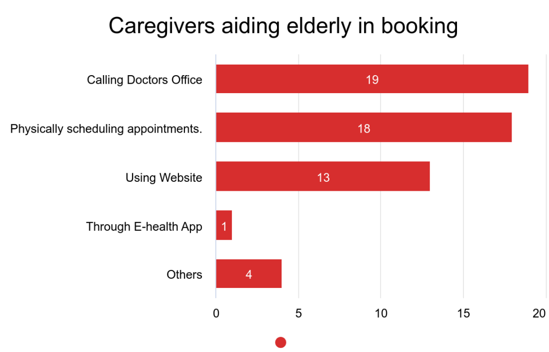

Figure 7: How caregiver book elder's appointment

Moreover, they do not want to use applications to book appointments. A caregiver shared with us,

"Why would I use these round ways such as an app to book an appointment when I know the number of the hospital and my friend is a doctor there so I can easily book an appointment with just a call"

The majority of caregivers also expressed that it is very easy to book an appointment for the elderly with a phone call. That is why 10 out of 19 caregivers are not willing to use an app for appointment booking.

In addition, Caregivers Shared with us that they usually call their familiar doctor to find out what type of doctor they need to take the elderly. Also, caregivers sometimes use Google to find out what type of doctor the elderly should visit. So when caregivers were asked if there had been an instance where they visited a doctor and were recommended to see another doctor, the majority responded affirmatively. Nearly 94.7% of caregivers find themselves compelled to accompany the elderly to consult different healthcare professionals. Caregiver Mohiul Islam told us,

"It is very inconvenient you know I have a job and Taking my grandfather to the hospital is already a tough task because I need to take a leave. But when doctors suggest other specialists It just gets worse"

This proves inconvenient for caregivers for all caregivers. Additionally, it poses challenges for the elderly, given their physical frailty. Now we understand both the problems elders and caregivers face using an E-health application.

5.6 Challenges And Opportunity For Intervention

After analyzing data gathered by interviewing related elderly and caretakers, the question is whether our application design will be able to fulfill the elderly needs and help them attain digital autonomy. So the following questions are related to how to design our application. After we interviewed the elderly we got to know the elderly problem. So we understand elders' preferences and know what they don't like. And as the current E-health sector, many of the apps are not elderly-friendly so there is a lot of opportunity for us to exploit. By creating an app that is easy for the elderly to use, help the elderly to use E-health-related apps. First, we know that for application design simplicity should be our main priority. So we wanted to know if the elderly are willing to use an app that will suggest a doctor based on symptoms. The elderly were unsure at first but the majority were positive. One of the elderly shared with us,

"I would only use it if it is free and easy to use otherwise there is no chance."

Moreover, we asked the caregiver the same question 57.9% (11 of the 19) caregivers' responses were positive. Approximately 36.9% of the caregivers were unsure whether to use it or not. So as we got a lot of positive answers both from the elderly and caregivers we decided to implement our application.

While this study provides valuable insights into technology usage among the elderly, the small sample size and the internal diversity within the categorized groups limit the ability to generalize the findings. Future studies should consider a larger and more uniformly distributed sample to enhance the representativeness of the results.

6 SMARTSHEBA DESIGN

To determine the responses to our second question in phase II we developed SmartSheba, an e-healthcare solution that suggests doctors to the patients according to their symptoms and provides easy access through call-to-action buttons to the important numbers and the emails of the designated hospital. We collected the data resources from Central Hospital Bangladesh's website according to fair use of data policy. We classified the classifiable data into a CSV file and the unclassifiable data into text formats in a PDF file. Open AI's assistant does not support the CSV format hence we converted the CSV format to HTML using Microsoft Excel's direct HTML Conversion feature. We fed the data to the assistant which we named central care. We provided it with the following prompt,

"You are a helpful assistant for the central hospital. You give empathetic responses based on your knowledge base You also detect symptoms and suggest which doctor should a patient visit based on your knowledge base. If you are unable to help you suggest they contact the central hospital at 02-41060800-19 for the information and appointment booking."

However, using the data resource in multiple languages can result in wrong results. We had skepticism about it. Hence we focused on the chat completion API. Which takes a system prompt we provide as much data as possible through the system prompt to ensure correct results [34] and we named it Primary Care. One skepticism remains if a less informative chatbot can fulfill the information expectations of the elderly population. Following is the system prompt that we provided to Primary Care.

"You are a helpful multilingual assistant for Central Hospital #the best hospital and no 1 in Dhaka. You empathetically respond to a user. You suggest what type of Doctor should a patient visit based on the symptoms. If you don't have any specific answer for something or a user wants to book an appointment you will suggest they call 02-41060800-19 or visit Central Hospital House 2, Road 5, Dhanmondi, Dhaka. You give your response in English. But if the user asks for other languages you give your response in that language. If the user wants to know more about the hospital you will ask them to use the Hospital Care bot. Maximum response word limit 50."

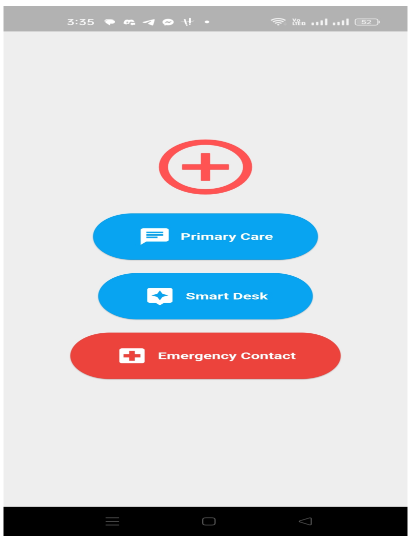

Figure 8: Home Screen in English

Figure 9: Home Screen in Bangla

Figure 8,9,10, and 11, represents the interface of SmartSheba.We ensured the design of both versions of the application ensures the cognitive barrier of the elderly in the usage of technology is met and reduced. Hence we deduced as many as features possible. We only kept the key feature of quick accessibility to the required contact sections and for navigation, we used icon buttons in the English version and numbered buttons in the Bangla version. Since our demographic distribution has a section that is unable to read we introduced a voice assistance in Bangla that reads out the navigation buttons with numbers. Since number recognition capacity is present in all categories in our demographic distribution we performed such a solution.

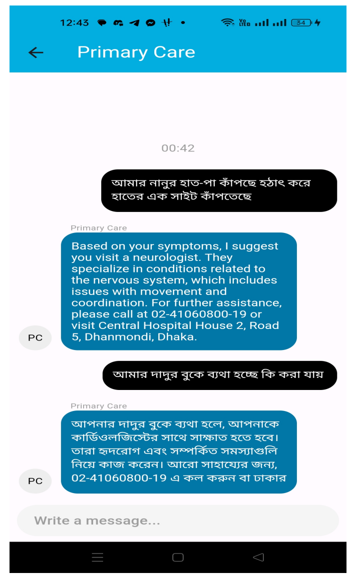

Figure 10: Primary care

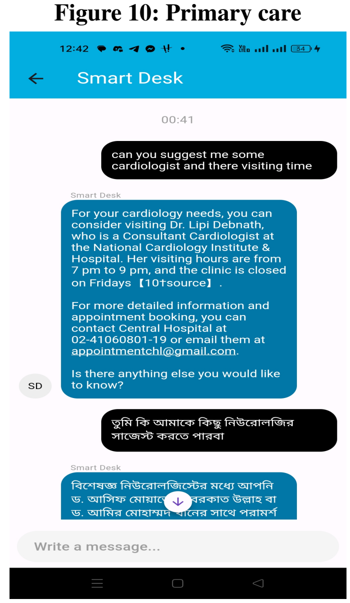

Figure 11: Smart desk in English

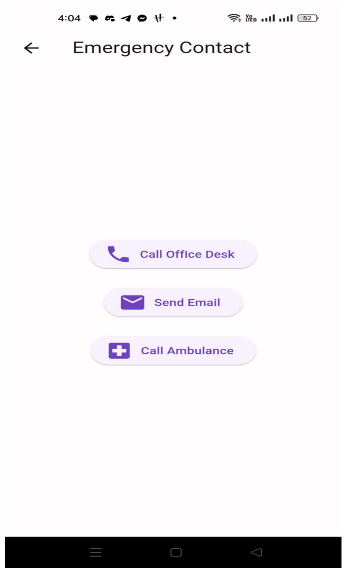

Figure 12: Emergency contact

6.1 Feedback From the Elderly

Following many interviews we have developed our final app, incorporating a Language Model (LLM)-based chatbot. We gave 18 elderly to test our app of which 8 were educated, 6 were semi-educated and 4 were illiterate. The Elderly found the smart desk feature of our app very useful due to getting more detailed information about the doctor. In our Likert scale measurement, we discovered that 44.4% agreed, and 16.7% strongly agreed that smartdesk is useful. However the elderly did not like the primary care chatbot due to only suggesting a single hospital and not giving many or a variety of data. In our Likert scale measurement, we discovered that 44.4% were neutral, and 27.8% disagreed that Primary care was useful.

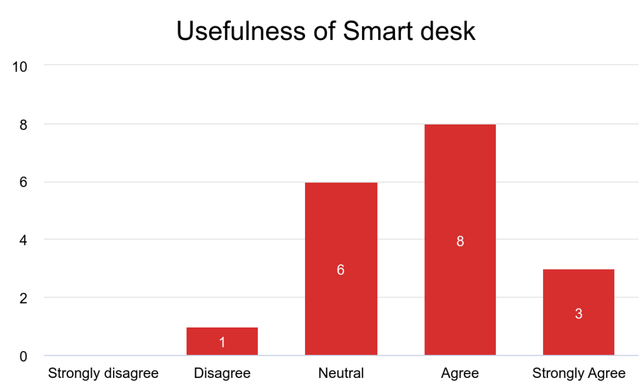

Figure 13: Usefulness of smart desk

To evaluate our application we are following several assessment strategies. Firstly we are doing UCD screening numerical analysis. This requires data such as Success rate, Error rate, and Completion Time.

We found out that the literate people's success rate is higher than both illiterate and semi-literate people. On the other hand, illiterate people's English results were invalid as they could not perform any task without assistance. By comparing the data we can further see that literate elderly performed the best.

Lastly, we used the System Usability Scale (SUS) to measure the usability. By asking those 10 questions we can better understand our app performance. After conducting the sus 2 times for both Bangla and English we found that illiterate had higher SUS scores for both Bangla and English. On the other hand, elderly who are illiterate because they do not understand English the SUS scores are very low which is 16.87 and 17.5 respectively.

While analysing elderly comments on the SmartSheba app we have found different codes. We found that the frequency of technology moving very is highest which is 7. So a lot of the elderly were amazed at how technology is developing at such a fast rate. They were very fascinated with the app as it was a new concept to them. Moreover, 5 of the elderly liked that they could easily get doctors' information. Even though it is very new to them, they liked it as it can save them much hassle. We also can see a lot of the elderly do not fully trust our app.

While conducting the interviews we also get comments from their givers. After taking them we started to analyze them. After a few iterations code started to emerge. Codes like "elderly are easily overwhelmed", and "They learn it easily if it is familiar" started to appear. It gives us a clear picture of the elderly mentality.

6.2 LLM Analysis

Now we are going to assess the LLM on the Metrics of Mean Accuracy-Performance Analysis. To calculate we have to understand Failure Numbers, Hallucination, and Response time. Firstly, We have assigned 200 points total, and the 200 is divided into two parts 100 points for accuracy and 100 for performance. We used the formula to calculate Accuracy-Perforation points. We had 19 elderly participated in our analysis. Then we conducted the calculation by adding accuracy points with performance points. Also when wrong data is generated or you can say hallucination occurs then we subtract it from the success point.

It showed that the mean Accuracy performance for English = 675+56.23 which is 123.75 and the mean Accuracy performance for Bangla = 52.5+56.25 which is 108.75. So we can successfully see that results signify a substantial advantage in the model's performance when processing and generating responses in English, highlighting its adaptability and effectiveness in different language scenarios.

7 DISCUSSION

In the section above we attempted to give a clear understanding of the elderly and what kind of barriers they face while using smartphones. By interviewing we get to know from them their problem. Also, we were able to carefully present elders' usage of applications in the e-health sector and what are the problems they face. We now present a discussion about our findings, how to meet the cognitive needs of the elderly, and how the elderly can get autonomy. Elderly people in Bangladesh are increasing [54] and they are a crucial part of the society [38]. If they are not well versed in technology they

	Literate			Semi Literate			Illiterate		
	Success	Fail	Time	Success	Fail	Time	Success	Fail	Time
English	0.787	0.213	22.25	0.606	0.394	24.16	0.082	0.918	invalid
Bangla	0.746	0.254	22.62	0.716	0.294	23.3	0.495	0.505	25

Table 3: UCD screening numerical analysis

App version	Literate		Semi Literate		Illiterate	
	Male	Female	Male	Female	Male	Female
Bangla	55.93	53.72	53.75	52.5	38.33	37.5
English	56.87	52.5	51.25	50	16.7	17.5

Table 4: Average SUS Score of Both Versions

Theme	Frequency
Easily get doctor information	5
Get emergency help	2
Not sure to fully trust it	4
Technology is moving very fast	7

Table 5: Thematic analysis of the feedback of elderly on smart sheba

	Accuracy Average	Performance Average
English	67.5	56.25
Bangla	52.5	56.25

Table 6: LLS Average table

would never be able to gain autonomy in this digital age. During the interviews, the elderly conveyed their frustration with icons and text being excessively small and difficulties in remembering the steps to use a particular feature. A frustration rate of 68.8% among the elderly indicates that as individuals age, there is a noticeable deterioration in their physical abilities, hindering their interaction with smartphones. The related result tells us to design an interface where text size should be 12pt and higher[58]. Also, it is a great indicator that most of the apps in the market do not consider the elderly when designing an interface. Moreover, the Elderly about 84.4% like vibrant colors. The reason is that as their eyesight decreases pale color becomes harder to read. Moreover, the related research shows when designing interfaces for the elderly it needs to have clear color contrast [72, 74].

Moreover, from the theme, it became very clear what are the frustrations the elderly face. As the majority of elderly people face problems such as small text or forgetting app navigation, it is clear that solving them can help the elderly to easily use different interfaces. In addition, one thing became very clear the key features that the elderly need are a user-friendly and easy-to-navigate interface and step-by-step guidance. Our research showed that elderly people rely heavily on the caretaker for technological needs. In other words, their or caregiver's opinion means very much to them. So we need to inform the caregivers of the e-health application that the elderly can easily use so that they can encourage the elderly to use this application. Which would help the elderly meet their needs. So in conclusion making the text big, Having great color contrast, Very easy-to-use navigation, and usage of meaningful icons can help the elderly a lot by removing barriers and solving their cognitive needs.

In this paper, we have conducted many interviews to understand the demand for E-health by the elderly population. The findings indicate that a significant majority, approximately 96.9%, primarily choose to call the doctor's office to make appointments. The reason is that calling a doctor's office is much easier. Our interview clearly shows that they face difficulties including complex nested expressions, using search bars, and small text and icons. Why would the elderly go through this hassle and challenge to book just an appointment when they have an easier alternative? Additionally, the interview results indicated that most Healthcare receptionists still maintain appointment lists in physical notebooks, suggesting a reluctance to embrace app-based appointment booking [27]. In Bangladesh, the adoption of appointment booking by the elderly is limited, largely due to complex interface designs. Our study also explored the use of video consultations among the elderly. We found that a significant 76.9% of the elderly have never used video consultations, primarily due to mistrust in the advice offered remotely by doctors. To address this measures such as educating the elderly about doctors' qualifications and reducing consultation costs could enhance trust and usage of e-health apps.

Moreover, the integration of Large Language Models (LLMs) into Smart Sheba provides a distinct advantage in the context of senior care, particularly when compared to traditional, non-LLM methods. One of the key differentiators is the ability of LLMs to eliminate the need for complex, nested navigation structures that are commonly found in non-LLM systems. Studies have shown that nested navigation—where multiple layers of menus and options must be navigated—significantly increases the complexity of use, especially for older adults who may struggle with cognitive overload or unfamiliarity with technology [62]. This design challenge often stems from the need to maintain a clear separation between the application's functionality and the user's experience. By leveraging LLMs, Smart Sheba simplifies the user interface and interaction model. Rather than requiring users to navigate through layers of menus, LLMs can infer the desired actions based on natural language input from the user, effectively bypassing the need for complex navigation. This leads to a more intuitive and seamless interaction, reducing cognitive load and frustration for senior users.

User-centric designs that reduce the number of interactions required to perform a task lead to improved user satisfaction and overall experience. (REF). Furthermore, seniors often face challenges related to reading difficulties, such as presbyopia, or memory issues, which make it harder for them to follow or remember multiple steps in a nested interface. Non-LLM systems, which rely on static menu-driven interactions, often leave these users feeling overwhelmed or lost [75]. In contrast, LLMs enhance the interaction by allowing users to express their needs conversationally, thereby simplifying the process of task execution. Additionally, the integration of LLMs significantly improves the voice-aided systems that many senior care applications rely on. Voice-activated systems are beneficial for seniors, particularly those with limited physical or visual capabilities [26].

However, non-LLM systems often provide voice functionality that is rigid and dependent on specific commands, which may frustrate users unfamiliar with the precise terminology. LLMs, on the other hand, allow for a more flexible and natural conversation, improving accessibility regardless of the user's technological proficiency or prior experience with such systems [52].The adaptability of LLMs also caters to the diverse cognitive and physical abilities of seniors, ensuring that the technology can be tailored to individual user needs, which is a critical factor in the design of assistive technologies for the elderly [19]. Thus, the incorporation of LLMs into Smart Sheba not only increases usability but also enhances inclusivity, ensuring that seniors, regardless of their reading abilities or memory limitations, can effectively interact with the system and benefit from its features.

7.1 Simplicity is the Key

In our system, simplicity is vital. We tried to build the most simple application that the elderly can use very easily. We wanted to find out how effective a number-based or icon-based button is for elderly people. The result clearly showed that the elderly who were educated preferred the icon button. Because the elderly who are educated from our interview showed that most of them are familiar with the interface of a smartphone. The elderly who have illiterate education backgrounds preferred the number button. Firstly as they do not have any formal education they are not very good at typing or reading text. The elderly population preferred smart desk feature of the smart Sheba app. One of the reasons is that it can help them find a good doctor or hospital and provide them with extensive information. On the other hand, The Primary Care Chatbot was not very liked by the elderly. The main reason is it is biased towards certain hospitals and as it keeps suggesting the hospital.

By giving 3 tasks for the 3 features of our app smart Sheba we were able to find out the success, failure rate, and completion time. From the ucd screening numeric analysis literate have a higher success rate as they can understand the language and they are more familiar with the interface of a smartphone. To further analyze the usability of our app smart sheba we have asked the SUS question and generated the SUS score. The result showed that the elderly who were educated had higher SUS score and their SUS score for both Bangla and English is quite close. However elderly who are illiterate their SUS scores are low in English because they cannot speak English. So for Bangladesh's perspective, Bangla has more edge than English is usability as almost everybody understands it. An inclusive design strategy is our research outcome. This is based on User-Centered Design. This strategy is an iterative design strategy. Implementation of this design strategy helped this research to gain the outcome which was the inclusion of elderly from various backgrounds of life to be included into the world of information exchange via technology.

7.1.1 Navigation. Navigation is a key tool in information access through digital mediums like websites, applications and other forms of digital medium. Our studies have shown that the majority of the elderly feel suffocated whilst using any application which has too many complex layouts. We thereby suggest in our research that whilst designing using an inclusive design strategy One must take into consideration not using the nested layout. Instead, our research suggests an alternative medium of information presentation through isolation and segmentations. Which is using LLMs instead of nesting in the layout section. Which results in a better result and makes navigation much easier for elderly individuals. The broader concept of navigation can be divided into further categories, Representational Navigation, Directed Navigation.

7.1.2 Representational Navigation. Representational navigation assesses the importance of creating isolated segments that deal with isolated functionalities but functionalities that are vital in the access to information. Such as CTA. CTA buttons reduce the complexity of navigation. This Isolation can be performed by the isolation of color. Our suggestion is to use Red as the isolation color. Which has produced a decent increase in the success of accessing the important CTA page.

7.1.3 Directed Navigation. In our research directed navigation was a key feature aside from CTA. Average CTA is a button that navigates the user to the designated mobile services that the user is looking for. However, message-directed navigation helped the users open the necessary mail to book their appointments more easily than the number. As the appointment number did not have this feature thus the elderly felt the necessity of the CTA on the number.

7.1.4 Language in Directed navigation. Language is a key feature in our research. Our research proposes that whilst designing using an inclusive design strategy the designer must know the demography. In the case of the demographic users are literate and semi-literate the designer may use Bangla or English. For the literate demography, English is slightly more preferable as it produces better results in LLM. Additionally, if the population is generic instead of Icon buttons numbered buttons must be used.

7.1.5 Reduced Complexity. Complexity in design is the biggest obstacle to designing inclusive designs. In the inclusive design strategy, the focus is more on simplicity and clarification than visual appeal and animations. From the qualitative analysis of our caregiver's feedback, we made discoveries such as the elderly often leave trying new applications in the very first steps. Whenever they face any complexity. It does not matter how much a design is instructional complexity in presentation is the barrier that surpasses the instructional design. Hence inclusive design strategy proposes simplicity over visual appeal.

7.1.6 Familiarity. The elderly are more reluctant to utilize new forms of apps than the existing ones. One of the key examples is the social communication applications. Elderly surveys have shown that some of the elderly do use some form of e-health such as asking for a doctor's advice through messenger. Which is a medium that they are already familiar with. This is because due to the usage of social communication apps by their familiar people, they got familiar with such apps. One of the key examples is the messaging apps. The reason familiarity is important is that we have seen that they are all using almost two types of social communication applications and the caregiver feedbacks suggest that the caregivers had a lot of trouble teaching them the first social communication application but not the second one so much. Thus for any effective design familiarity is important.

Finally, table 7 provides a comparative analysis of previous studies and our research, focusing on key factors such as the reduction of usage complexity for elderly users, the integration of AI and LLMs, and the associated limitations. The comparison highlights that while some prior studies address certain aspects of user experience improvement to varying degrees, none comprehensively meet all the criteria for an enhanced user experience. In contrast, our research offers a thorough approach, successfully addressing all categories with minimal limitations, thereby advancing the field with more robust and user-friendly solutions.

7.2 Meeting Sustainable Development Goals

This paper is dedicated to addressing the Sustainable Development Goals (SDGs), specifically focusing on the third and sixteenth goals. The third goal, "Ensure healthy lives and promote well-being for all at all ages," emphasizes the importance of universal health and wellness, advocating for comprehensive healthcare access and the promotion of healthy lifestyles across all demographics. The sixteenth goal, "Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels," underscores the necessity of fostering peaceful, inclusive, and just societies [**?**]. It highlights the imperative to ensure equitable access to justice and to establish robust, transparent, and accountable institutions at every level of governance. Our research endeavors to contribute to these global objectives by exploring relevant strategies, interventions, and policies that can advance health and well-being, as well as societal peace and inclusivity, thereby supporting the broader agenda of sustainable development.

This paper addresses the critical issue of promoting well-being for individuals of all ages by ensuring that the most deprived demographic—namely, the elderly—gains access to technology. By positioning the elderly as the primary beneficiaries of this research, we enable them to leverage the power of technology for their daily healthcare needs. This study aims to enhance the independence of the elderly from caregivers through the implementation of an inclusive design strategy, ensuring that essential health information becomes accessible to them. Access to reliable health information is crucial for maintaining a healthy life. The elderly, often deprived of such information, typically rely on caregivers who may be less informed on pertinent health matters. This dependency can result in improper treatments and potentially life-threatening situations. By facilitating direct communication between credible healthcare providers and the elderly population through the Smart Sheba initiative, this paper seeks to make public health information readily accessible to the elderly, thereby mitigating risks associated with misinformation and enhancing their overall well-being.

Additionally, including elderly individuals from all literacy segments in technological initiatives fosters the formation of an inclusive society, aligning with the sixteenth goal of the Sustainable Development Goals (SDGs). This goal emphasizes the creation of peaceful and inclusive societies for sustainable development by providing access to justice for all and building effective, accountable, and inclusive institutions at all levels. By promoting an inclusive design strategy that empowers the elderly to become independent in their use of technology, this paper highlights the potential for achieving sustainable development. Making design accessible not only enables the elderly to obtain credible information but also reduces their apprehension about using technology. The system usability score indicates that if the system can produce meaningful responses and deliver accurate results, the elderly will develop a positive perception of the system. Consequently, this positive perception and subsequent adaptation will contribute to the formation of a peaceful and inclusive society. Furthermore, by building effective institutions, such as healthcare institutions, and ensuring that information is effective and accessible, this paper demonstrates the critical role of inclusive design in supporting the broader agenda of sustainable development.

8 LIMITATIONS AND FUTURE WORK

We have explored the integration of LLM-enabled chatbots to enhance the user experience of older adults, but certain limitations must be acknowledged. First, the crucial limitation is Cultural Differences. Additionally, another shortcoming is our proposed solution relies on the capabilities of LLM-based chatbots. As a chatbot is not fully developed technology, it can make mistakes at times. Lastly, It is not possible to capture the long-term impact of the integration, and changes in elderly preferences due to factors like the longevity of the experiment and other constraints.

We have shed some light on the preferences of interface design and the various challenges faced by the elderly while using smartphones, specifically eHealth applications. Firstly, one of the future scopes is to Study AI-integrated UCD patterns for the elderly, overcoming cognitive and literacy constraints, and promoting smart living acceptance. Moreover, another scope is exploring the integration of an I/O medium with a native language interface for elderly-friendly chat screens and chatbots. Which would enhance elders' using experience. Lastly, Implement other open-source services to build free applications for the elderly so that they can use them without any financial liability.

9 CONCLUSION

In this paper, we explored the cognitive barriers the elderly face during application usage and proposed a feasible design strategy to address these challenges for seniors of all backgrounds. While we did not find a working solution for an automated I/O system and voice assistant playback, our manual systems suggest that automation could eventually provide complete autonomy in these areas. Our tests included feedback from the elderly, caregivers, appointment-booking professionals, and doctors. Integrating LLM to streamline information within the application showed promising results in reducing the complexity of nested navigation, a significant frustration point for both elderly users and their caregivers. However, accuracy issues remain a key challenge for LLM researchers. We proposed an "Inclusive Design Strategy" that aims to empower the elderly in their technology usage, and despite some limitations, our implementation in an e-healthcare application yielded promising results.

systems	Simplified system for elderly	Complete integration of elderly users	Used AI	Used LLM	Limitations
virtual pillbox [10]	✓	High	No	×	Only works with medical dosage reliability.
HomeCare4All [29]	✓	High	No	×	Only works to build trustworthiness, other usability factors are uncertain.
Chat-GPT Model for Medical Responses [13]	×	N/A	Yes	✓	Only checks accuracy of medical queries. Not tested for consumer use.
Ours	✓	High	Yes	✓	**Open Source Model**

Table 7: Comparison between previous research And our research

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