

Dristikohon: Reimagining Platform for Visually Impaired Individuals Inclusion to Digital Financial Services in Bangladesh

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A thesis submitted to the Department of Computer Science and Engineering
in partial fulfillment of the requirements for the degree of
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Declaration

It is hereby declared that

1. The thesis submitted is our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

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Ethics Statement

This research was conducted holding utmost respect towards the views, rights, dignity, and status of all participants, particularly acknowledging the marginalization by society due to the unique needs of Visually Impaired Persons. Before working on our data collection, our research protocol was reviewed and approved by the Institutional Review Board (IRB) of BRAC University. Our questionnaire was evaluated by multiple Visually Impaired Persons before the finalization and data collection. Prior to each interview we took verbal consent informing the participants adequately on the purpose of the study, data privacy, right to withdraw, recording conversations and their right as a participant. All the interviews were arranged in an environment the participants felt comfortable and safe within. All identifiable details were omitted while doing the transcription besides keeping the demographic information intact. We express our gratitude towards all the participants who opened up to us and shared their views and issues to represent to the world.

Abstract

Accelerated digitization has thoroughly reshaped the ways individuals communicate, access information, manage daily activities and conduct financial transactions - especially for people with disabilities. While existing research has extensively examined challenges and adoption strategies in the context of Global North, a significant gap remains in understanding user engagement in the Global South, given the infrastructural asymmetry and socio-economic distinction. Our study aims to bridge the gap by exploring how visually impaired individuals navigate the world of technology, focusing on the influence of socio-economic factors in shaping these engagement, access and navigate financial services - particularly digital financial services (DFS), and the strategies they employ to overcome structural and contextual barriers. Guided by these research questions we conducted focus group discussions and semi-structured interviews with 18 visually impaired individuals in urban settings to get a glimpse of their lived experiences with technology and digital financial services. The findings highlights the negative effect of societal perception in shaping technology use and hindering daily activities, challenges faced in financial transactions, local mobile financial services incompatibility with screen readers. It also reveals design features to enhance security in systems that often create vulnerability, reduce accessibility, and exclude the marginalized ones from such platforms. We align these findings to various sociological, post-colonial theories to assess the impact and draw similarities with previous work to emphasize the need for design and build with intended users and bring visibility through prototyping “Dristikohon”. Dristikohon is a platform prototype focused on incorporating the noticeable design limitations that Visually Impaired People face while using existing mobile financial systems. Our work brings the fundamental concepts of Human Computer Interaction into use to empower a marginalized community from alienation, exclusion with smart and participatory design.

Keywords: Visual Impairment, Digital Financing, Mobile Banking, Financial Inclusion of Blind and Visually Impaired, Accessibility, Global South.

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Chapter 1

Introduction

1.1 Background

With the rapid advancement in technology, the financial landscape in Bangladesh has witnessed great transformation in the digital financial service (DFS) sectors along with its escalated involvement in the post COVID-19 pandemic times. Although non-poor households, individuals in non-agricultural settings and those from urban areas have an upper hand in taking leverage of digital financial services like bKash and Rocket due to familiarity to such interfaces [44], the inclusion of marginalized groups in this ecosystem remains an ongoing challenge - especially for the visually impaired individuals. For a life without the privilege of vision, the access to banking sector has been a challenge to the independence of many from the beginning [49]. Additionally, due to lack of knowledge about technological competencies according to different needs, the designing interface that remains readable to the general users sometimes create usability challenges for the non-sighted users [76, 78, 102].

While there exists quite a platform to ease adaptation in daily life through digitization whether direct, supported, depended or restricted with the help of mobile phones [47], visual description services (VDS) like VizWiz, ShopTalk [55, 61] or usage of audio CAPTCHAs [10], screen readers [35] - none of them are seen to be in widespread use in the mobile financial banking sector; especially in context to a technologically deprived country like Bangladesh. On top of that, studies being conducted over blindfolded sighted participants instead of actual visually impaired individuals often stress onto the existing loopholes for creating such platforms for inclusivity [57]. This often leads to the dire need of the Blind and Visually Impaired (BVI) people to customize/personalize existing assistive technologies [75] which should have been inclusive as produced in the first place. Not to mention, where daily life remains a struggle to prove independence in performing the simplest of chores, having to depend for own account settlement adds to the sense of lack of privacy and security for the visually impaired individuals [22].

On the contrary to that, similar concerns have been noted in other regions. Older street vendors from China with impairment issues often rely on others' QR codes to perform transactions, depicting the shortcomings of accessible usage of digital financing across all ages and socio-economic settings [74]. As such accessibility is

often compromised when it comes to the consideration of special needs, frameworks have been proposed aiming at online banking to make it secure for blind users [72]. These examples illustrate that accessibility challenges in digital financing sectors are not unique to Bangladesh although the impact here is further grounded by socio-economic lackings and infrastructural barriers. In Bangladesh itself, during the early COVID-19 pandemic times, the presence of inaccessible devices with stable internet connection in academic settings among visually impaired students translated to the incompetency of digital financial interactive platforms as well [66]. Overall, such incidents suggest that, even though today's world is on people's fingertips, there is still a long way to go as the fear of being deceived weighs heavily on the minds of BVIs and we remain responsible to provide a fair ground by providing inclusive platforms for all, irrespective of who they are [56].

1.2 Rational of the Study

Access to financial services, irrespective of one's physical disabilities, must be ensured to establish economic empowerment and social inclusion in society. In Bangladesh, the tremendous spread of digital financial services - especially mobile banking platforms like Nagad, bKash, and Rocket, along with ATM services - has brought a revolutionary change in the financial sector. However, studies on the adoption of mobile banking highlights factors like trust, eased usability along with socio-cultural influence to play crucial roles in overall technical upgradation [26, 40]. While these developments face setbacks even to serve regular users, the concerns of visually impaired persons (VIPs) remain even more overlooked.

As of 2020, it was found that there were about 0.9 million blind people and 26.6 million people affected by some form of vision loss in Bangladesh [54]. In spite of the rapid digital transformations, the visually impaired people encounter uncountable obstacles due to the lack of technology that would properly assist them to read the screen, challenging app interfaces and lacking financial literacy targeted to their requirements [76]. Similarly, in regional studies, unadaptable designs besides lack of locally adaptable solutions prevent visually impaired individuals from actively participating in digital platforms [37]. Focusing on the broader picture, we can see that the United Nations Convention on the Rights of Persons Disabilities (CRPD) stands for the right of the disadvantaged and non-privileged people of the society to use digital financial services without any inconvenience [7]. Intellects promote inclusive learning environments and social participation as those have capability in reshaping confidence and independence of visually impaired peoples in public and economic settings [31, 84]. So, reinforcing such accessibility in financial maintenance must be envisioned as a vital feature of the broader rights-based inclusivity.

The motivation behind this study roots in the urgent necessity to re-evaluate the gateway to digital banking services by visually impaired persons in Bangladesh while understanding how modern technologies, improved interfaces, and proper planning can ensure their inclusivity. This motivation is also personal as we believe that financial inclusion is not confined only within providing service - it is also a matter of independence encapsulated by dignity. Not being able to perform the simplest of technical tasks alone without assistance undermines individuals' capability to

survive, often eroding confidence to participate at the same pace within a society. Furthermore, without guaranteed participation of all its citizens, regardless of disability - a nation cannot fully be developed.

While digital growth or economic indicators can work as parameters of development, true development remains confined within acknowledging the most vulnerable members of the societal class and working on building harmony through incorporating solutions to their needs within existing systems/newly built systems. Our understanding led us to believe in the necessity of building an inclusive platform from the very beginning instead of treating it as an optional feature. Therefore, this paper focuses on emphasizing on universal design principles and ensuring easy accessibility and usability to assistive tools. By exploring the experiences of visually impaired individuals, we aim to identify the challenges they face and propose measures to facilitate their inclusion in the financial industry. With the motto to ensure that one of society's most vulnerable groups is not left behind in the digital revolution, this study aspires to improve inclusive financial technology through both academic discourse and practical solutions. Ultimately, this paper remains a moral responsibility above academic exercise. It works as the motive to bring every citizen of Bangladesh, regardless of their disability, to stand on the same fair ground when it comes to opportunity and respect.

1.3 Problem Statement

The emergence of digital financial services like bKash, Nagad, Rocket, Upay and ATM systems have drastically changed the cash flow operation in Bangladesh. Even though these digital enhancements intend to make human life a bit more easy going, it often forgets to merge the visually impaired group of marginalized people in this advancement. While the main aim of this platform is to improve mobility along with self-sufficiency for all, visually challenged individuals face significant complicity in its accessibility. This necessarily means, that even routine financial activities require outside assistance at times which demeans their sense of liberty and personal freedom.

The current existing systems force the vision impaired people to rely on others to perform their tasks as those barely integrate screen readers, voice-based feedback or accessible ATM interfaces. This situation not only questions their independence but also raises significant risks to their privacy and data security [19, 73]. International researchers have upheld the fact that, in similar issues, they often come up with their own ways to gain their basic access to financial services [76]. However, these efforts are not recognized by mass generals facing the same difficulty and are neither fully-proved effective in the longer run.

Even though many regions like Kibera in Kenya have provided much support to the visually impaired people to use mobile phones for their daily needs, in Bangladesh, the situation is not improving drastically due to the infrastructural constraints, inconsistent enforcement of accessibility policies, and a lack of user-centered design practices [47]. Despite the growth of financial technologies, the gap remains noticeable in contrast to Bangladesh where limited conducted findings have examined the

bindings toward digital financing access for visually disadvantaged ones. Thus, this paper aims to examine the specific barriers faced by visually disabled individuals in accessing digital financial services in Bangladesh, and to recommend practical solutions based on both technological and policy reconstruction, that can support inclusive financial participation. Without the required intervention, digital financing sectors might widen inequality instead of eradicating it in the broader narrative. This study, therefore, contributes to ensuring the empowering of visually impaired citizens instead of excluding them.

1.4 Objective

More elaborately, this study focuses to explore and identify the usability and accessibility challenges faced by Visually Impaired People (VIP) when interacting with Digital Financial Systems. It focuses on interviewing visually impaired users who have been involved in interaction with such platforms to gather insights directly. Based on the insights and the identified issues in the existing systems by the existing users from this community, a functional and inclusive prototype called “Dristikohon” is introduced, acknowledging the limitations of existing systems. Finally, the prototype is evaluated considering the parameters of improvements that were required to be introduced within the modified system to assess its effectiveness with the help of visually impaired individuals. The key objectives are as follows:

To do a systematic analysis of existing literature related to the usability and accessibility of mobile and digital financial services (MFS & DFS) for visually challenged people, with an aim of specifying recurring challenges, examining current solutions, and evaluating the limitations of both proposed and implemented solutions in global and more importantly local contexts. The global context, considering more advanced scenarios - are to be suggestively incorporated within the modified system. Besides, as the Global South remains familiar to the socio-cultural scenario in consideration to existing stigma and financial hardship, the prototype will work on bringing inclusivity to the design such that the platform tends to be accessible irrespective of demographics.

To practically investigate and analyze widely used DFS and MFS platforms especially local platforms such as bKash, Nagad, Rocket etc. with the aim of identifying existing measures taken to modify and enhance accessibility for visually impaired people. This includes comparing the approaches and challenges focused in the literature and those evident in existing platforms with evaluating the feasibility and effectiveness of these approaches within it. From our study motive, with the taken interviews - emphasize on user acknowledged platforms are prioritized. This study looks into exploring what makes one platform to be better than the other in consideration to inclusivity and what remains unnoticed - to be included within the platforms. A core analysis focuses on whether the user experience for the visually impaired individuals remain compatible to that of general users in the locally used mobile banking platforms. It more specifically looks into whether the platforms are capable of providing financial independence irrespective of existing vision based disability with respect to Bangladesh.

To identify the specific shortcomings in the user experiences of visually impaired individuals when interacting with DFS and MFS platforms through open ended interview questionnaires and understand it. This includes gathering feedback on what could have been done differently, what features or improvements users believe would enhance usability, and synthesizing common challenges and suggestions across participants. Considering that the existing platforms will possibly require a lot more features of improvement, non-existent features that would be a nice-to-have while struggling with disability will be acknowledged through the vision of conscience of the visually impaired individuals. This will further, in near future evoke the sense of essentiality among the system builders to have a dedicated community to serve the purpose of inclusivity by considering the corner case solutions.

To design and develop a functional prototype, “Dristikohon”, that addresses the challenges identified through literature review and evaluation of existing DFS/MFS platforms acknowledged through interacting with the visually impaired users themselves, while integrating new features based on feedback gathered from visually impaired participants. The goal is to ensure a groundwork for developers and a motivation to work on building a full fledged working platform reintroduced with keeping inclusivity in mind. With limited workings done previously from Bangladesh’s perspective, the following prototype will essentially act as a ground work, one of its kind.

To conduct a germinal stage usability reachability of the prototype with the visually impaired participant in order to assess the effectiveness and overall user satisfaction. These findings will inform potential improvements, and with recurrent improvements within the prototype - a better version of the approached system will be created each time, resulting in the visually impaired users to get a close to general user experience in respect to efficiency and stability added to protected privacy and security concerns in the years to come.

Doing so, the study not only targets academic settings but also seeks assistance of industry practitioners, policymakers, financial institutions along with technology developers to embed inclusion within digital financial settings. By fulfilling these objectives, this research intends to navigate an ideal guideline for analyzing the current states of Digital Financial Services (DFS) and Mobile Financial Services (MFS), and for developing a system that addresses the usability and accessibility shortcomings faced by visually impaired users to a wider and more capable extent.

Based on the objectives defined above, this study is motivated by the following research questions:

RQ1. How do visually impaired individuals navigate and engage with digital technologies, including everyday platforms and financial services, and what roles do usability barriers, accessibility-oriented design, privacy concerns, and social or communal support systems play in shaping their patterns of use, trust, and adoption?

RQ2. How do visually impaired individuals in urban settings engage with financial transactions, and how do they navigate and utilize digital

financial services (DFS), particularly mobile banking, to manage routine tasks, and in what ways do inclusive design features, usability and privacy considerations, and external support systems shape their adoption and financial independence?

1.5 Methodology in Brief

To find the answers of our research questions we involved in interviews with the visually impaired population. For hiring participants, we used Convenience Sampling [63] as it helps to build a relationship of trust while learning about sensitive aspects of individuals experience. In order to build on with the rapport, our team representative contacted them beforehand to familiarize the participants with the gist of our intention. As the community is already marginalized and face allusion on regular intervals, gaining their trust remained pivotal to get honest opinions. We conducted semi-structured interviews [4] with the participants to allow them to express themselves. The identity of the participants have been kept anonymous throughout the research process and the participants have hold of all their rights as participants. The rights, privacy and safety of our participants have been protected during the research procedure by IRB approval.

Our questionnaire was made by keeping in mind the socio-economic status and condition of the participants. We tried not to include any questions that might have a negative impact on the mind of the participants or have created a sense of inferiority due to any sort of shortcomings. Our focus while conducting the interview was based on hearing the stories of participants rather than making it into a question-answer session. As the data collection was done in-person, with proper consent of the participants, the session was audio recorded - which we plan to diminish after the data analysis. Our participants included 9 females and 9 males where all of them belong within the 20-41 years of age threshold. All of our 18 participants currently belong from an urban setting where all of them fall under the partially blind to fully blind spectrum. Besides, each participant was awarded with a travelling expense of 300 Taka along with some refreshment snacks from our end for their contribution as per their requirement in the form of incentive. Furthermore, based on the feedback received from the participants on the existing system, after the establishing of the prototype, the prototype testing was done by four participants of which, two took part in our interviewing session as well. The participants were made well aware of their anonymity and the participation for it remained voluntary.

1.6 Scopes and Challenges

We configure the study scope along with possible challenges aligning with those of the research questions so that it directly reflects through our investigation.

1.6.1 Scopes

This study focuses on the visually impaired population; from partial sighted vision to complete blindness as the target user group. This group includes students, pro-

professionals and elderly visually impaired users in order to get a broader vision of the entanglements faced by all age ranges in order to grasp the usage of modern technology like digital financing systems. For comparison, references to global context are used but the primary geographic focus remains the urban areas of Bangladesh, with a special emphasis on the popular local Mobile Financial Services (MFS) platforms such as bKash, Nagad, Rocket, Upay etc., focusing especially on accessibility and usability features within those apps. The study refrains from focusing on other disabilities such as motor or hearing impairments along with the rural population due to constricted availability. During the platform analysis, UI/UX aspects such as layout, navigation, and labeling and compatibility aspects such as screen readers, and magnifiers are covered per intent and further usage is reviewed by visually impaired individuals. However, backend systems and security are excluded unless they directly affect UI performance or content delivery. Moreover, the research includes an overall review of works on DFS/MFS usability and accessibility for this certain community, that focus on Global and South Asian/Bangladeshi studies from the past 10-15 years. It involves heuristic analysis of popular local MFS apps and in-person or remote interviews with 18 visually impaired participants, based on recruitment feasibility. As part of the research, a functional prototype, named “Dristikohon”, is developed.

The implementation prioritizes the Android platform, due to its affordability and availability in the local market considering the budget visually impaired people of this demography sometimes have to maintain considering device affordability. While iOS mostly remains more of a luxury end device in a tech-developing country like Bangladesh, in order to serve the greater good by targeting a wider audience - our prototype targets android users. Besides, as low end and high end android devices exist in the market, we explicitly work on the low end android devices to make it feasible for the high-ends too. The prototype includes features like voice prompts and instruction screens for key financial tasks, a logical navigation flow optimized for screen-readers, and utilizable screen magnifier. However, specific infeasible features such as integration with every local MFS provider, advanced biometric authentication flows, and real money transactions has been excluded and will remain open for future enhancements. Use of real money has been simulated by utilizing a sandbox environment. Furthermore, basic security hardening has been implemented as part of good coding practice, but a full penetration test is out of scope, hence has been excluded. Overall, our prototype remains more of a conceptual outcome rather than a production based app as of this stage. Finally, the usability evaluation sessions to assess the effectiveness of the prototype aims to capture qualitative feedback and basic metrics like task completion and error rates. Setting the above boundary focuses - this paper works on being practical as well as impactful producing outcomes that are directly relevant to the reality of the visually impaired individuals of Bangladesh.

1.6.2 Challenges

During the course of this research, several challenges are anticipated, broadly categorized into recruitment & participation, contextual, technical & design, and evaluation & deployment challenges.

Recruitment & Participation Challenges

The most difficult challenge within this category was to recruit the visually impaired individuals, due to the possibility of not many local organizations or NGOs willing to assist the recruitment process. Since monetary involvement is often expected in return to such workings, the research being self-funded by the team members - it was hard to afford and manage more participants despite willingness. Added to that, having to contact the participants through the organization itself as the medium necessarily meant the organizing body of that particular organization had to manage time for our intentions outside of their working hours as well. This, in turn, made it challenging to schedule the interviews. Visual impairment varies significantly among individuals, from low vision to complete blindness. In addition, variation in age and a general lack of literacy can make it difficult to recruit a group that accurately represents the broader population of visually impaired people. While we tried our level best to have representatives of all backgrounds of visually impaired people from our end - we felt the scarcity of rural representatives not being represented in the urban settings. Belonging from a community of the vulnerable end, it is possible that many might not have been way too flexible of their vulnerability being expressed as it is never easy to freely talk about one's own weakness and disadvantages that is to be led as a reality in day to day life. Lastly, during interviews, obtaining proper consents from visually impaired people from certain ends remained challenging, as consents were to be provided through audio. To do so, we had to elaborate our intention to build on the trust of the participants.

Contextual Challenges

In Bangladesh, people's skepticism toward digital services is prevalent, as most people still consider cash-based transactions to be the safer option. This lack of trust imposed certain challenges during the implementation of the prototype. Not to mention, the stigma existing surrounding disabilities in the socio-cultural settings of Bangladesh often leads to ignorance of the advancements of this community which often excludes them from progressing in contrast to the technical world. While digital financial regulations do exist, lack of policy making for exceptional cases in a Bangladeshi perspective does lack behind. Finally, the absence of local studies on the accessibility of DFS/MFS platforms hindered the use of direct insights and addressing of challenges.

Technical and Design Challenges

These challenges primarily revolve around making digital interfaces truly accessible for visually impaired users. Due to device fragmentation in Bangladesh, there might be possible instances where low-end devices might not support accessibility features. Firstly, in order to ensure smooth navigation, especially on touch devices, it requires custom solutions which complicates procedures. In addition, audio feedback heavily depend on functioning Bangla Text-to-Speech engines, but the reliability of the existing engine is not sufficient enough for accurate feedback. Mixed Bangla-English text might create possible mispronunciation issues. Added to that, low end devices might end up generating low-quality TTS voices along with delayed timing to result in breaking of user flow issues. Finally, in the case of security flows within the

prototype, such as OTPs and biometrics, challenges surfaced from trying to balance accessibility and privacy.

Evaluation Challenges

The biggest challenge in this category remained to rule out through usability evaluation, whether the prototype addresses the previously discovered accessibility challenges in the platforms and the literature. A possible evaluation based bias might have affected the outcomes as the evaluation was based in a controlled setting which in turn might not reflect the real-world consequences. Added to that, possible sandbox testing limits the capturing of privacy anxiety. To effectively conduct these tests, a realistic task scenario may require, which reflects actual financial operations. As we could not risk real transactions, mimicking safe but realistic scenarios turned out to be tricky. Furthermore, visually impaired individuals may have at certain instances hesitated reporting their failures which can introduce bias to the results introducing - response bias or social desirability bias within the scenario. Also, during testing, the observer effect might have had the possibility to trigger self-consciousness among users which again may have skewed the results. Through that, data distortion might occur - making it either better or worse than usual. Finally, conducting the testing completely online, introduces challenges such as reliable internet connection along with performance fluctuation based on low-end and high-end phones.

To sum up, while the mentioned challenges impose existing limitations to the research, acknowledging them at an early stage permits to work on reforming the mitigation strategic handlings through maintaining transparency within the study base. Rather than witnessing the barriers as deterrents, we value them as future opportunities to refine our outcome from a Bangladeshi context. Even with existing infrastructural and resource bindings, this paper remains committed to the intention of producing a foundational insight and a proof-of-concept prototyping, working on implementing inclusive digital financial services.

Chapter 2

Literature Review

The number of visually impaired people is approximately 285 million globally [57]. While mobile applications can work as assistive technology playing a role in enabling visually impaired individuals performing daily activities, including financial transactions, many challenges come with the unique need of this community. These challenges change with demographic, socio-economic background and cultural beliefs. This section presents the relevant literature highlighting the setbacks faced by visually impaired community, their struggle to access financial services, steps taken to ease their life mostly from Global North perspective and an essence of digital finance in Global South.

2.1 Challenges Faced by Visually Impaired Persons

Below, we reflect back to the challenges faced by the VIPs in their daily used platforms, shortcomings faced by this community more specifically within the Global South region, influence of platform usage based on their privacy and security concerns, pushbacks faced in finance sector along with the current scenario to digital financing system within the Global South.

2.1.1 Challenges Faced in Daily Used Platforms and Personal Life

A study conducted by Romo et al. states that visual impairment is an inherently socially sensitive and may carry stigmatized communication that affects personal relationships. Their dependency on capable individuals for assistance, particularly transportation is very common, which can compromise autonomy and fuel stereotypes that those with an impairment need assistance frequently. This may lead to feelings of embarrassment, sadness, anxiety, poor self-image, and low self-confidence due to undermined independence. It further suggests that stigma is considered much more harmful than the disability itself. Visual markers like canes or guide dogs, while crucial aids, can label Visually Impaired Individuals (VIIs) and subject them to discrimination, patronization, over accommodation, pity, and feelings of shame. These aids draw attention to a “debasing identity discrepancy” and can make blindness the defining trait. Visually impaired individuals employ various strategies (facework) to

manage social interactions and face threats. These include preventive strategies (like politeness and humor) to ward off potential threats and corrective strategies (like avoidance, apologies, accounts, and humor) to repair damaged faces after a threat occurs. The source states that these ridesharing services (e.g., Uber and Lyft) removed transportation barriers, equalized interactions, enabled socializing freely and without shame, increased autonomy, and decreased shame related to reliance on others [84].

While current technological platforms consider general use cases, consideration for ones with special needs remain an exclusion sometimes. Screen Reader being the voice to “alternative text” has not had much of an advancement over the decades even after many technological advances. On top of that, the existing modern systems are sometimes devoid of the support to this system (ex- twitter being a heavily image dependent platform didn’t introduce alt attribute until 2016) [35]. Blind and Visually Impaired People (BVIPs) having greater access to Twitter platform showcase great trust on the captions that are computer generated for a corresponding image - even when the image caption does not continue to replicate to that of the image, for not being able to justify its correctness first hand [28]. This mismatch may lead to inaccurate representation and result in distrust on the platform.

Another work by Herskovitz et al. supports the inclusion of people with needs to justify an implementation before its launch in full scale. This becomes a dire need as existing creations do come to less help at times (ex- not all earphones are supportive of usage of hearing aids, while vision CAPTCHA is not an option- the audio CAPTCHA remains too complex to decode) [75]. While blind users often see assistive systems like screen reader issues as urgent “bugs”, developers are prone to decline requests of enhancements regarding accessibility due to reproducibility or technical difficulties in the later phases. This promotes the necessity for rebuilding a community-driven repository that might encourage third-party contribution to increase accessibility [80]. Learning from the use of individuals with such needs can play crucial role in understanding how they communicate with such platforms and what they require from their end to be integrated within the future design practices [68].

2.1.2 Challenges Faced by People of Global South

Sarker conducted in-depth interviews with 20 individuals from both urban and rural Bangladesh, discovering that people with physical disabilities frequently encounter stigma, marginalization, and false information while seeking microfinance services. It furthermore identifies the obstacles that they face including inaccessible loan terms, discrimination from the staff, and restricted access to non-credit services like training, insurance, and savings. Besides, financial insecurity increases due to the harsh debt collection practices and lack of complaint mechanisms [69].

Another study in the context of Bangladesh suggests that many students with visual impairment do not have the pass to basic technology even to cope up with the demand of present time, and even when facilities are available, special efforts are needed to make them actually accessible for visually impaired students. Before

the covid pandemic, study materials were frequently provided in hard copy, visually impaired students could not use these, requiring volunteer help to read and record them. During the pandemic, online class materials like zoom class, slides, or images were often inaccessible to screen reader software or did not provide accurate information. The study further states that a critical lack of sensitivity among some teachers and administrators, who felt they had already done a favor by admitting these students, was a pressing issue. Recommendations suggest organizing ICT training for visually impaired students, making libraries fully accessible with necessary software and resources such as Braille Monitors, allowing students to take exams electronically to reduce the dependency on volunteers, and ensuring free internet access and accessible digital notice boards [66]. With the existing inconsideration and lack of empathy in a bigger scenario for this vulnerable community, many participants often overlook their mental health due to the overwhelming burden of physical disability. Besides, the treatment gap within the mental health system of Bangladesh further only specifies how systemic neglect regarding it only overlaps with stigma, disability and poverty [98]. This necessarily urges the need for cross-sectional interventions that address both accessibility and psychological wellbeing in order to cope up with the pace of the modern world with feature based improvements that only desire to make people's life easier, just like mobile banking.

Das et al. argued that the potential contribution of individuals with visual impairments are often hindered due to the inadequate accessibility features. The study not only focuses on the technological barriers but also the social obstacles that prevent effective involvement such as incompatibility with screen readers and a lack of dynamic feedback [37].

2.1.3 Privacy and Security Concerns

Privacy is one of the key concerns of the visually impaired population. Study by Stangl et al. explores the privacy scenario of visually impaired individuals when sharing personal visual data with human or AI based Visual Assistance Technologies (VATs). They conducted interviews with 18 blind users, which revealed strong concerns about sharing sensitive content, especially unknowingly. Participants rated image content types, showing higher privacy concern for human VATs than AI. The further analysis of VAT privacy policies revealed gaps in transparency, highlighting the need for clearer communication and privacy safeguards in VAT design and involvement of the disadvantaged ones in the design process itself [70]. Furthermore, the use of camera-based assistive technologies increases the possible invasion of privacy of members of this community as they fear the disclosure of sensitive information [45].

Several other studies explored themes including identity theft [61] and safety concern [19, 22, 27] that resulted to the proposal of comprehensive framework for visual privacy protection [38, 99, 105, 113] especially when it comes down to agent-based assistive technologies [91]. A relevant study on authentication based on screen-reader implementation finds existing critical accessibility failures where numeric OTPs are read as long numbers instead of digits along with disadvantages of communicating in out-of-browser security prompts. This results in possible notification fatigue,

concurrent login attacks and so on besides delay within the authentication process resulting in increased frustration of visually impaired users [104].

In addition, CAPTCHAs remain a persistent problem [29] where a study by Fanelle et al. suggested that simply converting visual queues of CAPTCHA to audio form alone is inefficient, rather inclusive and usability-driver designing of such formats are important in order to balance between security and accessibility [48]. Besides, due to risks like aural eavesdropping, password entry, memorability problems and error prone interaction with screen readers being common aside of shoulder-surfing security and accessibility trade offs - this urges the need of “secured accessibility” approaches [52].

2.1.4 Challenges in Finance

Kameswaran highlights the challenges visually impaired people in metropolitan India face when accessing both the digital and the cash-based financial systems. Through semi-structured interviews with 30 participants, it was found that both payment methods require significant “moneywork”, such as identifying currency or navigating poorly designed apps. Moreover, trust and collaboration with ride-hailing drivers play a vital role in completing transactions. The study suggests improvements to be made in screen-reader compatibility, UPI integrations and alternative OTP based authentication [39].

The existing ATM systems lead to significant challenges for the day to day usage of visually impaired ones due to lack of existing accessibility guideline and troublesome screen-based interface interaction [16]. Building on this, another paper supports the adaptation of Talking ATM (T-ATM) to support the Visually Challenged ones but being accessible in hindi and english only resulted in not being accessible for other languages being mostly audio oriented along with the difficulty to relocating the audio jack. To ease the frustration of handling such system, Interactive ATM (I-ATM) prototype further worked on the issues [50]. According to Singanamalla et al., despite legal requirements- fewer than 18% of the 107 ATMs they evaluated had dedicated accessibility features for visually impaired users. The major issues while using public ATMs that visually impaired users faced were different hardware layouts, voice guidance that didn’t work right and privacy concerns [43].

Another study by Kameswaran, focusing on the Indian population, found that even though digital financing reduces the hurdles of physical banking for the visually impaired community, to access the service - discrimination was commonly imposed by the banking officials. Even if they were granted access, it required several forms to be filled, burdening with the hassle [76]. A conducted research showed that low level of staff expertise in Egypt leads most visually impaired individuals to not have access to their individual bank account. Even though most banks have access to digital services- they remain inaccessible in addition to negligible training provided to staff on handling visually disabled customers [49]. Significant challenges in the field of accessing ATM services and online banking demands the need for proper policy making and technological development to support systems to enhance banking accessibility [77].

2.2 Digital Finance in Global South

Mobile financial service has brought a revolution in financial inclusion among the marginalized and rural population. The study by Roy et al. explores the role MFS is playing in the rural area towards the development of women. While the study acknowledges the presence of persistent obstacles such as unequal pay, limited access to education, and cultural biases that continue to hinder women’s full economic participation, especially in rural settings, this gives a critical insight on how the technology can be used to improve the lifestyle of a marginalized community [97]. Another study reflects the idea of exclusion of women within the mobile banking scenario as they continue to depend on the male family members but does not restrict within rural regions [59]. A study highlighting the rural settings of India focuses on the need for socio-technical integration as usability challenges often remain deeply tied to the local socio-cultural contexts [25].

Furthermore, focusing on the urban areas of Bangladesh, particularly among low-income migrant workers in Dhaka, we can notice that numerous sociodemographic factors impact the adoption and findings of MFS. Khan et al. revealed the key factors in adoption and involvement of MFS platforms by the low-income migrant worker community of Dhaka. The qualitative study revealed the role of age in tech proficiency and its effect on usage. In a scene where navigating through the currencies remain a struggle itself even though related studies have worked on solving the problem [41], DFS remains a comparatively newer not-so-convenient from the perspective of ease of access for the vulnerables. While MFS provided easier access compared to traditional banks, factors like usability gap, low accessibility and low literacy negatively affected the efficient usage and imposed challenges [26]. But further studies also reveal that received ease of use, social influence and preconceived notion on the existing platforms on building trust - all have impactful positive hold of intention to adopt fintech services [64]. Building on accessible interfaces such as iFREEPHONY helps with easing the accessible challenges faced, which further promotes adapting fintech services [24]. While bKash and Nagad has been popularized within the digital financing sector of Bangladesh in the recent times, the scenario still remains adverse as people with disabilities often remain excluded from the rapidly growing fintech ecosystem [85]. Another survey by Ehsan et al. examines the ways demographic variables and user perceptions impact mobile banking adoption in a rapidly growing digital finance sector. The study focuses mainly on students and findings reveal security and cost concerns are major drivers of adoption, while network availability has little impact. The authors recommend service providers should focus on enhancing security, reducing complexity, and maintaining affordability to boost uptake [89].

However, with the rapid growth of MFS, there arises other associated concerns. As highlighted by Huda & Sony, the current regulatory framework has a weak Know Your Customer (KYC) verification system which lacks access to national identity cards (NID) and operates primarily under a reactive risk-based approach. To address this, the study suggests implementing a smart regulatory approach that will prioritize strengthening KYC verification, access to NID and enhanced security features [93]. As a regional activity, fraud happenings, information misuse by agents

and transaction related errors often constrict user behaviour where limiting account balances or even closing accounts remain adaptive behaviours for many. But such actions only lead to lack of user confidence. Besides that, exclusion of women from financial control often turns out to be the outcome due to possible victim blaming through arousal of certain fraud happenings further promoting dependency [103].

Beyond the financial domain, MFS and digital banking technologies also hold the potentiality to empower other marginalized groups, such as individuals with disabilities. As noted by Kemal, mobile wallets can be more accessible for visually impaired users due to their potential for user-friendly interfaces and voice-assisted technologies [40]. Additionally, by drawing connections with blind TikTok users who create identity work to increase public awareness about blindness and to ensure their inclusivity in digital sectors [95], Bangladesh can reshape digital spaces and seek ways to engage visually disabled individuals. These illustrations show how inclusive digital banking has the capacity to revolutionize the Global South on a larger scale.

2.3 Existing Approaches and Adaptive Strategies to Address Accessibility Challenges

Existing technological approaches to improve the accessibility and usability for visually impaired people in digital services are continually being developed and enhanced, for instance, image processing systems which are crucial for financial literacy and independence have made significant advancements. But significant shortcomings remain in detecting handwritten texts, UI simplicity and real time performance [86]. In that contrary, software based implementations are bringing greater changes compared to hardware evolution to keep pace with accessibility [79]. In fact, smartphone vision assistant apps remain to be of the greater advantage side due to their affordability and versatility. Only if they were universalized, it would be capable enough to change the scenario for the vision impaired community [82]. Building on that, platforms like DesignChecker, emphasize on building on more accessible design tools to make visual web designs more inclusive [94]. In a recent study, it has been shown that a currency detection system can help blind individuals accurately identify seven denominations of Indian currency in less than a second, 0.73 seconds to be precise. This innovation was possible due to the integration of image technology with auditory feedback, and it holds significant potential to be customized and used for other currency and mobile banking environments in other developing countries like Bangladesh [51].

While possible mobile banking features can be integrated, some existing systems, mostly surrounding android apps, have seen common issues like- small touch targets, poorly labeled elements and low text contrasts, making it complicated for screen-reader users from a digital financing perspective. Added to that, across the app version, a persistent lack of accessibility based updates mostly remain unresolved [53]. Even so, when the feedback based accessibility issues are overlooked, it barely overshadows the popularity of the app causing accessibility concerns to remain invisible in the mainstream market [46]. However, recent studies indicate that, for

illiterate and semi-illiterate users in India, Interactive Voice Response (IVR) based mobile banking models, especially cloud-hosted versions, have proven to be powerful tools in promoting financial inclusion. As highlighted by Folego et al., their mobile application Pay Voice remains one such application that gives clear knowledge of payment value, operation types and access to PIN pad machine using phones - making digital financing accessible to visually impaired users [33]. Existing work also shows that voice focused user interfaces are overall more efficient than text focused systems, as they yield better accuracy and faster task completion times. This approach has shown to reduce dependency as basic banking operations such as balance inquiry and money transfer can now be completed through IVR conducted in regional languages [18]. But in another study, repeating, elaborating, specifying remained a common scenario for voice assistant usage. Assistive technologies often lack personalizing features causing failure to meet user expectations [62], something that remains heavy in order to gain contextual accuracy and user trust from a financial banking ground. While previously described, the cloud computing aspect further aids the IVR approach by providing on demand resources and pay-per-use benefits, that allows banks to manage service demand surges cost effectively [18]. Similarly, a voice based learning platform called SEEDS has been designed to support visually impaired children in India, which delivers educational STEM content through a combination of an app dedicated to the teachers, an IVR system and a content management website [96]. Moreover, existing national infrastructure such as India’s Unified Payment Interface (UPI) platform features built-in screen readers such as TalkBack and VoiceOver for navigation and interactions, which in turn present significant opportunities for improved accessibility for the visually impaired users, as they can now take advantage of these technologies frequently [43]. Furthermore, Artificial Intelligence (AI) tools like Generative AI (GenAI), have shown to be highly accessible to VIPs. Additionally, visually impaired programmers can now use these tools to complete tasks more efficiently and the constant availability of these GenAI tools have also been very accessible in general [108]. Yet, there remains instances where reliance on sighted assistance remains preferable in terms of trust and usability [30].

Despite the technological advancement till date, visually challenged individuals have shown to construct their own sophisticated adaptive strategies and “Do-It-Yourself” (DIY) tools to navigate frequently inaccessible digital environments, especially those in professional and workplace settings. For instance, a study revealed that, Blind and Low Vision Software Professionals (BLVSPs) create various DIY tools ranging from simple scripts and screen reader plugins to complex standalone applications. Different BLVSPs needs like addressing inaccessibility in workplace software, enhancing productivity and maintaining professional dignity have been the primary motivators behind the development of the DIY tools. The motivations driving this “access labor” are both practical and emotional. On the practical side, BLVSPs look for greater efficiency and autonomy in navigating inaccessible systems . On the emotional side, their efforts are driven by frustration, the enjoyment found in creative problem-solving often described as the “joy of hacking” and a desire to contribute to the broader community. This situation gives rise to what is known as the “Double Hacker Dilemma”, where BLVSPs must choose between waiting indefinitely for companies to improve the accessibility of the tools or actively investing their own

personal time and energy to develop customized solutions themselves [107]. Furthermore, this gives rise to the idea on how accessibility rises from a combination of socio-technological strategies rather than technology alone when it comes to adaptation for blind, low-vision, and mixed-ability participants [32]. Studies show that this often goes unnoticed by organizations which leads to increased frustration among need based employees [21]. Beyond the self-developed tools, adaptive strategies can also frequently involve leveraging trusted intermediaries and personal connections. For example, the visually impaired individuals in Kibera, Kenya have shown to find comfort and build trust with specific M-Pesa (mobile-money) agents based on how they were treated by the agents during mobile transactions concerns [47]. This reliance on trusted individuals is more significantly relevant for older peoples within the visually impaired community, as they often prefer offline interactions, such as participating in community activities or exchanging information in social settings, despite the ability of digital technologies to bridge physical distances [100]. Moreover, individuals with visual and motor disabilities can also adapt utilizing a combination of mainstream and specialized mobile devices, even though specialized technologies have proven to be less economically feasible [12].

Significant inaccessibility and design shortcomings still persist across various digital platforms. Therefore, it can be inferred that current approaches may not be sufficient to ensure true inclusivity. For example, a usability study of popular UPI-based digital transactioning apps in India such as Google Pay, PhonePe and Paytm reveal significant design flaws for visually impaired users. These flaws include poor screen reader compatibility, unclearly labeled buttons and overly complex menu structures. Specific examples such as unclear error messages in Google Pay, misleading screen reader notifications in Paytm during login, and numerous unlabeled buttons along with deeply nested options in PhonePe seem to hinder accessibility in these UPI-based applications the most [101]. Many similarities can also be seen in top UK websites' cookie notices as well where poor contrast, missing headings and a failure to trigger screen readers remain common. These flaws have shown to compromise both user experience and privacy awareness [87].

A critical insight from the studies is that many standard approaches to improve accessibility, such as more compliance with Web Content Accessibility Guideline (WCAG), are often insufficient and may not guarantee usability, efficiency or user satisfaction for visually impaired people. Moreover, "context of use" and "cultural dimensions" such as user's location, the devices/platforms, the user's level of disability, time of day and language support for screen readers play a pivotal role to determine true accessibility. This indicates that even with multiple pain points, one solution adaption model is inadequate for the visually disabled community and emphasizes the need for customized web and mobile interfaces that account for the varying levels of visual impairments [17]. Furthermore, challenges such as organizational resistance to unofficial user-developed tools and a general lack of centralized sharing mechanism for these grassroots innovations introduce unequal 'access labour' for BLVSPs [107]. Complex procedures within these applications including intricate movements, visual-only cues, and minimal audio feedback within digital interfaces can contribute to a general lack of usability for the VIPs [102]. In addition, Privacy concerns and social awkwardness can sometimes limit the public use

of essential accessibility features, which in turn adds another layer of complexity to daily digital interactions [12]. Finally, study finds that to truly introduce inclusivity for the marginalized populations in digital services, certain steps such as developing inclusive tools, shifting funding streams, restructuring organizations and changing research methodologies along with restructuring disability-inclusive policies are truly necessary [92, 110].

2.4 Summary of Key Findings

Several studies have proposed different solutions to make digital services more accessible for the VIPs. Yet, these studies remain centered towards finding a solution to a single pain point rather than coming up with a holistic solution based framework. Besides, accessibility for all social classes including the low-literate and marginalized classes require solutions that remain capable of being reached even within existing bindings [83]. One study addresses the development of the Talking ATM (T-ATM) for the visually impaired people and later the development of Interactive ATM (I-ATM) to improve the accessibility of the T-ATM [50]. Another solution includes PocketATM, which utilizes the smartphone screen readers and the UPI infrastructure to assist VIPs in the digital services space [43]. While digital financial platforms are working on rectifying their system through renovating existing models, the problem remains rooted within the hassles of visually impaired individuals accessing services of commercial banks [90]. Moreover, a cloud based IVR model has been proposed to aid visually impaired users in performing basic banking tasks via regional languages [18]. Some studies also highlight how blind and low vision software professionals (BLVSPs) develop DIY tools such as scripts and screen reader plugins to enhance their workspace productivity [107]. However, many research gaps persist within these solutions. Despite the adaptations of T-ATM, less than 18% of the evaluated ATMs actually support accessibility features. Even the supported ones contain major issues such as flawed voice guidance and privacy concerns [50]. In the case of the BLVSPs, many create these DIY tools out of professional dignity and necessity. However, doing so requires them to invest considerable personal time and energy [107], which is not feasible. This showcases the tension between accessibility and security where increased exposure to risks become prominent in quest of finding independence. Unlike Global North the unique socio-economic conditions of Global South does not support the impaired individuals to create solutions on their own. Mostly used digital finance services, MFS do not come with accessibility features to help the visually impaired individuals to navigate properly even with the existing low digital literacy. In more of a Global South context, countries like Bangladesh face weak regulatory systems, low digital literacy along the rural settings and agent based dependency which results in mistrust and exclusion, particularly for women. Thus, many have to rely on third-party solutions to integrate into their daily used platforms. This raises the previously discussed concerns about privacy and security. To acknowledge such gaps properly, a more inclusive approach that supports universally designed solutions and addresses the challenges VIPs face when navigating through inaccessible systems is required. We, through our prototyping of “Dristikohon”, plan to implement an integrated system with feedback and recommendations taken from VIP’s to make digital finances to them more accessible, overcoming and bridging the gaps between obfuscation technologies [61].

Chapter 3

Methodology

Methodology serves as the foundation of any research project as it upholds the full assessment process of the research and explains how the data are collected, analyzed, and interpreted. The diagram below represents the main points of our detailed approach:

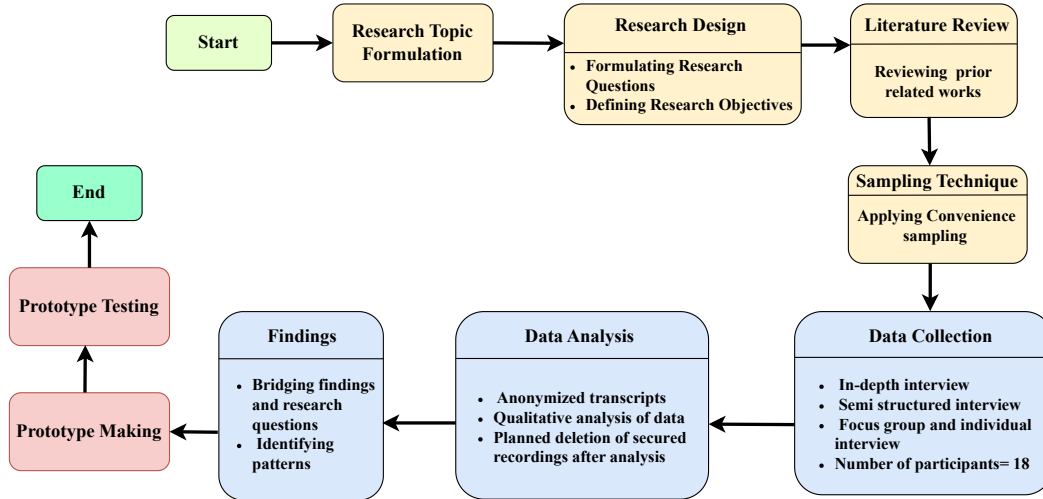


Figure 3.1: Workflow of our research methodology

3.1 Research Design and Approach

This research adopts a qualitative methodology to study the challenges faced by visually impaired people while accessing digital financial services (DFS) in Bangladesh. The primary aim of the study is to uphold their experiences with mobile banking platforms. It identifies the limitations of the tools designed for them, comprehends their accessibility issues and highlights the difficulties they face while accessing ATM booths or the traditional banking system. By understanding these barriers and through collecting user feedback, this study seeks to propose design improvements that can ensure to make digital financial services more inclusive and less hassle free for the visually impaired community.

To achieve these goals, we adopted a semi-structured interview method to understand the challenges faced by the participants as well as to explore their personal experiences in the financial sector. As our research is based on a qualitative approach, this method provides flexibility and encourages participants to share detailed information. Furthermore, the semi-structured interview method allows the interviewer to ask follow-up questions and explore the new themes that arise in a conversation. This helps to maintain a flow and also provides the opportunity to know about the issue in a broader meaning. Thus, in the areas where a fixed set of questions would not allow us to capture the full picture by delving deeper into each topic, the semi-structured interview method offers this flexibility to uncover new issues.

Additionally, while designing the type of questions that we would ask in the interview, we included open-ended questions so that it did not create any pressure on participants. This gave participants the opportunity to respond according to their knowledge and level of education. Moreover, the interviews were conducted both individually and in focused groups. There were two focused group based interviews where three participants were present in each group. By having focused group interviews, we tried to create a more dynamic discussion session. This helped us to raise topics that might not have emerged in individual interviews. The interviews were taken in person as qualitative data collections tend to remain less rich in virtual settings [6].

As our research questions are subjective and dependent on individual circumstances, the semi-structured interview method is more preferable for such cases. It allows us to understand complex issues like accessibility and user experience in a deeper sense. Besides, when the research design is more stern and rigid about the question pattern, the emotional and social aspect of using technology is often overlooked. Thus, overall the semi-structured interview method allows us not only to discover the technical challenges but also to unearth the personal and emotional factors that have an effect on the usability and adoption of digital financial services among visually impaired individuals.

Studies suggest that for understanding complex topics, qualitative research along with semi-structured interviews, is one of the most effective ways [14]. By adopting this approach, the study aims to uphold valuable perceptions about how DFS platforms can be improved to better serve visually impaired users by taking individual's experience into account, leading to a more inclusive and accessible financial system.

3.2 Participants

This research includes 18 participants of 12 fully blind individuals and 6 partially sighted individuals, to gain a broad perspective on the experiences of visually impaired users based on different levels of severity. These participants were enlisted from a non-profit organization that works for the development of the visually impaired people, ensuring that the sample reflects individuals who are actively engaged with financial services and are eager to develop their way of living. Among the 18 participants, 9 were female and 9 were male, creating an equal balance to derive

data from a gender perspective as well. This also allows identifying gender-related differences in access and usage patterns in the financial sector. The age of the participants ranges from 20-41 years old, providing a diverse demographic representation based on age and life experiences.

The participants were selected through convenience sampling based on their availability and willingness to take part in the interview. We chose this method due to the limited time and the specific nature of the population. The prime advantage of convenience sampling is that it helps to collect data from a particular group within a given time frame. Moreover, this sampling method was effective in gathering data from visually impaired individuals who are familiar with the services being studied. On the other hand, the major disadvantage of this is the potential for bias since it may not completely represent the targeted population, particularly those who live in a remote area.

The participants' residential setting was also considered, with all participants residing in urban areas in Bangladesh. Compared to the rural population, the urban population is more familiar with digital financial services and technology and thus they can provide feedback that would actually allow us to improve the overall system. But it is also necessary to consider the population from rural areas since they might not be able to access the services so easily compared to the urban population. It is necessary to consider their feedback and experiences particularly in terms of internet access, availability of digital financial tools, and general infrastructure.

A demographic table summarizing the main characteristics of the participants is represented below:

Participant Number	Age (year)	Gender	Visual Impairment Type	Highest Level of Education
G1 P1	27	Female	Fully Blind	Bachelor's Student
G1 P2	20	Female	Partially Blind	Bachelor's Graduate
G1 P3	30	Male	Fully Blind	Bachelor's Graduate
G2 P1	29	Female	Fully Blind	Bachelor's Graduate
G2 P2	27	Female	Partially Blind	Completed College
G2 P3	39	Male	Fully Blind	Master's Graduate
I1	28	Male	Partially Blind	Bachelor's Student
I2	24	Male	Fully Blind	Bachelor's Graduate
I3	28	Male	Fully Blind	Master's Student
I4	20	Male	Fully Blind	Bachelor's Student
I5	20	Female	Fully Blind	Bachelor's Student
I6	41	Male	Fully Blind	Master's Graduate
I7	27	Female	Partially Blind	Not Mentioned
I8	28	Female	Fully Blind	Bachelor's Graduate
I9	23	Female	Fully Blind	Completed College
I10	23	Male	Partially Blind	Bachelor's Student
I11	33	Male	Fully Blind	Master's Graduate
I12	25	Female	Partially Blind	Master's Graduate

Table 3.1: Demographic table summarizing the main characteristics of the participants.

3.3 Data Collection Method

This research followed a semi-structured interview pattern in order to explore experiences of the participants, the challenges they encountered and suggestions to improve the accessibility in digital financial services (DFS). The interviews were held in person, based on the convenience of the participants. The interview protocol, informed by prior research [106], covers a plethora of topics. The questions were designed in a way that we could explore the challenges, suggestions based on the real-life experiences of the visually impaired people. Below a detailed analysis of the questions and how they help us to comprehend the challenges encountered by the visually impaired people while accessing the financial sector is presented:

3.3.1 Demographics and Background

The initial set of questions focused on gathering demographic and background information of the participants. This section covered questions about their age, gender, highest level of education received and the type of visual impairment (fully blind or partially sighted). It was very necessary to understand the participant’s background to contextualize their experiences with the financial sector as it provides the reasoning behind how their specific condition might influence their use of technology. Furthermore, we asked them questions like if they were brought up in a rural or urban setting, this allowed us to understand their exposure to technological areas. Age demographic is shown in figure 3.2.

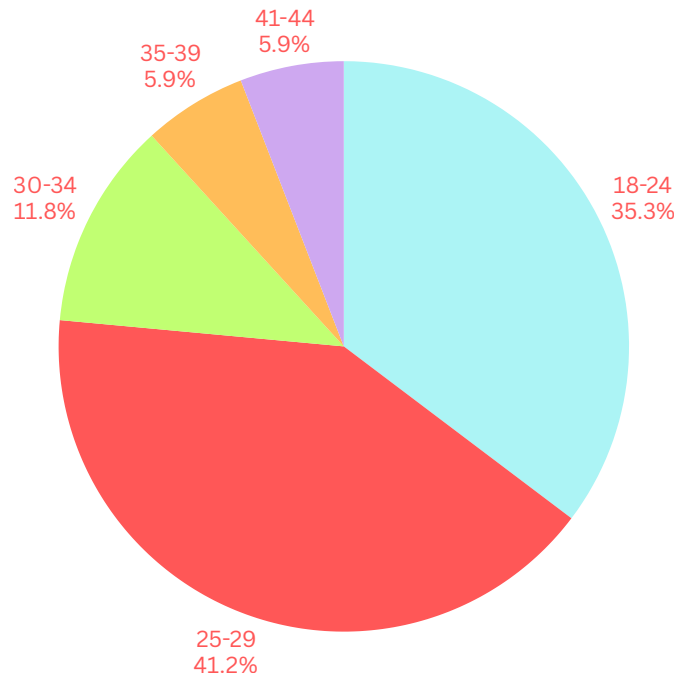


Figure 3.2: Age demographic of participants

3.3.2 Current Usage of Digital Financial Services (DFS)

The next section of questions were exploring the participants' familiarity and experiences with using mobile financial service platforms such as bKash, Nagad, and Rocket. It was followed by the question "How often do you use these services?" to understand their frequency of use. Furthermore, we asked them questions regarding the type of transactions they usually do such as - cash-outs, sending money, and mobile recharge. This helped us to understand the practical use of these services in their daily lives.

3.3.3 Usability and Accessibility Issues

Our next set of questions included "How do you access these services?" to get a deeper knowledge of the assistive tools that they rely on to use these services. Moreover, we focused on criticizing the current process by asking them questions like "Do you face any difficulties using these services due to your visual impairment?" and "Are the mobile apps you use screen reader-friendly?" to understand the actual effectiveness of the current platforms and how they tackle the shortcomings. As the interview proceeded, we focused on delving deeper into gathering information about the challenges that they encounter with screen reader compatibility, PIN entry, and CAPTCHA. These questions were asked with the aim of identifying sectors where design improvements are needed.

3.3.4 Security and Privacy Concerns

Maintaining security and privacy is one of the main preconditions that is to be fulfilled to ensure proper financial security. In this section, we asked questions like "How do you handle security during transactions, especially in terms of PIN entry or OTP verification?" and "Have you experienced any security or privacy issues while using digital financial services?" to understand the participants' concerns regarding data breaches and fraud. These questions revealed the participants' discomfort in sharing their financial information with other people, as the existing system isn't upgraded enough for their special needs.

3.3.5 Social and Emotional Aspects

Questions like "Would you prefer someone else to handle your financial tasks if they are sensitive?" and "How do you feel about sharing your personal financial information with mobile platforms?" were asked with a view of understanding their emotional experience about DFS. The participants have expressed how they often feel demotivated and low about their own capabilities in cases when they have to share their personal data with others to complete the daily transactions. These questions helped us to understand not only the technical challenges that the visually impaired people face but also the social and emotional challenges that they encounter.

3.3.6 Satisfaction and Recommendation

This was the final and most important section of the interview questions, as in this section, we focused on gathering their suggestions and feedback on improving the digital financial services. These questions encouraged them to share their thoughts about specific features of the system and how to improve those. Besides, they even shared that often the problems go unnoticed, as there are not any representatives from their side who could give constructive feedback to the higher authorities to bring positive changes in the system. They also urge to bridge this gap to experience a smooth and easy transaction like every other normal human being.

3.4 Prototype Development and User Testing

After gathering the required data, we developed our prototype that included the features and user needs that we identified from the interviews that we conducted. Another crucial step of our research was gathering user feedback after developing the prototype. A total of four participants used our design by installing the APK version of the app and gave their feedback. While collecting the feedback, we strictly followed the IRB rules and ethical guidelines. The participants voluntarily took part and no one was pressured to take part in the study. Moreover, all the participants were over the age 18 and their identities were kept anonymous. No personal information was collected in order to protect their anonymity and privacy. Further details regarding the prototype testing methodology and participant profiles are provided in Section 6.2.

3.5 Ethical Considerations

Before we started collecting the interviews, the research secured authorization from the Institutional Review Board (IRB), which ensures the maintenance of ethical standards and guidelines. This is a very critical part of the research as it ensures that the participants' rights and well-being are prioritized. Along with the IRB approval, we also took verbal consent of the organization that agreed to participate in the interview sessions. This process ensured that the organization was fully informed about the research objectives and its involvement. The interviewees willingly agreed to participate in the study, and no pressure was placed. Before recording their interviews, we sought consent from each individual which ensured that the participants were fully aware of the research process and their role in the study. We maintained transparency throughout the interviews and ensured the participants knew that they could leave at any time without facing any consequences.

By keeping the IRB guidelines in account, we made sure that no one under the age of 18 was included in the study. This upholds the fact that the research abides by the ethical standards regarding age and consent. To maintain further ethical integrity, no pressure was imposed on the participants, and data was collected based on individual person's capability so that they wouldn't have to seek others' assistance or create any kind of vulnerable situation. The participants' autonomy and dignity was taken into consideration through this process. Furthermore, as a token of appreciation for their time and effort, each participant was given 300 taka as compensation

for their participation in the interview. This compensation was self-funded and provided with a view of acknowledging the participants' contribution to the research. Additionally to maintain trust and transparency of the research, we informed the participants that after analyzing the data, the recording of the interviews would be deleted. Through this we tried to ensure that the personal data of the participants are safe with us and we would not keep the data stored beyond our research purpose.

As the ethical standards and behavior have been rigorously addressed and verified, the conclusions derived from this study is built on a strong foundation of integrity and trustworthiness.

3.6 Limitations

One of the limitations of the research was the relatively small sample size. Additionally, while collecting the data we observed that most of the candidates had received a certain level of education. Moreover, as we are working with a community who have faced certain challenges due to their disability, there is a chance that they would be reluctant to hide their vulnerability, leading to potential information-based bias. In a broader sense, the result of this biasness can distort the data. We do not know how rural or low-literacy users use MFS services in their daily life or what specific challenges they encounter. As many of them have limited English proficiency, it is tough to evaluate the effectiveness of TalkBack or other screen reader applications in the case of supporting Bangla. Furthermore, the participants' age mostly ranges from 20-41 years old, excluding the experiences of the senior citizens whose perspective could differ. Additionally, since the majority of the participants are from a single organization, they are more likely to have received the same training or have access to similar data which limits the diversity in data collection process. This lack of diversity creates a narrower view of the issue and reduces the ability of research to represent a broader range of experiences.

Chapter 4

Findings

In this section, we first present an overview of the social life and technology use of Visually Impaired Individuals (VIP's) in Bangladesh. We also provide a situated understanding of these factors shaping their behavior and creating challenges. Next, we highlight the usage of different financial tools in daily life and hurdle they face in both online and offline. Finally, we summarize the coping mechanism used by individuals to tackle these challenges and suggestions for building an inclusive system.

Participants from the group interviews are denoted using the format G#, P#. For example, "G1, P1" represents the first participant from group one. For individual interviews, we use the format I#. For instance, "I1" represents the first individual participant 1. The detail description of some used key terms are presented in Table 4.1. Also, some keywords from findings are presented in 4.1.

4.1 Social Participation and Technology Use among Visually Impaired Individuals

The following findings demonstrates the interconnected dimensions of visually impaired individuals' lives, focusing on familial role, societal life, technology access and usage patterns.

4.1.1 Social Life and Family

Participants' social life were largely influenced by their relationship with their family. In most cases the individuals are considered as *burden* to the family. This narrative limited their opportunities to actively participate in family discussion, decision making and activities. Often they felt excluded and distant from other family members.

"Often my family members question my capability and judgment which is not related to my eyesight. My voice gets suppressed under my blindness. Their continuous comment on my life and what I am going to do with my incapability make me feel like a burden. They don't include me in their gatherings because it is burdensome for them to help me to navigate whole time."[G1, P2]

Table 4.1: Descriptions of common terms used in findings.

Name	Description
bKash	bKash ¹ is a popular mobile financial service in Bangladesh that allows users to send money, pay bills, and make purchases using their phone. This platform serves over 80 million active users [112]
Nagad	Nagad ² is another mobile financial service in Bangladesh, offering money transfers, bill payments, and merchant payments.
Upay	Upay ³ is a mobile financial service in Bangladesh that provides money transfers, bill payments, merchant payments, and salary disbursement services.
Brac Bank Astha	The Brac Bank Astha app ⁴ is Brac Bank’s official mobile banking application, offering account management, fund transfers, bill payments, and lifestyle services through a secure digital platform.
Sonali e-Wallet	Sonali e-Wallet ⁵ is the official digital wallet of Sonali Bank Limited, providing services such as mobile banking, utility bill payments, fund transfers, and merchant payments.
Foodpanda	Foodpanda ⁶ is an online food and grocery delivery platform that connects users with restaurants and shops through a mobile app.
TalkBack	TalkBack ⁷ is an Android screen reader developed by Google that provides spoken feedback and allows visually impaired users to interact with their devices.
Narrator	Narrator ⁸ is a built-in Windows screen reader that reads on-screen text aloud and describes events, helping visually impaired users navigate the system.
NVDA	NVDA ⁹ is a free and open-source screen reader for Windows, offering speech and braille output for blind and visually impaired users. It offers greater functionality over Narrator in many cases.
CRM Machine	A CRM (Cash Recycling Machine) ¹⁰ is a type of ATM that allows both cash deposits and withdrawals, automatically counting, verifying, and recycling deposited cash for reuse.

¹<https://www.bkash.com/>

²<https://www.nagad.com.bd/>

³<https://www.upaybd.com/>

⁴<https://www.bracbank.com/astha>

⁵<https://www.sonalibank.com.bd/apps>

⁶<https://www.foodpanda.com.bd/>

⁷<https://support.google.com/accessibility/android/answer/6283677>

⁸<https://support.microsoft.com/en-us/windows/complete-guide-to-narrator-3a992e8e-3d3a-69a6-07c6-a37305a0dc>

⁹<https://www.nvaccess.org/>

¹⁰<https://www.ncr.com/solutions/cash-recycling>



Figure 4.1: Salient keywords from thematic analysis

For many participants, family relationships though being pivotal to development and social life, turned into disappointment. Incidents of neglecting needs, withholding resources or taking decisions without prior consultation were frequent. Denial of education led to growth in dependency on the family which acute crisis more.

“My family did not want to send me to Dhaka for education. After completing secondary school, I came to Dhaka for higher secondary education. They did not want me to get education as they always thought what a blind person like me would be able to do by receiving it. Several times they told me to go back to the village.”[G1, P2]

Family members took the benefit of participants vulnerability for monetary gain. Taking the advantage of participants helplessness and inability, money belonging to them were unlawfully taken by their close ones whom they entrusted with providing safeguard and banking security.

“Personally creating an account through someone’s help had created a sense of insecurity within me. There was a time when I used to recharge my mobile balance through other people’s help. Once, that very person whom I took assistance from for not knowing how to use bKash back then, transacted 1000 taka without informing me for their own purpose. This incident caused a sense of powerlessness where I was being taken advantage of my disability.”[I9]

While family failed to provide a proper safe environment, in many occasion husbands filled the role after marriage. They facilitated their partner with mobility, participation in social gatherings, encouraged educational pursuits and helped them to manage financial accounts. Such support played an important role in our participants achieving financial autonomy in some aspect and restore the confidence.

“The keyboard while using Upay does not show up in the screen reader. You need to open it manually by pressing. When my husband is with me I take help from him but when I have no trusted one by my side, I need to guess and then see if it is right or wrong. This is a big hassle.”[G2, P1]

Overall, family had both positive and negative influence on the VIP’s. Husband’s care and positive attitude helped them to feel included and confident despite their previous experiences.

4.1.2 Community Engagement

Existing social narrative often portrays them as dependent, passive, or incapable of meaningful contribution towards community. Such perceptions are rooted deep inside and these social stigma and lack of awareness contribute towards greater marginalization. The narratives are not limited in influencing the family behavior towards VIP’s but also shape their scope of participation in social events and degrading mental health.

“Sometimes I feel that if I still had resided within the rural settings, I would have attempted suicide - stigmas existing around there regarding child blindness are considered as the outcome of parents wrong deeds.”[I8]

The exclusion moves the participants away from their close ones, creating dependency on others for providing security and sincerity. This shows a shift of paradigm in the life of blind people where their main support should have been family members but due to their dependent and vulnerable state, they create bond with others who help them in assuring safety and security.

“I do not use ATMs outside of my university. When using the ATM at my university I take my friends with me. They enter with me and assist me. You know, sometimes I need to give them treats afterwards.”[I2]

Despite all the negative influence from outside, the participants reached to the top achieving success not only for themselves but for the country. To support each other they built small communities of VIP’s which works as support group. These groups work on cultivating extracurricular qualities among peers. With help from each other they find suitable solutions within their reach. These combined efforts bring out the silent talents in-front of the whole world to see.

“I am a chess player, you know. I have played chess for over 5 years. By the end of this year I am supposed to go to Kazakhstan to play. We have capabilities to navigate the world just like you. People sometimes don’t want to believe in our capability but we are also here to make our own way by fighting back obstacles. We need a push and suitable environment as you do to bring the best from us.”[G1, P1]

In absence of communal support VIP's created their own community. These communities play crucial role in creating support system and nurture the inherent qualities.

4.1.3 Technology Access and Usage Patterns

VIP's usually do not have active source of income. Thus, they remain dependent on family for big expenditures. It affects their need to possess good gadgets that can help them to become more independent and reliable on themselves. Weaponizing their incapability, they are often denied from the pleasure of using technological devices.

“As we cannot earn as much money as you guys, there is always a financial crisis there. Recently I lost my phone and asked for money to buy a phone from my parents. They refused immediately as they think I do not need it. I managed the money and bought a new one for myself...Our family believes that we do not need a good phone as we are blind. This could be not far from reality. In fact we need good phones more than anyone else. Less powerful phones can not take the load of the software we use. It hangs often. The hardware needs to be good for us more than anyone else.”[G1, P2]

Also, in our study we found technical issues such as phone hanging or delayed system responses create additional frustration for VIPs when using mobile phones. Unlike sighted users, VIPs need depend on screen readers voice output after touching the screen to perform any task. Steady user experience require timely response everytime. When devices lag or applications freeze or the feedback gets delayed users are forced to repeat the action. Over time, these technical barriers contribute to stress, discourage independent use among VIP's. As one participant shared,

“While using outdated devices with screen reader apps can lead to significant latency issues, causing noticeable delays when navigating or giving commands. This results in sluggish response times, making app transitions feel much slower. This causes frustration due to the increased time needed to perform even basic tasks.”[I11]

Taking help from family to navigate gadgets is very common for VIP's. Due to their limitation of operating social media like YouTube solely, participants rely on their closest ones for help and direction. Also, different platforms provide some edge over other. Participants develop fondness over certain features they become used to with. One participant mentioned,

“I believe in PC the apps (softwares) are good. Narrator is quite helpful and NVDA has many features. Though they sound like robot they are easy to navigate...While using YouTube on phone I cannot skip 15 minutes or 1 hour. Tapping on the screen for operating this system becomes a hassle for me. In those cases, I ask my son to help me out with the timing of the video. I ask him to skip 30 minutes or 1 hour which I can't do by myself.”[G2, P3]

Often society underestimates their capability of operating gadgets whereas most of the time these people prove their efficiency by challenging the stereotypical societal beliefs. Their exposure to technology has made them outshine in using several application which commoners often fail to understand. Figure 4.4 illustrates the participants' usage of their phones with TalkBack.

“I was in my room and then I heard the sound of TalkBack. I just rushed out of my room to see who it was, as I thought it could be my neighbor who is like me. I was standing on the gate of the house waiting for the person. When he passed I asked him to stop to have a conversation. However, he was a Foodpanda delivery boy who had accidentally turned on the accessibility option on the phone and could not stop it. He thought that his phone was facing some technical error and soon would be out of service. I helped him to turn that off as he was not able to do so. Though brief, we had a good conversation. I felt good after helping him.”[G1, P1]

Another participant shared a familiar experience while she visited her homeland to visit her parents. In rural environment people tend to marginalize VIP's more demeaning their capabilities, holding prejudice.

“ Once a neighbor of mine accidentally turned on the accessibility option on his phone. He did not know even such options existed. He thought his new phone was broken. My mother heard the news and suggested him to take the phone to me for fixing. He laughingly replied how a blind person can fix a phone. In the end it was me who fixed the phone.”[G1, P2]

With limited resources VIP's tackled the technological challenges. Most of them are self taught with occasional support from surroundings. Their mastery over daily used software sometimes even outshines the ordinary people.

4.2 Financial Tool Usage and Accessibility Challenges

In this section, we describe the use of different financial tools by VIP individuals, their approach to navigate through the traditional banking services, issues faced while doing financial transactions. Figure 4.2 shows participants enrollment in different financial services.

4.2.1 Use of Financial Tools in Daily Life

In our study, participants reported very less usage of offline banking services. The limited accessibility within offline banking services poses significant challenges for VIP's. In most cases the banks are physically not designed to cater the needs of VIP's cutting at the very beginning. Reliance on paper based system to open account, non-adaptive transaction system further reduces autonomy and brings reliance on others. Participants rely on managers and other bank staffs for assistance in bank services. As one participant mentioned,

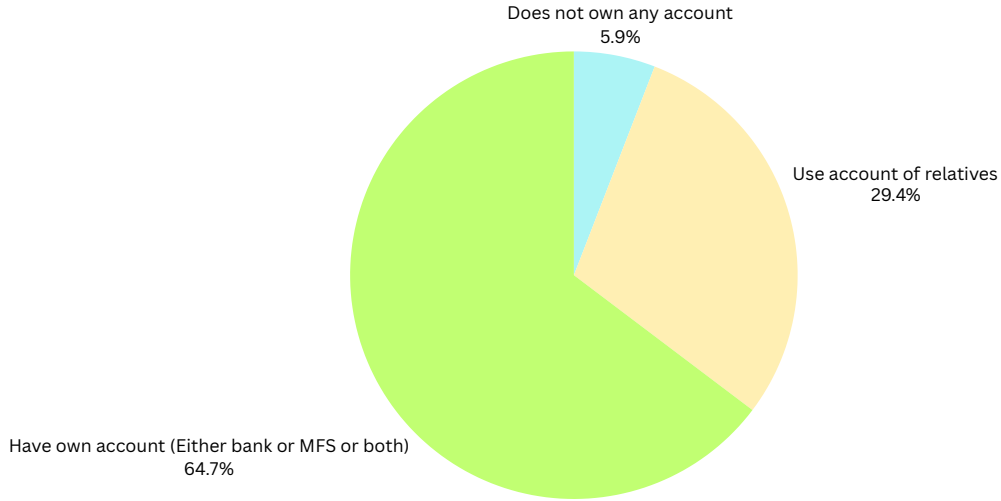


Figure 4.2: User enrollment into different services accounts

“I don’t wait for any individual to help me out. Even in banks, I directly look for the bank manager other than any existing people to guide me with my work.” [I9]

The amount of ATM which support voice assistance are very low. Also, the unavailability of CRM machines inclines the participants towards the banks. Inaccessible physical layouts poses a difficult barrier forcing the user to avoid the specific booth. On many occasions participants were forced to travel a distant place just to access an ATM supporting the assistance feature. As one described,

“Not all ATMs have voice assistance enabled. I have to travel a length from my house to go to one that has this enabled. I also need to avoid times when there will be rush as I need more time than others to withdraw money. ” [G1, P2]

Participants reported in some neighborhood there is not even a single machine with voice assistance or brail. As the participants cannot track people around them, it creates a privacy void while entering their pin for transaction. Many banks have more than one ATM in a single room, for multiple access at the same time. The lack of accessible voice-assisted or tactile solutions poses a significant barrier causing security vulnerability of the user credentials.

“I would be interested in attending workshops on accessibility technologies. I have also used ATMs many times, but since they are not accessible in Bangladesh, I always require sighted assistance. This creates a major security concern for me, especially when others can see my PIN while entering it. Banks have not been helpful in making ATMs accessible, as

they do not provide Braille, audio, or other support, although they have been supportive with other transactions at the branch.”[I3]

In several cases, VIP’s rely on guards of ATM’s for transaction of money. Their reliance is shaped by the technological error which confines them into a box and limits their access and functionality to operate fluently. Feeling confined within a certain frame for vulnerability makes the VIP’s feel burdensome and tired.

“Only one ATM in my neighborhood supports voice support. I go to it often. The problem is most people go there also. When there is a long line or rush I give the card to the guard and tell him my pin and amount I want to withdraw. I know it is not safe and the previous guard changed recently. But what choices do I have? Not every time I can take someone with me and bother them with my needs.”[G2, P1]

Users face difficulties while using offline financial services. These difficulties even when reported are not addressed, causing problems in daily life of VIP’s.

4.2.2 Use of Online Banking and MFS services

Participants’ use of MFS is driven by convenience over the traditional banking system. Figure 4.3 shows participants use of different MFS services in daily life. When using MFS services several participants accessed via dialing the USSD code for transaction. Sometimes the screen reader fail to read the popup of the menu of MFS service provider, read the menu in a form not understandable to the user. Users with over the time usage memorized some frequently used options number which helps them while using the service. The usage works in form of speed dial but also contains risk of misdial and leading to wrong transaction. As one participant shared,

“I use bKash manually (by dialing the code). It feels like checking balance. Though there are many options here. I have memorized some numbers with their option in there. This makes the use easier. Though once I mistakenly used other option from the intended one”[G2, P3]

In some cases, participants chose a particular shop for mobile banking. As they have often been betrayed by the closest ones, they rely on their best judgment while choosing a shop for money transaction. Shops being away from their accommodation hardly stops them from the need of securing their transaction.

“For my bKash transaction I have a trusted shop. They would give you 10 taka more rather than giving you 1 taka less. I have tried many shops and then chose it. It is air conditioned and away from main street. It sells other items too. So, it is hard for outsiders to know how much money I have withdrawn or even if I have.”[G1, P1]

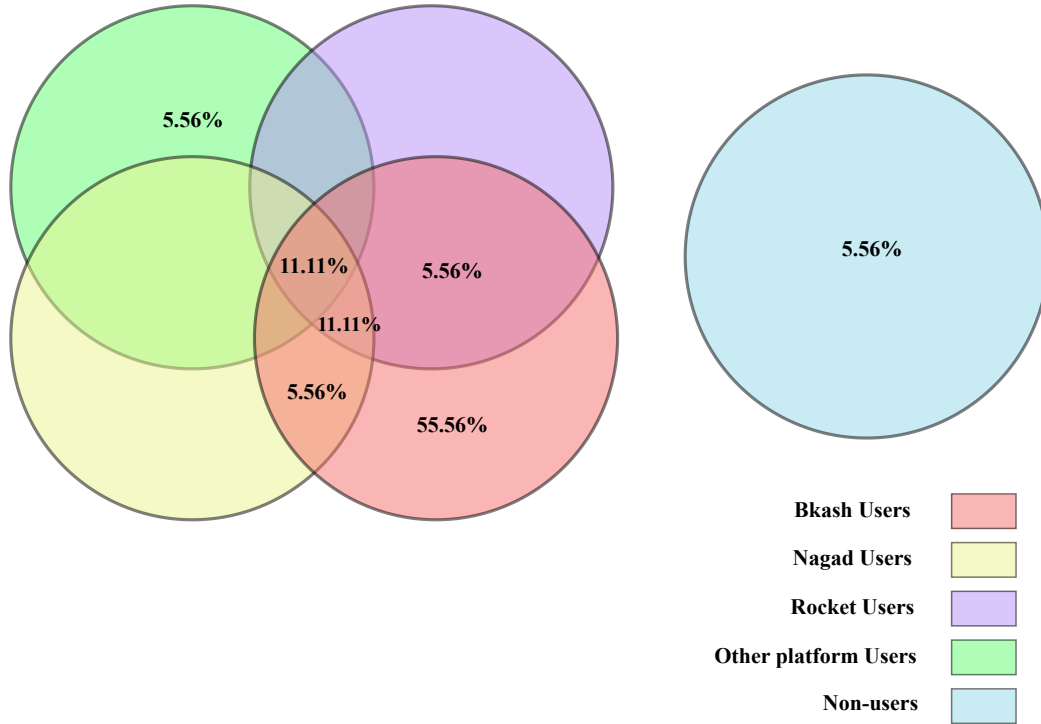


Figure 4.3: User distribution across major mobile financial services

Apart from the use of MFS services, many participants used online apps of bank for financial transactions. On one hand, these apps reduced the problems of offline transactions as the user does not need to visit any offline branch and can do transactions using phone. However, on the other side these apps alongside MFS platforms faced issues with screen reader. Screen readers often failed to read the interface out with correct words. When it fails and repeats output as *buttons*, participants need to take help from family members or people who are near at that time. This fail in case of some apps reduce the motivation of using these MFS platforms. One participant mentioned,

“I use Sonali e-wallet and Astha (BRAC Bank Astha) for transaction apart from bKash and Nagad...sometimes TalkBack cannot read the options on screen. It only say button, button. But what button? What is the use of that button? I ask my son to tell me what is the button. Then I was told it did not read enter.”[G2, P3]

Language plays vital role in communication and thus its role become more prominent for VIP’s as it is an important element to navigate their life. However, geographical boundary and limited access to resources make language a barrier for VIP’s. While these people are largely dependent on vocal instructions to operate applications, elements like tone, speed and pronunciation, make it hard for them to grasp in many aspects.

“ Language is a big barrier. I am a teacher myself and I even struggle sometimes to understand what is said. Though there is an option for controlling the speed it makes things worse. In many platforms which

are good with navigation the voice is hard to understand. It is hard to find the sweet spot. I feel the app does not speak the Bangla we speak. The voice is in the same language but the tone is not right. ”[G2, P2]

Though participants opted to MFS for increased accessibility and ease of usage over the offline banking and ATM, difficulties remain just in different form.

4.2.3 Barriers in Online and Offline Transactions

In our study, we found participants who are born blind cannot open MFS account. Despite having all the necessary documents, including valid sim card, NID the apps require participants to blink while turning on the camera at the time of registration. While this feature intends to verify the correct person is opening the account, it excludes a group of marginalized community out of service.

“I am blind by born, so I cannot blink my eyes. To open bKash account you need to blink your eyes. As I cannot blink I could not open my own account despite having ID and all the things. I use my father’s account as my own.”[G2, P1]

Also, certain banks do not provide service to the VIP’s and refer them to other places. As one participant shared her experience with us,

“Certain banks don’t allow access to fingerprints as a verification method. Again, there are some banks that don’t allow access to ATMs for the visually impaired ones. They do end up referring to other banks.”[I9]

Participants mentioned the unavailability of existing assistance services in several occasions. The assistance feature on some ATMs they used before was manually turned off by the authorities without citing any specific reason. Even after contacting the authority the services were not made available. This creates bigger hurdle while the number of available machine is scarce to begin with. Figure 4.5 shows the participant doing a transaction in bKash with help of TalkBack by dialing USSD.

“There are 3 ATMs nearby my house. When I first started to use it they all had voice feedback. But after some months 2 closed the voice service. When I asked the guard, he said people do not need it so the office closed the voice assistance. I called the bank many times and they assured me they would turn it on. Still they haven’t turned it on. ”[G2, P2]

Moreover, participants faced difficulties as the screen reader they were using could not read the icons properly on the screen. As the screen readers voice output works as their eyes, when not working properly it creates problem for them and their overall user experience. Most MFS as they use local icons and language suffer with optimization with the reader itself. The design of these platforms also make the users suffer. Figure 4.4 shows participant using phone with Talkback on.

“During mobile recharge the operator icons such as GP, Robi, or Banglalink are not labeled. The screen reader only says “icon” without specifying which one, so we often have to guess. Also Nagad app is not usable at all to any of these services without others help.”[I5]

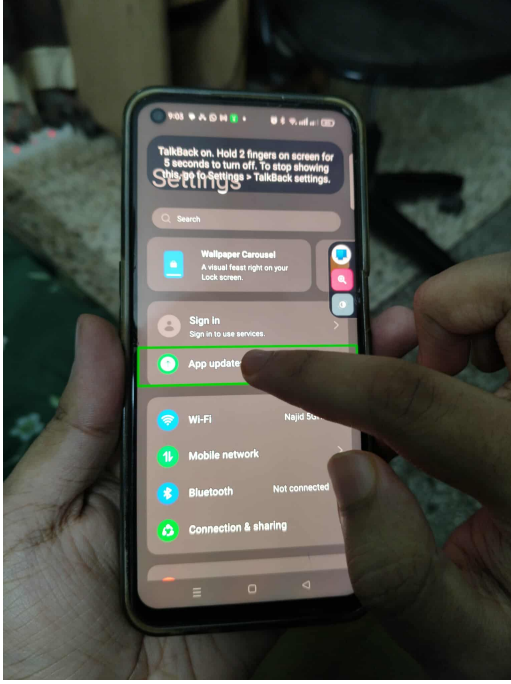


Figure 4.4: Participant using their phone with TalkBack (Screen reader assistance) turned on.

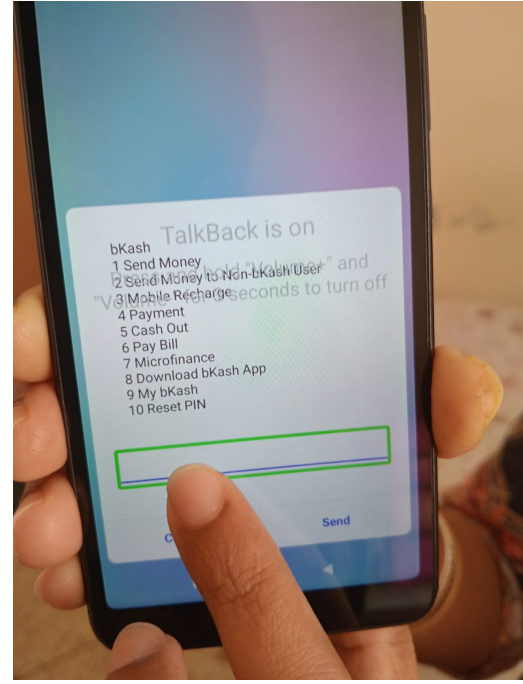


Figure 4.5: Participant logged into bKash manually by typing the USSD code.

On the other hand, privacy consequence has become one of the major issues for the VIP's. While they trust their closest one around them, misusing their trust these individuals took unlawful advantage. The financial loss with break of trust intensifies the existing challenge to achieve financial independence.

“Not good enough. I have faced a situation where a close one of mine had used my pin number as she saw it while I was trying to access the platform and later on did a transaction from my account without informing me - thinking that I would never get hold of it.”[I1]

While banks and financial institutions, employed modern technologies to boost the user security on many occasions they had negative impact on the usage and security of VIP's account. These techniques added extra stress and hassle for participants to complete the transactions. Technical design to ensure privacy and security has created barrier for them to access, resulting into forcefully taking help from others destroying the cause. As one participant shared,

“I am familiar with the use of CAPTCHA. Sometimes, it does have a lot of scratches within the visual and I find it tough to read with my vision. If the screen reader can't detect it too, I have to opt for others' help. In case there is none to ask for help, I have no other options remaining other than skipping it.”[I10]

Participants who also used banking apps apart from MFS, faced another issue while payment. Most apps do not auto complete the OTP request, resulting into participants inconvenience. The small time limit sometimes causes the participants to take help from people around them resulting into the whole security systems failure. Thus, the security feature just becomes another hurdle in transaction.

“The OTP is a big hassle. The time limit is very low, so I need to swipe quickly to make it in time. For me it is not a security but a burden.”[G2, P2]

Also, we observed lack of updated information availed to VIP’s. Due to the lack of social and technological exposure, they seldom get any information resulting into lack of operating knowledge. Often they are unaware of the advantageous features of applications due to proper guidelines and as a consequence they need to deal with difficulties.

“I did not know there is a way to authenticate using fingerprint on bKash. Are you sure? No one ever told me this. If it is there then it really is a blessing. Those of us who have fingerprints can easily use the service. But there remains a risk as we cannot see with our eyes what if our fingerprint is used without our knowledge”[G2, P3]

These barriers creates challenges to the user and often result into creating more problems for them. Even though measures are taken to ease their difficulties, they also lead to extra challenges and stress due to lack of proper accessibility, guideline, understanding and knowledge.

4.3 Coping Strategies and Pathways to Inclusion

As participants face challenges to operate banking and financial system through screen reader, they came up with a few suggestions that can make their way easier and ensure safeguard. These suggestions can be used to develop future systems catering their needs. Most were on the optimization of screen reader apps with local MFS services. Participants emphasized on boosting the security while maintaining the accessibility for them. Also, turning the readers to read local icon and correct buttons. One of the participant said-

“I also feel the app could be made more suitable for screen readers. Another issue is when entering a PIN, the screen reader does not detect the cursor’s position. There should be a feature that tells how many characters have been entered. It would also help if the app provided descriptions of images or some icons. For instance, I have had to use Gemini or ChatGPT to identify unlabeled icons, specifically to check whether they represent GP or Banglalink. I believe bKash should be able to detect when TalkBack is being used.”[I4]

Since privacy and security has become one of the most concerning fields, participants expressed concern of their phone screen being visible to others. This results in hiding their screen in public while entering their password. In several cases, updating the features of screen reader might be proved helpful as it has become a great help to them.

“I would suggest updating screen readers as it is much more usable and everything we do depends on the screen reader. I use hide screen option to make sure no one can see what I am doing in the screen.”[I12]

To eradicate the barrier of language, stabilization of language is important while navigating applications. As there is an issue with accent, the participants urged inclusion of voice feedback in an accent understandable to the locals. Also, participants reinstated their privacy concern while using the MFS apps.

“Keeping a stable language setting is important, as sometimes the icon texts are in English, sometimes in Bangla. Also, I’d like a more secure PIN input process. It would be great to have a system where even if the PIN is stolen, it is useless without the actual user.”[I6]

All of these findings reveal the issues VIPs’ face in their daily life while using non-digital and digital financial service platforms. Our findings highlight the special needs of VIP individuals and their suggestion to build an inclusive platform.

Chapter 5

Discussion

In the previous section, we presented our findings of our study highlighting the usage pattern of participants financial transactions, key barriers, societal role in shaping their behavior and coping mechanism and suggestions. In this section, at the beginning we offer a situated understanding on the effect of external factors on the behavior of our participants through psychological and social science theories. Then, we evaluate the usage of different existing technology where emphasize on challenges they face while operating tools for digital finances, risking privacy and security instead of strengthening. Lastly, we provide design guidelines for future implementation of an inclusive system suitable to the VIP persons.

5.1 Social Exclusion to Exploitation

Our findings reveal that being under the same societal umbrella, Visually Impaired Person's are often excluded from the society due to their incapability and vulnerability in dealing affairs unlike others. Labeling them as "burden", "different" and "vulnerable", they are denied from the the right of education and access to other fundamental resources which can enhance the possibility of leading a stable life. While they need the support of family, friends and society, they are often treated as the "other" one in our societal frame. Drawing from Edward Said's Theory of Othering, the dynamics of societal structure, role and power play can be identified in our social context as well where VIP's or deformed people are treated as "other", making them feel excluded from social facilities and numerous advantages [1]. Constant difference in treatment and behavior shows cultural exclusion and emphasizes their existence as "the Other" which identifies them less worthy than sighted people by setting a critical unfavorable narrative. Using the lens of the "Self" and the "Other", this discrimination become clear as they have been always otherized in every factor which limited the possibility of leading the life with comfort, protection and privacy. Our findings shows that several negative narratives are set to prove how they are "burdensome" and in some cases curse for parents. Neighbor often judge them based on prejudice, demeaning their capabilities to establish own superiority stressing the power hierarchy from the lens of identifying VIP's as "the other" and themselves as "the Self".

In several circumstances, VIPs are denied basic needs which deduce them from leading a privileged life to one with dissatisfaction due to disabilities. Their limited

access to technological devices, low understanding in operating modern gadgets, lack of information and knowledge mostly caused because of the negligence of their closest ones or from the people who are in the structural power. Our data reveals that the challenges they need to overcome in their daily life are mostly created by their family members as they are the one who they trust with safety, security and privacy. While they should have been recognized and cared as people with special needs, their identity is reduced to their susceptibility. This situation can be better understood with the Theory of Social Exclusion [3]. According to this theory, individuals are denied to participate in societal factors due to several withholding components like poverty, discrimination, limited access to resources, efficiency, opportunity and many other retarding social and economic elements. Analyzing the given conditions, our participants conditional access to social resources can be aligned from a very similar angle. Failure in navigating the world and operating life like others have created hindrance in their life resulting into denial participation in social and economic factors. As a consequence, they are lagging behind even in the era of technology where their life should have been smothering than before.

5.2 Security for You, Hurdle for Me

Often social exclusive led to Mental exclusion for VIP's. From an early age, they face challenges from different societal spheres which leads to creating a distance from family and friends. On many occasions denial to access common facilities like sighted people, continuous ignorance from closest ones, question on expertise make them feel alienated. This feeling of alienation creates distance making them confined and cornered under the same roof and boundary where their exclusion from societal frame results into making them a marginalized group. Using their disability as a barrier, society along with family members control their desire to use technology as well. From the perspective of Mike Oliver, a disabled academic professor - the concept of how societal barriers create disability rather than individuals impairment, can be interpreted fully. Aligning his theory of social model of disability [81] with our findings, it becomes clear that, the challenges VIP's are facing on regular basis are hardly created because of their incapability. For instance, VIP's are unable to navigate modern technology like sighted people, these population are given poor devices that keeps lagging and hanging which result into creating concerning objections while doing mobile banking. If they were given good devices with proper usage knowledge, navigating the application would have become easier for them. However, questioning their capability, they are deprived from the proper technological access as these accessed are considered "costly" for a blind person. As a consequence, when they get access to it, it adds stress to their understanding as technological devices, software or application are hardly made considering their perspective.

On this regard, our findings reveal that participants face trouble while doing mobile financial services (MFS) and digital financial services (DFS). Available resources are hardly related to their needs and often they become useless while using. MFS & DFS platforms such as bKash, Nagad, Rocket, Upay are designed for digital banking where only sighted users can use them properly as the features of these apps are not designed for VIP's. Even though bKash can be operated by screen reader, Nagad, Upay and Rocket are not usable on this regard. However, in bKash several

times, screen reader can not identify icons which creates stress to the VIP's. For higher security, using CAPTCHA has become very common but screen reader can not detect scenarios - resulting into increasing hassle and challenges for impaired people. Geographical barrier, language barrier, lack of information and knowledge had resulted into usage failure numerous times. Our participants also expressed concern while using ATM booth. Turning of the voice feature of ATM enhance the difficulties to use this system. Often these techniques make them rely on others for helping with pin numbers and code. These devices and applications are primarily made for sighted users. As a consequence, VIP's can not navigate them properly and efficiently without hindrance. Again it becomes prominent that the infrastructure of these devices and applications are problematic for visually impaired people. They are not liable for their inability to operate the system but it is the societal structure that leads to technological barrier in certain levels.

5.3 Critical Engagement with Research Findings and Future Implication

5.3.1 Need for a Separate System

Existing ICT-based and DIY-driven solutions for supporting visually impaired and blind individuals have played a pivotal role in enhancing their quality of life. Such initiatives have not only demonstrated a profoundly positive impact but have also fueled the transformation of earlier technologies into more sophisticated, accessible, and user-friendly innovations [42]. Incorporating user centric design these technologies fulfilled the participants need, predominantly Global North population. However, these solutions are hard to incorporate into the life of people from Global South considering the unique socio-economic settings. Anokwa et. al in their presented the unique challenges HCI researchers face in developing regions due to differences in culture, language, ethnicity, and socioeconomic status [9]. Their work suggests the need of unique approach to address the need of these populations rather than forcing a solution adopted from other settings. Since our participants have faced severe challenges in past due to numerous barriers while operating those systems, it is time to design a model that will be easy to navigate and at the same time it will ensure the better usage understanding of the devices. Offering such facilities to them will open a way for them where they will not need to adopt with the system, rather, the system will be designed considering their unique condition and geographical location in mind.

Our participants shared a strong desire for financial independence, highlighting the potential of technology to serve as a powerful enabler in achieving this goal. Their stories of achieving success in other fields defying all odds endorses their commitment. Previously, prominent research figure in ICT for Development in Global South Kentaro Toyama presented Law of Amplification to emphasize the role technology can play in changing the current condition of population. As the theory states, technology inherently do not posses the power of doing good or bad rather it amplifies the intent of user [23, 58]. It also indicates that it is on our hand how we handle the whole system to make technology accessible for them and at the same time it also

connotes our liability to enhance the utilization of technological resources to make it accessible for VIP's. Taking this into account we believe our proposed technology based solution will positively magnify the intent of Blind and Visually Impaired Population.

5.3.2 Design Guidelines

Shaping the design by user feedback is nothing new but a fundamental part of successful design methodology. Daggubati emphasizes the pivotal role of User-Centered Design (UCD) in shaping effective digital payment systems [88]. Drawing findings from comprehensive literature review alongside case study analysis, she illustrates the multifaceted benefits of adopting a user-centric approach, ranging from enhanced usability to greater trust and convenience in digital transactions. The HCI community whose main goal is to make the interaction of humans with computers smoother, shifted to experience design highlighting the relevance of a design-as-craft perspective[5]. In designing a platform for blind and Visually Impaired Persons, Don Norman's principles from *The Design of Everyday Things* [15], provide a crucial foundation for addressing both local needs and limitations of existing systems. Current assistive applications often suffer from recognizing local icons, identifying different buttons, usability limitations and de-optimization with local financial app. By applying Norman's concept of affordances and signifiers, the platform can incorporate haptic feedback and add locally understandable auditory cues so that these platforms can increase the usability. Tuning the platform to recognize the local icons will reduce the dependency on other by making the platform more functional and optimized. Moreover, these functionality directly addresses gaps in current systems, empowering users autonomy. Also, using *Seven Principles of Universal Design* [2] the platform can incorporate Principle of Flexibility in Use, Principle of Simple and Intuitive Use and Principle of Perceptible Information the platform can ensure accommodation of a wide range of individual into single application which is easy to understand regardless of user experience. Intending to make this platform work regardless of ambient conditions or the user's sensory abilities, we desire to make this design approachable and easily accessible for users.

The United Nations Convention on the Rights of Persons with Disabilities, ensures the rights of persons with disabilities including Blind and VIP's [8]. With principles of full and effective participation and inclusion in society, non-discrimination, equality of opportunity and accessibility the convention paves the road for a discrimination free inclusive environment for all, where disability would not be a hurdle. Bangladesh as a signed member of this convention [20] alongside the Marrakesh Treaty [67, 71] holds responsibility towards ensuring the right of people with disabilities. Following this spirit we propose, modification of rules and regulations specially tailored to the need of VIP's to be applied exclusive for them. To ensure inclusivity, all ATM should support brail keyboard, voice assistance enabling with just a button along with available sound adjusting system providers. Also, relaxation in registration rule for VIP excluding mandatory eye blink, increasing OTP completion and transaction time using manual dialing. Also, we believe these changes can be made in accordance and help of The Rights and Protection of Persons with Disabilities Act, passed on 2013 [13] to empower the community.

We believe, by integrating User-Centered Design, Universal Design, and Norman's principles, digital assistive system can become more intuitive, accessible, and responsive to diverse user needs. Also, the regulation changes would allow for a more inclusive environment to form ensuring equal rights for all.

Chapter 6

Prototype Development and Testing Results

Based on our findings we developed a prototype addressing the challenges Blind and VIP’s face while accessing existing MFS platforms.

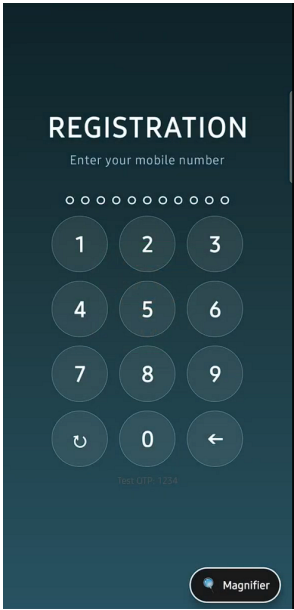
6.1 Prototype Development

To mitigate the barriers identified through the interviews, we built our prototype “Dristikohon” that incorporates targeted solutions that are derived directly from user feedback. To address the security risks of PIN entry in public settings, we implemented a toned-based keypad where each button is distinguishable through unique frequencies, allowing secure entry without any security breach. Moreover, to counter the exclusion of low vision users, we integrated a draggable magnifier that can be utilized to zoom in on any element on the screen. Alongside the magnifier, we maintained a high-contrast UI and proper button size so that elements are discernible. Furthermore, to acknowledge the issue of low end android devices in the Global South, we developed a lightweight, built in screen reader that supports both Bangla and English, tunable speech speed and is compatible with TalkBack’s gestures. We also handled navigation ambiguity by ensuring all semantic labels such as mobile operators are clearly enunciated. Finally, a three-finger gesture was introduced to exit the app immediately , providing a mechanism to safeguard autonomy during potential eavesdropping scenarios.

The prototype was developed using JavaScript [109] and its popular application development framework, React Native Expo [111]. This tech stack was chosen for its cross-platform feature and efficiency in rapid prototyping [36]. The development cycle began with a thorough analysis of interview findings to determine solution feasibility, followed by tech stack selection and coding implementation. During the implementation, we leveraged GitHub for version control and the Expo app for real-time testing. Finally, we built the Android Package Kit (APK) where Expo again provided efficiency. This development approach prioritized the constraints of the local contexts and ensured functional robustness. Some interface photos from the prototype is shown in Figure 6.1. Also, the GitHub link ¹of the project and YouTube

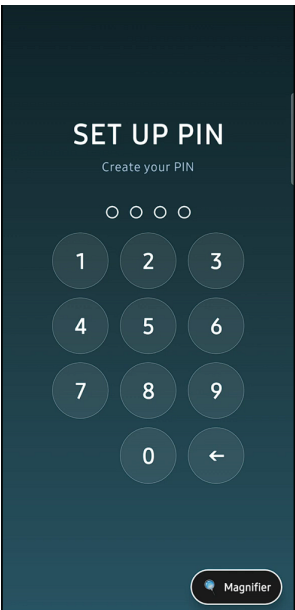
¹<https://github.com/ome-ehsan/Dristikohon-v2>

link of the demo video ² without turning Talkback provided.



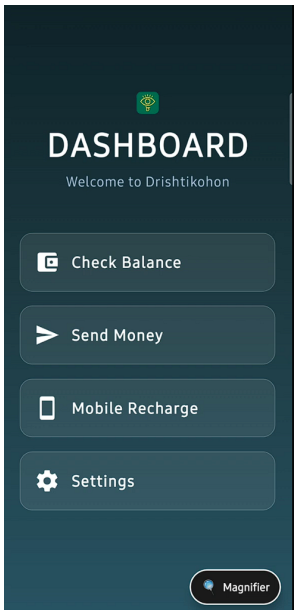
The

user registration page. User enters their number to register.

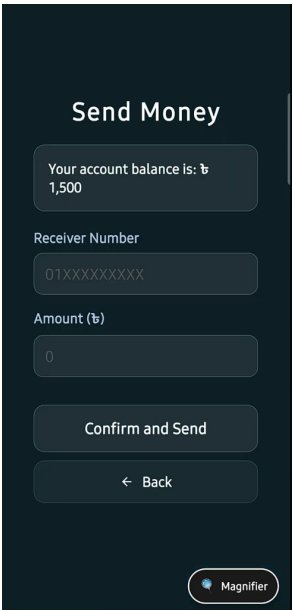


Pin

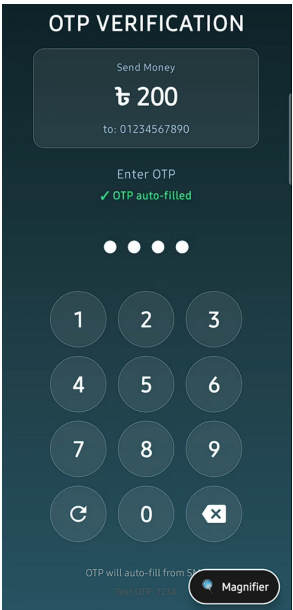
setup page, with distinct tone for each button.



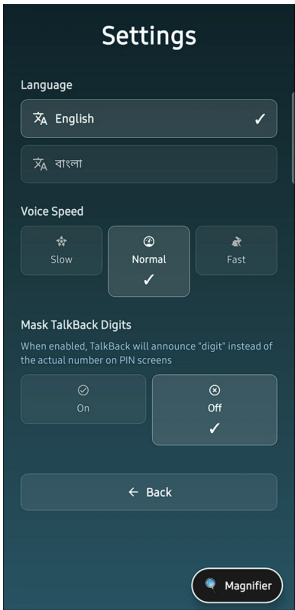
Main dashboard for navigation to different features.



Send money window. Users can choose amount independently.



After every transaction, the OTP gets auto-filled.



Settings page to control voice speed, voice medium, etc.

Figure 6.1: Different pages of the built prototype named *Dristikohon*.

6.2 Participant and Test Environment

After the development we shared the prototype as APK file with Blind and partially sighted individuals. In total we collected feedback from four persons, among whom two had previously participated in the interviews. In between the four participants

²<https://youtu.be/gsYT4RawKYY>

two were fully blind and two were partially sighted. One participant never used any MFS apps to do the transactions while other three had previous experience of using at least two MFS apps - commonly bKash and Nagad. Though the testing participant is limited in number, we tried to diversify the participant pool to have representation from various fields. Two participants from previous interview pole were selected to evaluate our prototype against the data collected and other two participants ensured the generality of the solution. We used remote asynchronous usability testing [11] method to test and collect feedback from users. The users used the app on their own terms and shared their experience with us. This method is known for getting results about the system in their real context, making behavior more authentic than in a lab. Also, the participant can do the testing at their convenience, without the fear of any judgment and outside expectation. Previously asynchronous method detected a greater number of usability problems related to content and navigation and was preferred by participants for being more comfortable, fast and convenient [34], [60]. Drawback such as limited scope of probing, task control, setup issues come with this method. However, we used this method considering the the convenience of participants to get an usage scenario as close to real life as possible, where the participants navigate the app on their own.

6.3 Test Results

Each of the participants used the app ranging between 15-30 minutes. The participants were given one day to send the feedback, while in between if they faced any technical issue eg. installation problem, they could contact us for help. We remotely instructed them to solve the issue. We used iterative feedback methods to minimize the drawbacks of remote asynchronous usability testing [65]. The feedback consisted of mixed reviews, though in most part the participants felt the app to be more responsive, easy to navigate and meets their needs. The critical responses and our remarks are presented in Table 6.1

Participant	Feature	Suggestion	Remark
P1	Magnifier state	Putting magnifier into a still state after finger is removed and have a separate button for un-checking it.	Adding an extra button may benefit the partially sighted individuals but may add difficulties to fully blind people.
P3	Voice termination	One voice should end first before cutting it and starting another.	Using queue method we tried to fast-track the user to the next phase, suggestions incorporated from initial collected data.

Table 6.1: Participant critical feature-suggestion table.

The magnifier option helped the partial visual impaired participants to use the app at ease, reduced cognitive load and opened opportunity for independent interac-

tion. It enhanced the text readability and improved the task accuracy. However, while appreciating effectiveness one participant suggested to have fixed magnifier with buttons for consistent hover over icons. The unique tone while pressing the pin, gave the participants flexibility to enhance privacy. All the participants patronized the feature as a good improvement over the existing system. The incorporated voice navigation helped the users navigate without reliance on Talkback. However, one of the participant expressed dissatisfaction over the app's movement towards the next screens voice feedback before finishing the prior. The concern they raised relates to the queuing system, which we implemented after encountering an earlier issue during testing where voice commands were overlapping upon screen switching. The queue system and immediate voice termination were built to prevent the overlapping issue. While the implementation may feel different to users, it actually addresses the initial problem. The auto OTP fill-up was positively acknowledged by all the participants, reducing their tension to fill-up OTP in-between certain time. Furthermore, all the participants reported the prototype was fully navigable with Talkback, with all the options getting recognized. Lastly, the high contrast and big sized icons with minimal but necessary features helped both the partially sighted participants to navigate through the app reducing reliance on the voice feedback.

Overall, the prototype has a positive impact on the usage of the participants. Their continuous feedback will guide us to make future refinements to the prototype.

Chapter 7

Limitations and Future work

Our study has a few limitations. Firstly, we could not conduct any interview in particular with participants in rural settings. Our data only represents the voice of Visually Impaired Persons who are now in urban environment, having spent their early days in rural/urban regions. Also, most of our participants are quite educated, though facing much hardship in the process. This necessarily indicates - our workings might be inclined towards the aspects and belief settings of the insightful ones. Moreover, we could not take interviews from diverse marginalized population such as person with more than one physical disabilities, LGBTQ+ community, indigenous groups, transgender people etc. Furthermore, we only focused on a single challenge the VIP's face - financial transactional environment, escaping the other barriers of their life. With a broader extend, we believe - future researchers can focus on presenting these issue to the borderer HCI and academic community to make their voices count mirroring their intrinsic vision and find inclusive solution suitable to this community.

Chapter 8

Conclusion

This study sheds light on the lived experiences of Blind and Visually Impaired Individuals in Bangladesh, unveiling the social scrutiny, familial struggles, and the multifaceted challenges they encounter in daily lives. We highlight the obstacles they face in doing financial transactions, blocking the way to achieve economic autonomy. We present the incapability of existing popular screen readers recognizing local icons, non-optimized performance with MFS apps, privacy concerns with the existing platform. We also present the problems current law and regulations creates in creating and operating digital finance accounts and offer exclusive suggestions and guidelines to resolve the problems. By focusing on this marginalized community we fill the gap in current existing literature on highlighting the issues faced by blind and VIP's and focusing on niche financial inclusion issue. Our work represents the voice of Global South in the HCI community's predominant works of Global North. This work focusing on ICT for Development and HCI4D contributes the ongoing discourse by solving a problem using multifaceted approach. By incorporating design guidelines and technology solutions from computer science, theories of social-science, post-colonial literature and psychology, our work opens future research directions to future researcher from multiple field. We hope this study will not stop as a single voice presenting the blind and visually impaired population but give rise to the thought for the need of inclusive designing and continue the discourse.

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8.1 Interview Guidelines

While conducting the interview the questions were asked in Bengali, and then they are here translated. We refrained from using anything that might hurt them mentally given societal state.

8.1.1 Basic Demographic Information

1. What is your age?
2. What is your gender?
3. What is your highest level of education?
4. Are you completely blind or partially sighted?
5. Did you grow up in an urban or rural setting?

8.1.2 Understand Condition and Technological Use

1. What devices do you daily use?
2. How did you first learn to use these technologies?
3. Which apps, tools, or features do you find most helpful in your daily life? (If uses both PC and Smartphones)
4. How does technology help you stay connected with family and friends?
5. Has technology increased your independence in social or professional life?

8.1.3 Current Usage of Digital Financial Services (DFS)

1. Which digital financial services do you currently use? (e.g., bKash, Nagad, Rocket, ATM services)
2. How long have you been using digital financial services?
3. How often do you use these services (e.g., daily, weekly, monthly)?
4. What specific types of transactions do you usually perform on these platforms? (e.g., sending money, paying bills, checking balances)
5. How do you access these services (e.g., using a screen reader, voice commands, manual navigation)?
6. Did someone assist you when setting up your mobile financial account (e.g., bKash/Nagad)?
7. Do you face any difficulties using these services due to your visual impairment? Please describe.
8. Are the mobile apps you use (e.g., bKash/Nagad) screen reader-friendly?

9. Do you use any assistive technologies (e.g., screen readers, voice assistants, Braille devices) to navigate mobile banking platforms? If so, which tools work best for you?
10. How do you verify transactions (e.g., PIN entry, OTP, voice confirmation)?
11. Do you face any difficulty reading SMS or confirmation messages after a transaction?
12. Have you ever made a wrong transaction due to inaccessibility or lack of support? If so, can you describe the issue?
13. Would you feel more confident using these platforms if there were voice-based navigation or Braille-compatible options?
14. How do you handle security during transactions, especially in terms of PIN entry or OTP verification?
15. Have you experienced any security or privacy issues while using digital financial services? If yes, please elaborate.
16. How satisfied are you with your current experience using digital financial services? (Rate 1–5)
17. Do digital financial services improve your financial independence? Please describe how.
18. What features or improvements would make digital financial services more accessible to you?
19. Have you encountered any complex financial terms or new concepts that were difficult to understand when using DFS?
20. Would you recommend these services to other visually impaired people? Why or why not?