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Product Narrative: Digital Assistive Technology. A market landscape and strategic approach to increasing access to digital assistive technology in low- and middle-income countries

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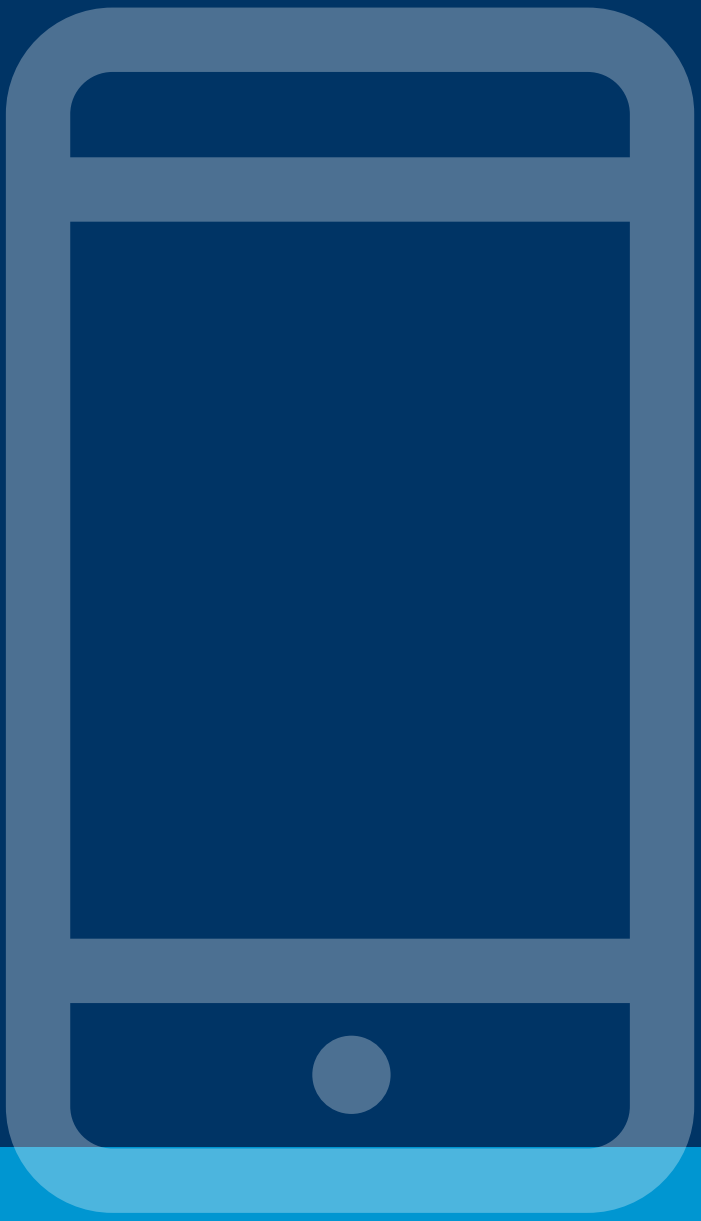
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A Market Landscape and Strategic Approach to Increasing Access to Digital Assistive Technology in Low- and Middle- Income Countries



PRODUCT NARRATIVE:

DIGITAL ASSISTIVE TECHNOLOGY

AT2030

ATscale
GLOBAL PARTNERSHIP FOR ASSISTIVE TECHNOLOGY
atscale2030.org

NOVEMBER 2020

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The views and opinions expressed within this report are those of the authors and do not necessarily reflect the official policies or position of ATscale Founding Partners, partners of the AT2030 programme, or funders.

Please use the following *form* ***(https://forms.gle/BrFnX52vX2NUDKX36)*** to register any comments or questions about the content of this document. Please direct any questions about ATscale, the Global Partnership for Assistive Technology, to *info@atscale2030.org* or visit *atscale2030.org.* To learn more about the AT2030 Programme, please visit *at2030.org*.

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ACRONYMS

AAC	Augmentative and alternative communication
ALS	Amyotrophic lateral sclerosis
AT	Assistive technology
CHAI	Clinton Health Access Initiative, Inc.
DAISY	Digital accessible information system (a technical standard)
digital AT	Assistive digital devices and software
DPO	Disabled persons' organisation
EU	European Union
G3ict	Global Initiative for Inclusive ICTs
GARI	Global Accessibility Reporting Initiative
GSMA	GSM Association
HIC	High-income country
ICF	International Classification of Functioning, Disability, and Health
ICT	Information and communications technology
ITU	International Telecommunication Union
JAWS	Job Access With Speech (a screen reader)
LMIC	Low- and middle-income country
MNO	Mobile network operator
NGO	Non-governmental organisation
NVDA	NonVisual Desktop Access (a screen reader)
PDA	Personal digital assistant
SLP	Speech language pathologist
UK	United Kingdom
US	United States (of America)
USD	United States Dollar
USSD	Unstructured supplementary service data
WCAG	Web content accessibility guidelines
WHO	World Health Organization

EXECUTIVE SUMMARY

ASSISTIVE TECHNOLOGY (AT) is an umbrella term covering the systems and services related to the delivery of assistive products such as wheelchairs, eyeglasses, hearing aids, prosthetic devices, and assistive digital devices and software. Today, over 1 billion people require AT to achieve their full potential, but 90% do not have access to the AT that they need.[1] Digital assistive technology (digital AT) is a broad category, but can be defined as assistive products that contain electronic information and communication technologies (ICT).[2] The digital AT ecosystem is made up of four interconnected components that are necessary for people to fully make use of the growing digital services and infrastructure, including: 1) accessible devices (e.g. mobile phones and tablets) and accessories (e.g. switches or braille readers); 2) accessible platforms or operating systems to enable consumption of what is on the device; 3) accessible software and applications that fulfil a particular purpose or user activity; and 4) accessible content, such as text, text-to-speech, native language availability and pictograms. The rate of adoption of the digital AT ecosystem is supported by four cross-cutting enablers: 1) awareness of digital AT and its accessibility by users, developers, suppliers, providers, and policymakers; 2) availability of mobile network and internet connectivity; 3) the application of universal design and inclusion of accessibility features; and 4) appropriate training in digital AT.

The digital AT areas described in this report represent different components of the digital AT ecosystem:

- Chapter (1) on mobile phones and **smartphones** is representative of the challenges and potential interventions related to **accessible devices** and **accessible platforms**.
- Chapters (2) and (3) on **screen readers** and **augmentative and alternative communication (AAC) devices** respectively highlight the challenges associated with **accessible software, applications,** and **accessible content.**

Individuals that require AT can benefit tremendously from the use of mobile phones, especially smartphones. Accessibility features and applications on a smartphone can provide similar assistance to many traditional assistive devices and/or augment digital assistive technologies. The use of digital AT enhances independence and productivity, improves access to the digital economy, and democratises access to information. However, penetration of mobile phones and telecommunication services is much lower in low- and middle-income countries (LMICs) than high-income countries (HICs).[3] Moreover, ownership among people with disabilities lags compared to the overall population. Barriers to mobile ownership and usage include, but are not limited to: the high cost of devices and network plans; limited awareness and understanding of the benefits of mobile phones as AT; limited disability-inclusive design; and limited use of tools that allow for the full use of mobile phones by persons with disabilities.[4] In order to increase access to mobile phones (particularly smartphones) as AT, there is a need to increase awareness and digital skills training, as well as to improve the affordability of mobile phones and data connectivity in LMICs.

[1] World Health Organization. Assistive technology. WHO; 2018. Available from: https://www.who.int/news-room/fact-sheets/detail/assistive-technology.
[2] Banes D, Hayes A, Kurz C, Kushalnagar R. Using information communications technologies (ICT) to implement universal design for learning (UDL). University Research Co; 2019. Available from: https://www.urc-chs.com/sites/default/files/urc-grn-ict.pdf.
[3] GSMA. The state of mobile internet connectivity. GSMA; 2019. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/07/GSMA-State-of-Mobile-Internet-Connectivity-Report-2019.pdf.
[4] GSMA. Understanding the mobile disability gap. GSMA; 2019. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/12/GSMA_Understanding-the-mobile-disability-gap_116pg_Accessible.pdf.

Screen readers are software programmes for people with vision impairment and/or learning disabilities[5] that convert screen content into an accessible format for the individual, such as braille, speech, or both. Screen readers can be used on laptops, desktop computers, and mobile devices. Different models of screen readers exist: software built into the operating system; open source and free stand-alone software; and commercial paid subscription stand-alone software. Access to screen readers in LMICs is hindered by a number of barriers, including the following: low awareness of the existence and benefits of screen readers; limited availability of screen readers in local languages; lack of training; lack of accessible content; and unaffordable prices for commercial screen readers. In order to increase access to and usability of screen readers, it is proposed to support the development of text-to-speech synthesisers in local languages; establish (sub-)national programmes to enable price agreements with commercial screen reader suppliers; adopt accessibility standards on public government websites and apps; and increase awareness of and training for the use of screen readers.

Augmentative and alternative communication (AAC) is any type of method or system that is used to replace, or supplement, natural speech. There are generally two types of AAC: aided and unaided. Unaided AAC does not require external tools, while aided AAC does. Aided systems range from low-tech (paper-based) to high-tech (electronic) products. These products can be accessed through an array of motions such as: touch, mouse/mouse alternatives (e.g. joystick), eye gaze, and switches. Recently, smartphones and tablets have begun to replicate standalone AAC systems, allowing users to access free and open-source AAC software through the internet. Among many other benefits, AAC encourages independence, increases people's ability to participate in society, and reduces the financial burden for individuals and caregivers. Furthermore, providing AAC to younger children can prevent learning delays, strengthen understanding of language and future communication ability, and allow for wider integration in school. However, access to AAC in LMICs is often much lower than in HICs. Barriers to accessing AAC include, but are not limited to: low awareness of the benefits and effective provision of AAC, limited availability of appropriate products, and lack of funding. In order to increase access to AAC, it is proposed to ensure clear global guidance for appropriate and effective AAC provision in LMICs; expand AAC access through government-level ownership of procurement, provision, and financing; test and validate AAC solutions for low-resource settings; and ensure the availability of free and effective AAC applications.

A common set of recommendations focused on improving access to the components and enablers of the digital AT ecosystem emerge from the individual product landscapes included in this document. These recommendations can be viewed as high priority areas for improving access to digital AT in LMICs. They include:

- **Develop and adopt policies**, including legislation, regulations, minimum product standards, and guidelines to support accessibility and uptake of digital AT at global and country levels.
- Support LMIC governments to **increase awareness** of digital AT by including digital AT products, such as smartphones and AAC devices, on national assistive product lists.
- Support innovating financing schemes or negotiate pricing agreements to **reduce the cost** of digital AT to end users.
- **Increase availability of training** programmes for users, suppliers, and service providers on the importance of digital AT and digital literacy skills.

[5] UNESCO. Global report: opening new avenues for empowerment. UNESCO; 2013.

INTRODUCTION

1. Assistive Technology and Market Shaping

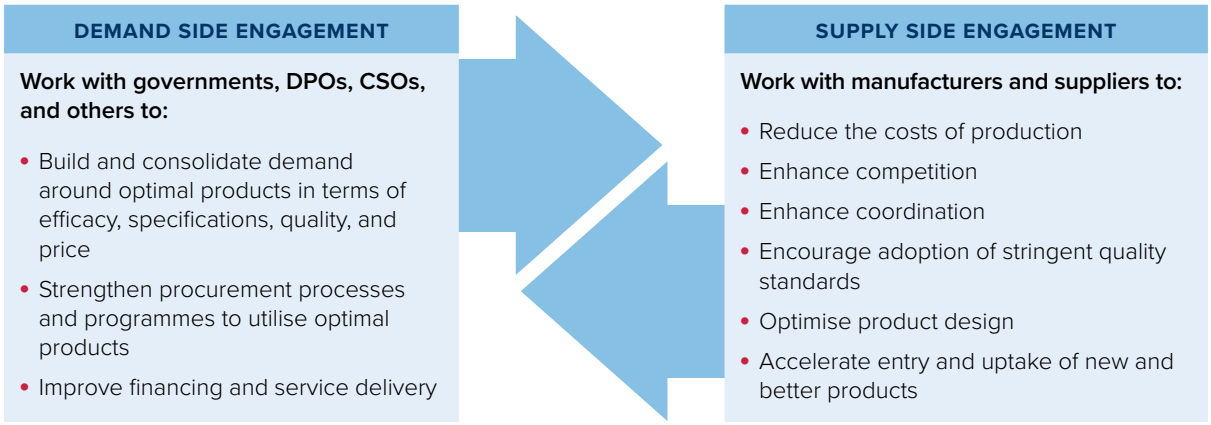
Assistive technology (AT) is an umbrella term covering the systems and services related to the delivery of assistive products such as wheelchairs, eyeglasses, hearing aids, prosthetic devices, and assistive digital devices and software. Today, over 1 billion people require AT to achieve their full potential, but 90% do not have access to the AT that they need.[6] This unmet need for AT is driven by a lack of awareness of this need, discrimination and stigma, a weak enabling ecosystem, lack of political prioritisation, limited investment, and market barriers on the demand and supply side. Narrowing in on the market shortcomings that limit the availability of assistive products, market shaping is proposed to address the root causes that limit the availability and affordability of and access to appropriate AT, with the wider aim of ensuring improved social, health, and economic outcomes for people who require AT. Increased access to AT is critical to achieve many global commitments, including universal health coverage, the obligations of the United Nations Convention on the Rights of Persons with Disabilities, and the ambitious Sustainable Development Goals. To accelerate access to AT, the global community needs to leverage the capabilities and resources of the public, private, and non-profit sectors to harness innovation and break down market barriers.

Whether by reducing the cost of antiretroviral drugs for HIV by 99% in 10 years, increasing the number of people receiving malaria treatment from 11 million in 2005 to 331 million in 2011,[7] or doubling the number of women receiving contraceptive implants in 4 years while saving donors and governments USD 240 million,[8] market shaping has addressed market barriers at scale. Market-shaping interventions play a role in enhancing market efficiencies, improving information transparency, and coordinating and incentivising the numerous stakeholders involved in both demand- and supply-side activities. Examples of market-shaping interventions include: pooled procurement, de-risking demand, bringing lower cost and high-quality manufacturers into global markets, developing demand forecasts and market intelligence reports, standardising specifications across markets, establishing differential pricing agreements, and improving service delivery and supply chains.

Market-shaping interventions often require coordinated engagement on the demand and supply side (see Figure 1). Successful interventions are tailored to specific markets after robust analysis of barriers and seek to coordinate action on both the demand and supply side. These interventions are catalytic and time-bound, with a focus on sustainability, and are implemented by a coalition of aligned partners providing support where each has comparative advantages.

[6] World Health Organization. Assistive technology. WHO; 2018. Available from: https://www.who.int/news-room/fact-sheets/detail/assistive-technology.
[7] UNITAID and World Health Organization. UNITAID 2013 annual report: transforming markets saving lives. UNITAID; 2013. Available from: http://unitaid.org/assets/UNITAID_Annual_Report_2013.pdf.
[8] Suzman, M. Using financial guarantees to provide women access to the modern contraceptive products they want to plan their families. Bill and Melinda Gates Foundation and World Economic Forum; 2016 May. Available from: http://www3.weforum.org/docs/GACSD_Knowledge%20Hub_Using_Financial_Guarantees_To_Provide_Women_Access_To_Modern_Contraceptives.pdf.

FIGURE 1: ENGAGING BOTH DEMAND AND SUPPLY SIDE FOR MARKET SHAPING



Historically, AT has been an under-resourced and fragmented sector, and initial analysis indicated that a new approach was required. ATscale, the Global Partnership for Assistive Technology, was launched in 2018 with an ambitious goal to provide 500 million people with the AT that they need by 2030. To achieve this goal, ATscale aims to mobilise global stakeholders to develop an enabling ecosystem for access to AT and to shape markets to overcome supply- and demand-side barriers, in line with a unified strategy (https://atscale2030.org/strategy). While the scope of AT is broad, ATscale has focused on identifying interventions needed to overcome these barriers for five priority products: wheelchairs, hearing aids, eyeglasses, prosthetic devices, and assistive digital devices and software.

Clinton Health Access Initiative (CHAI) is delivering these detailed analyses, called product narratives, of the markets for each of the priority products under the AT2030 programme (*https://at2030.org/at2030-partnership/*), which is led by GDI Hub and funded by UK aid from the UK government, in support of the ATscale Strategy.

The product narratives are meant to define the approach, identified by CHAI, to sustainably increase access to high-quality, low-cost AT in LMICs. The goals of these product narrative are to: 1) propose long-term strategic objectives for a market-shaping approach; and 2) identify immediate opportunities for investments to influence the accessibility, availability, and affordability of the assistive product and its related service areas.

While the previous product narratives have focused on one singular product category, such as wheelchairs, assistive digital devices and software, also known as digital AT, is a complicated, interconnected, and multi-faceted space that does not lend itself well to being summarised as a single product area. Guided by the understanding that the product scoping should be: 1) actionable (i.e. drive specific investment and activities); 2) practical; and 3) accessible, this product narrative is organised differently from the previously published narratives (wheelchairs, eyeglasses, hearing aids, and prostheses). What follows is an analysis of three product areas that are representative of the digital AT ecosystem (see next section) and are of interest to AT2030 and ATscale partners:

1. **Mobile phones**
2. **Screen-reading software (screen readers)**
3. **Augmented and alternative communication (AAC) devices**

Each product area chapter highlights the market landscape, key access challenges, and potential interventions that are needed to be implemented by a wide variety of stakeholders to increase access to the specific digital product category. When taken together, the interventions increase the potential for individuals to acquire accessible hardware solutions, accessible and usable applications, and appropriate content to improve their daily living activities and inclusion in the community, workforce, and in education.

The following report has been informed by desk research, market analysis, and key informant interviews to develop a robust understanding of the market landscape and the viability of market-shaping and market-building interventions. A list of all individuals interviewed during the development process can be found in Appendix A.

2. Framing the Digital AT Ecosystem

Digital AT is a broad category, but can be defined as assistive products that contain electronic information and communication technologies (ICT). These products can be organised into two categories: (1) **accessible technologies,** which refers to products, equipment and systems that have been inclusively designed so as to provide people with disabilities access to all available content within the technology, and can also be used by the general population; and (2) **assistive technologies,** which refers to specific products, equipment and systems designed to improve function and enhance activities of daily living specifically for people with disabilities.[9] Therefore, built-in speech-to-text applications on smartphones such as Google Live Transcribe are accessible technologies, while dedicated speech-to-text software such as Microsoft's Adaptive Controller are assistive technologies.[10] The intersection of these two areas is known as Disability Interaction.[11]

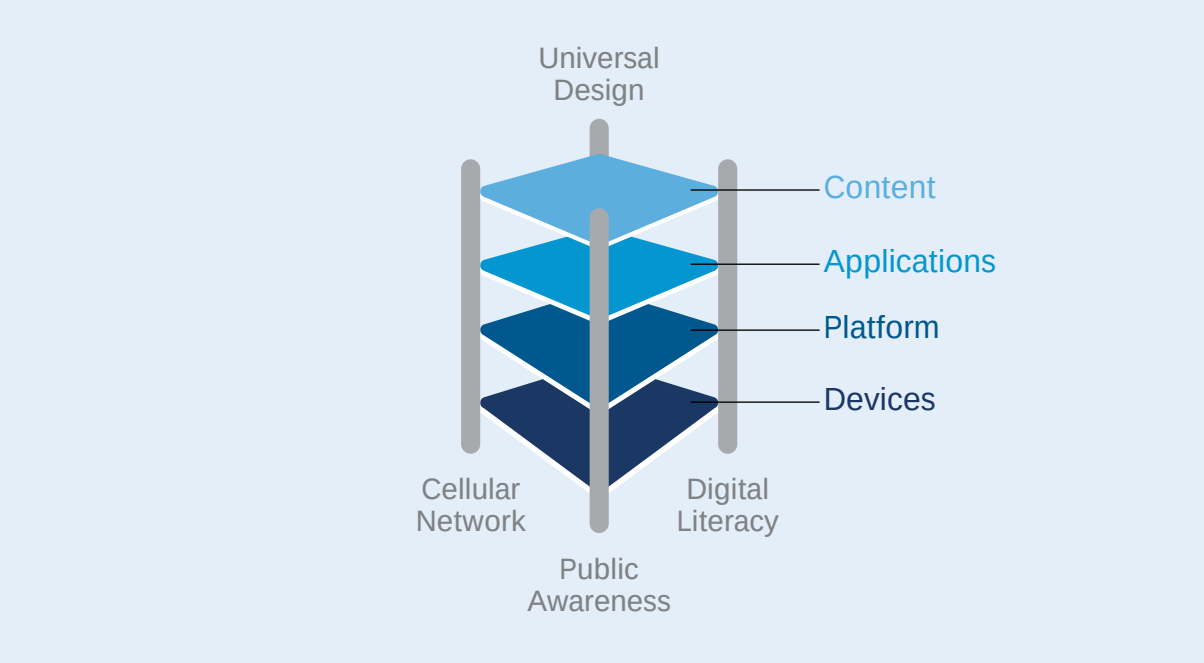
The digital AT ecosystem (Figure 2) is made up of four interconnected components that are necessary for digital AT to be effective:

- **ACCESSIBLE DEVICES,** such as mobile phones and tablets, and accessories, such as switches or braille readers that make communication with the device more accessible; these are hardware products that enable access to digital platforms, applications and content.
- **ACCESSIBLE PLATFORMS** or operating systems allow individuals to consume what is on the device. Universal design and accessibility features allow the system to adjust to the abilities of any individual needs so that they are able to consume what is on the device, regardless of age, disability, functional limitations, or impairment. By considering all the operations that are essential to access content early in the design process, universal design creates products and environments that are useable and convenient for all, regardless of ability.[12,13]
- **ACCESSIBLE SOFTWARE AND APPLICATIONS** are standalone programmes that fulfil a particular purpose or activity of the user – for example, typing notes and using a smartphone camera as a magnifier. Often, connectivity to the internet is needed to download cloud-based assistive software and applications that serve as AT onto a device. However, not all software and applications require an internet connection to operate.
- **ACCESSIBLE CONTENT**, such as text, native language, and pictograms that are digital or print-based. Content needs to be culturally appropriate, comprehensible in the local language or dialect, and adapted to the needs of the user. Content requires appropriate layout or presentation via suitable formats that can be changed (such as voiceover, sign language, or pictograms) so as to be easily understood and navigated. Content creators need to be trained in understanding accessibility features and creating accessible content, especially for websites and web-based services such as internet banking.

Adoption of the digital ecosystem is supported by four cross-cutting enablers: 1) awareness of digital AT and its accessibility by users, developers, suppliers, providers, and policymakers; 2) availability of mobile network and internet connectivity; 3) the inclusion of universal design and accessibility features; and 4) appropriate training in digital AT.

[9] Banes D, Hayes A, Kurz C, Kushalnagar R. Using information communications technologies (ICT) to implement universal design for learning (UDL). University Research Co; 2019. Available from: https://www.urc-chs.com/sites/default/files/urc-grn-ict.pdf.
[10] Banes D, Hayes A, Kurz C, Kushalnagar R. Using information communications technologies (ICT) to implement universal design for learning (UDL). University Research Co; 2019. Available from: https://www.urc-chs.com/sites/default/files/urc-grn-ict.pdf.
[11] Holloway C. Disability interaction (DIX): a manifesto. Interactions. 2019; 26(2):44-49. DOI: https://doi.org/10.1145/3310322.
[12] Wobbrock J, Kane S, Gajos K, Harada S, Froehlich J. Ability-based design: concept, principles and examples. 2011. ACM Transactions on Accessible Computing. 2011;3(3).
[13] Persson H, Åhman H, Yngling AA, Gulliksen J. Universal design, inclusive design, accessible design, design for all: different concepts – one goal? On the concept of accessibility – historical, methodological and philosophical aspects. Universal Access in the Information Society. 2014;14(4):505-526.

FIGURE 2: THE DIGITAL AT ECOSYSTEM: COMPONENTS AND ENABLERS



The digital AT areas described in this report represent different components of the digital AT ecosystem:

- Chapter (1) on mobile phones and **smartphones** is representative of the challenges and potential interventions related to **accessible devices** and **accessible platforms**.
- Chapters (2) and (3) on **screen readers** and **AAC** solutions highlight the challenges associated with **accessible software, applications,** and **accessible content.**

Access challenges in one component area will impact the others. For example, limited access to devices and/or the internet may prevent the uptake of AAC solutions as individuals cannot access low-cost AAC applications. Improving awareness of and training in digital AT will be common themes across all three chapters.

CHAPTER 1:

MOBILE PHONES AS ASSISTIVE TECHNOLOGY

CHAPTER SUMMARY: Individuals that require AT can benefit tremendously from the use of mobile phones, especially smartphones. Accessibility features and applications on a smartphone can provide similar assistance to many traditional assistive devices or augment digital assistive technologies. The use of mobile phones enhances independence and productivity, improves access to the digital economy, and democratises access to information. However, penetration of mobile phones and telecommunication services is much lower in low- and middle-income countries (LMICs) than high-income countries (HICs). Moreover, ownership among people with disabilities is lagging compared to the overall population. Barriers to mobile ownership and usage include, but are not limited to, the high cost of devices and network plans, limited awareness and understanding of the benefits of mobile as AT, and limited disability-inclusive designs and limited use of tools that allow for the full use of mobile phones by persons with disabilities. In order to increase access to mobile phones (particularly smartphones) as AT, the following objectives are proposed: 1) support government ministries in adopting policies that promote the use of mobile phones as AT for people with disabilities; 2) increase the affordability of mobile phones for people with disabilities through innovative financing; 3) ensure that people with disabilities can access mobile phones with appropriate feature sets for their individual needs; and 4) increase awareness of the benefits of mobile phones through expanded digital literacy training.

1. Mobile Phone Landscape

Mobile phones are a baseline access point for people with disabilities to access digital AT in LMICs.

Mobile phones (when connected to the mobile/data network) have tremendous benefits for economic, social, and physical well-being. Mobile phones enable economic inclusion through access to financial services, including mobile money, which is used widely in LMICs. When people with disabilities use mobile phones, they provide them with access to government services, including information on health and rehabilitation services, education and skills training, and civic engagement (e.g. voting in elections). Mobile technology reduces barriers in the physical and social environment, increases communication with families and communities, and enables mobilisation through disability rights networks and peer interaction. As services and products are increasingly digitised, mobile phones (with adequate mobile coverage and connection to a mobile and data network) become a critical tool to enable people with disabilities to live independent and socially connected lives. Persons with disabilities perceive that mobile phones enable

access to basic services.[14] However, the infrastructure for connectivity to the internet is often limited in LMICs. A 2013 survey found that many LMICs have insufficient broadband and communication services infrastructure, especially for accessing educational content.[15] But, as investment increases and countries adapt to the COVID-19 pandemic, this landscape is changing rapidly with the population covered by 3G and/or 4G networks trending upward.

Smartphones are becoming the preferred type of mobile device for all users, regardless of disability or functional limitation.

Mobile device technology is advancing rapidly, with innovations quickly replacing older models. **'Basic'** phones have the lowest functionality, and primarily allow voice calls, SMS (text messaging), and Unstructured Supplementary Service Data (USSD) features, which leverage cellular networks for mobile banking, location-based content, and other information services. These devices have a small, basic screen and limited connectivity functions beyond the mobile network. **'Feature'** phones contain all the features of a basic phone, but also add low-bandwidth internet access. They may contain multimedia features, including the ability to play video or music. **'Smartphones'** are the most advanced category of mobile phones and contain many of the functionalities of a computer. The device has a large touchscreen, and can access mobile internet, Wi-Fi, and Bluetooth. The operating system can download and operate a large library of third-party applications to create customised functionality and user experience. These applications, such as mobile-enabled screen readers and AACs, allow the smartphone to serve as AT. Smartphones are often able to connect to auxiliary devices through Bluetooth, which enables users to create modular digital AT that are typically lower in cost than standalone devices. While smartphones geared towards HIC markets can be priced over USD 1,000, there is an emerging segment of lower-cost **'Smart Feature Phones'** developed primarily by Chinese manufacturers. These devices rely on a different operating system to the standard Android or iOS, and contain many of the features of a smartphone, but with limited memory and processing power, which can limit functionality. Smart Feature Phones are the fastest growth segment of mobile phones in Africa. See Table 1.

PHASING OUT OF PERSONAL DIGITAL ASSISTANTS

The World Health Organization (WHO) includes personal digital assistants (PDA) in the Priority Assistive Products List. Popularised in the 1990s as new technology, PDAs are digital mobile devices that provide limited organiser functions, which can serve as an assistive tool to digitise certain common tasks (e.g. reminders, calendars, note-taking). Unlike a mobile phone, they do not connect to a network to provide calling, SMS, or internet access, and are usually limited to Bluetooth connectivity. PDAs do not contain a hard drive, which limits storage capacity, and typically have a short battery life. Accessibility features are limited for PDAs, or only found on more advanced models. PDAs are on the lower end of the technology and capability spectrum; hence mobile phones are typically preferred by new adopters of mobile technology. PDAs will not be a focus of this report.

[14] GSMA. Understanding the mobile disability gap. GSMA; 2019. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/12/GSMA_Understanding-the-mobile-disability-gap_116pg_Accessible.pdf.
[15] GSMA. The state of mobile internet connectivity. GSMA; 2019. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/07/GSMA-State-of-Mobile-Internet-Connectivity-Report-2019.pdf.

TABLE 1: TYPES OF MOBILE DEVICES (FROM BASIC TO ADVANCED)

	BASIC PHONE	FEATURE PHONE	SMART FEATURE PHONE	SMARTPHONE
Device	 Pixabay	 Pixabay	 Pixabay	 Pixabay
Functionality	Small screen, voice calls, SMS, USSD.	Small screen, voice calls, SMS, USSD, mobile internet, multimedia player, some pre-downloaded applications.	Some have touch screens, voice calls, SMS, mobile internet, limited storage and operating system (e.g. Android GO or KaiOS), capable of running a limited library of customisable applications. Accessibility features are variable.	Large touchscreen, voice calls, SMS, mobile internet, front and rear camera, powerful storage and operating system (Android or iOS) capable of running customisable applications, accessibility features.
Example brands/ models	Nokia (8110), Doro (6620), Light Phone, Easyfone (Prime A1)	Nokia (3300 Dual SIM card), Samsung (Guru/1200), Intex (Eco Beats)	Onyx (Connect), Transsion (Tecno, itel, Infinix), Orange (Sanza)	Apple (iPhone), Samsung (Galaxy Phone), Huawei (Mate 20 Pro), Transsion (Tecno, itel, Infinix)
Pricing (USD)	USD 25-USD 50	USD 100-USD 300	USD 20-USD 100	USD 100-USD 1,000+

Penetration of mobile phones and services is much lower in LMICs than in HICs, with ownership amongst people with disabilities lagging compared to the broader population.

More than 5.2 billion people worldwide are subscribers to mobile services, with 65% of those connections being smartphones.[16] Subscriptions are growing +1.9% per year, with LMICs leading the growth. By 2025, there will be 600 million *new* subscribers, with 73% from Latin America, Sub-Saharan Africa, and Asia-Pacific (excluding China).[17] The current median ownership rate in HICs stands at 76%, compared to 45% in LMICs.[18] People with disabilities in LMICs report even lower rates of coverage: a study in Kenya and Bangladesh showed a 13% gap in mobile phone ownership between people with disabilities and people without.[19] Mobile phone ownership and usage is also driven by network quality and level of coverage.[20]

[16] GSMA. The mobile economy 2020. GSMA; 2020. Available from: https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_Global.pdf.
[17] GSMA. The mobile economy 2020. GSMA; 2020. Available from: https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_Global.pdf.
[18] Silver L. Smartphone ownership is growing rapidly around the world, but not always equally. Pew Research Center [Internet]. 2019. Available from: https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/.
[19] GSMA. Understanding the mobile disability gap. GSMA; 2019. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/12/GSMA_Understanding-the-mobile-disability-gap_116pg_Accessible.pdf.
[20] GSMA. Accelerating digital literacy: empowering women to use the mobile internet. GSMA; 2015. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/06/DigitalLiteracy_v6_WEB_Singles.pdf.

Applications on a smartphone can provide similar assistance to many traditional assistive devices or augment connected digital assistive technologies.

Accessibility features help enable people with visual, hearing, or cognitive impairments to interact with content on mobile phones (Table 2) that would be otherwise inaccessible. Smartphones often employ universal design. This means that a product is designed to be accessible, understood, and used to the greatest extent possible by all people, regardless of their age or ability.[21] The International Telecommunication Union (ITU) and the Global Initiative for Inclusive ICTs (G3ict) promotes accessibility and universal design principles to be incorporated at the earliest stage of the product development to ensure that accessibility is mainstreamed. This limits additional product segments from being specifically created for people with disabilities.

Smartphones typically contain more accessibility features, either built-in or downloaded as an application. Smart feature phones and feature phones will often have fewer or limited accessibility features, while basic phones may have none. Beyond these accessibility features, people with disabilities can download applications or connect with external devices to replace some traditional AT, such as braille readers, AAC, or switches in some cases; the ability to connect to and be interoperable with other devices expands the use case of mobile phones as AT. However, mobile phones may not meet the digital AT needs of all individuals – some may need larger screens, such as tablets, or buttons that are easier to manipulate. When the handset is not designed with good usability and accessibility in mind, it can be worse than a feature for visually impaired people; however, when done well, mobile phones can successfully bridge physical accessibility challenges as well.[22]

In summary, smartphones offer a wide range of use cases and added value-for-money for people with disabilities or functional limitations; yet ownership is lower compared to the broader population. Over 70% of people with disabilities who are mobile device owners in Kenya and Bangladesh own a basic or feature phone. In Bangladesh, within the broader population, 49% of mobile phone users own smartphones, compared to only 29% of people with disabilities.[23] When persons with disabilities have access to accessibility features, they tend to make higher use of mobile services.[24]

TABLE 2: SELECTION OF ITU AND G3ict RECOMMENDED ACCESSIBILITY FEATURES OF MOBILE PHONES[25]

FEATURES	DESCRIPTION
Adjustable display settings (e.g. font size, colour contrast)	To assist people with visual impairments to **use mobile devices**
Text-to-speech / voice recognition	Enables visually impaired people to access menus/applications, receive audio feedback, or read messages aloud
Pictorial address book / menus	Enables cognitively impaired or non-readers to access contacts and other phone features
Visual or tactile indicators for the keypad and screen	Uses light or other indicators to demonstrate input
Mono audio	Makes listening to music and making calls easier for people with hearing loss affecting one ear
Captioning	Provides text captions for multimedia to assist deaf users

[21] International Telecommunication Union and G3ict. Making mobile phones and services accessible for persons with disabilities. ITU; 2012.
[22] Barbareschi G, Holloway C, Arnold K, Magomere G. The social network: how people with visual impairment use mobile phones in Kibera, Kenya. 2020. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20). Association for Computing Machinery.
[23] GSMA. Understanding the mobile disability gap. GSMA; 2019. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/12/GSMA_Understanding-the-mobile-disability-gap_116pg_Accessible.pdf.
[24] Barbareschi G, Holloway C, Arnold K, Magomere G. The social network: how people with visual impairment use mobile phones in Kibera, Kenya. 2020. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20). Association for Computing Machinery.
[25] International Telecommunication Union and G3ict. Making mobile phones and services accessible for persons with disabilities. ITU; 2012

Many people with disabilities in LMICs cannot afford to own a mobile phone.

The cost of owning a mobile phone is composed of the cost of the device itself, content (such as applications), and the network tariff plan, which includes airtime and/or data. The latter is on average the most expensive component. Based on average annual costs, 58% is spent on the network plan, followed by the device (25%) and content (17%).[26] The GSM Association (GSMA)[27] advocates that the total cost of ownership of a smartphone should not exceed 5% of annual income. LMIC users currently spend up to 9% of their income on smartphone ownership, with the lowest income users spending more than 16%.[28] People with disabilities often do not have a steady income to pay for a mobile phone.

In Kenya, 55% of people with disabilities who do not own a mobile phone cited that they could not afford the cost of purchasing the phone as the primary barrier to ownership. An additional 9% cited not being able to afford the network plan to access data.[29] Additionally, the network tariff plan may not be structured in a way that is adaptable to how people with disabilities use mobile services – for example, users with hearing impairments may only need a text-only or data-only package that does not include voice minutes.[30] Affordability challenges are exacerbated by the fact that people with disabilities can benefit from accessibility features that may be limited to higher-end smartphones. Purchasing second-hand smartphones, specifically second-hand iPhones, is one way in which people with visual impairment in India have overcome affordability barriers, for example.

People with disabilities and caregivers in LMICs may lack awareness and understanding of the benefits of mobile phones, and lack the digital literacy to use the device.

Mobile phones are often not viewed as an assistive product by people with disabilities, their caregivers, or social service or health providers. Digital literacy in LMICs remains a gap for many individuals, and stems from lack of access to devices and internet connectivity, as well as to education and programmes that promote digital skills training. For example, only 50% of African countries have digital or computer skills as part of their school curriculum, compared to 85% of non-African countries.[31] Without appropriate training, potential users may not know how to use mobile phones or know that features exist to facilitate access to mobile content. Family and caregivers may also not know about all the features and benefits. Last-mile (mostly rural) mobile phone sellers are often ill-equipped to provide recommendations on the best phone and corresponding features needed to meet the needs of people with disabilities or other limitations. This leaves a gap in awareness, feature- and device-matching, and digital literacy training. NGOs programmes and digital tools such as ATvisor can help fill this gap (See Case Study 1). The Global Accessibility Reporting Initiative (GARI) has created a website to help people with disabilities select the best mobile phones, tablets, apps, Smart TVs, or wearables based on their disability, and to see the accessibility features of each device.[32]

In addition to selecting the most appropriate device, people with disabilities may benefit from services that help them navigate the extensive list of applications that can be downloaded to a smartphone. Although the proliferation of mobile applications is positive in that it helps meet the unique needs of different users, it can also lead to confusion for people with disabilities. The development of directories or application bundles that serve a particular functional use case can help shorten the pathway for people with disabilities to get to the full suite of mobile applications they need. For example, a directory of vetted applications that can serve the needs of someone with visual impairment may include a screen reader, bank note identifier, talking calculator, and object/light/colour identifier. “App Catalogue”, led by UNICEF, is one such project.

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[26] CHAI analysis.
[27] GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile) Association is an industry organisation that represents the interests of mobile network operators worldwide..
[28] CHAI analysis based on World Bank Income Segmentation Data: World Bank Data Team. New country classifications by income level: 2019-2020. World Bank Blogs [Internet]. 2019. Available from: https://blogs.worldbank.org/opendata/new-country-classifications-income-level-2019-2020.
[29] GSMA. Understanding the mobile disability gap. GSMA; 2019. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/12/GSMA_Understanding-the-mobile-disability-gap_116pg_Accessible.pdf.
[30] International Telecommunication Union and G3ict. Model ICT accessibility policy report. ITU and G3ict; 2014. Available from: https://g3ict.org/publication/model-ict-accessibility-policy-report.
[31] World Bank Group. World development report: learning to realize education’s promise. World Bank; 2018.
[32] Global Accessibility Reporting Initiative (GARI). Website [Internet; cited 2020 September 1]. Available from: https://www.gari.info

CASE STUDY 1: ATvisor

ATvisor.ai is an artificial intelligence-enabled platform that recommends AT that meet the needs of an individual. Founded in 2016, ATvisor looked to fill a gap where people with disabilities and older people had limited awareness and understanding of what devices are most suitable for them. Healthcare professionals and caregivers lack awareness of the different AT on the market and how to fit them appropriately. To address this gap, ATvisor has developed a platform that makes recommendations based on the specific profile of the user, to break down the barriers of awareness and knowledge requirement.

While free for end-users and professionals, ATvisor charges manufacturers and suppliers a fee to be included on their platform. ATvisor has currently only launched in Israel via two closed pilots, on-boarding 200 healthcare professionals, conducting 1,000 personal searches, and connecting to 300 suppliers, and has shipped 20,000 products. On top of matching users to AT, ATvisor has created a database of AT suppliers and products to further illuminate trends in the global marketplace. ATvisor works through a model of collaboration with local partners to enter new markets and sees high potential for their platform in LMICs.[33]

Inefficiencies in the supply chain and distribution increase costs to the LMIC user; financing schemes can lower the upfront investment required.

The mobile phone industry in LMICs is led by mobile network operators (MNO), who invest in infrastructure, provide mobile network connection and subscription plans, and also work with global suppliers to source devices. Unfortunately, MNOs in LMICs often fail to buy in bulk volumes in order to limit stock risk exposure, leading to higher unit and transport costs for devices.[34] Industry and import taxes are often passed on to the end user. When it comes to distribution, MNOs typically count on independent retailers to sell devices and subscriptions, particularly in rural areas. These retailers may charge high premiums, do not offer full support for the devices, and/or sell unlicensed and outdated devices and components – leading to higher costs to the user. Cost-effective distribution, such as that found in rural Kenya (Case Study 2), could be further replicated and scaled; however, further consideration on how to meet the needs of people with disabilities is needed. This may include training sales and support staff to provide accessible education and device-matching.

In middle- and high-income countries, financing solutions that spread out a large lump-sum payment over time exist to make the purchase of a smartphone more affordable in the short-term to the customer. MNOs bundle the cost of the device with a network plan, whereby the full cost of the device is subsidised because of the guaranteed plan revenue over time – locking in a customer typically for one to two years. Customers pay in instalments. Though widely used in HICs, this structure is challenging in lower income economies because of the lack of credit history and user identification. This compounds the challenges people with disabilities often face, as they usually have additional barriers to financing the device. Some MNOs have promoted and created personal savings schemes that leverage community social networks which customise savings to each user's income stream. These mechanisms also enable users to accumulate sufficient funds to afford a mobile phone. Government and NGO programmes can help with the cost of ownership to people with disabilities by offering device and mobile network plan subsidies or providing low-cost asset financing.

[33] Atvisor. Website [Internet; cited 2020 September 1]. Available from: https://www.atvisor.ai.
[34] GSMA. Accelerating affordable smartphone ownership in emerging markets. GSMA; 2017. Available from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/08/Accelerating-affordable-smartphone-ownership-in-emerging-markets-2017_we.pdf.

CASE STUDY 2: COPIA

Smartphones are often inaccessible for people at the base of the pyramid market in Kenya. Users must either travel to an urban centre to purchase a phone, incurring travel costs, or buy from grey markets, where prices can be marked up by up to 300% compared to urban retail.

Copia is a mobile retail service for low-income rural and peri-rural people in Kenya, launched in 2013. Copia uses its direct agents to educate and create demand, becoming point of contact for users to own smartphones at retail price. Copia direct agents use tablets with e-catalogues that enable them to offer products without needing the capital to purchase inventory. Customers can have their order for smartphones placed and delivered via a strong local distribution network. Copia also works with local savings organisations to facilitate payment. While agents receive commission, tapping into this network allows more people in rural Kenya to enjoy the benefits of smartphones at prices similar to those found in urban centres.

Since its launch, Copia has expanded its agents from 200 to 1,200, 25-35% of whom sell and distribute smartphones to new areas that were not penetrated by MNOs and phone manufacturers previously. Copia has also expanded to providing items beyond mobile phones to include additional electronic, household, and other goods.

To create a healthy ecosystem that supports the uptake of mobile devices by people with disabilities, LMIC governments should create appropriate programmes and policies.

Most LMIC governments lack the policies needed to promote ICT accessibility and the uptake of mobile devices by people with disabilities. Access to mobile devices cuts across the purview of multiple government agencies, such as ICT, social welfare, and health, making co-ordination of efforts and funding difficult. Procurement of mobile devices intended to be used by persons with disabilities should be streamlined through inclusion in national procurement processes and the removal of industry taxes for such users. Furthermore, procurement should include mobile applications that can be downloaded to devices. Investment is needed to expand education programmes and digital skills training. Governments can also help enable people with disabilities access financing for devices through loans, or subsidies for devices and network plans. Beyond access to the device itself, governments should ensure that government services and digital content are designed with accessibility in mind, and can work with employers to incentivise digital skills training programmes and the creation of employment opportunities for people with disabilities.

ITU and G3ict have developed the *Model ICT Accessibility Policy Report* that provides an overview of key provisions that should be included in primary ICT legislation in order to mainstream ICT accessibility in national regulatory and policy frameworks, which includes modules on mobile communications accessibility and accessible ICT public procurement policies.[35] This document can serve as a starting point to provide national policy makers with a generic approach and model text that can be adapted to the country context.

[35] International Telecommunication Union and G3ict. Model ICT accessibility policy report. ITU and G3ict; 2014. Available from: https://g3ict.org/publication/model-ict-accessibility-policy-report.

2. Mobile Phone Access Challenges

Demand	
Awareness	Low awareness among policymakers, people with disabilities, caregivers, and social service and health providers on the benefits and use cases offered by mobile devices to improve the economic, social, and health well-being of persons with disabilities or individuals with specific functional limitations.
Financing	Upfront costs for a mobile phones are high. People with disabilities generally have lower access to financing schemes and subsidies that are offered to the general population and reduce the upfront investment. As people with disabilities are more likely to be affected by poverty and employment barriers, they face unique difficulties in accessing credit or accumulating sufficient savings. People with disabilities commonly rely on NGOs to provide free or heavily subsidised mobile devices, but these programmes are limited in reach.

Supply	
Product Features	Mobile phones that offer the highest value for persons with disabilities are those that contain accessibility features. Although ITU promotes universal design and accessibility features in all mobile phones, these are typically limited to higher-end smartphones. People with disabilities may need better guidance when selecting an appropriate mobile phone.
Cost	Low-volume purchasing, high industry taxation and import costs, and reliance on high-commission last-mile distribution chains all contribute to a high cost to the end user. In addition, the cost of airtime and data on mobile network plans is a significant barrier to mobile usage.

Enablers	
Policy	Governments lack policy frameworks that promote mobile phone access for people with disabilities, build awareness for mobile phone use, support MNOs to activate buyers that have a disability or functional limitation, or incentivise innovation in mobile technology and content catered to people with disabilities or impairments.
Digital Literacy	LMICs lack programmes and adequate education systems that provide people with disabilities with the digital skills to select, use, and maintain a mobile device, which also inhibits the understanding of the benefits, and presents barriers to purchasing and selection.
Connectivity	Mobile network coverage and quality in LMICs can limit the usability and applicability of mobile phones.

3. Proposed Interventions to Increase Access to Mobile Phones as AT

STRATEGIC OBJECTIVE 1: Support government ministries to adopt policies that promote the use of mobile phones as AT for people with disabilities.

Rationale	• Government leadership is needed to create an enabling policy environment for accessibility and uptake of mobile. • Coordinated planning and funding is required between various ministries that engage with people with disabilities.
Proposed activities	• Advocate and provide technical assistance to strengthen cross-ministry coordination between ICT, health, education, labour, and social welfare ministries to: 1) designate mobile and smart phones as AT; 2) develop policies that enable greater access to smartphones for people with disabilities (including the reduction of duties and industry taxation) on the import of phones for people with disabilities); and 3) include procurement and provisioning of mobile and smartphones to people with disabilities under the national disability plan and/or universal health coverage.

STRATEGIC OBJECTIVE 2: Increase affordability of mobile phones for people with disabilities through innovative financing.

Rationale	• High out-of-pocket upfront costs are a major barrier for people with disabilities. • People with disabilities are more likely to be poorer and less bankable than the broader population in LMICs.
Proposed activities	• Provide technical assistance to governments to create financing schemes for people with disabilities to purchase mobile phones, such as provision of loans and subsidies or inclusion in health insurance. • Expand third-party payment methods including subsidies and personalised pricing based on equity, whereby private companies, governments, or NGOs help offset the cost of ownership. • Encourage LMIC governments and MNO procurement efforts to purchase devices in bulk, enabling volume discounts for both public and private sector provision.

STRATEGIC OBJECTIVE 3: Ensure that people with disabilities or other functional limitations can access mobile phones with the appropriate feature set for their individual needs.

Rationale	• People with disabilities often lack awareness and understanding of the benefits and accessible features of mobile phones and accessible content. • Sales channels in LMICs lack knowledgeable advisors that can recommend and offer appropriate solutions for people with disabilities.
Proposed activities	• Support MNOs to create minimum product standards for universal design and accessibility features for phones on their networks, and ensure manufacturers and procurement agents adopt such features. • Encourage MNOs to promote accessibility features to all users, distributors, and retailers of smartphones to drive increased awareness. • Pilot AT recommendation and matching tools (e.g. ATvisor) to advise on AT selection at the individual level in LMICs. • Work with suppliers, governments, and service providers to create application directories or bundles specific to certain disabilities (at a global or local level).

STRATEGIC OBJECTIVE 4: Increase awareness of mobile phone benefits through expanding digital literacy training.

Rationale	• Digital literacy is a major gap for people with disabilities for adoption of mobile phones. • Lack of training for health and social service workers to understand and relay the benefits of mobile phone use to people with disabilities.
Proposed activities	• Support the scale up of digital inclusion education and skills-building programmes, and create referral mechanisms through schools and the ministry of education. • Support relevant government agencies to include digital literacy and device education for community health and rehabilitation care workers who work with people with disabilities and their families.

CHAPTER 2:

SCREEN READING SOFTWARE (SCREEN READERS)

CHAPTER SUMMARY: Screen readers are software programmes for people with vision impairment and/or learning disabilities[36] that convert screen content into a format that is accessible to the individual, such as braille, speech, or both. Screen readers can be used on laptops, desktop computers, and mobile devices. They contribute to the participation of people with disabilities in society and encourage them to live an independent life and fully benefit from their rights regarding health, social benefits, or employment. Different models of screen readers exist: software built into the operating system, open source and free stand-alone software, and commercial paid subscription stand-alone software. Open source screen readers are recognised as being equal in quality to commercial screen readers for common tasks such as web navigating, word processing, etc. Commercial screen readers remain the preferred choice for many employers as they offer more customisation options and support for specific applications. Access to screen readers in LMICs is hindered by the following barriers, among others: low awareness of the existence and benefits of screen readers, limited availability of screen readers in local languages, lack of training, lack of accessible content, and unaffordable prices for commercial screen readers. In order to increase access to screen readers, the following objectives are proposed: 1) adopt accessibility standards on public government websites and applications; 2) develop text-to-speech synthesisers in local languages; 3) establish (sub-)national programmes to enable price agreements with commercial screen reader suppliers; and 4) train people with disabilities in use of digital AT.

1. Screen Readers Landscape

Screen readers convert information from a desktop computer, laptop, or mobile into a format that is accessible for people with vision impairment or learning disabilities.

Screen readers are software programmes for people with vision impairment and/or learning disabilities that convert screen content into a format that is accessible to the individual, such as braille, speech, or both.[37] Screen readers use text-to-speech synthesiser software that converts the screen elements into speech. A refreshable braille display – a hardware device that displays a braille representation of the text – can additionally be combined with a screen reader to make the digital ecosystem even more accessible.[38]

Screen readers can be used on laptops, desktop computers, tablets, and smart feature and smartphones. On laptops and desktop computers, users navigate the content with keyboard commands, either stepping

[36] UNESCO. Global report: opening new avenues for empowerment. UNESCO; 2013.
[37] Göransson D. What is a screen reader? Axess lab [Internet]. 2019. Available from: https://axesslab.com/what-is-a-screen-reader.
[38] UNESCO. Global report: opening new avenues for empowerment. UNESCO; 2013.

from object to object or by jumping between different types of components, like headings or links. On smartphones, screen reader users move their finger on the screen, either swiping left and right to move to the next or previous item (swipe navigation) or getting what is under their finger read to them (touch navigation).

Screen readers contribute to people with disabilities participating in society and realising their human rights.

Globally, estimates show that at least 1 billion people are blind or have a vision impairment.[39] Many are not provided with equal opportunities. For example, in Rwanda in 2012, 56% of working-age people with a severe visual impairment were employed, compared to 71% of the national population, and 41% of those with severe visual impairment had never attended school, compared to 20% of the national population.[40]

With screen readers, people with visual impairment can both consume content, such as educational content, and create it through productivity software such as the Microsoft Office Suite. Screen readers can contribute to the participation of people with vison impairment in society and to the realisation of their human rights as defined in the United Nations Convention on the Rights of Persons with Disabilities.

LMIC governments have progressively transitioned their services to digital content, which is often inaccessible to people with disabilities and leads to their exclusion from accessing it. People with disabilities need equal access to government websites or applications so that they too can receive key information and use digital public services as full members of society. This would allow people with disabilities to take further steps towards living independent lives and fully benefitting from their rights regarding health, social benefits, or employment. Some initiatives exist in HICs and LMICs to promote equal access of people with disabilities to employment (see Case Study 3).

CASE STUDY 3: IMPROVING ACCESS OF PEOPLE WITH DISABILITIES TO EMPLOYMENT

- **UNITED STATES OF AMERICA:** The employment rate of people with disabilities in the United States is significantly lower than for the general population; in 2019, 19.3% of people with disabilities were employed compared to 66.3% of the broader population.[41] The diffusion of technologies in workplaces is likely to have further aggravated the unequal access of people with disabilities to the labour market.[42] The US Department of Labor, in collaboration with the Partnership on Employment and Accessible Technology, launched TalentWorks, a free online resource that provides guidance for organisations to ensure their web-based job applications and recruiting processes are accessible for people with disabilities.[43]
- **BANGLADESH AND KENYA:** Leonard Cheshire Disability, a UK organisation aiming to improve education and employment pathways for people with disabilities across the world, is working with job search sites in Bangladesh (BDjobs.com) and Kenya (Fuzu) to ensure those platforms are inclusive and accessible to people with disabilities. For example, in Bangladesh 80% of jobs are advertised through BDjobs.com, which does not currently employ accessibility features. Leonard Cheshire Disability has also partnered with Accenture and Microsoft India to develop an inclusive employment platform that matches someone's skills, abilities and career interests to jobs. The platform is powered by artificial intelligence.[44]

Screen readers are available as built-in, open source, or commercial products.

Different models of screen readers exist. Many smartphones, laptops, or desktop computers have some form of screen reader built into the operating system as an accessibility feature, but these often offer fewer features than stand-alone screen readers. Stand-alone screen reader software ranges from open source

[39] World Health Organization. World report on vision. WHO; 2019.
[40] National Institute of Statistics of Rwanda [Internet]. Fourth population and housing census. 2012. Available from: http://www.statistics.gov.rw/survey-period/fourth-population-and-housing-census-2012.
[41] US Bureau of Labor Statistics. Persons with a disability: labor force characteristics. USBLS; 2019. Available from: https://www.bls.gov/news.release/pdf/disabl.pdf.
[42] Global Research, Innovation, and Education in Assistive Technology (GREAT) Summit. TalentWorks. WHO; 2017. Available from: https://www.who.int/phi/implementation/assistive_technology/great_summit/GS28_BROGIOLI_TalentWorks.pdf.
[43] International Telecommunication Union. Good practices and achievements in ICT accessibility in the Americas region: guidelines and recommendations. ITU; 2016. Available from : https://www.itu.int/en/ITU-D/Regional-Presence/Americas/Documents/EVENTS/2016/15526-MX/AAIII-best-practices-and-guidelines-Accesible-EN.pdf.
[44] Perez A. Digital access for jobseekers with disabilities. Leonard Cheshire Disability; 2020. Available from: https://www.leonardcheshire.org/our-impact/stories/digital-access-jobseekers-disabilities.

and free to commercial and paid subscription software. Each screen reader is compatible with specific operating systems and their performance varies with different software and websites. Table 3 presents popular screen readers across those three categories.

TABLE 3: EXAMPLES OF POPULAR SCREEN READERS BY CATEGORY

Built-in software	**Voiceover** • **Operating system:** Apple • **Device:** computer and mobile • **Price:** free • **Features:** Audio screen reader; swipe and flick-through; double-tap; select icon and buttons with voice commands • **Languages availability:** 40+	**Talkback** • **Operating system:** Android • **Device:** mobile only • **Price:** free • **Features:** Audio screen reader; swipe and flick-through; double-tap; select icon and buttons with voice command; activate with different gestures • **Language availability:** 50+	**Narrator** • **Operating system:** Microsoft • **Device:** computer only • **Price:** free • **Features:** Audio screen reader; pick and read sentence; verbosity level adjustment; scan mode; narrator key • **Language availability:** 10+	**Orca** • **Operating system:** Linux • **Device:** computer only • **Price:** free • **Features:** Screen reader (braille/ speech); magnifier with auto-focus; different voice types • **Language availability:** 10+
Open source software	**NVDA** • **Operating system:** Windows • **Device:** computer only • **Price:** free • **Features:** Speech synthesiser in 50 languages; textual formatting report; braille-display enabled; optional audible mouse tracker • **Language availability:** 50+	**Chrome Vox** • **Operating system:** web-based, comes pre-installed on Google Chrome • **Device:** computer and mobile • **Price:** free • **Features:** web-based extension for Chrome – audio screen reader for content displayed on the web (HTML5; CSS; Javascript) • **Language availability**: 50+		
Commercial software	**JAWS** • **Operating system:** Windows • **Device:** computer only • **Price:** USD 90 (home version, up to 3 computers) • **Features:** Screen reader with built-in DAISY player; skim reader; text analyser; pearl camera (print-to-speech add on) • **Language availability**: 30+	**Supernova** • **Operating system:** Windows • **Device:** computer only • **Price:** USD 1,195 (upfront cost) + USD 240 (guaranteed lifetime updates) • **Features:** intelligent reader and magnifier; scan and read paper (print-to-speech); natural voice reading • **Language availability:** 40+	**Cobra** • **Operating system:** Windows • **Device:** computer only • **Price:** USD 849 (upfront cost) • **Features:** Screen reader (voice and braille); magnifier up to 32x; edge smoothing and extra-large mouse pointer • **Language availability:** 10+	**ZoomText Fusion** • **Operating system:** Windows • **Device:** computer only • **Price:** USD 160 (home version, up to 3 computers) • **Features:** Screen magnification and visual enhancement; all features of JAWS available • **Language availability:** 30+

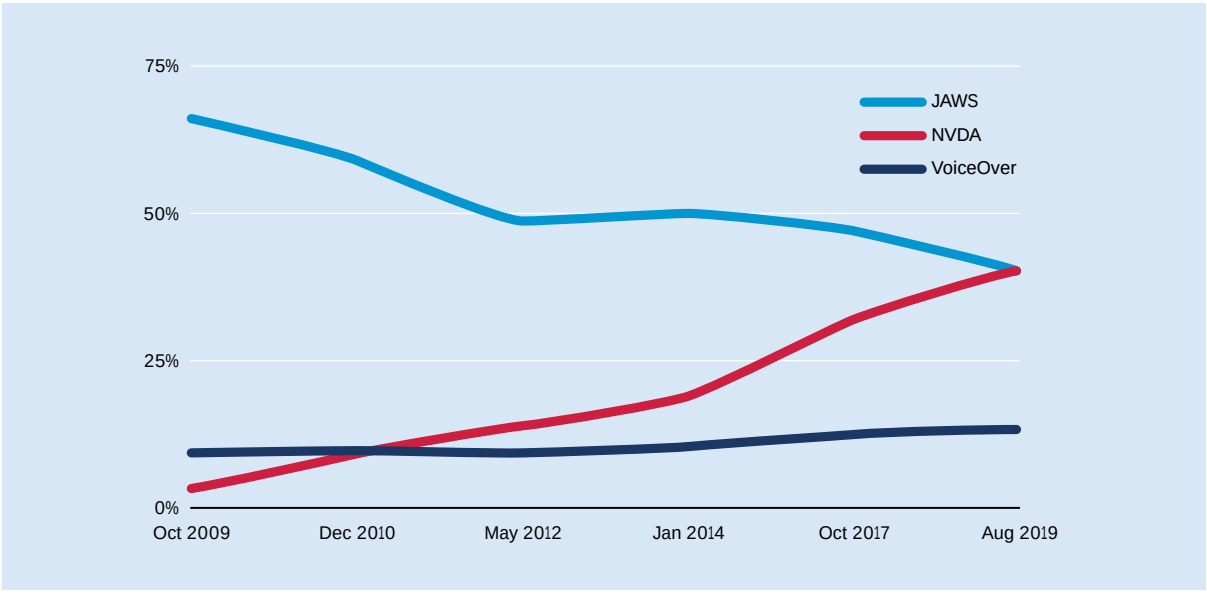
Open source screen readers are considered as good as commercial products.

A few years ago, commercial software such as JAWS and SuperNova were the most widely used screen readers worldwide.[45] Open source software like NVDA offered lower quality and fewer features.[46] In recent years, open source screen readers have addressed most of their limitations and are now recognised as being of equal quality in terms of:

- **FEATURES PARITY:** important parameters in the quality of screen readers include the number of tasks that can be performed and user-friendliness of the software. Examples include user-friendliness to install and navigate the software, or ability to perform tasks in word processing, spreadsheet, presentation, e-mail, web browsing, video-conferencing, or PDF applications. Initial versions of NVDA could perform fewer tasks compared to commercial screen readers like JAWS. Over the past few years, experts note that NVDA's features have gradually become as good as or even better than JAWS for some tasks related to web browsing or working with spreadsheets.
- **MAINTENANCE OF THE CODE:** sustainability of small-scale open source software has been a concern as the maintenance of its code is often left to the associated software development community. There is however little to no concern among developers and users that NVDA will stop being maintained. While open source, NVDA is organised as a company and sells customised NVDA packages at nominal prices to support operations.

A survey run by WebAIM across various regions showed that NVDA became the most common primary computer screen reader in 2018 ahead of JAWS (see Figure 3).[47] This trend is reflected for example in the National Association for the Blind, Delhi moving from JAWS to NVDA as the recommended screen reader five years ago. Users commonly use several screen readers, depending on the type of task they are performing: 73% use more than one screen reader, with 41% using three or more different screen readers. Each screen reader has differentiating features and no all-in-one solution exists.

FIGURE 3: SHARE OF NVDA, JAWS AND VOICEOVER AS PRIMARY SCREEN READERS OVER TIME, 2009-2019[48]



[45] UNESCO. Global report: opening new avenues for empowerment. UNESCO; 2013.
[46] Gunnarsson B, Hreinsson H. Practical screen reader comparison: a user-oriented approach. Icelandic National Institute for The Blind, Partially Sighted And Deaf Blind; 2011.
[47] WebAIM [Internet]. Screen reader user survey #8 ResultsSurvey. 2019. Available from: https://webaim.org/projects/screenreadersurvey8/.
[48] WebAIM [Internet]. Screen reader user survey #8 ResultsSurvey. 2019. Available from: https://webaim.org/projects/screenreadersurvey8/.

Commercial screen readers remain the preferred choice for many employers as they offer more customisation options and support for specific applications, as reported by WebAIM.[49] For example, if a person with vision impairment is hired by a banking company, JAWS will provide support to customise the screen reader to the banking application, unlike open source screen readers. Some governments have decided to support the employability and employment of people with disabilities by supporting the distribution of commercial screen readers (see Case Study 4).

CASE STUDY 4: FREE DISTRIBUTION OF JAWS SCREEN READER BY THE COLOMBIAN GOVERNMENT[50]

- **PROBLEM:** Visual impairment is one of the most common disabilities in Colombia. Local disabled persons organisations (DPOs) advocated to the government that providing free digital AT to people with disabilities could improve their employability and educational outcomes.
- **SOLUTION:** In 2014, the government budgeted USD 3 million for a digital AT package, supported by training centres in 15 cities and a support hotline. The package includes the commercial screen reader JAWS and screen magnifier MAGic. Commercial software was preferred as it offered better technical and training support.
- **RESULTS:** Over 30,000 people claimed the free package within the first weeks of implementation. The contract between JAWS and the government was renewed for another 4 years in 2018. The government hopes to see a reduction in the number of people on social welfare programmes as a direct result of the initiative.

Open source screen readers often do not have the financial leverage to purchase licences to use commercial adjacent technologies such as a text-to-speech synthesiser or braille refreshable display. For example, NVDA uses the open source speech synthesiser eSpeak, which has a lower voice quality than Eloquence, a popular speech synthesiser used by commercial screen readers such as JAWS. Experts consider the quality of eSpeak nonetheless sufficient for the everyday usage of a screen reader (but not for example to read an entire book) and is adapted to LMIC and low-resource settings, especially due to the number of languages supported (see next section).

Limited language compatibility and lack of user training are the primary barriers to access to screen readers.

Open source and built-in solutions have made access to quality screen readers more equitable. High price remains a barrier to accessing commercial screen readers, such as JAWS, limiting access to certain software. However, key barriers to access remain that are common to all screen readers:

- **LIMITED LANGUAGE COMPATIBILITY:** Text-to-speech synthesisers, which are developed separately, need to be available in the local language of the content being accessed. Many text-to-speech synthesisers are only available in English or other European languages. Limited language compatibility is particularly important as a barrier in regions with multiple languages and dialects, such as India or Sub-Saharan Africa.[51] Open source text-to-speech synthesisers often offer better local solutions as they can be adapted by volunteers all over the world: for example, eSpeak is the only text-to-speech synthesiser offering a Punjabi version.[52] Universities also carry out projects to develop text-to-speech synthesisers in local languages, but these initiatives are research-focused and often lack the capabilities to develop a product that can be deployed at scale.
- **LACK OF AWARENESS AND USER TRAINING:** In LMICs, health providers, care-givers, and people with disabilities themselves have low awareness of the existence and benefits of screen readers.

[49] Connell T. What is the cost of a free product? National Federation of the Blind; 2014. Available from: https://www.nfb.org/sites/www.nfb.org/files/images/nfb/publications/bm/bm14/bm1410/bm141006.htm.
[50] Connell T. What is the cost of a free product? National Federation of the Blind; 2014. Available from: https://www.nfb.org/sites/www.nfb.org/files/images/nfb/publications/bm/bm14/bm1410/bm141006.htm.
[51] Banes D, Hayes A, Kurz C, Kushalnagar R. Using information communications technologies (ICT) to implement universal design for learning (UDL). University Research Co; 2019. Available from: https://www.urc-chs.com/sites/default/files/urc-grn-ict.pdf.
[52] SourceForge. eSpeak text to speech. Available from: http://espeak.sourceforge.net.

People with disabilities may find it difficult to select a screen reader and other digital AT adapted to their disability without the help of a health professional or peers. Users then need training to use various screen readers across a variety of tasks and applications, and to use adjacent technologies such as refreshable braille displays. Software options like JAWS or VoiceOver offer keyboard shortcut options that users need to familiarise themselves and gain comfort with to take full advantage of the product. The National Association for the Blind, Delhi estimates that a young adult with no previous experience requires around 120 hours of training to become efficient at using a screen reader and adjacent technologies. The number of trainers and training centres in LMICs is limited and often managed by NGOs. Distance learning through video conferencing platforms like Zoom is emerging as a potential solution for training people with disabilities in using screen readers and other digital AT.

Screen readers are effective only when users have access to a both a quality device and web content that meets accessibility standards.

Accessibility of websites can be measured against a set of international guidelines: the Web Content Accessibility Guidelines version 2.0 (WCAG 2.0). These guidelines provide success criteria and associated requirements to ensure that web-based content can be accessed by people with disabilities.[53] However, these guidelines are not binding unless transposed and enforced by national legislation. The ITU and G3ict *Model ICT Accessibility Policy Report* and Accessibility Policy Toolkit (*e-accessibilitytoolkit.org*) provide a model web accessibility policy that governments can adopt. Legislation around web accessibility varies across countries:

- **UNITED STATES:** The US has the most advanced regulation of accessibility. Section 508 of the Rehabilitation Act and the Electronic and Information Technology Standards promulgated by the US Access Board requires all mainstream IT procured by the US federal government, including websites, to have certain accessibility features (***www.section508.gov/***). This legislation has positively impacted non-federal areas, with many private sector websites – such as e-commerce platforms – complying with accessibility standards.
- **EUROPEAN UNION:** the EU recently adopted the Web Accessibility Directive, which requires public websites and applications to meet European accessibility standards. The directive will become binding once transposed and implemented into national legislation. In addition, EN 301 549 by CEN/CENELEC/ETSI sets out accessibility requirements for public procurement of ICT products and services in Europe (***www.cencenelec.eu/standards/Topics/Accessibility/Pages/eAccessibility.aspx***).
- **LMICs:** LMICs typically do not have legislation around accessibility, or it is rarely enforced where it does exist. A 2017 study on the accessibility of government websites in Sub-Saharan Africa found that none of the 217 government websites examined adhered to WCAG 2.0 guidelines.[54] Among upper-middle income countries, Mexico is a notable exception as it has been active in promoting accessibility guidelines and best practices in both the public and private sector (see Case Study 5).

Web developers have little incentive to develop accessible websites, such as e-commerce platforms, government basic services, or banking platforms. They are often not aware that people with a disability or a functional limitation may use such platforms or do not consider people with disabilities as a consumer segment. Beyond awareness, it takes time, cost, and effort to create and maintain/update an accessible website or application. Web developers need to invest time to understand accessibility guidelines, or they need to outsource the work to competent organisations. To alleviate those challenges, some NGOs offer trainings to web developers around accessibility (see Case Study 5).

[53] UNESCO. Global report: opening new avenues for empowerment. UNESCO; 2013.
[54] Verkijika, SF, De Wet L. Determining the accessibility of e-government websites in Sub-Saharan Africa against WCAG 2.0 standard. International Journal of Electronic Government Research. 2017;13(1):52-68.

CASE STUDY 5: ACHIEVEMENTS IN ACCESSIBILITY IN MEXICO

It is estimated that 9.2 million people with disabilities live in Mexico, representing 7.5% of the population. Mexico has developed several initiatives to promote accessibility of content and devices:

- ACCESSIBILITY OF PUBLIC CONTENT: In 2007, the Mexican government signed a manifesto on web content accessibility to be followed by public agencies and state companies. In 2015, it was announced that all websites belonging to the Federal Public Administration of Mexico would become accessible to people with disabilities.
- ACCESSIBILITY OF PRIVATE CONTENT: In 2015, the ITU, in collaboration with the Secretariat of Communication and Transportation of Mexico, invited more than 250 regional telecommunication operators to be trained in web accessibility policies, increasing awareness of the barriers faced by people with disabilities when accessing webpages. The workshop recommendations included following WCAG, evaluating government websites, and training web designers in creating accessible content.
- TRAINING WEB DEVELOPERS: Following the web accessibility workshop, Telefonica Mexico and start-up accelerator Wayra partnered with HearColors, an organisation promoting accessible websites, to teach Mexican developers how to create accessible web content. HearColors also developed laboratories in universities to develop capabilities in digital accessibility among students. The first laboratory was opened at the Instituto Tecnológico Autónomo de México (ITAM) in November 2015, the second opened at the Universidad Nacional Autónoma de México (UNAM) in November 2016, the biggest public university in Mexico.
- ACCESSIBILITY OF DEVICES: In 2016, the Federal Telecommunications Institute published accessibility guidelines for telecommunication operators. Following a memorandum of understanding with G3ict, the Mexican government incorporated accessibility obligations in its procurement policies. Similar to the GARI initiative in Europe, the Federal Telecommunications Institute and Mobile Manufacturers Forum created a website where people with disabilities can select the most appropriate mobile handset with accessibility functionalities suitable for their disability.[55]

Access to print content is also an important issue for people with visual impairment and/or learning disabilities. To tackle this, the Digital Accessible Information System (DAISY) consortium has created technical standards for accessible books. The DAISY standards apply to digital talking books which offer a flexible reading experience for people who are 'print disabled', offering a significantly enhanced reading experience.[56] For example, users can search, place bookmarks, navigate line by line, or regulate the speaking speed.[57] Books in DAISY format have been adopted by large accessible libraries such as the Japanese Association of Libraries for the Blind, the US National Library Service for the Blind and Print Disabled, the South African Library for the Blind or the Bibliotheca Alexandrina in Egypt.[58,59] The Global Digital Library (https://digitallibrary.io/) is another initiative to support availability of books in accessible formats, including video books in sign languages.

[55] Cátalogo de dispositivos móviles accesibles. Website [Internet; cited 2020 September 1]. Available from: http://movilesaccesibles.ift.org.mx.
[56] DAISY standards. Website [Internet; cited 2020 September 1]. Available from: https://daisy.org/activities/standards.
[57] National Network for Equitable Library Service [Internet]. What is DAISY format? Available from: https://nnels.ca/help/downloading-and-reading-books/what-daisy-format.
[58] Orme R. Accelerating accessible content: progress through the DAISY Consortium. National Federation of the Blind; 2019. Available from: https://www.nfb.org/images/nfb/publications/bm/bm19/bm1910/bm191017.htm.
[59] DAISY Consortium membership. Website [Internet; cited 2020 September 1]. Available from: https://daisy.org/about-us/membership.

2. Screen Reader Access Challenges

Demand	
Awareness	***People with disabilities, caregivers, social service, and health providers:*** low awareness of the existence, use cases, and importance of screen readers to improve the economic, social, and health well-being of people with disabilities. There is low awareness of the availability and benefits of various digital AT, and people may find it difficult to select products or software adapted to their disability. ***Policymakers and web developers:*** low awareness of the benefits and importance of providing accessible content. For example, web developers often do not realise that people with disabilities can use online platforms and they additionally lack knowledge around the accessibility standards when developing a website or an application.
Training	***People with disabilities:*** there is usually an important learning curve for using a screen reader and other digital AT. Users often need to be trained on how to use a screen reader across a variety of tasks. Training in digital AT might be crucial for people with disabilities to be able to find employment. Training is limited in LMICs and is typically delivered by peer networks and NGOs. ***Web developers:*** developing a website or application that is accessible may add significant time, cost, and effort to the project. Web developers are not typically trained in digital accessibility and need to invest time to understand accessibility guidelines. Websites that are not inclusive from their initial development must adapt content to meet guidelines at a later date, which is a significant follow-on investment.
Price *(for commercial products)*	Commercial screen readers are preferred by companies or users in employment as they offer more customisation options. However, commercial screen readers require a significant investment and lead to high out-of-pocket costs as they are not typically covered by any benefit packages. For example, versions of JAWS are available at USD 90 per year, which remains unaffordable to many people with disabilities in LMICs. This cost may also discourage companies from hiring people with disabilities.

Supply	
Access to Device	To use a screen reader, you first need access to a smartphone, laptop, or desktop computer. *See Chapter I for barriers to access to mobile phones and mobile internet.*
Accessible Content	The vast majority of content available on the internet is not fully accessible to persons with disabilities or other functional limitations. This includes critical information provided on government websites and applications that prevent people with disabilities from benefiting from their rights regarding health, social benefits, or employment.
Product Profile	Screen readers use text-to-speech synthesisers that are mainly available in English and other European languages. People with disabilities cannot use a screen reader that is not available in the local language of the content visited. This issue is common across various digital AT.

Enablers	
Policy	Most LMIC governments do not have legislation around accessibility. Where they do exist, accessibility guidelines around government websites are often voluntary and rarely enforced if mandatory.

3. Proposed Interventions to Increase Access to Screen Readers

STRATEGIC OBJECTIVE 1: Adopt accessibility standards on public government websites and apps

Rationale	• Government websites and applications contain critical information and offer digital public services for people with disabilities to benefit from their rights regarding health, employment, information, social benefits, etc. • Government leadership on accessibility can positively impact the actions of the private sector, as has been observed in the US.
Proposed interventions	• Support LMIC governments to adopt and implement accessibility standards for government websites. • Advocate to LMIC governments to adopt the WCAG 2.0 and provide a mechanism for people with disabilities to report content that is not accessible.

STRATEGIC OBJECTIVE 2: Develop text-to-speech synthesisers in local languages

Rationale	• Screen readers use text-to-speech synthesisers that are mainly available in European languages. • People with disabilities cannot use a screen reader that is not available in the local language of the content visited. • Initiatives to develop text-to-speech synthesisers in local languages exist, but lack the capabilities to develop a product that can be deployed at scale.
Proposed interventions	• Support developers or start-ups interested in developing text-to-speech software in local languages, e.g. by promoting partnerships with national institutions and innovation funds. • Advocate for government incentives such as tax reductions, awards, or prizes for innovators working on localised digital AT solutions.

STRATEGIC OBJECTIVE 3: Establish (sub-)national programmes to enable price agreements with commercial screen reader suppliers

Rationale	• Commercial screen readers such as JAWS are preferred by companies or users in employment as they offer more customisation options, but they are more expensive. • Access to commercial screen readers at reduced cost can support the employability of people with severe visual impairment or other functional limitations.
Proposed interventions	• Work with LMIC governments and commercial screen reader suppliers to explore a pricing agreement, leveraging best practices from Colombia. • LMIC governments to distribute commercial screen readers at discounted prices or for free to people with disabilities looking for employment or to companies employing people with disabilities.

STRATEGIC OBJECTIVE 4: Train people with disabilities in digital AT

Rationale	• There is an important learning curve for using a screen reader and other digital AT and how to use a screen reader across a variety of tasks. • Training is typically provided by NGOs in LMICs.
Proposed interventions	• Provide training programmes and services to teachers, health workers, and other social service providers in how to use digital AT, including screen readers.

CHAPTER 3:

AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC) DEVICES

CHAPTER SUMMARY: AAC is any type of method or system that is used to replace, or supplement, natural speech. There are generally two types of AAC: aided and unaided. Unaided AAC does not require external tools, while aided AAC does. Aided systems range from low-tech (paper-based) to high-tech (electronic) products. These products can be accessed through an array of motions such as touch, mouse/mouse alternatives (e.g. joystick), eye gaze, and switches. Recently, smartphones and tablets have begun to replicate standalone AAC systems, allowing users to access free and open source AAC software through the internet. Among many other benefits, AAC encourages independence, increases people's ability to participate in society, and reduces the financial burden on an individual's environment. Furthermore, providing AAC to younger children can prevent learning delays, strengthen understanding of language and future communication ability, and allow for wider integration in school. However, access to AAC in LMICs is often much lower than HICs. Barriers to accessing AAC include, but are not limited to, low awareness of the benefits and effective provision of AAC, limited availability to appropriate products, and lack of funding. In order to increase access to AAC, the following objectives are proposed: 1) ensure clear global guidance for appropriate and effective AAC provision in LMICs, 2) expand AAC access through country-level adoption of procurement, provision, and financing, 3) test and validate AAC solutions for low-resource settings to ensure the availability of free and effective AAC applications.

1. AAC Landscape

AAC is necessary for people who cannot use conventional speech to communicate.

AAC is any type of method or system that is used to replace or supplement natural speech. AAC allows people who cannot use conventional speech to communicate daily with others, both in person and digitally. AAC encourages independence, increases people's ability to participate in society, and reduces the financial burden on their caregivers.

Common conditions that can lead to communication impairments include amyotrophic lateral sclerosis (ALS), Alzheimer's disease, Parkinson's disease, autism spectrum disorders, stroke, brain or head injuries, or cerebral palsy.[60] People with other lifelong, acquired or progressive conditions may also have or develop expressive and/or receptive communication impairments in parallel. For example, rural rehabilitation

[60] Jette A, Spicer CM, Flaubert JL. The promise of assistive technology to enhance activity and work participation. National Academies of Sciences, Engineering, and Medicine; 2017. Available from: https://www.ncbi.nlm.nih.gov/books/NBK453284/.

services across Pakistan, Uganda, and Zimbabwe identified that 38-49% of individuals with other primary disabilities also had some form of communication impairment.[61]

Both younger and older people face communication limitations. Children as young as 12 months old with little or no speech capabilities often benefit from early AAC intervention. Providing AAC to younger children can prevent learning delays, strengthen understanding of language and future communication ability, and allow for wider participation in school.[62] As children age, their AAC needs will most likely evolve. Adults who develop communication impairments later in life as a result of disease or injury will require different types of AAC as many may have previously had natural speech capabilities. Adults who use AAC may also experience changing communication needs, especially if they have progressive conditions that increase the severity of their communication impairment over time.

Approximations vary on the number of people who require AAC. Estimates in the UK suggest that 0.5% of the population struggle with daily communication and would benefit from AAC.[63] Applying the same prevalence as in the UK would indicate a global need of around 40 million people.[64] However, the number and types of people requiring AAC in LMICs may be different as they generally have younger populations. The number of people with communication needs will continue to grow, especially in LMICs, driven by growing populations and increasing awareness of common communication impairments like aphasia (a communication limitation that impacts people after stroke or brain injury) or those associated with autism spectrum disorders or neurodiversity.[65]

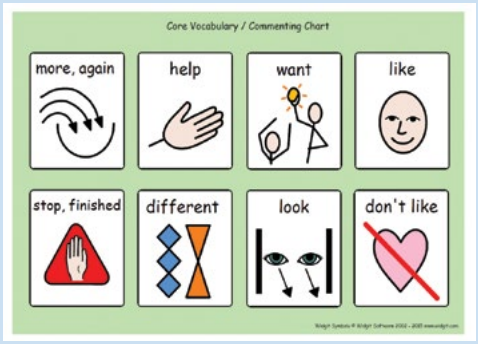
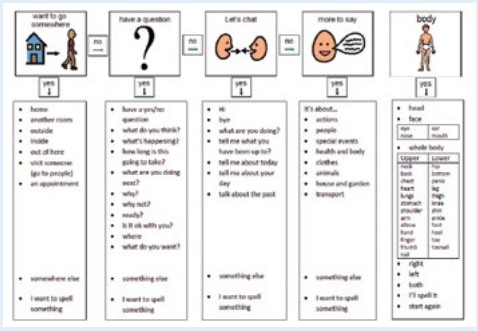
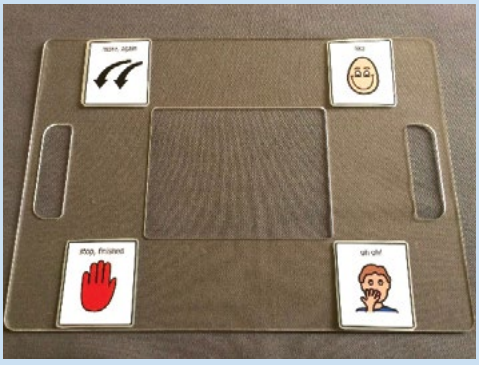
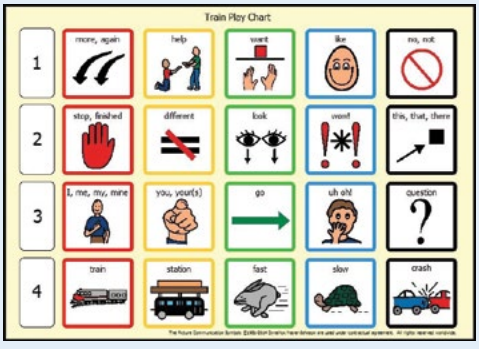
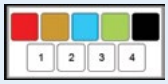
AAC can range from using physical motions without technical aid to high-tech digital products.

There are generally two types of AAC: aided and unaided. Unaided AAC does not require external tools and includes methods such as facial expressions, gestures, and sign language. Conversely, aided AAC requires electronic or non-electronic tools to facilitate communication. The remainder of this landscape will focus on aided AAC. The term 'system' will be used broadly to describe aided AAC mechanisms, while 'device' or 'product' will be used to refer to specific tools.

Aided systems range from low-tech to high-tech products. Low-tech products are paper-based, while high-tech products are electronically powered systems.[66] These products can be accessed through an array of motions. The four primary access methods for aided AAC systems are touch, mouse/mouse alternatives (e.g. joystick), eye gaze, and switches. Table 4 illustrates a range of methods to enable a person to access boards, charts, books, computers, etc. on which there will be text or symbols that the person is communicating. This may involve the use of speech output when using computer-based devices.

[61] Wylie K, McAllister L, Davidson B, Marshall J. Changing practice: implications of the World Report on Disability for responding to communication disability in under-served populations. Int J Speech-Lang Pa. 2013;15(1): 1-13.
[62] Davidoff, B. AAC with energy – earlier. The Asha Leader. 2017;22(1): 48-53.
[63] Communication Matters. Shining a light on augmentative and alternative communication. Communication Matters; 2013. Available from: https://communicationmatters.org.uk/wp-content/uploads/2019/01/2013_Shining_a_Light_on_AAC.pdf.
[64] Rounded estimate based on global population of 7.8 billion people.
[65] Franz L, Chambers N, Isenburg M, De Vries P. Autism spectrum disorder in Sub-Saharan Africa: a comprehensive scoping review. Autism Research. 2017;10(5):723-749.
[66] Discover AAC. Website [Internet; cited 2020 September 1]. Available from: http://www.discoveraac.org.

TABLE 4: EXAMPLES OF COMMON AIDED AAC SYSTEMS

ACCESS METHOD:	PAPER-BASED / LOW-TECH AAC EXAMPLES	
Direct touch/ access (paper-based)	 Anna Reeves – Ace Centre	The term direct touch describes the way someone points to symbols or letters/ words on a chart or page using a part of their body. It is also known as direct selection and direct access. People most often point using a finger, but sometimes use a fist, elbow, toe, or whatever works best for them. They may also use a pointing tool to facilitate direct touch.
Listener mediated scanning	 Anna Reeves – Ace Centre	Listener mediated scanning is the term used to describe the access method whereby a communication partner delivers the options that are available by pointing to symbols or speaking aloud the words, or by a combination of both, and the communicator indicates when the communication partner has reached the desired option.
Visual access	 Anna Reeves – Ace Centre	One way of presenting information when communicating through eye pointing is to use an E-tran frame. An E-tran (or eye transfer) frame is a clear screen rectangle with a central window removed. The idea is that the communication partner holds the frame between themselves and the communicator, making eye contact through the central window.
Coded access	 Anna Reeves – Ace Centre 	Coded access describes an access method where symbols/text are effectively given a grid reference that the individual then communicates. It requires two separate charts to communicate. One chart contains the symbols/text, the other allows the communicator to indicate the location of the symbol they wish to communicate.

ACCESS METHOD:	ELECTRONIC / HIGH-TECH AAC EXAMPLES	
Direct touch/ access (electronic)	 Anna Reeves – Ace Centre	The term direct touch describes the way someone points to symbols or text on a computer screen using a part of their body. It is also known as direct selection and direct access. People typically point using a finger, but sometimes use a fist, elbow, toe, or whatever works best for them. They may also use a pointing tool to facilitate direct touch.
Mouse/ mouse alternative	 Anna Reeves – Ace Centre	There are several alternative forms of a computer mouse that allow other ways of moving a pointer around a screen, selecting, clicking, and double-clicking when a typical computer mouse is difficult to use.
Switch	 Anna Reeves – Ace Centre	A switch is a device that when selected will activate a powered system, such as a computer, smartphone, or tablet, an electric wheelchair or environmental control.
Eye gaze	 Reproduced with permission from Tobii Dynavox, LLC ©2020 Tobii Dynavox. All rights reserved.	Eye gaze systems allow people with severe physical disabilities to access a communication aid or computer using their eyes. These devices have an inbuilt camera which tracks where an individual is looking, and allows the person to select an area of the screen by blinking, dwelling (staring for a consistent time), or clicking a switch using another part of their body whilst dwelling.

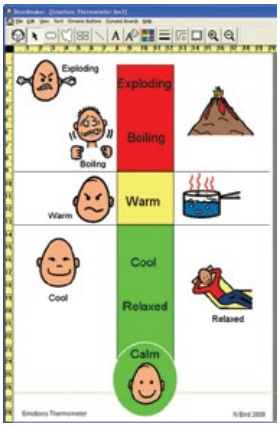
The high value AAC market is relatively small and concentrated in the US and Europe.

In 2017, global AAC revenue was USD 168.6 million,[67] with a 70% combined market share in Europe and North America.[68] Asia-Pacific made up 18%, while Latin America and Africa had 9% and 3% of market share respectively.[69] Higher demand for AAC in the US and Europe is predominantly driven by access to funding. As a result, the five largest AAC suppliers (Abilia, Mayer-Johnson, PRC-Saltillo, Zygo, and Tobii Dyanox) can also be found in those regions. These suppliers tend to focus on product innovation and continuously release new high-tech devices.

Suppliers have minimal operations in LMICs because they cannot capture the same prices on their portfolio of high-tech products. Furthermore, they often do not see a strong business case to produce cheaper, less complex AAC products that could serve as alternative, more scalable options for LMICs. Some organisations, including non-profits and suppliers, have developed inexpensive online content that can be printed onto physical boards and shared across multiple users in order to increase access to AAC. NGOs, social enterprises, and other local manufacturers have also attempted to fill this gap by creating low-cost paper-based AAC products. Despite these efforts, there are currently no widespread solutions available.

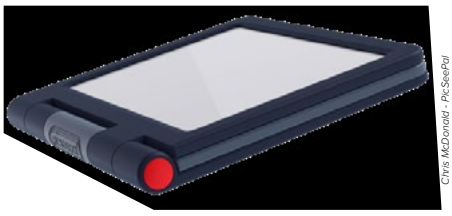
CASE STUDY 6: BOARDMAKER (TOBII DYNAVOX)[70]

- **PROBLEM:** Teachers and therapists in the US and Europe were looking for a way to create their own classroom tools as well as find resources and support for different teaching methods.
- **SOLUTION:** Tobii Dynavox, an assistive technology and communication solutions manufacturer, launched a suite of tools and resources called Boardmaker. The software costs around USD 10/month in the US and includes a subscription to an online platform of over 5,000 individual picture symbols available in several different styles (Classic, ThinLine, High Contrast, and Persona). While not specifically designed for LMICs, the software is a low-cost option since only one subscription is needed to print customised boards that can be shared with thousands of students. The software has been translated into 44 languages.
- **RESULTS:** There are now over 500,000 people using the platform, which supports over 6 million students in 51 countries.



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CASE STUDY 7: PICSEEPAL[71]


Chris McDonald - PicSeePal

- **PROBLEM:** Few, if any, low-cost, durable AAC solutions existed without the need for electricity or some type of digital device. Furthermore, existing low-tech solutions such as communication boards were simply laminated pieces of paper that were not very durable.
- **SOLUTION:** PicSeePal, a standalone product invented by former teachers, was created to be a portable, customisable, durable, affordable, splash-proof, modular, and easy to use AAC device. The product itself is the size of a large book and contains three double-sided transparent plastic cases. Users can add up to 6 sheets of their own symbol-based pages. At scale, PicSeePal can be manufactured for around USD 25.
- **RESULTS:** Several thousand products have been sold or donated, with a goal of donating over 1 million PicSeePal units to individuals in need.

[67] Fact.MR [Internet]. Speech generating devices market forecast, trend analysis and competition tracking: global market insights 2017 to 2022. 2017. Available from: https://www.factmr.com/report/53/speech-generating-devices-market.
[68] RResearch Nester [Internet]. Global speech generating devices market overview. 2020. Available from: https://www.researchnester.com/reports/speech-generating-devices-market/666.
[69] BResearch Nester [Internet]. Global speech generating devices market overview. 2020. Available from: https://www.researchnester.com/reports/speech-generating-devices-market/666.
[70] Boardmaker. Website [Internet; cited 2020 September 1]. Available from: https://goboardmaker.com.
[71] PicSeePal. Website [Internet; cited 2020 September 1]. Available from: https://picseepal.com.

Smartphones and tablets are replicating the need for standalone high-tech AAC.

Electronic AAC typically requires some form of hardware and software. Suppliers previously sold standalone AAC systems that had all necessary hardware and software self-contained within the device. Recently, smartphones and tablets have been able to replicate the operating systems of some AAC products, which has removed the need for standalone AAC devices. However, many individuals may need additional AAC products (e.g. switches or eye gaze cameras) beyond a smartphone or tablet. Suppliers have also created AAC products that can be connected (wired or wirelessly) to smartphones and tablets in order to further address the changing market. For example, some switches can now be connected via Bluetooth to generic smartphones and tablets.

People who need/use AAC also have access to a wider range of AAC software on the internet that can be downloaded onto their own smartphone or tablet for significantly lower cost. Organisations have also developed inexpensive and sometimes free AAC applications. Additionally, cloud-based software can now be accessed across multiple devices. Using tablets and smartphones as AAC devices also allows people to access other forms of interaction beyond in-person communication, such as social media and online content. While face-to-face communication is often the primary reason for AAC, many end users highlight the personal importance of these other forms of digital interaction. This increased connection is a key component of independent living and contributes to the realisation of human rights for people with disabilities.

As smartphone and internet penetration grows, there is an opportunity for LMICs to prioritise these devices as AAC tools. As discussed in Chapter 1, governments and insurers often do not want to pay for smartphones or tablets as a form of AT, given the perception that these devices are a luxury and are broadly accessible to the general public. Instead, many insurance plans restrict consumer choice by requiring users to buy more expensive standalone AAC systems.

Lack of financing remains a key barrier to accessing AAC in LMICs.

Limited funding remains a key challenge to expanding AAC access to people with communication impairments. Many LMIC governments have issued public mandates to provide AAC, but there is often a lack of ownership across ministries and consequently no money is budgeted. Furthermore, many LMICs lack national health insurance plans like those in the US and Europe to partially or fully cover AAC. Without this financial support, people with communication impairments are forced to pay out-of-pocket for AAC solutions.

Awareness of the benefits of AAC is low, especially in LMICs.

Awareness of the benefits of AAC is low in LMICs for several reasons. Data about communication impairments is not systematically captured in LMICs and therefore the need for AAC may not be fully understood. Identifying communication impairments can also be challenging in LMICs because there is a general shortage of experts capable of diagnosing and recommending AAC solutions. For example, there is one speech language pathologist (SLP) for every 3 million people in Sub-Saharan Africa, compared to one SLP for every 3,250 people in the US and UK.[72] Furthermore, SLPs in LMICs are typically concentrated in urban areas, which can result in neglect of rural communities.

Medical professionals, including SLPs, often also have limited training in the benefits of AAC. In HICs, some organisations and governments have created tools to help build awareness and learning for medical professionals. For example, the NHS Education for Scotland developed IPAACKS (informing and profiling AAC knowledge and skills) as a resource to support the learning and development of people working with individuals who use AAC.[73] However, these types of resources are lacking in LMICs.

[72] Wylie K, McAllister L, Davidson B, Marshall J. Changing practice: implications of the World Report on Disability for responding to communication disability in under-served populations. Int J Speech-Lang Pa. 2013;15(1): 1-13."

[73] NHS Education for Scotland. Informing and profiling augmentative and alternative communication knowledge and skills. NHS Scotland; 2014. Available from: https://www.nes.scot.nhs.uk/media/2507407/nesd0214aacframework-re.pdf.

In addition, many people who need AAC often lack the tools and resources to find and compare different AAC solutions. In HICs, social media and informal peer groups have allowed users to share their experiences with AAC and increase awareness. However, access to these groups can be restricted in low resource settings. With limited tools and resources, many people with communication impairments in LMICs go undiagnosed and do not have access to effective AAC solutions.

Feature-matching and providing culturally appropriate products drive AAC adoption and adherence.

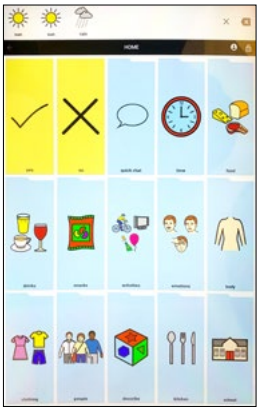
Feature-matching is the process of assessing the skills, preferences, and environmental needs of a person with communication impairments and identifying the appropriate AAC system for their daily lives. If done incorrectly, a user may end up using AAC that does not adequately address their functional limitation. For example, an assistive switch would be difficult to use for someone with severe ALS, also known as Lou Gehrig's disease, a progressive nervous system condition that results in loss of muscle control. Instead, an eye-tracking device that does not require muscle control may be more effective.

Incorrect feature-matching and providing unsuitable products can result in several negative consequences. Users may require additional training to learn how to use the AAC system since it does not adequately address their needs; however, there is extremely limited availability of access to AAC training internationally. It can also be extremely tiring or disappointing for some people to use an ineffective system. This can lead people to only attempt communication for short periods of time or abandon the use of AAC altogether, which can increase the risk of isolation and result in additional demands on existing health services. Additionally, people with communication impairments have different limitations that require a wide variety of AAC. The most effective system for any individual is based on the user's context and needs. AAC products must be culturally and linguistically appropriate for the user in order to ensure adoption. Finding culturally appropriate AAC products can be a challenge in LMICs, given many AAC products are first developed in English and/or with an American or European frame of reference. It is often difficult and time consuming to translate these tools into local languages, or to adjust symbols and pictures to fit local traditions and customs.

Freely available culturally appropriate symbol sets were created to overcome some of these challenges. For example, Global Symbols is an open source project that was started in 2016 in order to create an online database of high-quality symbols for different cultural contexts.[74] Initiatives like Global Symbols are helping to expand AAC access to LMICs, especially in countries without localised AAC content.

CASE STUDY 8: CBOARD[75,76]

- **PROBLEM:** Children with complex communication needs are often left out of early childhood education services, as well as everyday situations in society.
- **SOLUTION:** Supported by UNICEF's Innovation Fund, Cboard is an open source, offline-compatible and freely available AAC application that can be accessed on mobile or desktop devices. Content is available in over 30 languages and accesses the Global Symbols database of over 20,000 symbols. In low resource settings, the pictographic symbol sets can also be exported and printed to support communication for children using paper-based resources.
- **RESULTS:** After the first phase of the pilot, parents and professionals reported a positive response in children with communication needs that have effectively integrated Cboard into their daily lives, both at home and with professionals.



David Banes

[74] Global Symbols. Website [Internet; cited 2020 September 1]. Available from: https://globalsymbols.com.
[75] Cboard. Website [Internet; cited 2020 September 1]. Available from: https://www.cboard.io.
[76] Jovic A, Panwar BP, Hyun C, Mapuranga M, Constantopedos E. Giving every child a voice with AAC technology. UNICEF [Internet]. Available from: https://www.unicef.org/innovation/stories/giving-every-child-voice-aac-technology.

Ongoing user support and training are critical for continued and effective use.

Research in the US indicates that roughly one-third of AAC systems will be abandoned by users, often due to lack of support and training.[77] Ongoing support and training, both for the user and their support network (e.g. parents, teachers, and colleagues), are essential to avoiding product abandonment. Formal training programmes, online communities, and informal channels all help people learn how to effectively use and integrate AAC products into their daily lives. Routine evaluation is also necessary to ensure an AAC system continues to meet a person's communication needs. For instance, people with ALS may have evolving communication needs as their condition changes. Loaning devices to people and replacing them once their needs change has proven to be an effective model. For example, the UK has saved taxpayer funds by reissuing almost 40% of nationally procured AAC devices. However, follow up after product provision is often neglected in LMICs due to budget constraints, limited professional expertise, and distribution complexity. This can result in even higher abandonment rates for AAC systems in LMICs.

2. AAC Access Challenges

The market landscape identified several barriers to address to provider greater access to AAC in LMICs. Other relevant barriers were also previously covered in Chapter 1.

Demand	
Awareness	Many individuals and service providers are not aware of the benefits of AAC, primarily due to a lack of resources to find the right products that fit their needs. Furthermore, there is limited professional training and expertise to diagnose communication disabilities.
Financing	Out-of-pocket costs for AAC tools are too high and there is limited external funding. Furthermore, LMICs do not have health insurance programmes equivalent in coverage to those in HICs to partially or fully cover AAC products. Given one-third of AAC products will be abandoned by users, there is also false economy in purchasing AAC equipment that is not fully used.

Supply	
Competitive Landscape	A limited number of AAC suppliers operate in LMICs as many believe the business case does not exist.
Product Profile	AAC tools are heavily skewed towards European languages and Western cultures. Finding culturally appropriate AAC products is difficult and time consuming.

Enablers	
Provision	Limited knowledge and diagnostic skills to identify communication impairments can result in individuals not getting the products they need. LMICs have a shortage of resources and experts to facilitate appropriate feature matching, which can result in ineffective provision of tools.
Support	Ongoing support, training, and maintenance of AAC tools is often neglected in LMICs due to budget constraints, limited professional expertise, and distribution complexity, which can result in higher abandonment rates.

[77] Starble A, Hutchins T, Favro M, Prelock P, Bitner B. Family-centered intervention and satisfaction with AAC device training. Comm Disord Q. 2005;27:47-54.

3. Proposed Interventions to Increase Access to AAC

STRATEGIC OBJECTIVE 1: Ensure clear global guidance for appropriate and effective AAC provision in LMICs

Rationale	• A wide range of AAC tools is required to meet the various needs of people with communication disabilities. • Providers often lack the expertise to match an appropriate AAC tool to a user's needs. • AAC tools should be linguistically and culturally appropriate to avoid abandonment.
Activities	• Support a global normative body, such as WHO, to develop guidelines on appropriate communication impairment identification and feature-matching techniques. • Disseminate guidelines through bilateral meetings and engagements to encourage adoption. • Develop an online repository of AAC tools for LMICs that meet WHO Assistive Product Specifications.

STRATEGIC OBJECTIVE 2: Expand AAC access through country-level adoption of procurement, provision, and financing

Rationale	• Out-of-pocket expenses for AAC tools are too high for people in LMICs. • National insurance programmes can help defray costs across socio-economic levels. • National procurement of AAC tools would encourage identification of AAC users and data collection on actual demand. This would also help pool demand for and reduce overall costs of the many different AAC tools needed to meet users' needs. Furthermore, this would help systematically capture AAC outcome measures and increase feedback on useful tools. • Early efforts to provide AAC have a profound influence on ability to learn and greatly improve the chances for that child to become an active part of society later in life.
Activities	• Support LMIC governments to: 1) include AAC tools on national assistive product lists; 2) strengthen governance for AAC; 3) improve data collection; and 4) expand SLP capacity. • Support the development of AAC programs specifically targeted toward early childhood and school based intervention.

STRATEGIC OBJECTIVE 3: Test and validate AAC solutions for low resource settings

Rationale	• AAC suppliers are concentrated in HICs and often have limited operations in LMICs because of unclear demand and limited funding. • Validating market demand and funding could encourage global suppliers to enter LMICs with new products.
Activities	• Develop pilot programmes to test and validate low-tech and scalable AAC solutions. • Improve market visibility of global suppliers (including examples of effective AAC services and equipment management models) to encourage expansion into LMICs.

STRATEGIC OBJECTIVE 4: Ensure availability of free and effective AAC applications

Rationale	• Smartphones and tablets are some of the most cost-effective AAC devices on the market and offer access to a wide variety of AAC software. • As smartphone and tablet penetration increases in LMICs, there is an opportunity to identify free software applications that can meet a variety of user needs. • Expanding access to devices with free AAC applications can lower overall costs and increase AAC provision.
Activities	• Support software developers to adapt free applications and resources to LMICs and local contexts. • Advocate to governments to expand access to tablets and phones as a digital AT solution (see Chapter 1).

NEXT STEPS AND RECOMMENDATIONS

THIS DOCUMENT IS MEANT TO SUPPORT AT STAKEHOLDERS as they work to understand and define the complex and interconnected digital AT space, and to identify activities for increased and sustainable access to appropriate and affordable digital AT. It will guide investment by the UK aid funded AT2030 programme, which is led by the GDI Hub, to test what works to increase awareness of, access to and successful adoption of affordable AT. ATscale will utilise the information to define its investment strategy. Based on the analysis in this report, increasing access to digital AT, including mobile phone-based solutions and stand-alone digital devices, can follow similar interventions identified for hearing aids, mobility devices, and eyeglasses. Like other AT, digital AT is not a just matter of provisioning the digital device, but also of ensuring its appropriate adoption, training, and accessible content development so that users can take full advantage of its benefits.

Similar to other AT areas, multiple large-scale investments and financial instruments will be needed to achieve long-term outcomes. For example, system-strengthening grants can support integration and uptake of digital AT into social service, education, and health systems, while match-funding or co-investments may catalyse government investment. On the supply side, donor investment may be leveraged to de-risk investment in accessible devices, and MNOs and other private sector stakeholders can be encouraged to further develop access programmes for people with disabilities and other limitations

Numerous stakeholders have a role to play in strengthening the digital AT ecosystem, including several ministries, such as labour, education, ICT, social protection and/or health, the private sector, peer groups, DPOs, and other non-governmental and civil society organisations. MNOs, suppliers, manufacturers, and content developers should create and manufacture universally designed digital solutions that are low cost and can feed into and build the ecosystem. Any investments to increase access to digital AT should include technical assistance to strengthen cross-ministry coordination between ICT, health, education and social welfare ministries at the government level and with various other stakeholders, including the private sector.

The digital ecosystem continues to be driven by mobile technology globally, both within and beyond the AT sector. Prioritising mobile phones, particularly smartphones, as the digital AT of choice where appropriate would allow mobile to become the gateway to access additional applications, content, supportive add-ons (e.g. braille readers or switches), and features that can augment or replace stand-alone assistive devices. While smartphones will not be useable by everyone and they may have limitations (e.g. screen size), a smartphone is perhaps the easiest and at times the only digital device that is affordable and available in LMICs. The rise in awareness of AT and a growing focus on accessibility by industry also incentivises developers of AT to stick to smartphone ecosystems when making digital AT. This gives the AT ecosystem the necessary opportunity for consistent development and innovation. We envision a future in which all smartphones (and smart feature phones) have universal design embedded with accessible content, making them an integrated solution for individuals with disabilities or other functional limitations. Lastly, it will be important that interventions balance the need for freely available products with supporting commercial use and growth.

A common set of recommendations focused on improving access to the components and enablers of the AT ecosystem emerged from the individual product landscapes included in this document. While additional research is required on the potential prioritisation and sequencing of interventions to increase access, on how government policy and private sector engagement may drive local access to digital products, the role of local production, and on how to best bridge the gap between innovation and commercial sustainability, this common set of recommendations can be seen as high priority areas for improving access to digital AT in LMICs. The set includes:

- **Develop and adopt policies,** including legislation, regulations, minimum product standards, and guidelines to support accessibility and uptake of digital AT at the global and country level.
- Support LMIC governments to **increase awareness** of digital AT by including digital AT products such as smartphones and AAC devices on national assistive product lists.
- Support innovating financing schemes or negotiate pricing agreements to **reduce the cost** of digital AT to end users.
- **Increase availability of training** programmes for users, suppliers, and service providers on the availability of digital AT and digital literacy skills.

To define and prioritise specific interventions applicable in a given country, mapping the digital AT ecosystem will likely be required and should highlight the strengths, weaknesses, and gaps in availability, affordability, appropriateness, quality, and access to digital AT. This will allow for the development of a cross-sector and cross-ministry strategy that will improve access to the devices, platforms, applications and content that make up the digital AT ecosystem.

ANNEX

APPENDIX A: INDIVIDUALS INTERVIEWED OR CONSULTED

ORGANISATION	NAME
ACE Centre	Anna Reeves
ATvisor	Moran Ran
	Ofer Shanny
Barrier Break	Shilpi Kapoor
European Disability Forum	Alejandro Moledo
Government of Kenya, Department of Social Protection	Rose Bukania
GSM Association (GSMA)	Clara Aranda Jan
Independent consultant	David Banes
International Telecommunication Union (ITU)	Simão Campos
Kilimanjaro Blind Trust	Suparna Biswas
Leonard Cheshire Disability	Angel Perez
National Association for the Blind, Delhi	Prashant Ranjan Verma
PicSeePal	Chris McDonald
Rwanda Assistive Technology Access (RATA)	Rene William Ngabo
South Africa National Council for the Blind	Hanif Kruger
Tobii Dynavox	Rob Gregory
UNICEF	Julie De Barbeyrac Elias Constantopedos
World Health Organization (WHO)	Wei Zhang



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