Global Disability Innovation Hub

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Mobile as Assistive Technology

Kenya Case Study Report

AT2030 Insight Paper | Inquire Cluster
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Executive Summary

Mobile phones are increasingly important to our lives. They can connect people to learning and employment opportunities and support social and cultural interactions. Mobile phones have also been identified as assistive technology in prior AT2030 research. However, mobile phones and the Internet are often excluded from Government or Insurance-based assistive technology provision schemes in low- and middle-income countries. There is insufficient evidence to explain how mobile phones function as assistive technologies and what support is needed for people to learn the full suite of accessibility features on mobile devices.

Purpose

This Kenya study examines how smartphones function as assistive technology (AT) for Blind or Partially Sighted (BPS) and Deaf or Hard of Hearing (DHH) people, following device onboarding, accessibility training, and six months of supported use.

Design

A mixed-methods approach combined baseline and follow-up surveys with interviews. Participants received Samsung A14 devices, 2 days of digital skills and accessibility training (e.g., TalkBack, Lookout, Live Transcribe, Sound Amplifier, Live Captions), and 2 GB of mobile data per month for 6 months. Smartphone usage was also passively observed using the Murmuras app (privacy-preserving, metadata only).

Sample

In Kenya, 194 people were recruited at baseline (97 BPS, 97 DHH); 126 responded to the exit survey, and 121 completed both surveys for the paired analysis (72 DHH; 49 BPS). Interviews were conducted with a purposive subset.

What changed

Key improvements observed include:

- Statistically significant improvements in 71% of digital skills items.
- Increased use in 10 of 25 activity areas, including communication, travel, job access, and health services.
- Significant improvement in access to information; DHH participants also reported gains in leisure.
- BPS participants showed strong gains in screen-reader/device navigation; DHH participants showed strong gains in communications.

Connectivity reality

Challenges related to connectivity included:

- Over half (≈53%) exhausted the 2 GB monthly data within a week.
- Regular Wi-Fi access doubled among high-volume users and was associated with higher engagement.

What users valued

Participants appreciated:

- DHH: Real-time transcription (Live Transcribe), Live Captions, and video communication.
- BPS/BPS: TalkBack, Lookout, magnification, and assistant apps for independent tasks.

Gaps to fix

Identified gaps include:

- Need for ability-based onboarding and training.
- Inaccessibility of many essential apps and websites.
- Accessibility reliability issues with lower-end Android devices.

Recommendations

The study recommends:

- **Finance connectivity:** Concessional data bundles or zero-rating of accessibility-critical services.
- **Institutionalise training:** Modular, ability-based curricula and interpreter upskilling.
- **Enforce digital accessibility:** Mandate WCAG conformance and usability testing.
- **Procurement standards:** Specify accessibility performance for funded devices.

Project Partners

Kilimanjaro Blind Trust Africa

KBTA is a charitable Trust based in Nairobi that provides access to quality education for children and youth with visual impairments (VI) in Kenya, Tanzania, Uganda, Rwanda, Malawi & Ethiopia. KBTA uses innovation &technology to provide access to digital Braille literacy & skills. KBTA served as the community partner on this project, facilitating mobile phone procurement, participant recruitment, and the delivery of digital skills training.

Jomo Kenyatta University of Agriculture and Technology

JKUAT is one of Kenya's leading technology universities at the forefront of assistive technology innovation. Having recently launched the Innovative Wheelchair Centre, JKUAT is trailblazing in raising awareness and advancing assistive technology innovation in Kenya. A team from the Department of Rehabilitation Sciences facilitated project delivery and quantitative analysis.

Safaricom

As Kenya's largest telecommunications provider, Safaricom is well-positioned as the mobile network partner for this project. Safaricom provided free six-month mobile network data for the research participants. This enabled the researchers to continuously engage the participants throughout the project and examine the impact of Internet access on smartphone use among people with visual and hearing impairments.

Senses Hub

Established in 2023, Senses Hub is the brainchild of Hope Tech, a pioneering assistive device development company and a collaborator of GDI Hub on the AT2030 programme. Senses Hub provided the workshop space for the delivery of the digital skills training in Nairobi.

Introduction

1.1 Smartphone Adoption in Lower-and Middle-Income Countries

Over the past two decades, smartphones have evolved from simple communication devices into powerful, multifunctional tools that can significantly enhance the lives of people with disabilities. As assistive technology (AT), smartphones offer a wide range of functionalities, including accessibility features, applications, and Internet connectivity, that allow disabled individuals to overcome various accessibility barriers. Unlike traditional physical assistive devices, such as braille readers and hearing aids, which are often expensive and difficult to obtain in low-resource settings, affordable smartphones are widely available in lower and middle income countries (LMICs), such as Transsion, Xiaomi, Oppo, and Realme [1], [2], which run on Google's Android operating system, allowing a certain level of consistency across different smartphone manufacturers and models.

The Global Systems for Mobile Technology Association (GSMA) estimates that approximately 85% of the African population owns a mobile phone. Although the ownership of feature phones (button phones without Internet-enabled applications) continues to increase rapidly, there is also a more modest but steady uptake in smartphone ownership. A recent GSMA report estimates smartphone ownership among adults at 42% to 56% across various Sub-Saharan African regions, with rates expected to reach 80% to 92% by 2030 [3]. However, this number is significantly lower among disabled individuals; in Kenya, smartphone ownership among disabled individuals is only 12% compared to 41% in the non-disabled population (a 72% gap) [4]. The gap, termed the 'digital divide' is largely due to persistent challenges, including awareness, affordability, accessibility, and digital literacy [5], [6], [7].

1.2 Disability in Kenya

According to the 2019 Kenya Population and Housing Census, approximately 2.2% of the population reported having a disability. However, disability advocates and international agencies believe this is a significant undercount, partly due to underreporting and stigma. Based on the global estimates from the World Health Organisation, around 15% of the population is expected to experience some form of disability, suggesting that the actual number of persons with disabilities in Kenya could be over 7 million. Among people with disabilities, visual impairments are among the most common. The Kenya National Survey for Persons with Disabilities [8] reported that 30% of individuals with disabilities had visual impairments.

Despite having one of the highest levels of mobile phone ownership, disabled people in Kenya are 11% less likely to own a mobile phone, 36% less likely to be aware of mobile internet, and 85% less likely to use the Internet than non-disabled people [9]. These disability gaps are significant, as mobile Internet access plays a vital role in enabling communication, accessing services, and participating in social, economic, and civic life. Key barriers to mobile internet use include a lack of smartphone ownership, internet connectivity, awareness of or access to the internet, general literacy and digital skills, and the affordability of internet data and devices. While disability is a major determinant of mobile phone ownership, gender further exacerbates this gap. Women with disabilities are less likely to own smartphones and often rely on borrowing phones, which limits their autonomy and access to mobile-enabled services [10]. This is due to the compounding nature of the additional constraints faced by women due to entrenched gender norms, safety concerns, and financial limitations, all of which further restrict their access to mobile Internet and devices [11].

We conducted a mixed-methods longitudinal study with 194 BPS and DHH participants in Kenya, yielding important insights into their lived experiences as they integrated smartphones into their lives. Although we appreciate that smartphones can be beneficial to many sub-sections of the disability community, we chose to focus on the BPS and DHH communities for this research due to the increasing number of accessibility features such as TalkBack, Google Assistant, and Lookout that were designed for BPS individuals and Live Transcribe, Live Captions, and Sound Amplifications designed to address the needs of DHH individuals.

Methodology

This study used a mixed-methods research design that combined quantitative and qualitative approaches to comprehensively assess the impact of smartphones as assistive technology for BPS and DHH individuals in Kenya. The mixed-methods approach was chosen to capture both measurable changes in participants' experiences and the nuanced, lived realities of their interactions with mobile technology. The quantitative component involved a baseline and a follow-up survey, while the qualitative component involved in-depth semi-structured interviews. This combination enabled data triangulation, thereby enhancing the validity and reliability of the findings. We included both BPS and DHH participants to explore cross-disability differences in smartphone use and impact. Although their accessibility needs differ, their shared experiences in navigating mobile technology in a low-resource setting offer a unique comparative lens.

1.3 Research Design

This research employs a mixed-methods approach (illustrated in Figure 1 below), leveraging the strengths of both quantitative and qualitative research methods to gain a comprehensive understanding of participants' experiences and the impact of mobile phones on their quality of life.

Figure 1: Research procedure

Baseline and Follow Up Surveys

To establish a baseline understanding of the participant's personal and social circumstances, we administered a set of questionnaires that focused on quality of life, their use of AT and mobile phones, and expectations for the smartphone as assistive technology. The survey questions were available in English and Kiswahili for participants' convenience. The study ran for 6 months, after which the participants were asked to complete a follow-up survey. The following questionnaires were administered at the beginning and end of the research.

The questionnaire combined several outcome measures, including:

S1: Demographic questionnaire (DQ) [baseline only]

This section includes 21 questions to capture participants' demographic information, including age, gender, location, disability type, living environment, education level, occupation, and mobile phone access.

S2: Self-reported need and use of AT (ATNU) [baseline only]

To gather information on the met and unmet needs for assistive technology among participants, we adapted the WHO's Rapid Assistive Technology Assessment (rATA) tool in our questionnaire, incorporating seven questions.

S3: Mobile phone expectations questionnaire (MPE) [baseline only]

This section consists of 21 questions exploring participants' expectations regarding mobile phones, including how helpful they believe these devices will be in addressing their daily needs and how frequently they anticipate using specific features.

S4: Mobile phone usage questionnaire (MPU)

Comprising 30 questions, this section focuses on participants' current mobile phone usage, including the frequency of feature use (e.g., calling, entertainment, information seeking), app usage, and accessibility features. Responses are recorded on a 5-point Likert scale.

S5: Digital skills self-assessment questionnaire (DSA)

This section evaluates participants' digital skills through 60 questions, ranging from basic tasks like turning the phone on/off and charging to more advanced skills involving app use and accessibility features. Responses are quantified using a 5-point Likert scale.

S6: WHO quality of life questionnaire (QOL)

We employed the WHO Quality of Life Questionnaire \cite{whoqol1993} to assess participants' quality of life. It includes 14 questions across five domains: self-esteem/satisfaction, environment, education/employment, access to information and opportunities for leisure. Participants rated their satisfaction with these aspects of life using a 5-point Likert scale.

S7: Internet use and impact (IUI) [follow-up only]

A questionnaire was developed to assess the participants’ internet usage behaviour and the impact of internet access. It includes 21 questions focusing on the frequency of mobile data and WiFi use, the amount and cost of data, mobile applications used on mobile data, and mobile data conservation behaviours. Participants provided their ratings using a 5-point Likert scale along with multiple-choice questions.

Mobile Onboarding and Digital Skills Training

The participants were then given Samsung A14 smartphones — a low-end smartphone worth approximately 150 USD and easily available in Kenya. Additionally, the participants attended a two-day training to learn how to use mobile phones and Android accessibility features and apps such as Live Transcribe, Sound Amplifier, Live Captions, TalkBack, Google Assistant, and Lookout to enable them to use mobile phones effectively in their daily activities.

Mobile Internet Data

To reduce any limitations on mobile phone use due to limited internet data access, participants were also given 2GB of data per month for the six-month duration of the research. Each month, a 2GB data package was automatically added to their SIM cards. Any unused data rolled over into the next month, allowing accumulation throughout the research.

Mobile Phone Use

To monitor how participants adapted and integrated the mobile phone into their daily activities, we utilised a discrete mobile use tracking app called 'Murmuras'. Murmuras anonymously tracks user interactions with smartphone features and installed apps. It only collects data on app names and usage duration and does not monitor the contents within the apps. Due to its compliance with the UK General Data Protection Regulation, Murmuras was selected for use in this research.

Interviews

Six months after the baseline survey, in-depth interviews were conducted with a purposively selected subset of 12 participants to represent diverse experiences within the larger sample. The semi-structured interviews allowed flexibility to explore participants' lived experiences while covering key topics, including the benefits and challenges of smartphone use, its impact on daily life, and suggestions for improving smartphone accessibility. The interviews were conducted in the participant's preferred language, including a mix of Swahili, English, and Kenyan Sign Language, and were conducted face-to-face at the KBTA office in Kenya. Each interview lasted between 45 minutes and one hour and was audio-recorded with participants' consent. The recordings were transcribed and anonymised prior to analysis.

Participants

Baseline Survey

In Kenya, 194 participants (97 BPS, 97 DHH) were recruited for this study through Kilimanjaro Blind Trust Africa (KBTA) from its existing network in the disability community. In the BPS group, 66 participants identified as completely blind and 31 identified as partially sighted or low vision. The BPS participants were aged between 20 and 68 years (mean=30.6, SD=10.07); 55 identified as male and 42 identified as female. For their professions, 48 (49.5%) participants were students, 20 (20.6%) were business owners or were self-employed, 14 (14.4%) were in salaried jobs, 4 (4.1%) were qualified manual workers (e.g. plumber, mechanic), 5 (5.1%) were volunteers or casual workers, four were unemployed, and two preferred not to answer. Regarding education, 81 participants had completed college or university education, 6 had completed secondary school, 8 had received vocational training, and 2 had completed primary school.

In the DHH group, 84 participants identified as Deaf, while 13 identified as hard of hearing or having a hearing impairment. The DHH participants were aged 19-59 years (mean=31.26, SD=8.26); 51 (52.6%) identified as male and 46 (47.4%) as female. Regarding marital status, 61 participants were single, 29 were married, 1 was cohabiting, 4 were divorced or widowed, and 2 preferred not to answer. The DHH participants had diverse professions; 30 (30.9%) participants were students, 25 (25.8%) were business owners or self-employed, 23 (23.7%) were employed in salaried jobs, 10 (10.3%) were volunteer or casual workers, 4 (4.1%) were in skilled manual jobs, 3 (3.1%) were unemployed, and 2 (2.1%) preferred not to answer. Regarding education, 52 participants had a college diploma or university degree, 14 had a secondary school diploma, and 31 had vocational training. All participants were residents of the Nairobi metropolitan area and surrounding counties, living in urban and suburban areas.

Follow-up Survey

A total of 126 (65.3%) responded to the exit survey. After filtering for participants who completed both surveys, 121 (62.8%) were included in the final analysis, including 72 DHH participants and 49 BPS participants. Of these, 37% (n=45) were aged 25-29, followed by 24% (n=29) aged 18-24. The smallest group, 8.3% (n=10), were 45 years or older. Most participants had tertiary or university-level education (70.3%; n=85), followed by those with vocational training (19.8%; n=24), while a small portion (9.9%; n=12) had only secondary education. Regarding phone ownership, 82.6% (n=100) had smartphones, while 11.6% (n=14) owned basic phones. In terms of phone ownership duration, 33.0% (n=40) had owned a phone for two years or less, and 20.6% (n=25) had owned one for five or more years. Gender representation was nearly balanced: 51.4% of DHH and 46.9% of BPS follow-up survey respondents identified as females, and 48.6% of DHH and 54.1% of BPS participants identified as males.

Digital Skills Training

A digital skills training curriculum has been designed based on the Android Accessibility Guides published by Google. The training is organised into five modules, each building on the knowledge and skills from the previous one to help participants gradually develop proficiency in digital skills and smartphone use. Each module also includes hands-on activities to practice the skills, during which the participants will be supported by the workshop facilitators. Additionally, exercises will be designed to foster critical thinking, allowing participants to identify challenges they may face in accessing specific features and collaborate on solutions. The training will also cover best practices for troubleshooting common issues and customising settings to meet individual needs.

Module 1: Unboxing & Set-up

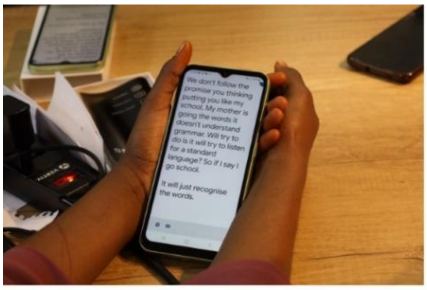
Module 2: Accessibility Features

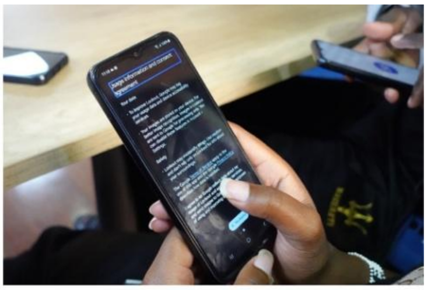
Module 3: Communication & Social Media

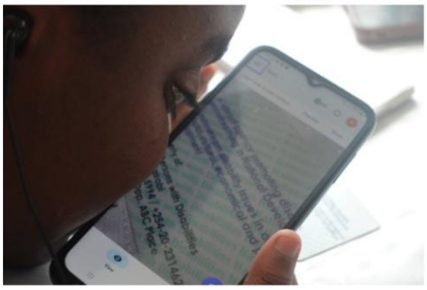
Module 4: Entertainment & Education

Module 5: Privacy & Digital Wellbeing

Facilitators will provide real-world problem-solving scenarios, ensuring each participant feels confident in applying these skills in everyday situations. Overall, the digital skills training aimed to empower smartphone users, helping them harness the full potential of their devices to enhance communication and connectivity.







Findings: Digital Skills Training

Participants' baseline digital skills varied across several factors, including age, disability status, and prior mobile phone ownership. For example, younger participants were more familiar with accessibility gestures and features compared to older participants. The majority of young DHH participants learned the phone features more quickly than BPS participants. This was in part due to the greater accessibility afforded by visual instructions and sign language interpretation, as well as the support of more knowledgeable peers, as mentioned in the previous section. However, for BPS participants, digital skills uptake was considerably slower and more challenging, possibly due to the need for individualised, adaptive training.

Furthermore, demographic factors such as age, education, baseline digital skills scores, and other learning needs not screened during participant recruitment and baseline assessment also played a role in shaping each participant's learning process. Disability and residual sensory function also significantly affected participants' performance and engagement during training. Participants who were partially sighted or hard of hearing were significantly more efficient at learning new skills than their peers. No significant gender disparities were observed in participants' performance during the digital skills training or in interviews.

Despite having sign-language interpreters present, the trainers found it difficult to communicate effectively with the DHH participants because the interpreters' responses were delayed. This also significantly slowed communication and overall training, as the sign language interpreters often did not understand the terminology and struggled to translate between spoken and sign languages.

DHH participants also experienced another challenge during the training, and smartphone accessibility features used as AT, as they had limited proficiency in English and regional languages. The trainers discovered that the DHH participants were taught local sign language (Kenyan Sign Language) and English (to a limited extent) but were not proficient in regional languages due to the unavailability of accessible learning resources. Many of the regional languages in the Indian subcontinent and Sub-Saharan Africa are spoken predominantly and are not commonly available in written form, resulting in a lack of learning resources and training for DHH people.

Moreover, as participants became more familiar with accessibility features such as LiveTranscribe and Sound Notification, they were quicker to follow the trainers' verbal instructions, which were transcribed live on their phone screens. Additionally, the participants set up a notification on their phones to vibrate and flash when the trainer clapped, drawing their attention.

"The training was very positive and interactive, and we really learnt a lot in terms of the new features, the new app, some of the live descriptions, so we learnt so many things actually we'd never seen in the phones. Yes, so because, for example, when you compare it with the phones that we had, the current phones that we have now."

Findings: Smartphone Use and Impact

Quantitative Analysis

We conducted Wilcoxon signed-rank tests to identify significant differences between baseline and follow-up survey responses across two questionnaire sections: S4 (smartphone usage) and S5 (WHO quality of life). A total of 93 questions were analysed. The Wilcoxon signed-rank test was chosen because it allows the comparison of two related samples, in this case, the responses of the same participants, at the beginning and end of the study, without requiring assumptions about data normality. Additionally, Likert-scale data were quantified into ordinal values (e.g., 1 for "Very Dissatisfied" to 5 for "Very Satisfied"), making them particularly suitable for non-parametric analysis. Descriptive statistics, including medians, interquartile ranges, means, standard deviations, and percentages, were calculated to provide a detailed overview of the results. We also used the effect size *r* to assess the strength of the difference between the two groups. Data were analysed using Stata SE Version 17.

Overview of the Combined Group Data

In the combined dataset, significant improvements were observed in 39 of the 55 questions assessing smartphone competence (71%), indicating that participants' digital skills improved markedly following the training session (Figure 3). The most notable advancements were in managing calendar functions ($Z = -7.732$, $p < 0.001$, $r = 0.737$), file management ($Z = -7.614$, $p < 0.001$, $r = 0.726$), and enabling/disabling accessibility settings ($Z = -8.278$, $p < 0.001$, $r = 0.782$), reflecting moderate to large enhancements in these specific competencies. Regarding smartphone usage patterns, 25 questions examined participants' activity frequency, with increased participation in 10 activities.

These included making or receiving voice calls, watching videos, communicating with organisations, travelling independently, organising and managing daily activities, accessing employment opportunities, and using healthcare services. The most significant improvement was observed in organising and managing daily activities (Z = −7.238, p < 0.01, r = 0.693).

Furthermore, a substantial increase was observed in the use of accessibility features such as Live Transcribe (Z = −6.425, p < 0.001, r = 0.823), Sound Amplifier (Z = −5.573, p < 0.001, r = 0.719), and Live Captions (Z = −5.936, p < 0.001, r = 0.748). In the QoL domain, significant improvement was detected in access to information (Z = −7.424, p < 0.001, r = 0.675), reflecting a moderate effect size. Although other quality-of-life measures, such as concentration, leisure opportunities, and safety, did not show significant changes, participants reported notable increases in the perceived helpfulness of accessibility features in their daily lives. Improvements were particularly evident for the Magnification Tool (Z = −5.144, p < 0.01, r = 0.694), Live Transcribe (Z = −5.299, p < 0.01, r = 0.69), Sound Amplifier (Z = −4.858, p < 0.01, r = 0.649), and Live Captions (Z = −5.351, p < 0.01, r = 0.709).

Improved Smartphone Competence Across Groups

Significant improvements in smartphone competency were observed between both groups. In the BPS group, 33 out of 50 questions (66%) showed significant improvement, while in the DHH group, 21 out of 51 questions (41%) demonstrated meaningful progress. For the BPS group, participants showed notable progress in turning on/off accessibility settings (Z = −5.45, p < 0.01, r = 0.822), navigating on-screen menus (Z = −5.216, p < 0.01, r = 0.795), and managing cloud storage services (Z = −4.569, p < 0.01, r = 0.689). These changes suggest a large effect size, indicating substantial gains in proficiency for managing device settings. Similarly, in the DHH group, there were improvements in making and receiving voice calls (Z = −5.918, $p < 0.001$, r = 0.718), navigating on-screen menus (Z = −5.823, $p < 0.05$, r = 0.706), and using Live Transcribe for conversation replies (Z = −6.692, $p < 0.001$, r = 0.824), again demonstrating moderate to large improvements in smartphone competence.

Quality of Life Improvements

Both groups reported significant improvements in quality of life, accompanied by notable advancements in accessing information for daily living. Participants in the BPS group demonstrated increased access to the information for daily living (Z = −4.929, $p <$ 0.05, r = 0.704). However, no other quality-of-life measures showed significant changes in this group. In contrast, participants in the DHH group experienced significant improvements in accessing information for daily living (Z = −5.584, $p < 0.01$, r = 0.658) and leisure activities (Z = −5.177, $p < 0.05$, r = 0.61), also reflecting a moderate effect size.

Accessibility Feature Use

The follow-up survey included questions to assess the participants' responses on the helpfulness and use of accessibility features using Likert scales, as below.

Helpfulness: 1 (Not helpful at all) to 6 (Extremely helpful)

Frequency of Use: 1 (Never) to 4 (Every day)

TalkBack

- 97% of participants who were completely blind (CB) rated Talkback helpfulness as 4 or higher, while 60% of participants who were partially sighted (LV) did so.
- 92% of the CB participants used TalkBack at least several times a week, compared to 55% of the LV participants.

Google Assistant

- 89% of CB participants rated Google Assistant as 4 or above, while 70% of LV participants rated the same.

Zoom to magnify items on the screen

- 80% of LV participants rated Zoom helpfulness as 4 or above.
- 65% of the LV participants used the Zoom magnification feature at least several times a week.

Magnifier to use the phone camera to look at objects

- 80% of the LV participants used the phone camera as a magnifier to view objects.

Live Transcribe

- 82% of the Deaf participants and 80% of the hard-of-hearing (HoH) participants rated Live Transcribe helpfulness as 4 or above.
- 78% of the Deaf participants and 67% of HoH participants used Live Transcribe at least several times a week.
- 73% of the Deaf participants and 67% of HoH participants used Live Transcribe in real-world conversation settings (e.g. communicating with a doctor)
- 76% of Deaf participants and 60% of HoH participants used Live Transcribe to reply to others during conversations.

Live Captions

84% of the Deaf participants and 73% of HoH participants rated Live Captions helpfulness as 4 or above.

82% of the Deaf participants and 60% of HoH participants used Live Captions at least several times a week.

Sound Notifications

71% of the Deaf participants and 53% of HoH participants rated setting Sound Notification feature helpfulness as 4 or above.

Findings: Internet Access, Use, and Impact

Latent Class Analysis

We used Latent Class Analysis (LCA) with modal class assignment to identify behavioural typologies in mobile data use. LCA is a model-based clustering method that detects unobserved subgroups based on categorical response patterns.

Our aim was exploratory, to support interpretation given the modest sample size and to inform a mixed-methods analysis, not causal inference. Although modal assignment does not account for classification uncertainty, perfect separation in our model (entropy = 1.0; mean posterior = 1.0) supported its use as a pragmatic typological framework.

We derived five binary variables from ordinal survey responses for use in the latent class analysis (LCA): High Data Usage (>1GB/day), Frequent Data Monitoring ('Frequently' or 'Always'), and Data-Saving Behaviour (any reported effort to conserve data). Ordinal variables were dichotomised to conform to the categorical input requirements of latent class analysis and to mitigate model complexity, particularly given the modest sample size. Cut-points (e.g., defining high data usage as greater than 1GB/day) were determined based on theoretical grounding and contextual relevance in data-constrained environments, where such thresholds may indicate meaningful distinctions in digital engagement.

Additional variables such as Regular WiFi Access ('Everyday'), and High Impact of Data Depletion ('Considerably' or 'Significantly' affected) were also dichotomised. While this approach necessarily entails a loss of within-variable variance and may obscure more nuanced behavioural patterns, it reflects a methodological trade-off made to ensure model stability and interpretability for the smaller sample size.

We conducted LCA using the poLCA package in R, which estimates latent class models via maximum likelihood using the Expectation-Maximisation (EM) algorithm. Models with two to five classes were fit using 50 random starts and a maximum of 5,000 iterations to ensure convergence and minimise the risk of local maxima. A fixed random seed was used for reproducibility, following initial testing with multiple seeds to confirm solution stability. Model fit was assessed using BIC (primary criterion), AIC, and log-likelihood. A two-class solution was selected based on model fit (BIC = 463.6; AIC = 443.6; log-likelihood = −214.8; entropy = 1.00).

A two-class model was selected as optimal based on model fit statistics and interpretability. The model identified two user profiles based on Internet usage: High-Volume Users - Class 1 (26.6%) was defined by high daily data usage (1GB per day), moderate frequency of monitoring data use (58.8%), and substantial use of data-saving strategies (73.5%), and Conservative Users - Class 2 (73.4%) which included users with less than 1GB daily data use, had lower rates of monitoring data use (42.6%), and a higher prevalence of data-saving behaviours (88.3%).

Table 1: Latent class analysis resulting in two user profiles (1) high-volume users and (2) conservative users

Class	Size (%)	High Data Usage (>1GB/day)	Frequently Monitors Data	Uses Data Saving Strategies
1 (High-Volume Users)	26.6%	100%	58.8%	73.5%
2 (Conservative Users)	73.4%	0%	42.6%	88.3%

Demographic and Structural Characteristics by User Profile

Table 2 presents the demographic and structural composition of participants by the two aforementioned user profiles. Gender and location (rural / urban) were distributed similarly between groups. Deaf participants constituted a greater share of High-Volume Users (61.8%), while participants with low vision were observed exclusively in the Conservative group. Regular WiFi access was reported by 50.0% of High-Volume Users (61.8%), while participants with low vision were observed exclusively in the Conservative group. Regular WiFi access was reported by 50.0% of High-Volume Users, twice the rate observed among Conservative Users (25.5%). These patterns provide contextual insight into the characteristics associated with each behavioural profile and are further examined in multinomial logistic regression. The qualitative interview sample also reflected a comparable distribution (33% High-Volume, 67% Conservative), ensuring representation of the user profiles' experiences.

Table 2: Participant demographics across High-volume users and conservative user classes

Demographic Variable	High-Volume Users	Conservative Users
Gender		
Female	50.0%	48.9%
Male	50.0%	51.1%
Mean Age (SD)	32.0 (7.7)	29.1 (8.3)
Location		
Rural	52.9%	47.9%
Urban	47.1%	52.1%
Disability Type		
Completely Blind	26.5%	34.0%
Deaf	61.8%	41.5%
Hard of Hearing	11.8%	9.6%
Low Vision	0.0%	14.9%
WiFi Access		
Regular Access	50.0%	25.5%
Limited Access	50.0%	74.5%

Multinomial logistic regression was used to examine factors associated with assignment to the two user profiles, with the Conservative User profile (Class 2) specified as the reference category. Predictor variables included disability type (DHH vs. BPS), gender, location (urban vs. rural), and WiFi access (regular or 'everyday' vs. limited vs 'less regular than everyday')

Regular WiFi access was a statistically significant predictor of user profile assignment ($p = 0.034$). Participants with regular access had 61% lower odds of being in the Conservative User profile (OR = 0.39), suggesting a greater likelihood of being classified as High-Volume Users.

Disability type was marginally associated with profile assignment ($p = 0.078$). Deaf or Hard of Hearing participants had 56% lower odds of being in the Conservative profile compared to those who were Blind or had Low Vision (OR = 0.44). Gender and location were not statistically significant.

The model showed an acceptable fit (AIC = 147.8), and a likelihood ratio test indicated a statistically significant improvement over the null model ($\chi^2 = 10.39$, df = 4, $p = 0.0344$). These findings suggest that WiFi access—and, to a lesser extent, disability type—are associated with the behavioural patterns that distinguish the two user profiles.

Availability and Affordability of Internet Access

Access to WiFi

Quantitative findings showed that 50.0% of High-Volume Users reported regular WiFi access—twice the rate observed among Conservative Users (25.5%). To understand how participants accessed and used WiFi, qualitative interviews were examined. Ten of the thirty interview participants (33.3%) reported regular access to WiFi at work, university, when visiting friends, or in public spaces such as shopping centres. All participants preferred to use WiFi when available to conserve mobile data. One participant mentioned using a neighbour's WiFi at home due to a lack of personal WiFi connection.

Although participants generally found WiFi more affordable than mobile data packages, three BPS and one DHH participants reported difficulties obtaining reliable home WiFi, citing power shortages and poor network coverage, particularly in rural areas.

> *"Sometimes I buy credit, so I can use data but I mostly use data because the WiFi I am using, sometimes it is not reliable." (D56, Male, Urban, Business Owner)*

Cost of Mobile Internet

All but two participants (1 BPS, 1 DHH) stated that mobile internet data was expensive and difficult to afford. Students, volunteers, and self-employed individuals, in particular, noted the high costs. Most interviewees purchased “daily” internet bundles as needed, rather than longer-term packages or pay-as-you-go plans. Many students and employed participants preferred to use free WiFi at educational institutions or workplaces, relying on mobile data only when outdoors or away from WiFi.

Five participants expressed concern about maintaining mobile internet access after the project ended, when the free 2GB monthly data would no longer be available.

> "Maybe I can spend, let me say, from Ksh500 (Kenyan shilling) at most... Since I'm a student, let me say it's a struggle." *(BPS32, Female, Urban, Student, Conservative User)*

"Sometimes it may not be affordable, but because we live in an era whereby internet has become a basic need so, we need to work out and see how we can get better but sometimes it may not be affordable so there are some months that I may not use data." *(BPS6, Male, Urban, Employed, High-Volume User)*

"Let's say, per day I can spend around Ksh50 bob (Kenyan shilling) that is most I can spend in a day. About getting that data, it is a bit challenging because I don't have any job that I can depend on getting that data, so, sometimes I'm online, sometimes I'm not online." *(BPS24, Female, Urban, Student, Conservative User)*

"Affordable? It's not affordable, it's very expensive for me, but I have no other option but just to use it." *(DHH30, Female, Urban, Student, High-Volume User)*

On average, rural BPS participants spent 20% less on mobile data than urban BPS participants, while rural DHH participants spent 51% less than urban DHH participants. Overall, rural participants spent about 40% less than their urban counterparts. These disparities may reflect differences in connectivity infrastructure, affordability, and opportunities for internet use.

Negotiating Internet Access

Most participants reported using WiFi whenever possible to conserve mobile data. Those with stable WiFi at home, school, university, or work preferred connecting to WiFi over mobile data.

> *"I depend on both, but mostly I use data because maybe where I stay here is no Wi-Fi connection, so most of the time I use mobile data." (B32, Female, Urban, Student, Conservative User)*

In the absence of reliable WiFi—or while travelling—participants relied on mobile data. In some cases, unstable WiFi connections or high costs forced participants to use both mobile data and WiFi.

> *"Sometimes I may be forced to use both depending on the environment and the circumstance." (BPS6, Male, Urban, Employed, High-Volume User)*

Need for Internet Connectivity

Participants described multiple uses for internet connectivity, including online classes, communication with friends and family, social media, content sharing, online businesses, job searches, wayfinding, and entertainment. Importantly, BPS participants emphasised mobile internet's role in supporting assistive technology (AT) while on the move—apps like BeMyEyes and Google Maps require a stable connection.

> *"For sure, because we have to live with the internet, as a person with visual impairment, when I am walking, I have to use Google Maps, and*

that one requires me to be online, so I have to use data bundles." (BPS17, Male, Urban, Student, Conservative User)

DHH participants highlighted the importance of internet connectivity for making video calls in Kenyan Sign Language, which contributed to their higher mobile internet expenditure.

"When I'm in the field, I often use mobile data, but I switch to Wi-Fi when I'm in the office. As a deaf person, I rely on video calls for clear communication, so having a stable data connection is essential for me." (DHH66, Female, Urban, Student, Conservative User)

Internet and Smartphone App Usage Behaviour

App Usage and Data-Saving Behaviours

Analysis of app usage revealed similar rates of WhatsApp messaging and general social media use across profiles. However, High-Volume Users were more likely to use WhatsApp calls (58.8% vs. 47.9%) and YouTube (47.1% vs. 38.3%). Shopping/payment app usage was also higher among High-Volume Users (23.5% vs. 8.5%).

Conservative Users were more likely to avoid high-data apps, particularly video-based platforms. For example, 28.7% of Conservative Users avoided WhatsApp video calls, compared to 8.8% of High-Volume Users—a statistically significant difference ($p = 0.019$). This may reflect accessibility needs, as DHH participants often rely on video calls for communication.

Interviews supported these findings, with BPS participants reporting they only used data-heavy apps like YouTube or TikTok on WiFi. One BPS student only attended online classes when connected to WiFi.

Impact of Data Depletion

Over half of participants (52.8%) reported exhausting their free 2GB monthly data within one week, and an additional 28.3% within two weeks. BPS participants were more likely to deplete data quickly (67% within one week) compared to DHH participants (45%).

Both High-Volume and Conservative Users reported substantial disruption when data ran out—79.4% and 78.7% respectively said it significantly impacted phone use. This suggests that, regardless of usage pattern, both groups faced resource limitations and had to adopt strategies to manage scarcity. Data-related precarity was a shared reality across participants.

Findings: Quality of Life Impact

Key Findings from DHH Participants

Participants with hearing impairments found the digital skills training sessions valuable, particularly learning the accessibility features such as Live Transcribe, Captions, and Sound Amplification, among others, which greatly enhanced their independence, communication, and access to information. Additionally, smartphones enable them to use apps such as WhatsApp, Facebook, and YouTube for social interactions, entertainment, and education. Smartphones provided a sense of independence and privacy, positively impacting their relationships with family and friends. Improved social interactions allowed them to communicate more effectively, join WhatsApp groups, make video calls, and participate in community activities.

Agency and Independence

For participants who are Deaf and Hard of Hearing (DHH), accessing communication and information often hinges on the availability of sign language interpreters. DHH participants reported that finding Kenyan Sign Language (KSL) interpreters is challenging due to limited awareness of KSL and a limited understanding of the needs of Deaf individuals. However, the use of real-time transcription through Live Transcribe has enabled them to participate in meetings without requiring a KSL interpreter.

> *The phone has transformed my life. As a deaf person, I can now control many things independently and attend meetings without a sign language interpreter, using live transcriptions instead.*

In addition to fostering independence in communication, participants pointed out that KSL interpreters are frequently unavailable for formal social settings, such as meetings and doctors' appointments, which forces Deaf individuals to hire interpreters themselves. Therefore, by utilising Live Transcribe, Deaf participants also benefit from cost savings.

Live transcription further bridges the communication gap by enabling DHH individuals to engage in spoken conversations in real time. Instead of relying on an interpreter to relay information, individuals can request that speakers use English and read the text directly from their phones. This shift reduces dependency on interpreters and increases direct interaction, enabling DHH individuals to control their own communication.

> *"When I receive a call, I enable live transcriptions and ask speakers to communicate in English. This helps me follow along without needing interpretation, increasing our self-awareness since not all interpreters convey everything accurately."*

Moreover, the DHH participants highlighted the benefits of using WhatsApp video calls to communicate with friends and family in sign language. As Deaf individuals prefer sign language as their preferred way of communicating, video calls are particularly valuable for maintaining social connections, attending virtual meetings, and engaging in learning or work-related discussions.

> *"On WhatsApp, you can video call each other because its camera is very clear. This quality allows me to see someone signing, and I can*

also see another person signing. That's one of the things I've experienced."

Access to Information

The participants described the role of accessibility features in enabling access to information through communication and social media applications. For example, using Live Captions, participants reported being able to access audio and video content, something they had been unable to do before.

"When you watch a video, you'll find not all of them that have been played, but with the phone, [YouTube] it's able to indicate its own live description in front of the screen."

Moreover, social media applications not only improved access to global news updates but also allow users to discuss news developments in real-time with friends.

"Yeah, also, for WhatsApp, I am also able to catch information, because maybe I don't know about anything, then you can ask your friend on WhatsApp about what's happening."

"On Facebook, I am able to check for information, or I am able to get news from Facebook. I am also able to know so many things that are

happening around the world, because you are able to see information being posted."

Finally, generative AI applications also helped improve comprehension and access to information, as participants could look up simplified explanations of unfamiliar words during conversations.

"When I want to search for something, or I don't understand a word, then I just write it on the AI app, and it gives explanations very well."

Personal Safety

The ability to detect sounds through vibration alerts, for example, provides reassurance when sleeping or in environments where auditory cues are essential. This small but significant feature translates into increased independence and confidence in daily life.

"Another thing is detecting sounds when I am sleeping, the phone is able to vibrate. If any person, for example, if someone wants to check their phone, the phone can vibrate and it really detects a lot of things so for me, it has been able to create a lot of independence."

Key Findings from BPS Participants

Participants with visual impairments found smartphones to be highly beneficial. They primarily used mobile data to connect to the internet, incurring significant costs. The digital skills training sessions were effective, equipping them with the skills to use smartphones independently.

They appreciated learning to navigate various apps and features, which improved their overall experience. Smartphones greatly enhanced their ability to access information and perform tasks independently, using apps like WhatsApp, Facebook, and YouTube for communication, entertainment, and educational purposes. Accessibility features and apps such as TalkBack, Google Assistant, and Lookout were crucial in helping them access information and perform tasks.

Smartphones gave them a sense of independence and privacy, allowing them to perform tasks without relying on others. This independence positively impacted their relationships with family and friends, as they were no longer seen as a burden. Smartphones have also improved their social interactions, enabling them to communicate more effectively with friends and family, join WhatsApp groups, make video calls, and participate in community activities. Additionally, smartphones enable them to access information about their rights and advocate for their needs, thereby empowering them with a stronger sense of agency and control.

Impact of Accessibility Features on Daily Activities

Accessibility features have had a profound impact on participants' ability to perform essential daily tasks, particularly in areas such as reading and financial management. Assistive apps have significantly enhanced their ability to access written content independently, reducing reliance on others and improving their overall engagement with digital information. One participant shared how an accessible reading app has made a significant difference in their ability to read documents effortlessly:

"And also, there is an app which helps me in reading, the InstaReader, which I'm using in reading. I'm opening a document, then it reads the document for me, and I'm enjoying that app a lot."

This ability to read documents independently, whether for work, education, or personal use, enhances not only accessibility but also personal agency, enabling individuals to interact with digital information more efficiently.

Managing finances independently is another area where accessibility features have been transformative. For many individuals with visual impairments, identifying currency and making digital transactions can be challenging without accessible tools. Participants highlighted how apps such as Lookout help them recognise and differentiate currency notes, enabling them to handle money securely and with confidence. Additionally, financial management applications such as My Safaricom and digital communication tools like WhatsApp and YouTube provide further independence in navigating essential services. One participant explained how these tools have been instrumental in their daily life:

"My Safaricom app, WhatsApp, YouTube, Lookout, we have the Lookout app and it really helps me in identifying money, so when I reflect the money, it normally reads for me, so it helps me a lot, the Lookout, I have PDF and those apps which is used to open documents, almost all apps are good to me."

These experiences highlight how accessible digital solutions are not just conveniences but necessities, empowering individuals with visual impairments to read independently, manage finances, and navigate essential services. By continuing to improve and expand these accessibility features, developers can further enhance the autonomy and inclusion of people with disabilities in all aspects of daily life.

Agency and Independence

For many participants, accessible smartphones have played a transformative role in fostering independence and control over their daily activities. The integration of features like TalkBack and voice assistants has enabled users to engage more actively in their professional and personal lives without relying on others for assistance. One participant described how they leverage TalkBack and voice commands to take notes and deliver lessons to students, highlighting how assistive technology not only enhances their personal efficiency but also contributes to their professional responsibilities:

> *"Yes, sometimes I let TalkBack, if I am doing it on my own, I just listen using TalkBack, if I make notes, then I go and teach the students, or even if it is something to watch, for watching, I just use the voice assistant, I give it a command, then it plays whatever thing for the students to listen or even to watch."*

Beyond professional tasks, participants also emphasised the profound impact of accessible smartphones on their autonomy in managing personal and financial matters. The ability to send money, read and respond to messages independently, and access entertainment for themselves and their families significantly improved their sense of control and dignity. One participant described how this newfound independence reduced their reliance on others, particularly in private tasks such as financial transactions and digital communication:

> *"A lot has changed because now I can operate a phone on my own, and I don't have to depend on somebody to send money for me. I am proud of having some privacy now that I can receive and reply to messages on my own. I can even, when my children want some entertainment, open YouTube, and connect to some entertainment for my kids."*

These experiences underscore the critical role of accessible digital technology in fostering self-reliance and dignity among users with visual impairments. By reducing dependence on others for routine digital interactions, assistive technologies not only enhance personal autonomy but also empower individuals to participate more fully in both social and economic life.

Access to Information

Using the TalkBack feature on their phone, the participants were able to independently browse job search websites. They also described their enhanced ability to find job advertisements and complete job applications (and attach their CV) on their phones.

> *“I am able to go to the website of my employer and see, check on maybe interviews or an advert that is there, I am able to read on my own, I am able to access information about my employer, whatever thing that is required.”*

Moreover, described access to information through peer WhatsApp groups and through communicating with tutors via WhatsApp. Additionally, the participants also described using generative AI applications like ChatGPT to conduct coursework-related research and accessible reading applications such as InstaReader to convert documents, presentations, and spreadsheets into audiobooks to easily access the written content shared by tutors and peers.

"Using various apps, like ChatGPT app, WhatsApp and others, I'm able to do research on the questions that we are supposed to do during studies and also communicate to the tutors and lecturers in a platform or a WhatsApp group that we are forming at the university or colleges so I am able to get information and make an inquiry from the lecturer and even the lecturers are sending notes in those platforms so I am able to read by use of the read assistant apps such as the InstaReader."

Social Inclusion and Sense of Belonging

For many participants, access to an accessible smartphone was more than just a technological upgrade—it was a gateway to greater social inclusion and a strengthened sense of belonging. The ability to engage with digital communication platforms such as WhatsApp and Imo allowed them to connect with their communities in ways that were previously inaccessible. One participant emphasised how joining WhatsApp groups provided a sense of inclusion, as they could now independently listen to and respond to messages, fostering meaningful interactions with peers who share common interests:

"I am able to interact with the wider community through different WhatsApp groups now that people nowadays if you have something in common, most people create WhatsApp group, so I am able to also listen to their messages and also reply, and I feel part and parcel of the community."

This shift from isolation to active participation was particularly transformative for those who previously relied on basic feature phones with limited functionality. Another participant reflected on the stark contrast between their past experiences with a *Kabambe* (a basic button phone) and their present ability to access online platforms, engage in group discussions, and maintain digital social connections:

"There is a big change compared to the previous times when I have been using kabambe (button phone)... right now, I can get into online, I have WhatsApp, Imo and also, I'm included in groups."

These experiences highlight how mobile accessibility features empower individuals with visual impairments to overcome social barriers, fostering a sense of independence and inclusion. The ability to participate in digital conversations not only enhances their social interactions but also reinforces their role as active members of the community, bridging the digital divide and reducing feelings of exclusion.

Privacy and Digital Accessibility

Participants highlighted the transformative impact of mobile phone accessibility features, such as TalkBack and Lookout, in safeguarding their right to privacy. These assistive technologies allowed individuals with visual impairments to interact with their devices independently—reading documents, making phone calls, and sending emails—without relying on others. This autonomy was not only a matter of convenience but a crucial factor in enhancing personal privacy and security.

Although the digital skills training did not explicitly cover screen lock configurations (such as password or PIN setup), some participants took the initiative to explore these privacy settings independently. This self-directed learning enabled them to set up passwords and restrict unauthorised access to their devices, reinforcing their sense of control over their personal information.

“Using smartphone to me is a privilege because it has that accessibility which reads for me almost everything, I'm able to do my transaction without involving anybody which is very good because when you involve someone in your transaction, especially money

> *transaction, it is not safe, but right now, I can use, I can send money, I can withdraw money by my own, which is safe."*

Beyond securing their devices, participants expressed how the ability to perform tasks independently further strengthened their sense of freedom and dignity. The need for assistance—especially when handling private communications—was significantly reduced, helping them maintain personal boundaries.

> *"I think it gives you a sense of freedom. You can do things independently and freely, and even when you want privacy, you don't need anyone to do things for you. You have your privacy and your independence."*

However, despite these advancements, participants also expressed significant concerns about privacy violations stemming from the lack of access to digital financial services. Many mobile banking applications and payment platforms, such as M-Pesa, remain inaccessible despite their user-friendly design due to inadequate training, forcing individuals with disabilities to rely on others to complete transactions. This dependence often led to an involuntary breach of privacy, as participants had no choice but to share sensitive financial information with friends or family members.

> *"I can't type on this phone, so I need to ask for someone's help for M-Pesa, because of privacy, only for security purposes."*

This paradox of digital accessibility underscores a critical gap in the current ecosystem: while assistive technologies empower users to protect their privacy in some areas, systemic barriers in digital infrastructure continue to undermine these gains. Ensuring that financial and other essential digital services are fully accessible is fundamental to enabling people with disabilities to exercise their right to privacy across all aspects of their digital lives. Addressing these challenges requires a concerted effort from policymakers, service providers, and technology developers to create inclusive, barrier-free digital environments.

Gaps Identified through this Research

Need for Ability-based Digital Skills Training

BPS participants found it difficult to remove the smartphone from the packaging and to intuitively learn its physical features in the absence of a mental model of the specific smartphone make and model, despite having some prior experience with smartphones. This process took much longer than anticipated and caused considerable discomfort to the participants. Additionally, there was a steep learning curve for BPS participants to learn the Android accessibility features, particularly the shortcut gestures, which needed to be memorised.

Due to this, the trainers encouraged the repetition of certain tasks to support the participants in developing a mental model of the smartphone's physical features as well as the Android settings and accessibility menus. For example, participants learned to turn Talkback on and off using the volume key shortcut by repeatedly pressing both volume keys for a few seconds until the phone's notification was heard. As this task required the participants to familiarise themselves with the volume keys and listen for the Talkback notification from the phone, it was particularly challenging at the beginning, but the participants became more confident and comfortable with it as the training continued.

Need to Customise Accessibility Features

Participants expressed a need for more refined, customisable accessibility features to better accommodate their daily interactions with digital devices. While TalkBack and Lookout have significantly improved their ability to navigate smartphones independently, some limitations persist, impacting their usability. One key concern was the disruption caused by frequent notifications, which interfered with TalkBack's functionality. As one visually impaired participant highlighted:

> *"I think the TalkBack, although I keep on updating my phone but I think we need a more digital TalkBack that is not disturbed by the number of notifications or messages."*

This suggests the need for developers to introduce greater flexibility in how TalkBack interacts with system notifications, such as allowing users to temporarily mute or prioritise certain alerts to maintain an uninterrupted experience.

Additionally, participants noted that some accessibility tools, such as Lookout, need greater adaptability to real-world use cases. For example, users found it challenging to determine the optimal phone position to accurately identify objects, particularly when searching for items at different distances or on the floor. As one participant described:

> *"Apps, I find Lookout a little challenging because sometimes I don't know how I'm looking for something on the floor and I don't know how to hold the phone for me to get that thing. Sometimes, I hold it in a way that gives me something that is far."*

This feedback underscores the importance of refining Lookout's object recognition features, perhaps by integrating more intuitive audio cues or haptic feedback to guide users in adjusting their phone's position. Enhancing the adaptability of accessibility tools through user-centred design would significantly improve the digital experience for people with visual impairments, making these technologies more practical and effective in everyday scenarios.

Need for an Accessible Digital Ecosystem: Enforcing WCAG and Digital Accessibility Policies

Digital accessibility ensures that all individuals, regardless of disability, can effectively access and use digital content and services. As essential services—such as paying utility bills and managing financial transactions—become increasingly digitised, ensuring their accessibility is crucial. However, participants in this study consistently reported significant barriers when navigating websites and mobile applications using TalkBack, a widely used screen reader for Android devices. The lack of accessible design prevents BPS individuals from independently accessing online services, ultimately limiting their ability to fully participate in the digital economy.

One of the most prominent barriers identified was the incompatibility of screen readers with interactive web elements, such as online forms and date pickers. The inability to access these elements independently forces users to rely on assistance, compromising their autonomy and privacy. As one participant described:

"You find that using TalkBack, there are some things that are not really accessible, maybe like online you go, you find that you are filling in a form, an online form and maybe you need to select something like a date, but instead of typing in the date, I am supposed to access the date picker, I am afraid this kind of situation is not accessible."

Beyond usability challenges, participants emphasised the broader systemic issue of inadequate accessibility policies and poor implementation of digital accessibility standards. They stressed that accessibility should not be an afterthought but an essential component of digital service development. One participant highlighted the failure of designers to consider the needs of diverse users, including individuals with hearing impairments, those who experience seizures due to poor colour contrast, and users who rely on image descriptions:

"They [designers] just follow the policy because when you are creating a website, you are supposed to make it accessible even to screen readers and even people who are hard of hearing, you know. Even people who are limited to colour contrast can get seizures. And it's not good for image description. When you find an image, you try to tap it so that the screen reader describes the image, but then it doesn't."

Another participant specifically pointed out accessibility issues on widely used social media platforms, such as Facebook, where TalkBack often fails to provide image descriptions, limiting their ability to engage with visual content.

These findings highlight the urgent need to enforce the Web Content Accessibility Guidelines (WCAG) and strengthen digital accessibility policies. While assistive technologies like TalkBack and Lookout play a crucial role in supporting BPS users, their effectiveness ultimately depends on the accessibility of the platforms they interact with. Without a concerted effort from developers, policymakers, and service providers to integrate accessibility into digital design from the outset, these barriers will continue to exclude people with disabilities from fully engaging in digital spaces. Ensuring that web and mobile services meet accessibility standards is not just a technical necessity but a fundamental human right that fosters equal participation for all.

Key Insights and Recommendations

Technology Insights and Recommendations

Mobile phones, like all AT, are not a one-size-fits-all solution.

Disability is a spectrum, highly influenced by unique lived experiences, and requires personalised, adaptable solutions. Customising mobile devices and applications is crucial for addressing the specific functional and usability needs of AT users. Personal, environmental, and socioeconomic factors also influence the use of mobile phones as AT. For example, access to mobile phones, the Internet, and digital skills are essential for enabling their use as AT. The transition from *Kabambe* (button phone) to touchscreen smartphones was challenging for participants with visual impairments and required a longer onboarding period to get used to the new features and interaction methods. For example, as mentioned in the quote below, participants with visual impairments were concerned about battery consumption and drainage when using the smartphone and about the impact on their ability to stay connected for longer periods without needing to charge the phone.

> *"Due to its operations consuming power, and sometimes when you travel, it can get off while on the way, although there are those things, the power banks, I don't know if they are provided, I think power also can be a challenge because with Kabambe (Button phone) you can charge and stay with it for almost a week." (BPS participant)*

Additionally, environmental challenges, such as regular access to electricity, perceptions of mobile phones, support from the community, and wider societal attitudes towards disability and mobile phones, also impact how individuals with disabilities in LMICs use mobile phones as AT.

Thus, a nuanced approach to developing and implementing these technologies is essential; how it is configured and how people are trained is also essential; the mobile phone alone cannot meet the diverse needs of all AT users.

Not All Mobile Phones Are Designed for Accessibility

Advancements in mobile technology have led to the widespread availability and affordability of smartphones worldwide. However, the financial accessibility of high-end smartphones remains challenging in LMICs due to prevailing socioeconomic constraints [12]. Low-end smartphones manufactured in China, India, and Africa, which offer lower functionality and storage, are a cost-effective solution. However, these phones often lack the comprehensive accessibility features necessary to effectively use Android-based smartphones such as AT. These phones typically operate a version of Google's

Android system that is trimmed down to minimise functional and storage requirements while optimising performance.

Our research has uncovered accessibility issues with *Techno* and *Infinix* phones, which are widely used in LMICs due to their ease of availability and affordability. We observed compatibility issues between the Android OS and the mobile phone's hardware components, such as the screen, camera, and physical buttons, leading to accessibility features, such as TalkBack, not recognising the components or the actions associated with them.

Training Insights and Recommendations

Touch-based interactions are challenging for novice smartphone users.

The smartphone unboxing experience varied among BPS participants across all research settings. Participants with significant residual functional vision were able to remove the packaging and extract the smartphone and accessories with greater ease than those with more severe vision loss. Due to a lack of appropriate tactile marking and Braille labelling, the unboxing experience did not accommodate the strengths of the BPS participants in navigating through touch and sound. Instead, the inaccessible packaging caused undue frustration and stress for participants who were unfamiliar with its design. An example of frustration in the process was demonstrated by a blind Indian participant, who became visibly upset when their SIM card fell on the floor while trying to insert it.

During the pilot training, researchers found that BPS participants with prior mobile phone experience were skilled at basic functions, such as texting and making calls, but struggled with essential tasks. These tasks included inserting and removing SIM cards, using the fingerprint sensor to unlock the phone, and becoming familiar with the smartphone's physical layout. Understanding this, we introduced unboxing skills training as the first step to improve the participants' digital literacy. Although some participants initially found these skills challenging to learn, once they mastered them, they experienced greater independence and agency. This was highlighted by a participant from Kenya, who shared insights into the impact of these skills.

"The other phone that I was using, I had to request somebody to set it up for me. But for this one, since I got it here, I have been able to adapt it in every way I wanted. Things like even removing the SIM cards, putting them back, these are things that I could not do before."

For DHH participants, unboxing and setting up the phone were relatively easy. They were able to follow the trainers' instructions, accompanied by visual guides projected onto a large screen.

BPS participants also found it difficult to familiarise themselves with and learn the smartphone's physical features in the absence of a mental model of the specific smartphone manufacturer and model, despite having some prior experience with smartphones. This process took much longer than anticipated, causing considerable frustration for the participants. Additionally, there was a steep learning curve for BPS participants to learn the Android accessibility features, particularly the shortcut gestures, which needed to be memorised. As a result, the trainers encouraged the repetition of certain tasks to help participants develop a mental model of the smartphone's physical features, as well as the Android settings and accessibility menus. For example, participants learned to turn Talkback on and off using the volume key shortcut by repeatedly pressing both volume keys for a few seconds until the phone's notification was heard. As this task required the participants to locate and interact with the volume keys and listen for the Talkback notification, it was particularly challenging at the beginning.

Voice-based interactions need more accuracy and diversity

Non-fluent English speakers struggled to set up and use the Google Assistant. The voice recognition training phrases were too complex to memorise and repeat easily. During the training, the facilitators helped participants memorise the phrases and repeat them, but this was neither effective nor efficient, as it required 1-to-1 support for each participant and had a low success rate. To ensure ease of onboarding for users whose primary language is not English, particularly blind users, an alternative approach to setting up the Google Assistant should be used.

> *"Why do I have to use English to communicate with Google Assistant? I don't have a lot of problems with Google Assistant, but just to improve accuracy and make it more diverse."*

Older BPS participants found it significantly challenging to memorise and fluently repeat training phrases such as "OK Google, remind me to water my plants on Monday". A longer, simpler onboarding process may be more effective at enabling users to repeat simple phrases or words necessary for setup and daily use.

AT Training must be adaptable to the AT users' needs

Like the AT, the training must be adaptable to the AT users' needs. One of the barriers we experienced while designing and delivering the digital skills training was making it suitable to the participants' existing knowledge, abilities, and context of use. The training design and delivery considered factors such as age, communication language, knowledge and experience with mobile devices, academic qualifications, and general understanding of technology and assistive technology. For example, older participants unfamiliar with digital and mobile technologies required additional assistance. Particularly, learning how to install a SIM card was challenging for some of the older participants who were BPS and had limited hand dexterity.

A different training approach was required to help DHH participants manage delays caused by KSL interpretation. As some accessibility features and concepts were novel to Kenyan DHH smartphone users, even KSL interpreters were unfamiliar with them and lacked the appropriate KSL vocabulary to interpret them. This led to unprecedented delays in the training for DHH groups. To overcome this challenge, a separate training session was arranged for KSL interpreters involved in the group to familiarise themselves with the Android accessibility features and build the necessary understanding to help facilitate the training for the DHH individuals.

Policy Insights and Recommendations

Access to Mobile Internet is Essential to Reduce the Digital Divide.

Mobile Internet access enables people to connect to essential services such as education, healthcare, and financial systems, offering opportunities for growth and development.

Our findings highlight the crucial role of mobile internet services for several reasons. Firstly, for self-employed people and business owners, Internet connectivity is essential for self-reliance and financial autonomy. It can directly affect their ability to earn a living [13].

Secondly, Deaf and hard-of-hearing people are more likely to use video-calling applications like WhatsApp to communicate in Sign Language. Therefore, mobile Internet access facilitates communication and social inclusion, allowing people to stay connected with family and friends and engage with broader community activities.

Participants almost unanimously pointed out the challenges of obtaining mobile Internet data. As a coping strategy, many participants reported purchasing data in small amounts, daily or weekly, rather than committing to larger data packages, which were perceived as financially unviable due to high costs. The affordability of mobile Internet is one of the main barriers to Internet connectivity [14], and despite efforts by the public and private sectors to reduce this gap, implementation remains lacking. Affordable Internet access is particularly essential for BPS and DHH individuals due to the reliance on assistive mobile apps such as BeMyEyes, Lookout, SeeingAI, LiveTranscribe, among others, to provide the essential support disabled smartphone users need. Additionally, navigation apps like Google Maps serve as assistive technology for BPS smartphone users, enabling them to navigate routes independently. BPS participants also highlighted the struggle to sustain mobile Internet access while outdoors, which limited their ability to consistently use smartphone-based assistive technologies.

Disability Shapes Internet Engagement

The marginal association between disability type and user profile membership highlights the relevance of impairment modality in shaping mobile internet engagement. Although the association did not reach conventional thresholds of statistical significance ($p = 0.078$) in our modest sample, the direction and consistency of the findings are theoretically meaningful. DHH participants were more likely to belong to the High-Volume User profile, while BPS participants were more frequently represented in the Conservative User group. This pattern likely reflects modality-specific communication needs and platform preferences. For many DHH users, mobile internet use is closely linked to visual and video-based communication, such as WhatsApp video calls, video messaging, and consumption of sign language content. These activities are inherently data-intensive and demand higher bandwidth than text-based or audio-based communication. In contrast, BPS participants are more likely to engage with screen readers, audio navigation, and text-based communication platforms, which typically require less data. Additionally, accessibility barriers on visual-first platforms may discourage BPS users from adopting high-data applications, further reinforcing lower-volume usage patterns.

These findings suggest that disability is not a uniform predictor of digital engagement but rather interacts with the specific modalities of digital communication and platform design. Interventions to expand digital inclusion for disabled people must therefore move beyond a generic understanding of disability to consider the differentiated access needs and data demands associated with specific impairment types. Policies and programs that fail to account for these modality-specific needs risk perpetuating exclusion, even when overall access to devices and connectivity is improved.

Gender and Rural/Urban Divide

The absence of significant associations for gender and rural or urban location in predicting user profile membership warrants careful interpretation. In many settings, these factors are well-documented determinants of digital exclusion, with women and rural residents often facing disproportionate barriers to device ownership, connectivity, and digital skills acquisition. However, in the context of this intervention, where all participants received smartphones, digital skills training, and a baseline allocation of mobile data, such baseline inequalities may have been partially mitigated. The provision of uniform resources and support may have enabled participants across gender and geographic groups to engage with mobile internet services on more comparable terms, thereby attenuating expected disparities in usage profiles.

Alternatively, in this disability-focused sample, other factors, such as infrastructural access (e.g., WiFi availability) and disability-related modality needs, may have been more proximate determinants of mobile Internet behaviour than gender or geography. Given the cross-sectional nature of the data, we cannot establish causality or intervention effects, but these findings suggest the potential for targeted interventions to disrupt entrenched patterns of digital exclusion. Future research employing longitudinal or comparative designs would be valuable to assess the extent to which equitable provision of devices, data, and skills training can sustainably close gendered and geographic gaps in digital participation.

Digital Accessibility is Fundamental to Digital Inclusion

Digital accessibility ensures that all individuals can access and use digital content and services regardless of their physical or cognitive abilities. By implementing standards such as the Web Content Accessibility Guidelines (WCAG), we can make digital platforms more accessible and user-friendly, reducing the barriers to entry for people with disabilities[1]. Furthermore, digital accessibility can lead to a more significant economic impact, enabling people with disabilities to access employment and financial services, fostering economic growth and social participation. Our findings highlight that both BPS and DHH participants were able to effectively use web and mobile applications using smartphone accessibility features such as TalkBack and Live Transcribe. However, BPS participants also noted that some applications were not fully accessible using TalkBack due to inaccessible design.

1 Delivering together for inclusive development: digital access to Information and knowledge for persons with disabilities. UNESCO. 2019. https://unesdoc.unesco.org/ark:/48223/pf0000369088.locale=en

Conclusion

This study demonstrates that smartphone-based interventions can significantly improve digital inclusion for persons with sensory disabilities in Kenya. The substantial improvements in digital skills (78.8% for BPS, 71.8% for DHH) and the meaningful real-world impacts reported by participants highlight the potential of mobile technology as an accessible, relatively affordable assistive technology solution in the Kenyan context. The qualitative insights reveal significant transformations in participants' lives, with many reporting newfound independence, educational opportunities, and social connections that were previously unattainable. Our results provide evidence that Kenya's high baseline digital literacy (with pre-intervention scores of 3.58 and 3.92 for BPS and DHH participants, respectively) provides fertile ground for accessibility-focused interventions. The impact appears particularly pronounced for features addressing specific practical challenges:

- Currency identification features addressing documented pain points for BPS individuals
- Video calling capabilities resolve communication barriers for DHH individuals, where literacy challenges may limit text-based solutions
- Independent transportation booking that directly addresses mobility restrictions in Kenya's predominantly rural disability population

The data suggest that digital literacy interventions have the greatest impact when they target specific practical needs rather than general technology exposure. The big difference in pre-intervention assistive technology use between BPS (90.4%) and DHH (26.8%) participants also indicates that there may be significant untapped potential for accessibility feature adoption in the DHH community.

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