# Empowering Inclusion: Bridging the Gap in Assistive Technology in Low and Middle-Income Countries

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## ABSTRACT

**Background:** Assistive Technology (AT) is essential for improving independence, social participation, and quality of life for persons with disabilities (PWDs). Despite its benefits, only 5–15% of people in low- and middle-income countries (LMICs) have access to AT, primarily due to high costs, limited trained professionals, weak infrastructure, and inadequate policy frameworks. This gap contributes to exclusion, poverty, and poor health outcomes.

**Objectives:** This paper aims to examine systemic barriers to AT access in LMICs and propose a framework to improve affordability, availability, appropriateness, and quality of AT services.

**Methods:** A comprehensive review of global and LMIC-specific data sources (e.g., WHO, Namibia, Malawi, Zambia) was performed. Through thematic synthesis, key risk factors were identified, and the analysis evaluated policy frameworks, workforce development strategies, procurement mechanisms, the application of Universal Design principles, and digital innovation approaches.

**Results:** The review highlights significant systemic barriers: inadequate public financing, fragmented governance, and poorly functioning procurement and distribution systems. Over 75% of low-income countries lack structured prosthetics and orthotics training programs, resulting in a shortage of skilled professionals. Limited awareness among communities and healthcare providers further reduces AT uptake. Promising enablers include integration of Universal Design principles, digital platforms for service delivery, and regulatory frameworks to standardize AT provision.

**Conclusions:** Strengthening AT access in LMICs requires a comprehensive, multisectoral approach. A five-pillar roadmap is proposed: (1) Empowering people through awareness and inclusion, (2) Enabling policy via national health integration, (3) Tailoring affordable products for local contexts, (4) Expanding service provision to underserved regions, and (5) Enhancing personnel capacity through formal training and international collaboration. Implementation of this roadmap, alongside innovative financing and global partnerships, is critical to bridging the AT access gap and ensuring equitable inclusion of PWDs worldwide.

## INTRODUCTION

Assistive Technology (AT) plays a vital role in promoting independence and improving participation. [1-3] Assistive Technology promotes people with PWDs to live healthy, independent, and respectful lives. Assistive devices like hearing aids, walking sticks, wheelchairs, artificial limbs, and devices for people with low vision or speech problem helps to activity of daily living more easily and take part in society equally. [1,2] However, many people—belongs to poor and under developing countries do not benefit with the assistive technology which leads to loneliness, poverty, and poor health for individuals and their families. As listed, around 1.3 billion people living with serious disabilities, and over 1 billion people need at least one assistive device and in many low- and middle-income countries (LMICs), the proportion of individuals who have accessed it ranges between 5% and 15% [1,6]

There are many reasons for this problem:
- High cost of AT devices.
- Few trained professionals like prosthetists and orthotists.
- Weak supply chains and poor transportation.
- Lack of government support and policies.
- Cultural stigma and lack of public awareness.

In fact, over 75% of total population of low-income countries do not have proper training programs in prosthetics and orthotics, so there is lackness of skilled workers which creates a huge gap in between the number of people who need AT and those who receive it. [1,2,12] To fix this gap, we need to plan accordingly:

1. **Better Policies** – Government should make policies and rules that ensures the availability, affordability, and part of national health plans.
2. **Trained Professionals** – More training programs are needed to produce experts who can deliver these services professionally.
3. **Affordable Products** – AT should be designed for local conditions (like rough roads or hot weather) and will be low-cost.
4. **Awareness and Education** – People should know about and the benefits of AT, so they can ask for the help they need.
5. **Funds** – Both government and private funding (like insurance or donations) can help people get AT.
6. **Inclusive Design** – Devices should be designed according to universal design so everybody can use.
7. **Global Help** – Organizations like WHO, Niti Ayog are already working on global AT programs like *the Priority Assistive Products List* and *GATE* initiative.

## Difficulties in Ensuring Assistive Technology Access in Resource-Limited Countries

Even though the need for assistive technology (AT) is increasing around the world, access to it in low- and middle-income countries (LMICs) is still very limited. Today, over one billion people need at least one assistive device, and this number may double by 2050. [7] However, only 5% to 15% of these people actually get the help they need. This problem is not only because there are not enough products, but also because many people don't know they need them. There is a lack of awareness among users, their families, and even healthcare workers. As a result, many people don't ask for or receive AT. This problem is not only because there are not enough products, but also because many people don't know they need them.

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Other big challenges include:
- High prices and lack of money to buy devices.

- Weak government support and poor.
- Systems for buying and distributing products.
- Not enough trained professionals to provide AT services, especially in villages and smaller towns.

This paper talks about the main challenges, barriers, and gaps in AT access. It also suggests solutions, as this issue affects the daily lives of many people with disabilities.

## Contextual and Systemic Constraints in the Assistive Technology Ecosystem

Assistive technologies and their accessibility are deeply connected to the strength of local and national markets. In many low- and middle-income countries, these markets are often underdeveloped: supply chains are weak, competition is limited, and infrastructure is poor. These factors severely restrict AT distribution. Additionally, the lack of clear government policies and national AT programs hampers public procurement efforts and discourages investment in necessary services. [4,5,10] Physical barriers—such as inaccessible roads, buildings, and transport systems—further isolate individuals in need of assistive devices. [1,5,8]

The situation is exacerbated by a serious shortage of trained professionals, including prosthetists, orthotists, rehabilitation therapists, and technicians, which diminishes outreach and service quality. [1,5,8] Consequently, addressing these intertwined issues requires coordinated policy development, targeted investment in local markets, and robust, inclusive service delivery. systems to meet the rising demand for assistive technologies in LMICs. targeted investment in local markets, and robust, inclusive service delivery systems to meet the rising demand for assistive technologies in LMICs.

## OBJECTIVE

The *WHO's Global Disability Action Plan (2014–2021)* offers a roadmap aligned with the UN Convention on the Rights of Persons with Disabilities (CRPD). It focuses on three main objectives:

1. Removing barriers and improving access to health services and programs;
2. Building up rehabilitation services, including assistive technologies, personal support, and community-based care.
3. Enhancing data systems to produce reliable, comparable information on disability, empowering evidence-driven policy and service decisions.

To support countries in establishing coherent AT policies and programs, the WHO is also creating additional tools designed to integrate assistive technology into broader universal health-coverage systems.

Meanwhile, the **CRPD**, adopted in 2006 and ratified by 177 countries by 2018, obligates States Parties to ensure access to quality, affordable assistive technologies. However, implementation in LMICs has been slow, largely due to insufficient funding. In alignment with the *Sustainable Development Goals, WHO's GATE (Global Cooperation on Assistive Technology)* initiative aims to increase global access to effective, affordable assistive products.

## METHODOLOGY

This study employed a thematic synthesis approach reviewing WHO, World Bank. one of its key contributions is the Priority Assistive Products List (APL), which identifies essential AT items that countries should prioritize. A 4-P Framework for Assistive Technology is establishing strong standards for Assistive Technology (AT) which is essential to ensure fair access, good quality services, and user involvement everywhere. [1,4,5,12] Here's what each part should include:

(a) **Policy:**
A good policy framework is the base of a strong AT system. It should include laws, strategic planning, clear rules, and dedicated funding. These help guide how assistive technology is developed, bought, and shared so it's affordable, accessible, safe, and reliable. Plus,

including AT in universal health coverage helps ensure long-term access for everyone.

**(b) Products:**

AT devices must fit the local context—how and where people use them matters. Creating a national "priority list" of essential AT products helps raise awareness, encourages businesses to innovate, guides what governments buy, and boosts competition. That leads to more affordable and available options.

**(c) Personnel:**

We need a skilled, certified workforce—prosthetists, orthotists, rehab experts, and technicians—who meet people's needs. This requires investment in training and clear national rules to protect users from low-quality services and to ensure these roles are recognized and accountable.

**(d) Provision:**

AT services must focus on the user. People needing AT should be part of the decision- making process, treated as equal partners in planning and care. They also need full making process, treated as equal partners in planning and care. They also need full. Information to make the best choices. This involvement leads to better results and solutions that truly match their personal needs and circumstances.

**5-P Roadmap for AT in LMICs: Empower People, Enable Policy, Tailor Products, Expand Provision, and Enhance Personnel**

Addressing the significant barriers to assistive technology (AT) access in low- and middle- income countries (LMICs) require a multidimensional approach focused on enhancing affordability, availability, quality, and contextual appropriateness of products and services. Affordability remains a major constraint; well-functioning AT market must ensure that product prices are sufficiently low to remain accessible to users, while still incentivizing manufacturers to innovate and remain engaged. However, current market analyses reveal that most assistive products remain financially inaccessible across LMICs due to limited funding mechanisms and high production costs. Availability is also a critical concern—while many assistive products exist globally, their distribution in LMICs is limited due to lack of market focus from suppliers, resulting in reduced variety and poor geographic reach.

The quality of assistive products in LMIC markets is frequently substandard, with many items failing to meet international benchmarks or lacking evidence-based quality assurance measures. Beyond quality, other dimensions are vital to user experience and outcomes. Accessibility implies that individuals in need are aware of and can obtain AT services, while acceptability relates to how well these technologies integrate into users' lives, meeting cultural, social, and personal needs. While acceptability relates to how well these technologies integrate into users' lives, meeting cultural, social, and personal needs. Adaptability is especially important in resource-limited settings, where technologies must accommodate individual functional requirements and environmental conditions. Nevertheless, Appropriate product design often fails to reflect the realities of LMIC contexts—many devices, such as wheelchairs and prosthetics, are not engineered for rugged terrains, high humidity, or frequent exposure high humidity, or frequent exposure to dust and water, leading to premature failure and abandonment. Furthermore, policy-level challenges persist.

Many policy makers lack adequate knowledge about the role and impact of AT, which impedes informed decision-making around procurement, financing, and inclusion in national health strategies. Stigma in communities toward individuals using assistive devices also limits uptake, while service providers frequently lack training in product options and appropriate service delivery models. To overcome these barriers, it is essential to invest in policy advocacy, market-shaping strategies, local capacity building, and user-centered innovation to

ensure that assistive technologies are not only available and affordable, but also appropriate, sustainable, and effectively utilized. [1,2,4,12].

**Funding Mechanism**
These funding mechanisms encompass multiple sources, including government funding, insurance coverage, donor contributions, and charity-based initiatives. Governments often play a central role by providing direct financial support through health and social protection systems.

This may include national assistive technology funds or grants that aim to cover the costs of devices for people with disabilities. In addition to public funding, private sector contributions are also essential. Employers may offer financial support for assistive technology through workplace accommodations or insurance schemes, ensuring that employees with disabilities can access the necessary devices. Private health insurance programs may also include coverage for AT, reducing the out-of-pocket costs for individuals. Furthermore, rehabilitation and job training programs often allocate part of their budgets to assistive technology, facilitating integration into the workforce for individuals with disabilities.

Another source of funding comes from family contributions, where families often share the financial burden of purchasing assistive products for their loved ones.

Another innovative mechanism to promote access to AT is the income-generation model, where organizations or communities generate revenue through the sale of products or services to subsidize the provision of assistive devices. This can be particularly effective in resource- constrained environments, where sustainability is key to ensuring continued access to AT. Additionally, some countries have implemented voucher systems. [8,9] Another innovative mechanism to promote access to these systems offer users a voucher equivalent to the value of basic assistive technology that meets minimum quality standards. If individuals require more advanced or customized devices, they are responsible for covering the additional costs, either through personal funds or through supplementary financing options. This system can help balance individual needs and public financial capacity while encouraging a degree of user responsibility and choice in the selection of appropriate technology. Ultimately, a multi- faceted approach to funding, incorporating both public and private sector contributions, as well as innovative financial models, is necessary to overcome the financial barriers preventing access to assistive technologies.

**RESULT**
*Universal Design Meets Multisector Action: Scaling AT in LMICs*-Achieving universal design requires coordinated multisectoral actions involving embedded in the national assistive technology policy framework, ensuring that AT solutions are government agencies, manufacturers, consumers, and users. This collaborative approach can be integrated into the broader societal and economic context. Data on unmet needs from both high-income and low- income settings, including reports from countries such as Namibia, Malawi, and Zambia, highlighted the critical gap in the availability of appropriate assistive technologies, particularly in resource- constrained environments. [1,4,7] Moreover, culturally relevant assistive devices tailored to the needs of specific subpopulations help reduce the unmet needs of those requiring AT. Appropriate assistive technologies, particularly in resource-constrained environments. Moreover, culturally relevant assistive devices tailored to the needs of specific subpopulations help reduce the unmet needs of those requiring Assistive devices.

**DISCUSSION**
The data on disability prevalence worldwide emphasizes the urgency for increased investment in assistive technology in LMICs, where barriers such as a general lack of state

funding, inadequate nationwide service delivery systems, insufficient user-centered research and development, and suboptimal procurement processes hinder access.

Key obstacles also include the absence of robust governance mechanisms, including necessary legislation, policies, and research frameworks, along with high customs and excise charges, which further limit the availability of essential assistive devices. Many nations have yet to implement the requisite legislation or policies for the provision of assistive technology, leaving a significant gap in care for people with disabilities.

Consequently, national governments must prioritize the development of comprehensive policies that focus on the affordability, availability, quality, accessibility, adaptability, and acceptability of assistive technologies. To address these gaps, governments should adopt a structured approach to funding distribution that takes into account the proportion of direct costs covered, the number of people served, and the diversity of products available to meet the needs of all individuals with disabilities. Additionally, infrastructure, such as transportation systems (roadways, railways, and airways), plays a crucial role in ensuring the effective delivery of assistive technology in LMICs.

The advent of digitalization also presents a promising solution to these challenges, as it can enhance internet access, facilitate remote training programs, and improve the overall provision of assistive technology. Furthermore, the lack of professional regulation in LMICs remains a significant barrier to the effective provision of AT. The establishment of national associations for qualified professionals, such as prosthetists and orthotists, is crucial for Maintain high standards in assistive technology prescription and service delivery.

For instance, India has made strides by employing certified healthcare professionals, such as prosthetists and orthotists, to ensure that assistive technologies are prescribed and delivered according to patient needs.

National schemes, such as the Assistance to Disabled Persons for Purchase/Fitting of Aids and Appliances (ADIP), Rashtriya Vayoshri Yojana (RVY), and the Sarva Shiksha Abhiyan (SSA), implemented by the Ministry of Social Justice and Empowerment, provide a structured framework to facilitate the provision of AT and overcome barriers to healthcare, rehabilitation, education, and employment for people with disabilities. [8,9]

Additionally, state-level assistance such as the Chief Minister's Relief Fund (CMRF) also play a vital role by offering financial assistance for the procurement of assistive devices to eligible beneficiaries, especially in underserved or emergency situations, thereby complementing national efforts and promoting inclusive welfare.

*As Rohwerder (2018)* explains, assistive technology access is affected by social stigma and structural barriers. [11] that presents in many developing countries, people with disabilities often face social stigma, economic barriers, and physical barriers that prevent them from using necessary assistive devices. Rohwerder emphasizes the need for integrated strategies that consider the economic, cultural, and infrastructural challenges when designing interventions to increase accessibility.

Where *Viroj Tangcharoensathien, Woranan Witthayapipopsakul, Shaheda Viriyathorn, and Walaiporn Patcharanarumol (2018)* focus on the primary challenges and potential solutions for improving access to assistive technologies in LMICs. They identify key barriers, including the high cost of assistive devices, limited availability of products tailored to local needs, and inadequate healthcare policies that fail to prioritize AT. (Tangcharoensathien, et al. 2018).

## CONCLUSION
Despite the clear benefits of assistive technology (AT) for enhancing independence, social inclusion, and economic participation, access in LMICs remains critically low, with only 10– 15% of those in need currently served. Persistent

barriers—high costs, poor infrastructure, fragmented policy environments, weak supply chains, limited professional capacity, and cultural stigma—continue to constrain AT systems. Successful strategies hinge on embedding Universal Design into national frameworks, backed by multisectoral collaboration among government, industry, users, and professionals.

## Effective AT systems also require:

1. Robust policies with dedicated funding and clear priority product lists.
2. Local manufacturing and tax reduction to lower costs.
3. Training programs to build a certified workforce; workforce.
4. User-centered service models.
5. Digital innovation to expand reach.
6. Global initiatives—like WHO's GATE and the Priority Assistive Products List—provide actionable templates for scalable AT integration into universal health coverage. By adopting a holistic, system-wide approach that centers on affordability, availability, quality, and cultural relevance, LMICs can significantly close the AT access gap and advance equitable inclusion and well-being for people with disabilities.

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