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The Role of Assistive Technology in Advancing Sustainable Development Goals

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Assistive technologies (AT) have presented significant equalizing opportunities for many to access opportunities and meaningfully participate in society. Enhancing the impact of AT in enabling participation requires an individualized and holistic understanding of the value and meaning of AT for the individual in their unique context. In Southeast Asia (SEA), children with disabilities account for a significant proportion of the population. The SEA region has one of the highest prevalence of moderate disability and severe disability in the world. AT can play a significant role in achieving Sustainable Development Goals (SDGs) and enabling all children with disabilities to lead healthy, productive, independent and dignified lives. In this perspective article, we discuss case studies of how AT can advance SDGs in SEA, focusing on the role of AT in providing quality education (SDG4), improving health and wellbeing (SDG3), and reducing inequalities (SDG10) for children with disabilities in SEA. We also explore how access to AT can be improved in SEA countries by examining different government initiatives and their gaps.

Keywords: assistive technologies, Sustainable Development Goals, Southeast Asia (SEA) region, quality education, health and wellbeing, reducing inequalities

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INTRODUCTION

Nearly 240 million children worldwide one in 10 of all children—are living with some form of disability. In East Asia and the Pacific region alone, there are an estimated 43.1 million children with disabilities (United Nations Children's Fund, 2021, p. 18). In Southeast Asia (SEA), children with disabilities account for a significant proportion of the population. For instance, one out of seven, or around 5.1 million, children in Philippines, and nearly 1.6 million children in Indonesia have disabilities (United Nations Children's Fund Philippines, 2018; Renaldi, 2021).

In 2015, the United Nations (UN) 2030 Agenda for Sustainable Development was adopted, and calls for a commitment to achieving 17 Sustainable Development Goals (SDGs) to end all forms of poverty, protect the planet and ensure that all people enjoy peace and prosperity (United Nations Development Programme, 2021). At the core of the 2030 Agenda is a pledge to "Leave No One Behind" and to reach those furthest behind first (United Nations Sustainable Development Group, 2022). Children with disabilities are among the most vulnerable groups in society, and often face significant barriers in accessing mainstream programme and services, including education and healthcare (UNICEF, 2021, p. 144–146).

Assistive technology (AT) can play a substantive role in achieving the SDGs and enabling all children with disabilities to lead healthy, productive, independent and dignified lives (Tebbutt et al., 2016). AT encompasses systems and services related to the delivery of assistive products, which maintain or improve an individual's functioning and independence, thereby promoting their wellbeing (World Health Organization, 2018). Examples of assistive products include hearing aids, wheelchairs, communication aids, spectacles, prostheses, pill organizers and memory aids (World Health Organization, 2021).

In this perspective article, we discuss case studies of initiatives that demonstrate how AT can advance SDGs in SEA, focusing on the role of AT in providing quality education (SDG4), improving health and wellbeing (SDG3), and reducing inequalities (SDG10) for children with disabilities in SEA. We also explore how access to AT can be improved in SEA countries by examining different government initiatives and their gaps.

PROVIDING QUALITY EDUCATION WITH ASSISTIVE TECHNOLOGY

Most SEA countries have national legislation and early childhood policy designed to support the rights of all children to an early childhood education that is non-discriminatory and inclusive (Philippines National Printing Office, 1987; Association of South East Asian Nations, 1999; Singapore Attorney-General's Chambers, 2000) as signatories of the United Nations Convention on the Rights of the Child (UNCRC). Despite these non-discriminatory laws and policies, literature suggests that children with disabilities and their families often are part of a disabling education system that does not cater to their needs, leading to experiences of prejudice, exclusion and discrimination (Higgins, 2001; Brown, 2002; MacArthur and Ware, 2004). Barriers that these children face include slower learning pace, mobility and communications (Nasir and Efendi, 2017). Effective use of AT, seen in the three case studies below, can help governments to reduce these barriers for children with disabilities, thereby moving them closer to achieving SDG4 of quality education for all.

Since the introduction of its Smart Nation initiative (Prime Minister's Office, 2014), the Singapore government has taken big steps in ensuring that no one is left behind in its digitalization journey. To achieve this vision, the Government Technology Agency of Singapore (GovTech) and National University of Singapore (NUS) has spearheaded AT development in the country, building hardware to improve the education experience of children with disabilities. eCanvas (Government Technology Agency, 2019) a product that helps children with cerebral palsy paint independently, was built by the Sensors and Internet of Things Group in the GovTech. eCanvas consists of two components—a voice-activated easel stand and a color dispenser with five colors numbered 1–5. The user can provide voice commands such as "Down" and "Up" to move the device and use numbers like "1" and "2" to choose the colo. It is now being expanded to include additional colors and brush changing features. The Institute of System Science in NUS has also expanded this partnership by running the GovTech Digital Academy, which seeks to raise the technical competency of public service employees in customized curriculum such as cyber security, data science and project management.

Other SEA governments have similarly taken centralized approaches in developing AT to address education barriers. In Thailand, the Ministry of Public Health founded The Wheelchair Project in 1999 and have since delivered more than 40,000 wheelchairs (Tell, 2021) for physically disabled children in Thailand, Myanmar, Laos and Malaysia. In addition, The Wheelchair Project has trained up to 2,000 volunteers to perform repairs and technical customizations, as improper fitting in mobility technologies such as wheelchairs could exacerbate a patient's condition (Shore, 2017). The project has been impactful, with literatures reporting a positive correlation of mobility achieved by users to better mental and respiratory health (Rousseau-Harrison and Rochette, 2013), greater community involvement (Sumner et al., 2017) and accessibility to educational resources like schools (Bickenbach, 2011).

In SEA, we also observe the trend of developing "next-generation" AT that can further bridge the educational gap for children with disabilities. The University of Manila has recently improved existing open-source prosthetic models by incorporating elements of Brain-Computer Interface and Voice Control. 3D printing was used to create the prototype prosthetic arm to which the team added a BCI Control Module and Voice Recognition module. In trials, the prototype could react to users' controls in games of Rock, Paper, and Scissors with an average accuracy of 85% for both male and female users (Oppus et al., 2016). The continuous advancements in 3D printing and signal transmission can not only lead to more affordable AT, but also allow for the integration of modern control systems such as BCI to increase their functionality.

While advancement of AT landscape will be significant in mitigating the educational disadvantages faced by children with disabilities, the case studies have shown that there is value in aligning the efforts from different SEA countries. An alignment to a common framework will help in multiplying the societal benefits through coordination, while creating a larger safety net to ensure that no child is left behind.

IMPROVING HEALTH AND WELLBEING WITH ASSISTIVE TECHNOLOGY

Children with disabilities experience poorer levels of health, have a lower life expectancy, and are more vulnerable to developing secondary conditions, comorbidities, and age-related health conditions (World Health Organization World Bank, 2011, p. 58–59; United Nations Department of Economic Social Affairs, 2019, p. 49–50). AT can substantively improve health outcomes and enhance the quality of life for children with disabilities, thereby contributing to the achievement of SDG3, which aims to ensure healthy lives and promote wellbeing for all at all ages.

AT can be used in rehabilitation and training programmes to improve function and reduce symptom burden in children with disabilities. Cerebral palsy is a group of permanent

disorders that affect movement, muscle tone and posture, and children suffering from cerebral palsy often have reduced motor function, such as the ability to walk or handle objects (Patel et al., 2020). A team of Singaporean researchers developed a novel pediatric robotic device, reachMAN2, for rehabilitation of upper limb function in children suffering from hemiplegic cerebral palsy (Ong et al., 2017). The device trained users in pinching, forearm supination/pronation and wrist flexion/extension movements and incorporated an interactive virtual reality game to better engage children. After therapy with the reachMAN2 device, Ong et al. (2017) observed that the children exhibited an increased range of movement in the upper limbs and an improvement in dexterity and fine motor skills.

Children with disabilities frequently suffer from malnutrition and are 34% more likely to be stunted and 25% more likely to be wasted (UNICEF, 2021, p. 42–45). This may be due to physical difficulties in feeding such as inability to move arms, hands or fingers. To address this issue, researchers from the Ho Chi Minh City University of Science and Technology designed a Feedbot, a self-feeding device for individuals with disabilities in the upper limbs (Nguyen et al., 2017). Feedbot comprises of a food tray and a robotic arm that brings food from the tray to the user's mouth and is connected to a mobile application which tracks the nutritional value of the food and provides recommendations for improving users' nutrition.

In addition to struggling with inadequate nutrition, children with disabilities also display poorer levels of mental health and wellbeing—they were 51% more likely to feel unhappy and 20% less likely to have expectations of a better life (UNICEF, 2021, p. 144–146). AT can enhance functional capability in children with disabilities, and thereby promote self-efficacy, self-confidence and a positive sense of self (Shinohara and Wobbrock, 2016).

AT can also directly contribute to improving cognitive and socio-emotional functions. Studies have shown that children with attention deficit hyperactivity disorder (ADHD) may experience anxiety, depression and mood disorders, which worsen their disease burden (Xia et al., 2015; Lim et al., 2019). Singapore-based firm Neeuro designed a gamified, brain-computer interface-based attention training programme, CogoLand, for children suffering from ADHD (Neeuro, 2022). By wearing a headset which detects and transmits real-time brain signals to the game algorithm, users can control the speed of their game avatar with their attention level. The higher the concentration level of the user, the faster the avatar moves. An improvement in ADHD symptoms and a reduction in internalizing symptoms, such as anxiety and negative mood, were achieved after 24 sessions of training (Lim et al., 2019).

Assistive technology can greatly improve health and wellbeing outcomes for children with disabilities, as well as reduce the need for caregivers and long-term care (World Health Organization, 2021). Therefore, there is a critical need to ensure easy and affordable access to these technologies for children with disabilities.

REDUCING INEQUALITIES WITH ASSISTIVE TECHNOLOGY

At the heart of SDG10 is the pledge that "no one will be left behind" and that governments will endeavor to reach the furthest behind first. However, persons with disabilities are among the groups of people who are most likely to remain left behind. They have lower education achievements and consequently, face disproportionate unemployment (World Health Organization World Bank, 2011), depriving societies of an estimated 1.37–1.94 trillion US dollars in annual loss of GDP (Tebbutt et al., 2016).

AT can greatly reduce inequalities experienced by children and adults with disabilities by enabling them to be productive and participate in all areas of life. For example, following the completion of a national prevalence study on disabilities and impairment among children in Cambodia, the Global Partnership for Education (GPE) recognized the opportunity to test school-based eye care and spectacles delivery. The study found that up to 65% of children who dropped out of school suffered from poor vision. Therefore, GPE partnered with the Ministry of Education, Sightsavers and Imperial College London to launch a school eye health pilot. The pilot ran in 56 schools in Siem Reap province to provide teachers with a full day of training to conduct basic vision screenings. A team of visiting eye health professionals also examined children identified with poor vision and provided those who did not need fully customized spectacles with a ready-made pair on-site, with those requiring fully customized spectacles receiving them a few days later (Smith and Bastawrous, 2019).

A six-month follow-up found that vision screenings conducted by teachers were fully aligned with those by trained professionals, demonstrating the pilot's effectiveness and safety. The provision of spectacles also reduced the drop-out rate by 40%, with the average standardized test scores increasing by 34% amongst students with spectacles. Accordingly, the Cambodian Ministry of Education incorporated the school eye health model into its latest five-year national education sector plan, paving the way to tap into the government's resources (Smith and Bastawrous, 2019).

AT can have a marked impact in the empowerment of youth, allowing them to productively participate in education and employment. Hence, they need to be prioritized by governments as an essential component for inclusive sustainable development. To ensure no one is really left behind and that SDG10 is achieved equitably, universal access to high-quality, affordable AT needs to be prioritized.

IMPROVING ACCESS TO ASSISTIVE TECHNOLOGY

While AT is life-changing for children with disabilities, many often face challenges in accessing these technologies due to a variety of factors, including high costs, limited production, low quality and lack of awareness (World Health Organization, 2021).

A major barrier to access is high cost as many would have to incur significant out-of-pocket expenditure to purchase AT. To

address this issue, some SEA countries have provided subsidized access to AT through national health insurance schemes. In Philippines, all persons with disabilities automatically enjoy fully subsidized health insurance through the national health insurance programme, PhilHealth, which provides specific packages for persons with disabilities, such as access to assistive devices and rehabilitation, in addition to standard health coverage (Cote, 2021). In Indonesia, persons with disabilities in the poorest 40% of the population have access to free health insurance, Jaminan Kesehatan Nasional–Penerima Bantuan Iuran, which covers access to assistive devices for a limited number of individuals based on medical assessment (Larasati et al., 2019, p. 3–4).

Other SEA countries have dedicated government funds to support persons with disabilities in acquiring AT. In Malaysia, persons with disabilities can apply for the Financial Assistance for Artificial Aids and Assistive Devices scheme to enjoy fully subsidized access to AT (Malaysia Department of Social Welfare, 2022). Similarly, the Assistive Technology Fund provides subsidies to support persons with disabilities in Singapore to acquire, replace, upgrade or repair AT, and covers up to 90% of the cost of the equipment (Singapore Ministry of Social Family Development, 2020).

Singapore has also increased efforts to raise awareness about AT both among persons with disabilities, as well as key stakeholders such as social service agencies. To ensure the proper development of the AT community in Singapore, the former-Minister of State for Social and Family Development, Sam Tan, announced in Parliament the formation of a workgroup to improve the ability of persons with disabilities to live independently and be provided sufficient opportunities in employment (Singapore Ministry of Social Family Development, 2019). With regards to AT, the workgroup found out that not all social service agencies and organizations in Singapore are familiar with the available AT solutions or have them on hand for their clients to try and assess the suitability of such solutions, which can affect their ability in providing AT services and support schemes. These have resulted in gaps on the ground, lowering the rate of AT adoption. As such, the Singapore government has recommended to expand the Tech Able space[1] to raise awareness of the range and applications of AT devices available in the country and serve the assessment and prescription needs of persons with disabilities and their caregivers. This expansion also aims to deepen sectoral know-how by starting a Community of Practice to facilitate the sharing of knowledge among therapists and professionals (such as engineers and designers, in addition to social service and healthcare professionals) in the use of AT (Singapore Ministry of Social Family Development, 2021).

However, the extent of governments' efforts has not been equal and a significant proportion of children with disabilities in SEA remains excluded from such initiatives. Countries like Indonesia, Viet Nam, and Philippines had to supplement government subsidies for AT with an informal market that is characterized by an absence of state regulation (Nasip and Pradipto, 2016), as industry AT remain inaccessible and costly for a large proportion of their citizens. Indeed, the difficulty to access AT can result in the exacerbation of inequalities (Kett et al., 2021).

While improving access to quality AT is extremely important, it is worth highlighting that AT is no panacea. The field is still growing and there is a lack of high-quality and well-designed research for assessing the effectiveness of AT, particularly in resource-limited settings (Anttila et al., 2012; Tangcharoensathien et al., 2018). Most research also tends to focus on AT that address mobility and vision needs, with little evidence on AT for hearing, communication and cognition (Matter et al., 2017). Furthermore, more high-tech AT may require significant training for users and caregivers, and the perceived social stigma associated with the use of AT and being labeled as "disabled" may limit the effectiveness of AT interventions (Draffan et al., 2015).

CONCLUSION

Children with disabilities are among the most vulnerable groups in society and often encounter significant challenges in realizing their fundamental rights. Facing stigma and discrimination, these children are often excluded from accessing basic services such as education and healthcare. Studies have demonstrated that AT can serve as an effective leveler to reduce inequalities experienced by children with disabilities, by supporting them to lead healthier, more productive and more participatory lives. This directly contributes to the achievement of the SDGs, particularly SDG3 on Good Health and Wellbeing, SDG4 on Quality Education and SDG10 on Reducing Inequalities.

Despite the tremendous benefits conferred by AT, many in SEA continue to face difficulties in accessing these technologies. While governments in SEA have adopted policies to varying degrees to tackle this issue, more measures at the national and regional levels are required to guarantee affordable access to high-quality AT for each child with disability, to truly realize the vision of "leaving no child behind" in SEA.

AUTHOR CONTRIBUTIONS

GS and SK were responsible for the initial drafting of the manuscript, with support from AB. AB edited the manuscript. All authors contributed to study design, selection and development of case studies and data interpretation, and approved the final form of the manuscript.

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[1]Tech Able is an integrated assistive technology space within the Enabling Village in Singapore, aimed to increase awareness and promote the adoption and benefits of AT in enabling persons with disabilities in various aspects of their lives.

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