Mobile Phones as Assistive Technologies: Gaps and Opportunities

Giulia Barbareschi[1], Clara Aranda Jan[2], Michael Nique[2], Felipe Ramos Barajas[1], Catherine Holloway[1]

[1]Global Disability Innovation Hub, University College London. Contact: giulia.barbareschi.14@ucl.ac.uk
[2]*GSMA Mobile for Development*

Keywords

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Abstract

In the last decade, mobile phones have become invaluable allays in the everyday lives of people with disabilities. Even in low and middle income countries mobile phones are highly popular and the penetration rate of mobile technology is almost three times higher than for desktop computers and broadband lines. Despite their diffusion and their importance, large datasets on how people with disabilities in lower resourced settings use mobile phones, the services they access and the barriers they encounter when interacting with mobile technology, are scarce. This article presents data from a survey with 1000 participants that explored how people with disabilities use mobile phones and the impact that mobile technology has on their daily lives. Findings highlight the presence of a mobile gap with many people with disability struggling to acquire and operate mobile phones independently. Most respondents had only access to basic or feature phones that lacked appropriate accessibility features and offered limited functionality. However, participants still described mobile phones as invaluable tools that could increase access to basic services and offer support in many important activities in their daily lives.

Introduction

Assistive products are generally defined as products whose "primary" purpose is to support the independence, and promote the wellbeing of people with disabilities *[1].* However, it is important to remember that there are also other products which are equally important to the everyday independence and wellbeing of people with disabilities. These technologies might not have specifically been designed with that purpose in mind, but add benefit none

the less. Mobile phones are an interesting and potentially unique case as they simultaneously belong to both categories of products. A mobile phone can effectively work as an assistive technology (AT) in one of two ways. Firstly, a mobile phone can offer important support to a person with disabilities through built-in features or applications that were not specifically designed with that purpose in mind *[2]*. For example, a mobile phone can easily be used by a person with memory loss to receive text messages with reminders about which medication needs to be taken when. Alternatively, a mobile phone can work as an AT due to external applications or accessibility features that were explicitly designed for people with disabilities *[2].* For example, a person with a visual impairment can use an application such as BlindSquare to receive relevant information about their surroundings in order to locate shops or other points of interest and navigate to these. Due to their versatile nature, mobile phones have the potential to become incredibly powerful, bespoke and cost-effective tools for people with disabilities, essentially clustering together multiple ATs in a single device *[3]*.

Arguably, laptop and desktop computers can offer similar capabilities. However, the penetration rate of laptops and desktop computers is significantly lower than for mobile phones. In many low and middle-income countries (LMICs), the diffusion rate of these technologies rarely goes above 25% of the total population *[4].* On the other hand, mobile phones have become nearly ubiquitous in most countries around the world with over 5.1 billion users recorded at the end of 2018 *[5]*. In contrast with more expensive and infrastructurally complex technologies such as landlines or laptop computers, mobile phones are intrinsically portable and more likely to be accessible even to the poorer segments of the population, which unfortunately include most people with disabilities *[6]*. Yet, although mobile phones are getting more widespread and sophisticated, many people with disabilities in LMICs still encounter significant difficulties in leveraging them effectively to eliminate or reduce the impact of their disability *[7]*.

For example, many built-in features and applications that can be used as ATs are only available on smartphones, whereas many people with disabilities only have access to basic or feature phones *[8, 9].* Furthermore, many applications rely on the use of mobile data which could represent an additional barrier for people with limited incomes. Finally, to take full advantage of certain applications or accessibility features a person needs to have a sufficient level of digital literacy that many people with disabilities might not possess due to a lack of training and adequate support *[10].*

Most of the current research on the availability and use of mobile technologies by people with disabilities is, as expected, largely focused on high income countries *[11,12].* Geographical and cultural context can radically change how people access and use mobile technologies due to the availability of different devices and services, the state of physical and legal infrastructures, the implementation of specific policies by various mobile operators and the personal preferences and concerns of individuals who might live in very

different situations. Developing international or even global policies and interventions based on data gathered mainly in high income countries could lead to the formulation of solutions that exacerbate the digital divide rather than lessening it.

Especially in domains such as Human Computer Interaction and Computing in general, recent efforts from researchers and developers on improving the functionality of mobile phones for people with disabilities, have mainly focused towards the development of novel smartphone applications to facilitate access to education *[13],* healthcare *[14],* public transport *[15]* or leisure opportunities *[16]*. Although these efforts are laudable and could generate a positive impact on the everyday lives of people with disabilities, many mainstream mobile-based services and applications still remain largely inaccessible *[17].* Interestingly, the development of new AT mobile applications seems to be targeting some groups of people with disabilities more than others. In particular, in recent years a significant amount of effort from the mobile technology community has been invested on the development of new applications to support people with visual impairment, especially within the context of independent navigation *[18].* In contrast, significantly fewer applications seem to be specifically targeted towards individuals with a hearing impairment. However, previous studies have suggested that people who are deaf are more likely to own and use a smartphone or a tablet compared to blind people *[19]*. This discrepancy suggests that there is a disconnect between baseline research and development of specific applications which needs to be addressed in order to formulate clear and cross-cutting recommendations that could enable a more coordinated effort from the various actors within the mobile technology ecosystem.

Generally, the research on mobile phone ownership and the benefits and barriers associated with its usage among people with disabilities who live in LMICs has used small datasets *[20]* and is focused on very specific groups *[21]* making it difficult to create more generalised recommendations. Gathering larger and more comprehensive datasets will allow researchers, developers, governments and mobile providers to formulate comprehensive guidelines, promote country-level and international policies, implement better services and develop new functionalities where appropriate. However, it is important to ensure that new datasets collected can also be easily disaggregated into relevant subcategories to facilitate the development of a more detailed understanding of the needs of different mobile phone users with disabilities.

The aim of the study was to capture a comprehensive picture of how people with disabilities in Kenya leverage the potential of mobile phones to overcome difficulties they encounter in their everyday lives. Data is collected and analysed as part of a survey on mobile phone usage among people with disabilities in Kenya to present an overview of how people with disabilities in a LMIC access and use mobile phones and services, and the resulting benefits or barriers encountered in their lives. Based on the results presented, we will provide a series of recommendations for researchers, mobile operators, developers and government

agencies on how mobile products and services could drive inclusion of persons with disabilities in LMICs. The study was funded by the UK Department for International Development as part of the larger AT2030 programme which aims to increase access to ATs for people with disabilities who live in LMICs.

Approach

To quantify access and usage of mobile phones and services, a survey with 1000 participants has been carried out in Kenya between May and June 2019.

Survey data were collected in collaboration with local agencies that employ interviewers with experience gathering survey data. Interviewers received appropriate training before the start of data collection to ensure that data were collected in a systematic manner and that participants' rights were respected at all times. Participants were identified and recruited through a variety of methods. Survey sessions were held in community spaces on predefined days and local Disabled People's Organisations (DPOs) shared within their networks a series of calls for participants with the details about location and date for each session. Other participants were recruited directly by the interviewers at specific events for people with disabilities such as sport events or community gathering. Some participants were recruited via word of mouth or directly via phone by the volunteers at DPOs who had their contact details. All participants were briefly screened by the interviewer who also explained the research and enquired about their willingness to participate. Before the start of the survey, each participant was given an explanation of the purpose of the research, the structure of the survey, data handling procedures and their rights as participants. Interviewers read each question aloud to the participants in order to enable individuals who were unable to read, due to visual impairment or illiteracy to take part in the research. The questionnaire was administered in English, Kiswahili or Kenya Sign Language depending on the preferences of the participant and the responses were digitally captured by the interviewers.

As we wanted the dataset to be as inclusive as possible, participants with different functional impairments were recruited for the study. An approximate quota of 200 individuals for each of four categories (vision, hearing, mobility, speech/memory) of functional impairment was established to guarantee equal statistical representation to each subgroup. To enable for comparison between people with disabilities and nondisabled people, a group of 200 nondisabled respondents was also included in the survey. Non-disabled respondents were mainly recruited by random selection by volunteers on the streets in the same communities in which people with disabilities had been recruited. Furthermore, to ensure sufficient variability in the dataset, people of different gender, educational level, socio-economic status and geographical location were included in each subgroup. This was achieved by setting sub-quotas for gender, age, environment (urban/rural) and income level which were weighted on the latest census data to guarantee

the representativeness of the sample. Disability status and categorization were determined based on the recommendations and reports made by the different DPO's that identified participants.

Individuals under the age of 18 were excluded from the study as only participants who were old enough to provide legal consent were allowed to take part in the study. Individuals who, based on recommendations from local DPOs or their caregivers were unable to understand what participating in the survey meant and who were not be able to provide informed consent independently were excluded due to ethical concerns.

The survey was structured across six different parts: Classification of impairment, Mobile phone access and ownership, Mobile phone usage, Access to basic services and participation in society, Difficulties with mobile phone usage, Socio-demographic characteristics.

- Classification of impairment: This section of the survey featured six questions directly extracted from the Washington Group short set questionnaire on disability and focused on identifying the type of impairment that the respondent was affected by.
- Mobile Phone Access and Ownership: This part of the survey revolved on determining if the respondents directly owned mobile phones and SIM cards or if they were able to access them through family members, friends or local organizations. Reasons for lack of ownership or reduced access to a mobile phone were also explored.
- Mobile phone usage: This section of the survey explored the usage of different mobile services (such as voice calls, text messaging, mobile internet, mobile money and other applications), the frequency of use for different types of services and the reasons determining frequency of use.
- Access to basic services and participation in society: This section of the survey investigated the level of access that respondents had to various basic services such as healthcare, education, employment, transportation and financial services. The impact of mobile phone usage on people's ability to access various services was also analysed.
- Difficulties with mobile phone usage: This section of the survey looked at the different barriers encountered by respondents when using mobile phones in general and when accessing specific applications or mobile services. The use of additional ATs in combination with the mobile phone (such as braille keyboards, magnifiers, text-to-speech technology) was also explored.
- Socio demographic characteristics: This section of the survey aimed to capture general characteristics of the respondents (such as gender, education level, age group).

Statistical analysis was carried out on the data collected to identify relevant groups of respondents and to present an overall map of how people with disabilities access mobile phones, the services they use, the barriers they encounter and the impact that the use of mobile phones have on their everyday lives. Written informed consent was recorded before the start of the survey for all participants. Participants who were unable to sign the informed consent sheet due to illiteracy or visual impairment were asked to sign their consent using their thumbprint. Procedures for ethics approval and data protection compliance as stated by the UCL ethics committee were appropriately followed.

Findings

A total of 1005 completed surveys were collected. Impairment quotas were respected as responses were categorized as follows: 201 from participants with visual impairment, 220 from participants with hearing impairments, 206 from participants with mobility impairments, 182 from participants with impairments affecting speech/memory/cognition/self-care (common causes reported for such impairments were stroke, dwarfism, depression, cerebral palsy) and 196 from participants who reported no impairments. When comparing responses to the WG questions with the categorizations based on the recommendations made by DPOs we found the a priori classification to be mostly correct, however, few discrepancies were found. For example, 15.9% of people who declared to have severe or insurmountable difficulty seeing even when wearing glasses were not directly assigned to the visual impairment subgroup. Although of these 8.8% were participants with multiple disabilities who had a visual impairment associated with difficulties in mobility or hearing, the remaining 7.1% were classified as nondisabled people. Despite these discrepancies that the total percentage of people with disabilities among respondents according to the WG questionnaire and according to DPOs recommendations were found to be mostly similar and were respectively 81.2% and 80.5%. Ultimately, we relied on the assessment that identified the most people with disabilities. For example, some people with difficulties remembering and concentrating were identified as people with disabilities by relevant DPOs despite only stating that they encountered “Some difficulties” in the WG questionnaires. On the other hand, people who reported “A lot of difficulty” in one of the WG questions were reassigned to the relevant impairment category regardless of the DPO assessment.

Across both people with disabilities and non-disabled people, the distribution of survey respondents was found to be mostly homogeneous across different demographic and social characteristics. Forty six percent of the respondents were female and 52.3% reported living in an urban environment. Younger age groups were in general better represented with 50.6% of participants between the age of 18 and 34. Participants between 35 and 44 years of age and between 45 and 54 years were respectively 22.6% and 12.5%, whereas only 14.2% reported to be above 55 years old. Educational levels were generally high with 34.8%

of participants stating that they completed higher education and 30.8% had completed at least secondary school, 26.3% had completed only primary school and 8.1% had received no formal education. Despite the high level of education, only 42.3% of respondents reported to be regularly employed, either self-employed or employed in the private or public sector.

Mobile phone ownership was found to be significantly lower for people with disabilities compared to nondisabled people. As shown in Figure 1 below, only 82% of people with disabilities reported the ownership of a mobile phone compared to 93% of non-disabled people, establishing a mobile gap of 12%[1]. Over one third of people (36.4%) who did not own a mobile phone did own a mobile SIM and more than two thirds of people (71.6%) who did not own a mobile phone were able to access one occasionally through friends, or family members. However, when people with disabilities accessed a mobile phone via a third party they often encountered restrictions regarding cost, frequency or duration of use and the level of autonomy they were allowed to have during use.

Among people with disabilities, mobile phone ownership levels did not seem to be affected by their living environment, but it was moderately influenced by type of impairment and highly influenced by level of education and age. Almost 90% of people with vision, hearing, mobility or communication impairments owned a mobile phone, compared to approximately 80% of people with cognitive impairment or people who encountered significant difficulties with self-care tasks. Education was found to be the biggest differentiator with 99% of people who obtained higher education reporting possessing a mobile phone compared to 77% of people who had received no formal education.

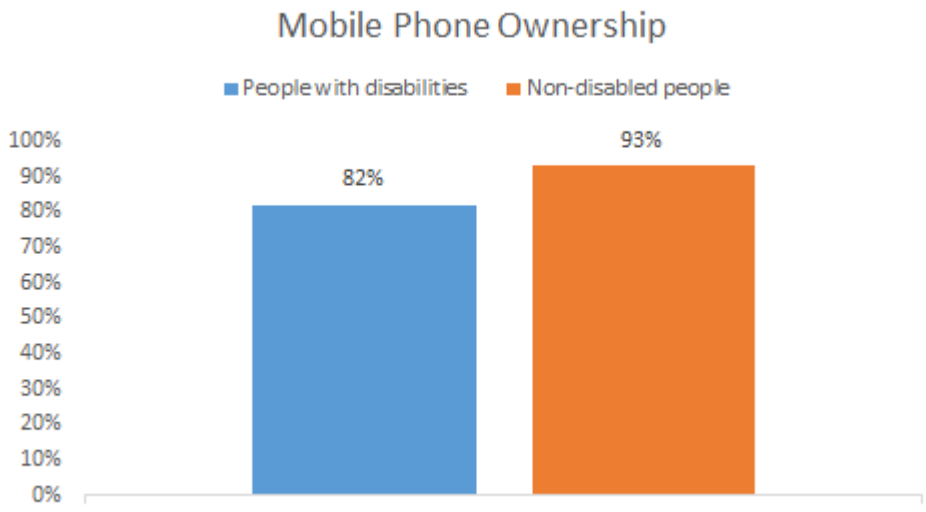

Figure 1 Bar Chart showing the rate of mobile phone ownership among people with disabilities and non-disabled people

When looking at the reasons for not owning a mobile phone, cost was found to be the main one. Over 50% of the people who did not own a mobile phone thought that the device was

[1] The disability gap in mobile phone ownership tells by how much people with disability are less likely to own a phone compared to non-disabled persons. It is defined as follows:
(% non-disabled owners - % owners with disabilities) ÷ (% non-disabled owners)

simply too expensive to buy and another 10% found that the cost of airtime was too high. Perceived physical or cognitive limitation associated with personal impairments prevented 15.9% of respondents from owning a mobile phone and lack of confidence due to no digital skills training was a deciding factor for 9.1% of participants.

When looking at the type of phone accessed, people with disabilities were significantly more likely to have access to basic mobile phones. On the other hand, as shown in Figure 2, over half of non-disabled people had access to either a smartphone or a feature phone.

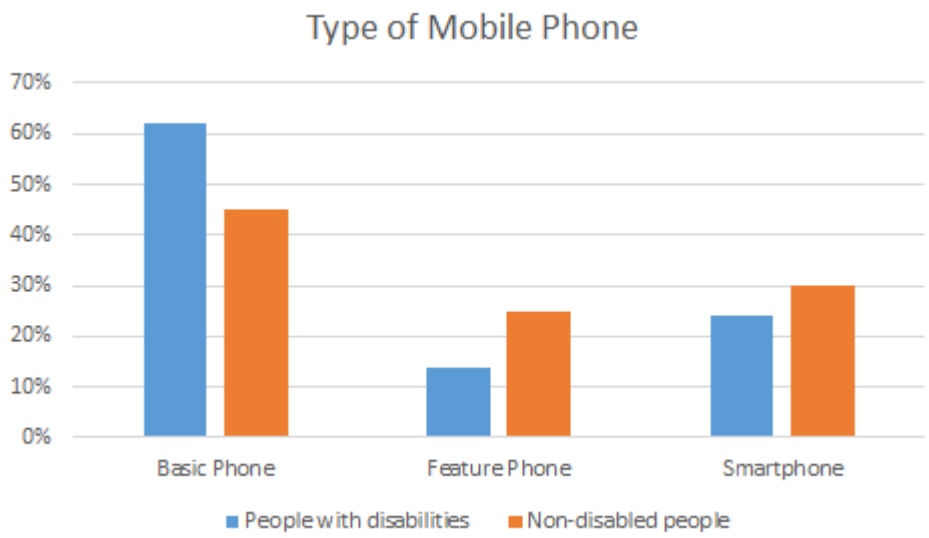

Figure 2 Bar Chart showing the type of phone owned by people with disabilities and non-disabled people

People with disabilities are not only less likely to own a mobile phone, but they are also less likely to be able to use various services independently once they have access to a mobile phone. Only 54% of people with disabilities were able to make or receive calls autonomously compared to 91% of non-disabled people. Similarly, only 47% of people with disabilities were able to send and receive SMS without help, compared to 74% of non-disabled people. Mobile internet and applications for messaging, entertainment and social media were only fully accessible for 24-29% of people with disabilities compared to 33-40% for non-disabled people. Finally, specific apps for transport, maps and other services were only accessible to 18% of people with disabilities compared to 29% of non-disabled people. Thanks to the M-Pesa service, mobile money has become increasingly widespread and more accessible to both people with and without disabilities in Kenya [23]. This was shown by the fact that over half of respondents with disabilities reported being able to access mobile money services independently and the rate increased to 78% among non-disabled people.

Amongst various groups of people with disabilities, people with visual impairments appeared to be the most disadvantaged when it came to be able to use mobile phone independently, regardless of the application considered. The most accessible mobile service to people who were visually impaired was making and receiving calls, which only 34% of respondents were able to do independently. SMS and Mobile money were only accessible to respectively 16% and 18% and all other services and applications were accessible to less

than 10% of visually impaired users. As expected 94% of hearing impaired participants and 82% of speech impaired participants were unable to make voice calls independently. However, most of them were able to use SMS services (76% hearing impaired and 69% speech impaired) autonomously.

Only 22.6% of participants with disabilities reported using accessibility features such as text-to-speech, voice commands and magnifiers, in order to be more independent when using the mobile phone. The use of accessibility features was found to be more common amongst speech impaired (24%) and hearing impaired (20.1%) respondents compared to other impairment sub groups (16.6%). The impairment group who reported the lowest use of accessibility features was visually impaired with only 12%. The lack of accessibility features was also one of the most often cited barriers to mobile phone usage, although many respondents frame this as a limitation caused by their impairments. Other significant barriers to mobile phone use were cost (of mobile phones themselves, airtime and accessibility features such as apps or external products), illiteracy and lack of knowledge on how to effectively use the mobile phone.

Despite the difficulties encountered when attempting to use various mobile services, most people with disabilities reported using their phones on a daily basis. Figure 3 and 4 show the frequency of use for SMS and voice services for both people with and without disabilities. Although in general mobile phone usage was less frequent among people with disabilities, the frequency of use for specific services was affected by the type of impairment of the individual. For example, respondents who had a hearing or speech impairment, were more likely to use SMS texts and mobile money than their non-disabled counterparts. On the other hand, only 6% of respondents with a hearing impairment and 14% of respondents with communication difficulties were able to make and receive voice calls independently. Finally, although only a few people with disabilities had access to mobile internet through their phones, the ones who did were as likely to access it on a daily basis as respondents who were non-disabled.

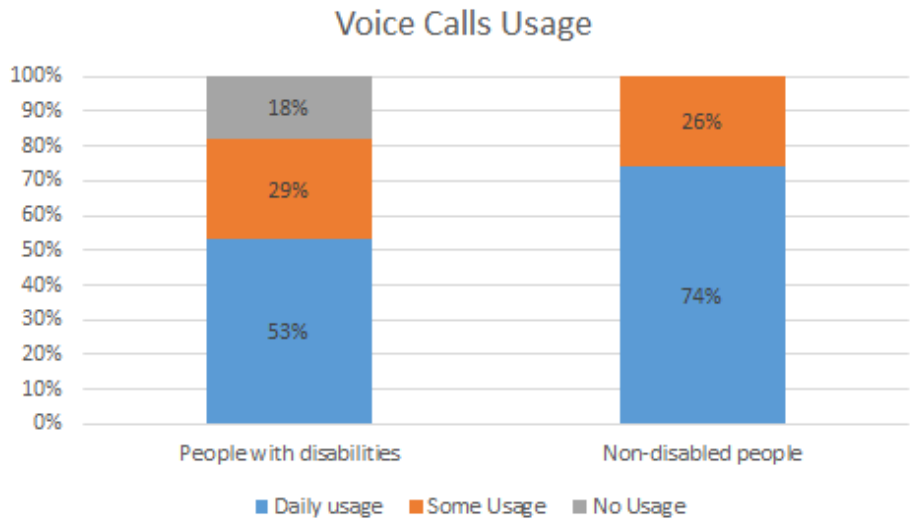

Figure 3 Bar Chart showing the frequency of voice call use among people with disabilities and non-disabled people

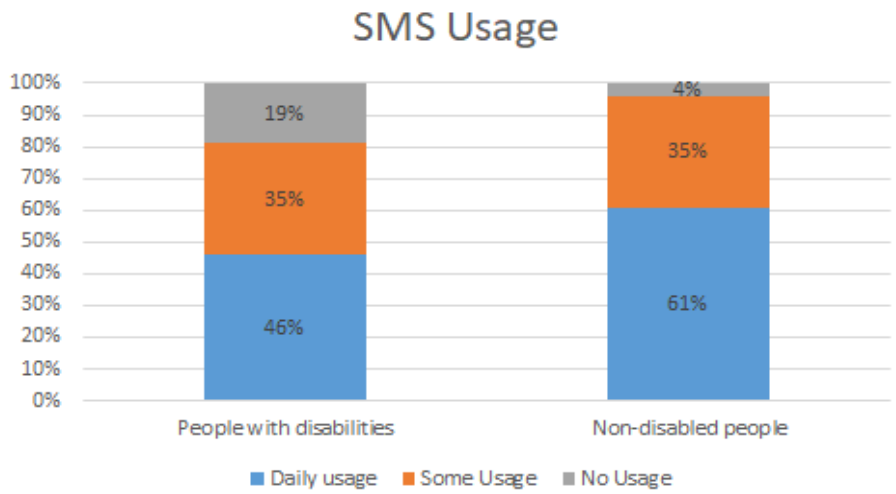

Figure 4 Bar Chart showing the rate frequency of SMS texting use among people with disabilities and non-disabled people

As expected, most respondents who had a disability reported limited access to basic services such as healthcare, education, employment and transportation. However, it was surprising to see that the level of access to different services were often similar for people with no disabilities. For example, 57% of participants with disabilities stated that they had no access to employment, which was also reported by 52% of non-disabled respondents, creating a gap of "only" 5%. A larger gap between people with and without disabilities was recorded for education (9%), whereas people with disabilities were found to be more likely to have full access to healthcare services when compared to non-disabled people (respectively 25% and 19%).

Most respondents stated that mobile phones had been a crucial enabler for their ability to access different basic services. Across all types of impairments, approximately one third of participants found that mobile phones had provided significant help in accessing healthcare (33%) , education (33%) and employment (36%) services. Higher rates were reported for transport (43%) and financial services (62%). However, these findings varied considerably

depending on the type of impairment. For example, only 26% of people with hearing impairment stated that mobile phone use had a significant impact on their ability to access transportation. However, the rate increased to 45% for people with reduced mobility and to 72% for people who had difficulties remembering and concentrating. Furthermore, great differences were also observed among participants who had similar impairments but had access to different types of mobile phones. Among people with visual impairments, only 36% reported that their mobile phone facilitates them in gaining access to education, but the rate almost doubled (71%) when looking only at visually impaired users who had access to a smartphone.

Owning a mobile phone was found to be not only important to access basic services, but also in support to many daily activities that are crucial for the personal and social wellbeing of the individual. Figure 5 shows the rate of participants with disabilities who declared that they would be unable to complete certain activities without their mobile phones.

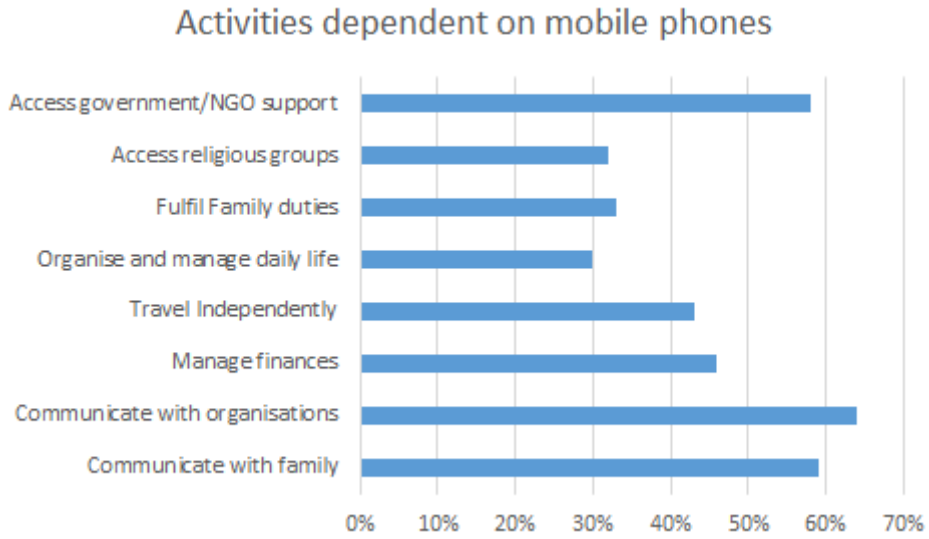

Figure 5 Bar chart showing the percentage of people with disabilities who described their mobile phone as "essential" for carrying out different activities

Discussion

Results from this large-scale survey present a complex and detailed picture of mobile phone ownership and usage among people with disabilities in Kenya, their role as activity enablers, and the difficulties encountered in their daily lives when using mobile phones or accessing mobile services.

When recruiting participants to take part in the survey, we relied on recommendations made by local DPOs to identify a sufficient number of participants to reach our quotas for different types of impairment. It is worth noticing that, as mentioned in the findings, when analyzing the responses to the WG questions collected as part of the survey we found a few discrepancies between the perceived severity of the impairment and the classification

provided by DPOs on the ground. These discrepancies were only minor if, for the purpose of our stratification, we assigned participants to a particular impairment group if their response to the related WG question was at least “Yes - a lot of difficulty”. Nonetheless, we found that a lot of participants who were not registered as people with disabilities with their local authorities, nor had been identified as people with disabilities by relevant DPOs, responded to at least one of the WG questions with “Yes - some difficulty”. This underreporting of functional impairments, despite experiencing quite significant difficulties in everyday lives is in line with what shown in both Kenya and Cameroon when subjective estimation and objective assessment of impairment were compared *[22].* Findings from this survey corroborate previous evidence that highlights how both government and DPOs services often underestimate the number of people with disabilities in the country.

Overall, most people with disabilities in Kenya reported owning a mobile phone. Such a high diffusion rate points to the importance of leveraging mobile technology when developing new AT products or service delivery models in order to reach the largest possible number of people with disabilities. Over two thirds of people who declared that they did not own a mobile phone stated that they were able to access one when needed through family members, friends or local organizations. However, mobile access through third parties was often sporadic and subject to heavy restrictions, which severely limited the independence of the person and the potential positive impact of the mobile phone. Although individuals with intellectual challenges or particularly severe functional impairments might not have been able to take part in the survey, they are likely to also experience these barriers and not enjoy full access to a mobile phone.

Mobile phone ownership was less common among people with cognitive and self-care impairment, which were also the most likely to have multiple impairments. This trend is particularly problematic as people with more severe and multifaceted disabilities are more likely to experience social exclusion *[23]*, hence they are the ones who would benefit the most from the ability to use a mobile phone without restrictions. Mobile phone access was also influenced by the level of education of the person. People who had generally received little or no education are less likely to be confident to use mobile phones. Moreover, someone with had no knowledge of mobile technology is unlikely to be able to foresee the potential benefits that a mobile phone could offer, and consequently is less likely to be willing to invest money in purchasing one. Although the decision to not own a mobile phone is not necessarily a negative one, people with disabilities should be empowered to make that decision in an informed manner to ensure that they understand the potential impact that mobile technology could have on their everyday lives.

Survey respondents confirmed results from previous research *[8,9]* showing that only a relatively small percentage of people with disabilities had access to smartphones, whereas the majority was only able to access basic phones. This finding is particularly relevant as researchers, developers and mobile phones operators continue to develop new products

and services for people with disabilities that are only available to smartphone users. Although basic and feature phones have significantly less capabilities, they are almost twice as popular amongst people with disabilities living in LAMICs and they are often the only choice available to people with lower incomes.

As expected, the high cost associated with mobile phones was found to be not only one of the main entry barriers to acquiring and operating a mobile phone, but also one of the main difficulties encountered when attempting to access mobile services and accessibility features. This highlights the need to develop cross cutting strategies between, governments, DPOs, open-source developers and mobile operators that aim to reduce the various costs associated with mobile phones ownership and usage. Lack of training and knowledge of how to effectively use the mobile phone was also a significant barrier for many respondents with disabilities. Currently, some people with disabilities in LMICs might be able to receive a mobile phone for free from a family member or friend, or through donation schemes run by NGOs. However, they rarely receive appropriate training that would enable them to become more competent users and to take full advantage of the possibilities offered by the technology. Within this context mobile phones represent a perfect example of how ATs cannot be simply considered as a standalone device but they need to be incorporated the wider ecosystem that encompass the various elements that determine the success, or failure of AT interventions. Individual elements of the system, from cost of devices, to education of users and operators will constantly influence each other, creating a complex system that needs to be considered in its entirety *[24].*

Finally, regardless of the difficulties and barriers encountered when using mobile phones, the large majority of the respondents considered them essential to their daily lives. Mobile phones were described as a precious tool in accessing services such as education, healthcare and transportation, but also to stay in touch with family and take part in religious and social life. Smartphones in particular were found to be extremely impactful enablers for many basic services and crucial everyday activities. Although this is largely due to the increased possibilities offered by a more advanced technological means, the development of new products and services for basic and feature phones could allow us to increase the impact of more affordable technologies to a wider range of people with disabilities. Putting disability at the forefront of the development of new products and services could revolutionise the mobile technology domain. Leveraging participatory and disruptive approaches as advocated by the new Disability Interaction (DIX) manifesto will enable the creation of innovative and inclusive solutions that would benefit not only people with disabilities but mobile users around the world *[25]*.

Overall, mobile phones might not precisely fit the definition of AT, yet they represent one of the most powerful, ubiquitous and versatile technologies to support people with different disabilities in their everyday lives.

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