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Towards the Adoption of Digital Assistive Technologies in the UK: An International Comparison of Policy Factors

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Table of Contents

Executive Summary

As part of the broader Royal Society project on Disability, Data and Digital Assistive Technologies, this report addresses the question:

> *What are the policy factors (e.g. legal, regulatory, industrial, economic) that enable—or inhibit—the effective design and roll-out of Digital Assistive Technologies in the UK versus other jurisdictions?*

To provide a globally informed policy recommendation for the United Kingdom, we adapt the PESTEL strategy framework to examine the political, economic, social, technological, and legal factors across three national jurisdictions–the United States, Kenya, and India–in addition to the UK. Further, we discuss ethical considerations that cut across all country case studies. Based on our analysis, we observe the following trends across all four case studies:

- Uneven implementation and enforcement of existing disability rights and accessibility regulations constrain DigAT adoption;
- Investments in coordinated national innovation ecosystems for emerging technologies facilitate the development and commercialisation of DigAT;
- Inclusive design practices help disabled individuals access the quality-of-life and economic productivity benefits from emerging technologies;
- National economic conditions exacerbate pre-existing inequalities, including barriers to accessing technology, between the abled and disabled population.

We integrate findings from the PESTL analysis and ethics to make four policy recommendations specific to the UK:

(1) Strengthen the implementation and enforcement of existing disability rights and accessibility regulation to support the economic resilience, independence, and access to DigAT of disabled people in the UK.
(2) Consider market-shaping policies such as private-public funding of DigAT research and commercialization to strengthen the UK innovation ecosystem;

(3) Actively collaborate with disability advocacy groups throughout the development of DigAT regulations and technologies to incorporate the perspective of disabled individuals;
(4) Enhance capacity and improve efficiency of AT procurement and provision systems to promote DigAT access across the UK.

Recommendations for further research include expanding on the PESTEL analytical framework to generate a more comprehensive quantitative index of policy factors and considering jurisdictions such as the European Union, China, South Korea and Japan to provide additional case study learnings for the United Kingdom.

I. Introduction

The World Health Organization (WHO) estimates that 16% of people around the world have a disability [1]. People with disabilities (PwDs) often face significant societal barriers including access to education, healthcare, employment, and information–fundamental rights protected by the UN Convention of Rights of Persons with Disabilities [2]. The emergence of novel technologies like artificial intelligence (AI) presents an incredible opportunity to empower PwDs through integrating advanced capabilities into assistive devices. However, it is just as critical that these emerging technologies do not become barriers themselves. This report leverages an international comparative approach to evaluating the policy factors that influence the adoption of these Digital Assistive Technologies. The objective is to illustrate the challenges and opportunities in the existing Digital Assistive Technology (DigAT) ecosystem in diverse jurisdictions and provide policy recommendations for the UK, specifically.

II. Literature Review & Methods

A. Defining Digital Assistive Technologies

For the purposes of this report, we define **digital assistive technologies (DigAT)** as:

Assistive products, as defined by the International Standardization Organization (ISO), that involve the digital electronic transmission of information, in other words, assistive products that are based on information and communication technology (ICT)

In turn, the ISO defines an assistive product as:

> Any product (including devices, equipment, instruments and software), specially produced or generally available, used by or for persons with disability for participation; to protect, support, train, measure or substitute for body functions/structures and activities; or to prevent impairments, activity limitations or participation restrictions [3, p. 6].

It is important to acknowledge that many definitions for "assistive technology" (AT) exist. None, however, is considered definitive nor the universal standard [3, p. 6]. Many countries have created specific definitions tailored to their domestic circumstances and needs, and the WHO also uses a bespoke definition [3, p. 6].

We decided upon the ISO definition for "assistive products" for several reasons. First, as one of the key definitions cited in the research literature, the ISO definition grounds our report in the existing body of research in this area, allowing for generalizability of findings and cross-comparisons. Second, the definition is also a pragmatic, industry-relevant one that serves as an international standard for firms that develop and sell AT.

Third, the WHO definitions for AT and assistive products did not, in our view, capture the critical aspects of DigAT. The WHO AT definition is overly expansive as "the application of organised knowledge and skills related to assistive products, including systems and services" [3, p. 6]. Assistive products are defined by the WHO as:

> Any external product (including devices, equipment, instruments or software), especially produced or generally available, the primary purpose of which is to maintain or improve an individual's functioning and independence, and thereby promote their well-being. Assistive products are also used to prevent impairments and secondary health conditions [3, p. 6].

This delimitation of assistive products to "external products" excludes emerging assistive technologies that increasingly blur the line between internal and external devices, as observed by the World Intellectual Property Organization (WIPO) [4, p. 14].

To centre the focus on the Royal Society's broader project—assistive technologies that are *digital* in nature—we modify the ISO definition for "assistive products" to emphasise their basis in ICT, another established term used by industry and academia.

B. Assistive Technologies Landscape Analysis

Thousands of assistive technologies (AT) have been developed for those in need, but there is limited consensus on their classification. Notable classification systems include the National Classification System for Assistive Technology Devices and Services (US), ISO 9999 (Europe), and ICF/AT2007 [5]. These systems primarily serve persons with disabilities (PwDs), but AT is also crucial for the elderly and individuals with chronic conditions. Conventionally, AT can be categorised from two perspectives: design & development and user requirements. The former aids developers, while the latter addresses patients' functional difficulties as shown in Table I. Additionally, AT can be classified into no-tech, low-tech, and high-tech categories as shown in Table II.

TABLE I

Classification of Assistive Technologies and Their Applications [5]

Assistive Technology	Description	Examples
Vision impairment	Designed for persons with vision loss. Such devices can be used by individuals with low vision or total blindness	Optical magnifiers for low vision, spectacles, DAISY player, and Braille system for total blindness
Mobility	Designed to help persons who have difficulties performing activities involving movement. Such AT helps to move safely and independently without any assistance	Wheelchairs, auxiliary crutches, orthoses lower limb, walking frame, walker
Hearing impairment	Designed to enhance or increase the volume of sound for persons with difficulty in hearing	Hearing aids, hearing loops, amplified telephone
Communication disorders	AT helps people with communication disorders - a problem in understanding, expresses or interact in terms of verbal or nonverbal languages. For example, Down syndrome, Parkinson's disease, CP, MND, and so on	Augmentative and alternative communication devices (AAC), communication boards for stroke or patients who cannot talk, or picture symbols, electrolarynx
Self-care and daily living	Designed to help with personal care and daily activities, maintain health, and prevent or protect body parts, including self-medication	Incontinence products, absorbent, personal digital assistant, toilet arm support, grab bar or rail, smartphones apps, modified utensils
Cognition	AT helps enhance or augment cognition function memory, thinking, reasoning or attention	Voice recorders, smartphones (for adapted task lists and schedules), global positing system locators for a patient with dementia
Sports and recreation	Designed to assist in participating and engaging in a wide range of indoor and outdoor leisure and sporting events	Adapted board games and toys, adapting playing cards, musical or audible cricket ball

DAISY: digital accessible information system, CP: cerebral palsy, MND: motor neuron disease

TABLE II

Classification of Assistive Technologies [6]

Category	Technologies
No Tech	Grab rails, Wet Room/Toilet Equipment, Pencil Grip, Post-it Notes, Slanted surfaces, Raised line paper, Weighted pencils, Magnifying bars, Tactile letters, Covered overlays.
Low Tech	Hoists, Mobility Equipment/Bath Seat/Chairs Buzzers, Portable word processors, Talking calculator, Switches, Lights, Electronic organisers, Apps, Sensors.
High Tech	E Readers, Touch screen devices, Computerised testing, Speech recognition software, Text to speech, Progress monitoring software, GPS, Eye gaze technology.

Advancements in high-tech AT are revolutionising accessibility, independence, and functionality for individuals with disabilities. The WIPO observes a trend of "convergence of assistive technology with other technologies, disciplines and markets" [4, p. 14]. A patent analysis of emerging technological developments and their AT implications found that seven enabling technologies are the most relevant: artificial intelligence, emerging human-computer interfaces, sensor technology, robotics, advances in connectivity and computing, additive manufacturing and new materials [7]. Other key trends include the Internet-of-Things (IoT), smart devices, and augmented and virtual reality.

AI and machine learning significantly enhance AT capabilities. Accessibility apps like OpenAI's ChatGPT-4o [8] and Microsoft's Seeing AI provide real-time descriptions of surroundings, aiding the visually impaired with navigation and interaction, while gesture and voice control technologies, such as Leap Motion, offer intuitive control for those with mobility impairments. Advanced NLP technologies enable voice-activated controls and real-time transcription, facilitating digital interactions for individuals with disabilities. Moreover, a growing body of evidence supports the finding that mobile phones can serve as AT by increasing access to education and participation in resource-limited environments [9].

Additionally, cutting-edge technologies such as AI-driven smart home systems automate routine tasks, and AI-powered prosthetics from Newcastle [10] and Utah Universities [11] adapt to user movements for improved functionality. Robotics and smart devices also enhance mobility and independence. Wearable technologies, such as CGM and ECG sensors, monitor user health data. Exoskeletons like Ekso Bionics' Ekso NR assist with walking and rehabilitation [12], significantly improving mobility for users [13]. Smart home devices like Amazon Echo and Google Home use IoT for voice-controlled home management, increasing accessibility [14]. Remote monitoring systems, such as Philips Healthsuite, provide real-time health data to caregivers [15], ensuring timely interventions.

In augmented and virtual reality, devices like OrCam MyEye use AR to assist the visually impaired by reading text and recognizing faces [16], while VR platforms like Penumbra's REAL System create immersive environments for rehabilitation [17]. Brain-computer interfaces (BCIs) from companies like Neuralink [18] and Synchron [19] enable individuals with severe paralysis to control devices with their thoughts, revolutionising communication and interaction capabilities.

These advancements highlight the growing integration of cutting-edge technology into assistive devices, introducing a world where assistive technologies harbour the potential to foster ground-breaking accessibility, independence, and quality-of-life improvements for individuals with disabilities.

C. Methods and Analytical Framework

What are the policy factors (e.g. legal, regulatory, industrial, economic) that enable—or inhibit—the effective design and roll-out of Digital Assistive Technologies in the UK versus other jurisdictions?

To address the report's central question (above), we undertook a case study analysis of four countries to compare how the policy factors in each might inform recommendations for the United Kingdom. The four countries we studied were the United Kingdom (UK), the United States (US), the Republic of Kenya, and the Republic of India. We selected these countries to incorporate the Royal Society team's interest in understanding how both developing and developed countries tackled the adoption of DigAT to provide a global perspective. Over 80 percent of individuals with disabilities live in low- and middle-income countries where AT are not readily available [20]. Our team provided a list of potential case study options–US, European Union, Singapore, Japan, India, and Kenya–from which the Royal Society team made the final selection.

The United States was selected given its similarities to the United Kingdom—socially, economically, and institutionally—as a fellow member of the Organization for Economic Cooperation and Development (OECD), a group of high-income countries (chiefly Western market-oriented democracies). Further, the United States boasts a strong technology sector and is a top global destination for the application of AT patents. Kenya also has a strong technology sector (Nairobi is considered a tech hub for the African continent), and its government recently unveiled a strategic initiative to improve digital accessibility. India similarly enjoys a burgeoning tech sector, with Bangalore as its chief tech hub, and its national legislation demonstrates a growing concern for disability rights and accessibility.

With respect to methods, we conducted desk research as well as interviews with relevant subject-matter experts. To guide our research and analysis of the four case studies, we relied on the PESTEL or STEEP framework. PESTEL is an acronym that stands for 'political', 'economic', 'social', 'technological', 'environmental', and 'legal' factors. A key strategic framework for firms, PESTEL helped us survey each country's

DigAT ecosystem and identify critical levers for adoption. We adapted this framework to exchange 'ethical' for 'environmental' based on feedback from the Royal Society's expert committee who noted the importance of ethical considerations in the adoption of DigAT. This ethics discussion was then separated from our international country comparison to emphasise the cross-cutting nature of ethical issues around DigAT across jurisdictions. Table III below provides a more detailed description of the PESTEL/STEEP framework and its factors.

TABLE III

PESTEL/STEEP Analytical Framework [21]

Table 6.1 Macro-Environmental Factors in a STEEP Analysis

Factors	Description	Considerations
Sociocultural factors	Sociocultural factors capture societies' cultures, norms, beliefs, and behaviors, as well as demographic shifts in population distribution.	• Ideological issues and concerns • Lifestyle and fashion trends • Population growth and segmentation • Age distribution • Media views and influence
Technological factors	Technological factors account for technology changes and trajectories, including the emergence of new technologies that may disrupt a firm or industry.	• Technology maturity • Emergent technology developments • Pace of technological change • Research funding and focus • Licensing and patenting norms and regulations
Economic factors	Economic factors account for shifts in economic indicators and trends and the impact of those indicators and trends on a firm and industry.	• Gross domestic product growth rates • Interest rates • Employment levels • Price stability (inflation and deflation) • Currency exchange rates • Income distribution
Ecological factors	Ecological factors concern broad environmental issues pertaining to the natural environment, global warming, and sustainable economic growth.	• Consumer preferences and demands for sustainable products and services • Environmental regulation and incentives • Access to sustainable resources (e.g., natural resources)
Political and legal factors	Political and legal factors account for the processes and actions of government and for changes in relevant laws, regulations, policies, and incentives.	• Industry laws and regulations • Political party policies and power distribution • Ability to influence political decisions • Voting rates and trends • Power and focus of regulatory agencies

D. Disability Prevalence and Definitions in International Perspective

Definitions of disability differ across and within countries, complicating precise comparisons of disability prevalence. According to official figures, the prevalence of disability is highest in the US at 27% [22], followed by the UK at 24% [23], India at 4.5% [24], and Kenya with estimates ranging from 2.2% to 10% [25], [26].

United Kingdom

In the UK, statistics on disability generally use a definition consistent with the Government Statistical Service (GSS)'s harmonised definition—if a person self-reports having a physical or mental health condition lasting or expected to last at least 12 months and which restricts their ability to carry out everyday activities, they are considered disabled [27]. In the 2022-23 financial year, 16 million people (24%) in the UK reported a disability [23]. Prevalence varied with age and region, and impairment types also varied by age group, with mobility the most common among State Pension age adults, mental health the most common among working-age adults, and social/behavioural the most common among children (Fig. 1-2) [23].

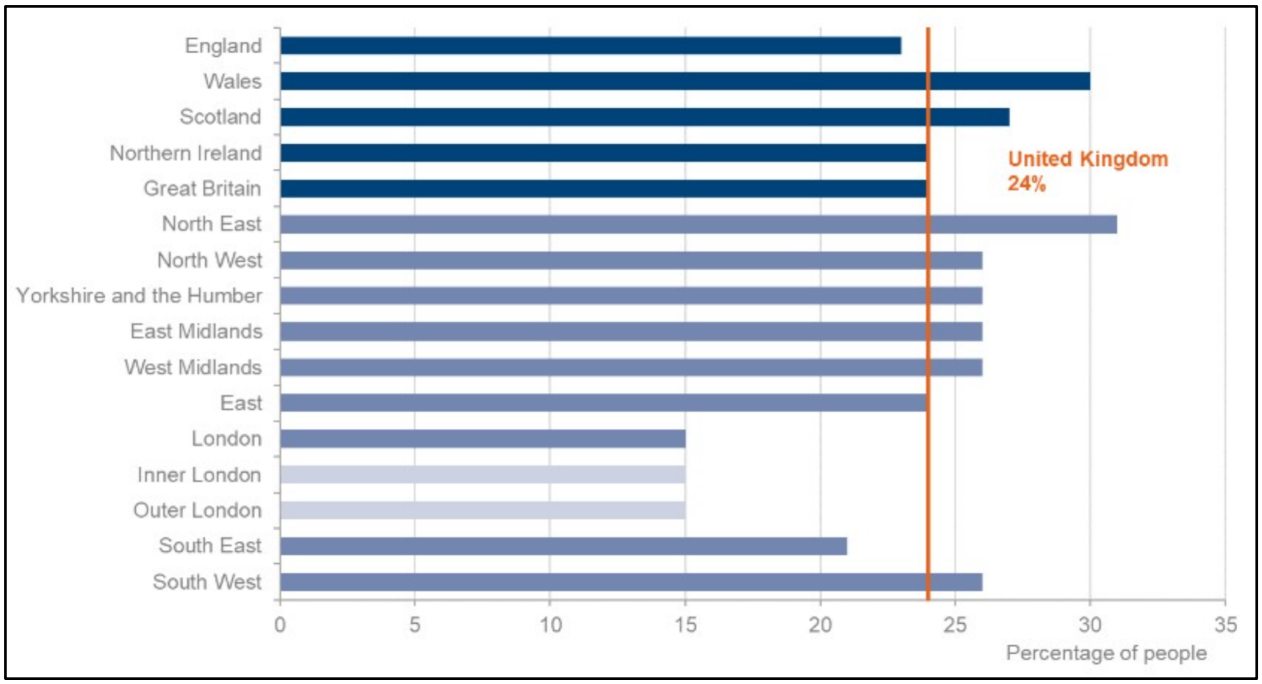

Fig. 1. Prevalence of disability in the UK, broken down by region [28]

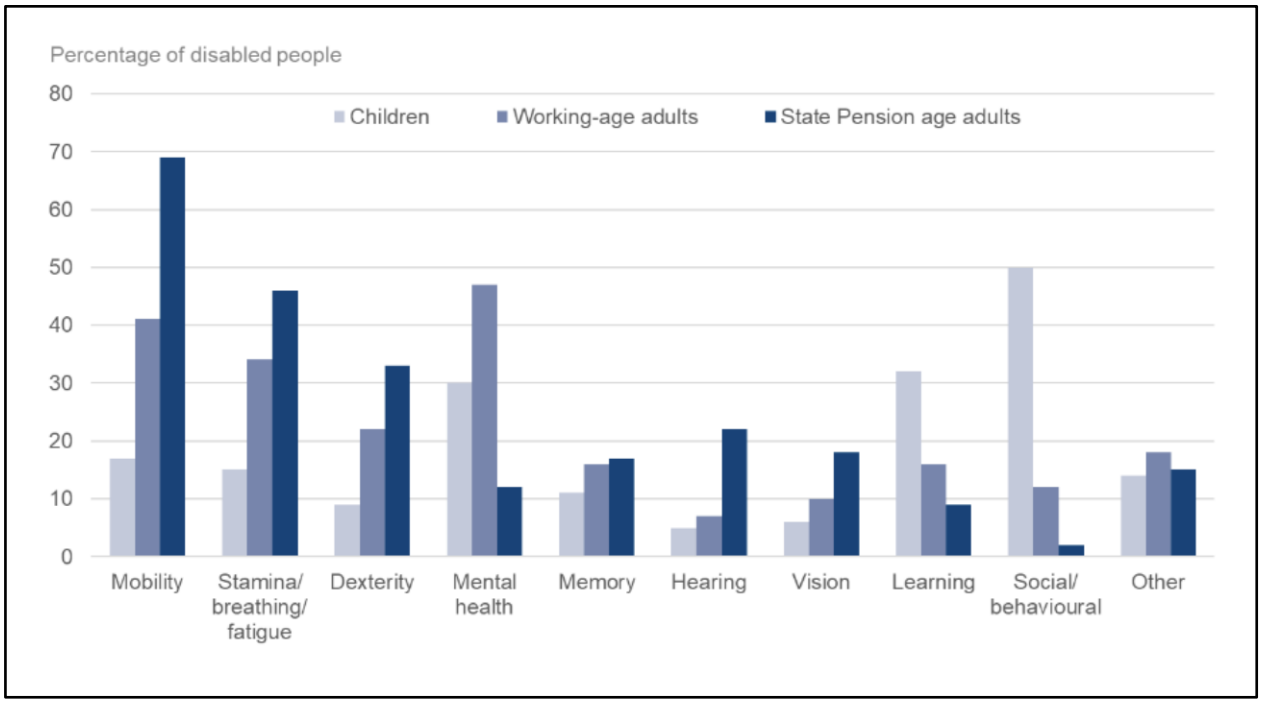

Fig. 2. Prevalence of impairment types among disabled people in the UK [28]

Kenya

The 2019 Census reports that 2.2% of the Kenyan population is disabled, with physical disabilities being the most prevalent followed by visual, hearing and communication [25]. However, other estimates are as high as 10% of the population [26]. To improve consistent reporting of disability prevalence, Kenya released the 2022 Disability Medical Assessment and Categorization Guidelines that defines disability as:

> *"Long term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder full and effective participation in the society on an equal basis with others." [29]*

The definition reflects the interpretation of disability through a biopsychosocial lens which aims to integrate the medical and social models of disability, as supported by WHO's International Classification of Functioning, Disability, and Health (ICF) [30].

United States

The US Center for Disease Control (CDC), the chief federal public health agency, defines disability as:

> *"Any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions)."* [31]

The CDC definition acknowledges the existence of many kinds of disabilities, including those that impact "vision, movement, thinking, remembering, learning, communicating, hearing, mental health, [and/or] social relationships" [31].

As of May 2023, the CDC estimates that up to 27% of Americans have some kind of disability e.g. mobility, cognition, independent living, hearing, vision, self-care [22]. It is important to note that the CDC definition is not the only government definition of disability. The Americans with Disabilities Act and the US Social Security Act have distinct legal definitions for disability tailored toward prohibiting discrimination based on disability (or perceived disability) and determining individual eligibility for federal benefits, respectively [32], [33].

India

In India, the list of criteria that categorises people as disabled was revamped in 2016 and came into effect with the Rights of Persons with Disabilities Act (RPwD), which established a list of disabilities comprising 21 categories [34]. The Census 2021 further updated the definition based on the RPwD Act to include the recognition of physical deformities and injuries resulting from acid attacks as disabilities [35]. According to the Census 2011, the prevalence of disability was estimated to be 2.2% in India [36]. However, these figures likely underestimate the true prevalence of disability in the country. More recent studies, such as the National Family Health Survey from 2019-21 (NFHS-5), suggest that the actual prevalence of disability in India is around 4.5% [24]. Locomotor disability is the most common type of disability among the population.

Comparison

The definitions and prevalence rates of disability in the UK, Kenya, the US, and India are summarised in Table IV below. These differences highlight the challenges in cross-country comparisons. The US and UK have broad, inclusive definitions but face variability issues. Kenya and India tend to underestimate prevalence and are refining their frameworks. India's detailed list provides targeted support but faces bureaucratic challenges, while Kenya's biopsychosocial approach aligns with international standards but struggles with data consistency.

TABLE IV

Comparison of Disability Definitions and Prevalence Rates

Country	Definition	Key Features	Strengths	Weaknesses	Prevalence
United States	CDC, ADA, Social Security Act (among others)	Broad inclusion of physical and mental impairments	Inclusive, strong legal protections, official public health data	Multiple official and legal definitions; prevalence may vary depending on definition	27%
United Kingdom	Equality Act 2010	Impairments with substantial and long-term impact on daily activities	Simple and clear, strong legal protection	May miss specific needs, regional variability	24%
India	RPwD Act, 2016	21 specific categories, including physical, sensory, intellectual, and mental disabilities	Comprehensive coverage, strong legal framework	Complexity in implementation, potential underreporting	4.5% (2.2% in Census)
Kenya	2003 Disability Act; Washington Group Questions	5 categories including seeing, hearing, mobility, self-care, communication, cognition	Capture domain of functioning and severity	Inconsistently interpreted, underreporting (Now uses 2022 Disability Guidelines)	2.2% (2019 census)

III. PESTL Analysis

In this section, we apply the PESTL framework to assess the four country case studies along the major policy factors relevant to DigAT adoption. We scored each country along each PESTL factor using a three-point Likert scale (see Table V) to indicate the relative strength of each factor in facilitating or inhibiting DigAT adoption within the nuanced context of that country. The table and charts below represent a general illustration of how the four countries compare on each policy factor. We recommend that further studies expand on our work to develop a more comprehensive index of each policy factor to provide a more detailed picture of the DigAT adoption policy landscape.

TABLE V

Likert Scale for PESTL Scores

1: Needs improvement
2: Meets minimum expectations
3: Exceeds expectations

Table VI

PESTL Scores for Country Case Studies

	UK	USA	Kenya	India
Political	1	2	3	2
Economic	1	3	1	1
Social	2	2	1	1
Technological	2	3	1	2
Legal	1	2	2	2
Total	7	12	8	8

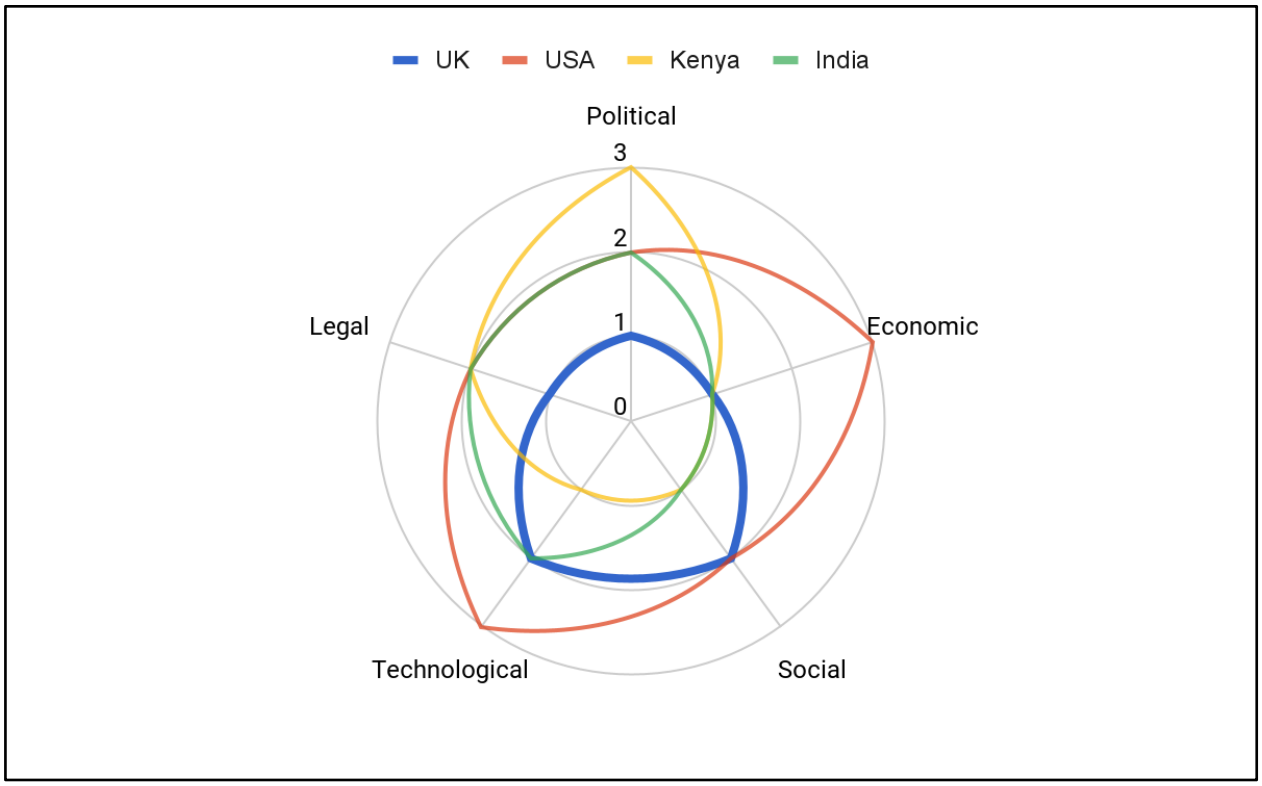

Fig. 3. Spider Chart for Country Case Study PESTL Score Comparison

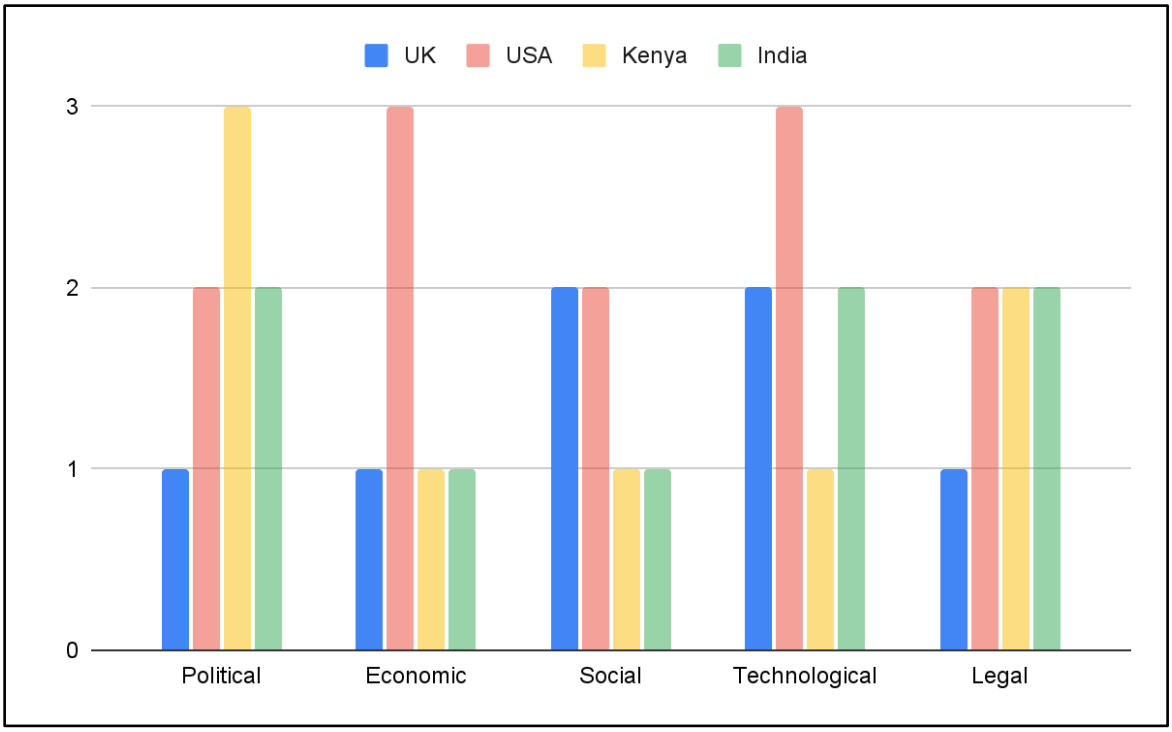

Fig. 4. PESTL Scores for Country Case Studies

A. Political Factors

United Kingdom

In the UK, local authorities are key players in delivering last-mile, everyday services to residents, and these responsibilities include providing social care and procuring assistive technology [37]. However, local authorities have faced reductions in spending power alongside increasing demand and costs; some councils' core budgets dropped by almost 50% over the last decade [38]. As such, many have struggled to maintain delivery of their services, with 8 issuing a section 114 notice of financial distress over the past 6 years (compared to none over the preceding 18 years) [39]. These conditions present a challenging backdrop for the rollout of DigAT due to the key role of local councils in procurement and their lack of sufficient resources.

Another key political trend is welfare reform—the Conservative government revamped the benefit system and has continued to undertake cost-saving measures since 2010. In a 2019 report from the Disability Benefits Consortium, researchers found that these reforms have resulted in an average loss to disabled adults of £1,201 in benefits each year by 2021-22 compared to 2010 levels [40]. In addition, these negative effects disproportionately affect households with lower incomes and individuals with higher numbers of functional disabilities (Fig. 5-6).

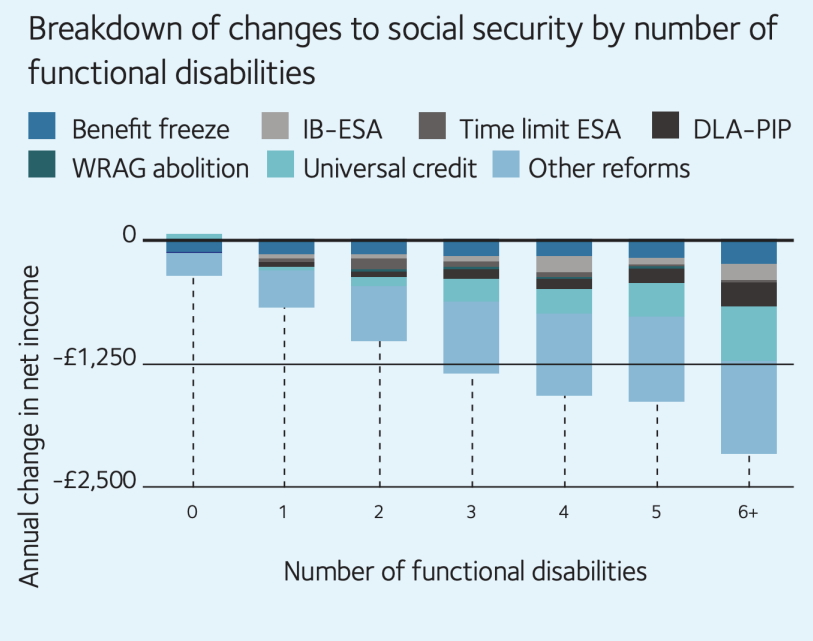

Fig. 5. Changes to social security by number of functional disabilities [40]

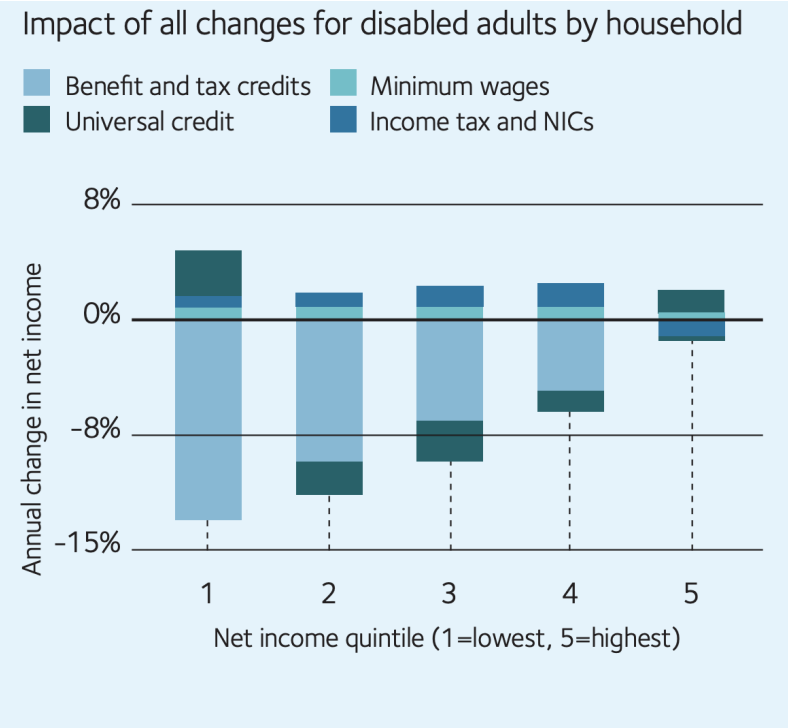

Fig. 6. Impact of all changes for disabled adults by household [40]

The government has continued to focus on disability, publishing a National Disability Strategy (NDS) in 2021 [41], the Health and Disability White Paper in 2023 [42], and a Disability Action Plan in 2024 [43], as well as proposing additional reforms to the Personal Independence Payment (PIP) system of disability benefits [44]. In the run-up to the local and general elections, the Prime Minister has announced more reforms, driven by an increase in "economically inactive" working-age adults [45]. However, these approaches have been largely denounced by disability advocacy groups [45], with complaints that the NDS did not sufficiently engage Disabled People's Organizations (DPOs) and that the Disability Action Plan does not contain any impactful measures prior to the General Election [46].

Likert Score: 1

United States

Generally, US politics is a net positive factor for DigAT adoption, despite some opposing forces that may change this in future.

Two policy issues directly relevant to DigAT adoption—disability rights/accessibility and the regulation of Big Tech—enjoy bipartisan political support in the US.

Landmark disability rights and accessibility legislation, including the 2010 Communications and Video Accessibility Act (CVAA) which "updates federal communications law to increase the access of persons with disabilities to modern communications", have passed with the support of more than two-thirds of each house [47], [48], [49], [50]. Regarding tech regulation, both parties' members actively collaborate to conduct oversight on the data privacy, safety, bias, fairness, and transparency implications of large tech companies' products and services [51], [52]. Consequently, the US political environment favours DigAT adoption in terms of legislating equal access and conducting oversight of technology companies.

However, partisan cleavages exist when it comes to the enforcement and funding of existing legislation and regulation. For example, in 2015, the US Government Accountability Office found that funding shortfalls and poor implementation by the responsible federal regulator, the Federal Communications Commission, compromised the efficacy of the CVAA [53]. Further, increasing political polarisation (Fig. 7) could threaten future legislation and enforcement action should DigAT adoption or accessibility become a partisan issue. For instance, the diversity, equity, and inclusion movement incurred significant political backlash once it became a partisan issue [54].

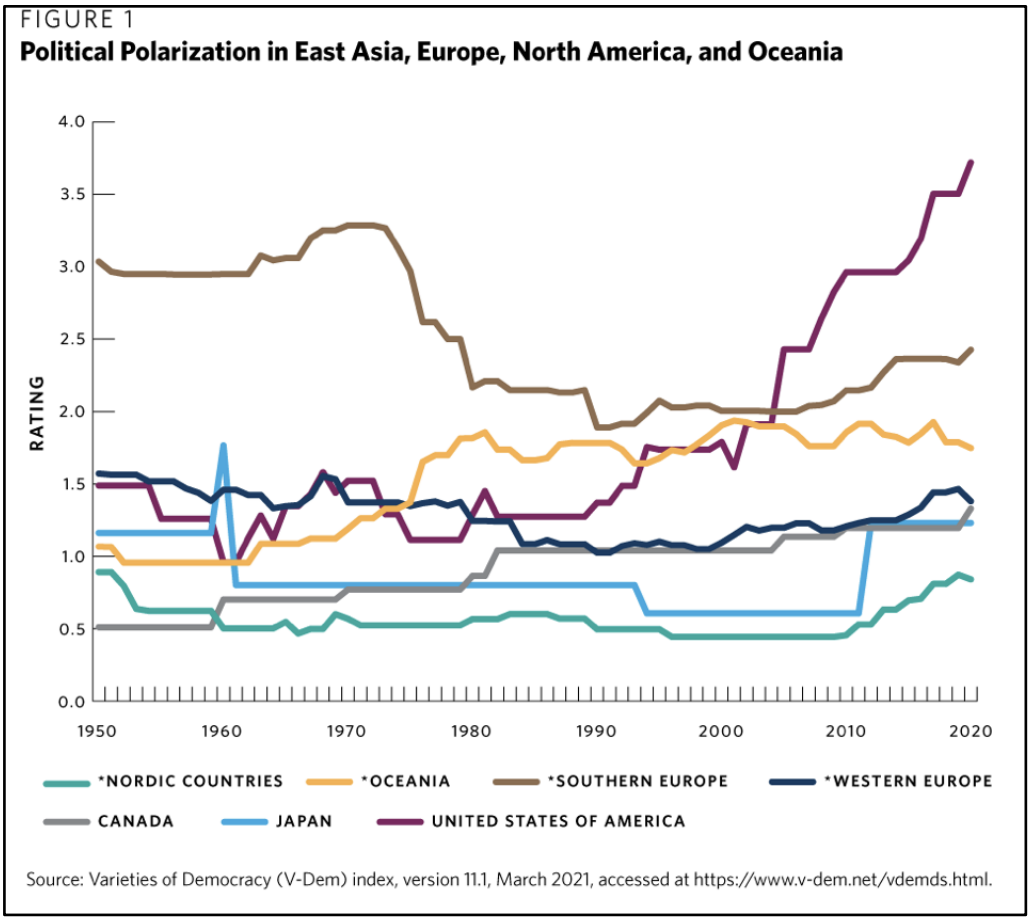

Fig. 7. Political Polarisation in East Asia, Europe, North America, and Oceania [55]

Additionally, existing ICT accessibility requirements face resistance from the powerful tech industry. For example, the Information Technology Industry Council (ITI), whose members include Google, Apple, and Amazon, has lobbied to replace the binary compliance verification outlined by Section 508 of the 1973 Rehabilitation Act, which requires the federal government to ensure all its ICT systems are accessible [56]. ITI also lobbies for a similar revision to the EU equivalent to Section 508, which remains UK regulation for now [57].

Likert Score: 2

Kenya

Inclusion on the basis of ability has been a critical focus for the Kenyan government. The 2010 Kenyan Constitution mandates that at least 5% of elected and appointed positions are occupied by PwDs [58]. To comply with this mandate, Kenya has built a strong political apparatus on the national level with the Kenya Disability

Parliamentary Association (KEDIPA) and county level with the County Assemblies Disability Caucus (CADICA). In 2022, Westminster Foundation for Democracy, launched the Kenya Inclusive Political Parties (KIPP) program to strengthen political coordination [59].

Inclusive representation in Kenyan politics has translated into a series of government initiatives. The 2003 Disability Act established The National Council for Persons with Disability to mainstream disability issues, finance service providers, and oversee the National Development Fund that subsidises device costs [60]. NDF has an annual budget of KES 259 million (2.1 million dollars) [61]; however, the provision of devices has been challenged by high demand of applicants and limited quality supply.

To address these concerns, the Ministry of Health released the Rehabilitative Services and Assistive Technology Strategy 2022-2026 [62]. The plan integrates the AT ecosystem into the national health service. It also expands Universal Health Coverage (UHC) to subsidise the cost of AT and outlines a consolidated supply chain which centralises the government (Kenya Medical Supply Authority) in the provision of AT. Leveraging established healthcare infrastructure can improve delivery but may also create barriers to entry for start-ups that require government contracts to scale. Interview findings indicate the benefits outweigh the challenges given the government's focus on access to AT.

Likert Score: 3

India

India's support system for persons with disabilities is coordinated by multiple government departments and agencies. However, concerns remain about implementation, transparency, and bureaucratic inefficiencies. The Ministry of Social Justice and Empowerment (MoSJE) creates policies for marginalised groups [63], while the Department of Empowerment of Persons with Disabilities (DEPwD) within MoSJE enforces disability rights laws and promotes assistive technology research [64].

National institutes under DEPwD provide specialised services and training for different disabilities, including the National Institute for the Empowerment of Persons with Visual Disabilities (NIEPVD) [65] and the National Institute for Locomotor Disabilities (NILD) [66]. ALIMCO, the primary manufacturer of assistive devices, manages initiatives like the Rashtriya Vayoshri Yojana (RVY), which provides free aid to senior citizens, and the Assistance to Disabled Persons (ADIP) Scheme, which distributes assistive devices to persons with disabilities [67].

The Rehabilitation Council of India (RCI) regulates rehabilitation training [68], while the National Trust supports persons with autism, cerebral palsy, and other e disabilities, offering legal guardianship and promoting independent living [69].

State governments implement national policies, while local bodies ensure grassroots delivery. Key national initiatives include UDID, the National Policy for Persons with Disabilities (2006) [70], Accessible India Campaign (2015) [71], and the National Action Plan for Skill Development of Persons with Disabilities (NAP-SDP) [72], which collectively aim to foster accessibility and inclusivity.

The DEPwD plays a vital role in supporting PwDs in India. Figure 8 shows government funding allocation for this department, with ₹989.35 crore (approx. £97 million) released in 2022-23 [73], a sum that reflects significant government investment.

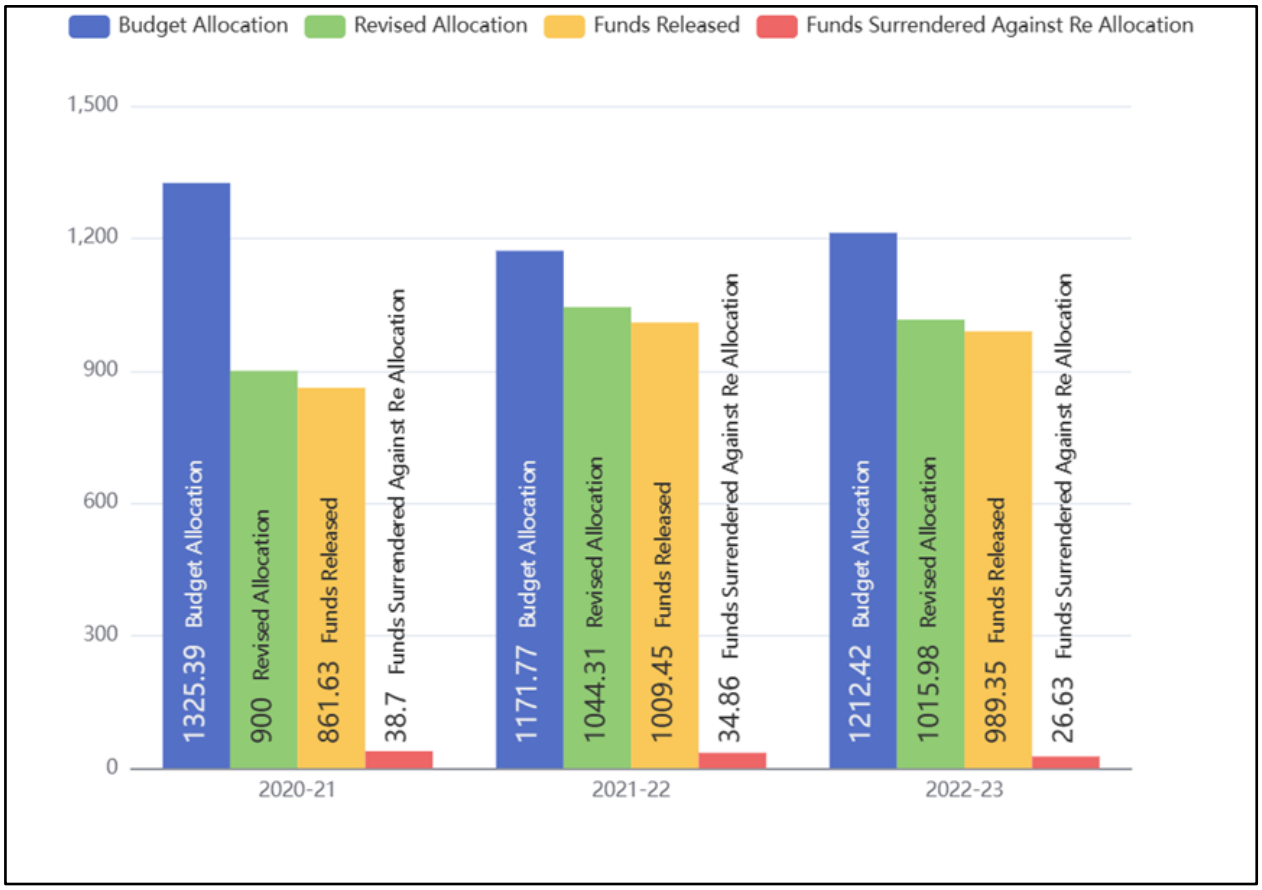

Fig. 8. DEPwD budget allocation from 2020-21 to 2022-23 [73]

Research and development in assistive technology are bolstered by the Centre for Assistive Technology and Innovation (CATI) at NISH as well as multiple Indian Institutes of Technology (IITs) [74]. Public-private partnerships, like the Prosus Social Impact Challenge for Accessibility (SICA), enhance service quality and scope [75]. The AssisTech Foundation (ATF) has helped numerous start-ups produce innovative assistive products and has generated multiple patents [76].

Likert Score: 2

B. Economic Factors

United Kingdom

The UK has had slow growth during its recovery from the COVID-19 pandemic; since 2019, real GDP has increased only 1.7% [77]. Due to global inflationary pressures from the pandemic recovery and Ukraine war, exacerbated by Brexit and the fall in the sterling exchange rate, the UK has experienced a real fall in its national income—the largest decline in purchasing power of the UK's GDP since the mid-1970s [78]. In the year to Q3 2022, even as real GDP grew there was a decline in real gross domestic income (GDI); in other words, each unit of the UK's GDP was worth less in the global market [78].

These economic pressures have led to a cost-of-living crisis in the UK. In 2024, cost of living was the most common issue reported by adults in the UK [79], a concern mostly driven by the cost of food, fuel, and gas or electricity bills. Annual food and beverage inflation spiked up to more than 19% in 2023, though it has since eased to 3% as of April 2024 [80]. This crisis has disproportionately affected disabled adults, with higher percentages finding it impossible to save money (50% vs. 34%), afford rent (45% vs. 37%), or run out of food (8% vs. 3%) in 2023 [81]. Disabled people also tend to be more impoverished: in 2022/23, 24% of individuals in families where someone is disabled had relatively low income after housing costs, compared to 20% without family disability [82].

Formidable barriers to access result in a lack of full participation by disabled individuals in the workforce. This is a significant economic issue, contributing to the rise in "economic inactivity" in the UK. In late 2023, only 54% of disabled people of working age were employed, compared to. 82% of non-disabled people [83]. Disabled people were more likely to be working in industries affected by the pandemic and therefore face redundancy [84]. The new paradigm of remote/hybrid work offered some opportunities for disabled people, but also presented new access barriers, e.g. to accessing and using digital tech [85].

These economic outcomes for people with disability may significantly influence demand for DigAT—when many disabled people are impoverished or struggling with paying for daily necessities, emerging digital solutions such as robotics, wearables, or implants may be commercially unviable. In sum, the economic challenges that disabled people face in the UK both inhibit the adoption of DigAT and contribute to challenges across the other PESTL factors.

Likert Score: 1

United States

The Biden Administration successfully steered the US economy through the COVID-19 pandemic, achieving a faster recovery compared to many countries, especially those in Western Europe and the UK which have struggled to control inflation and face sluggish growth (Fig. 9). Economic growth carries significant implications for DigAT adoption. As the WHO and *The Lancet* have found, wealthier countries are more likely to have more robust and comprehensive infrastructure for AT adoption, and unemployment among disabled Americans participating in the workforce recovered quickly post-pandemic (Fig. 10) [86, p. 2], [87], [88]. As shown by OECD data, governments of countries with higher GDP per capita tend to spend 1 to 2 percent of GDP addressing incapacity, which includes disability benefits, pensions, and associated healthcare [89]. Already, there is a pre-existing disparity in median income levels between the US and UK (US$74,000 vs. US$40,000) (Fig. 11). Spending on incapacity includes individual disability payments which can stimulate demand for DigAT by providing additional disposal income. However, worsening income inequality is a concern, as there is a higher prevalence of poverty among disabled Americans (who are more likely to be unemployed, work part-time and have less education) relative to their non-disabled peers [90], [91].

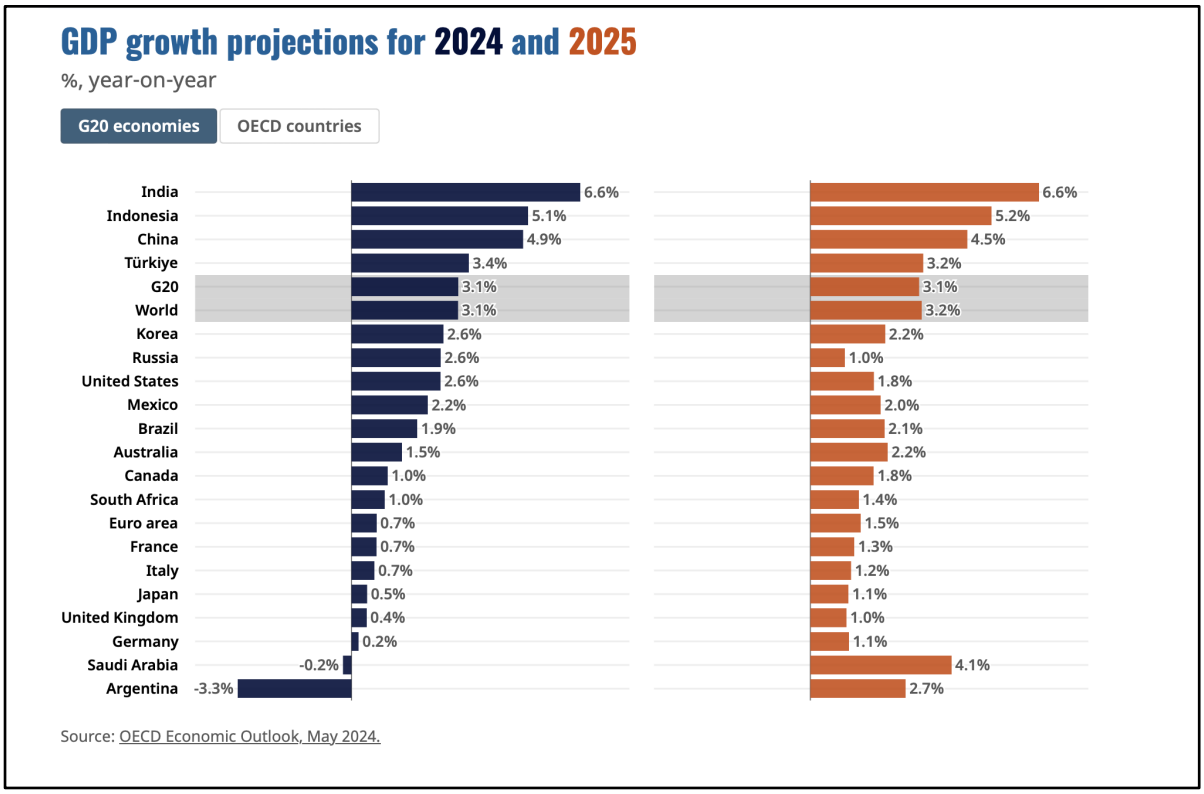

Fig. 9. [Global] GDP growth projects for 2024 and 2025 [92]

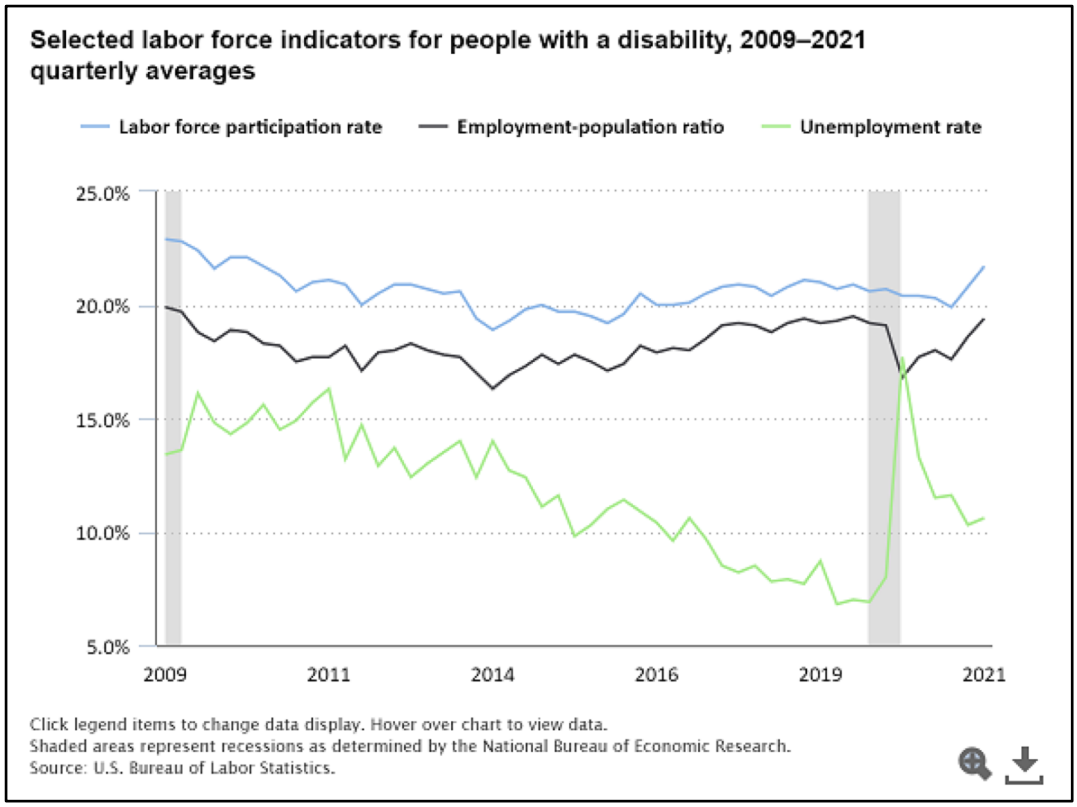

Fig. 10. Selected [US] labour force indicators for people with a disability, 2009-2021 [86, p. 2]

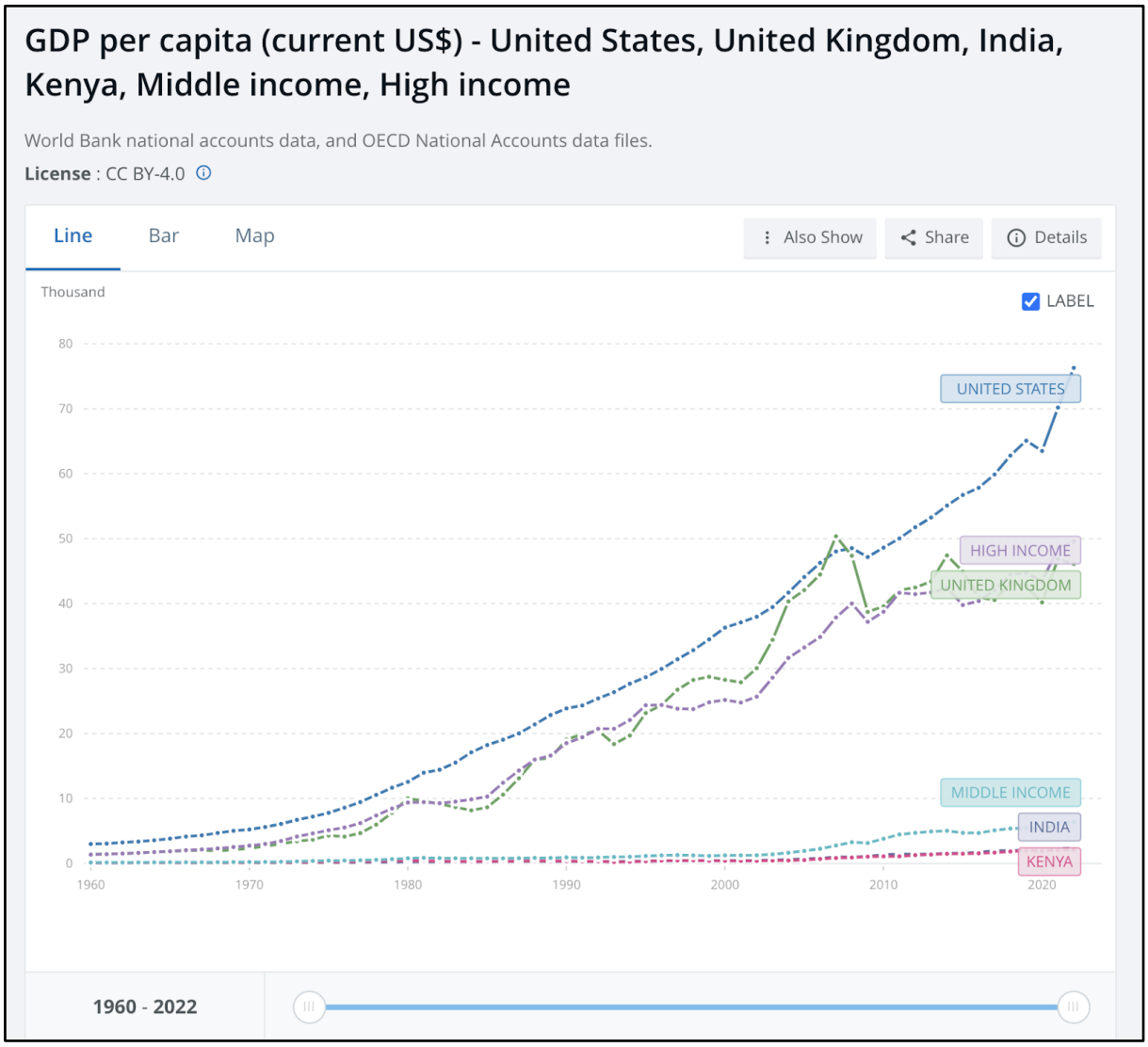

Fig. 11. GDP per capita (current US$) - United States, United Kingdom, India, Kenya, Middle income, High income [93]

Further, after an initial post-pandemic stumble, the US tech industry has largely rebounded with recent record earnings reported by companies like Nvidia. The US remains the epicentre of the AI boom and other frontier technologies like brain-computer interfaces (BCI). Given the convergence seen in recent years between general use technology and AT, the continued strength of the US tech sector is indicative of how the country is likely to continue to be an incubator for emerging and digital AT.

Likert Score: 3

Kenya

Kenya has experienced significant economic growth, with an average GDP growth of 4.8% between 2015-2019 [94]. The COVID-19 pandemic disrupted international trade and tourism, but the impact was minimised due to Kenya's resilient agricultural industry, a keystone of the economy. The country's growth is expected to reach 5.2% by 2026 [94] due to increased foreign direct investment and enhanced trade agreements [95].

Despite this progress, poverty is still a significant issue as the cost of living rises. Kenya Bureau of Statistics shows annual food inflation increased to 12.4% in the year from May 2021 to May 2022 [96]. These resource constraints are amplified for PwDs. Almost half of Kenyans with disabilities are unemployed and 67% live below the poverty line [97]. Furthermore, over 80% of people with disabilities live in rural areas [98], which have a 18% higher poverty rate than urban centres [99].

These economic conditions greatly influence access to assistive devices. While the government subsidises devices that cost more than 100,000 Kenyan shillings and provides tax exemptions on all AT, only 32% of national survey respondents with disabilities use an assistive product or support service [100]. 90% of these respondents stated that lack of access to assistive products was problematic, particularly in rural communities [100].

A significant part of the issue is that demand significantly exceeds supply. Research notes the lack of financial incentives to stimulate domestic production of DigAT, limited materials for product development, and fragmented distribution [101]. To address this, ATScale recently invested 7.5 million USD in capacity building and supply chain support [62]. Overall, Kenya experiences significant economic barriers to building a robust DigAT ecosystem that are common in emerging markets.

Likert Score: 1

India

India has shown remarkable economic progress over the past two decades (Fig. 12). In 2024, India's GDP growth rate was 8.4% and GDP was $4.112 trillion, making it the 5th largest economy globally [102]. India's purchasing power continues to grow, with Deloitte predicting that nearly 50% of Indian households will belong to high- or upper-middle-income categories by 2030 [103]. This has the potential to drive demand and affordability for assistive devices.

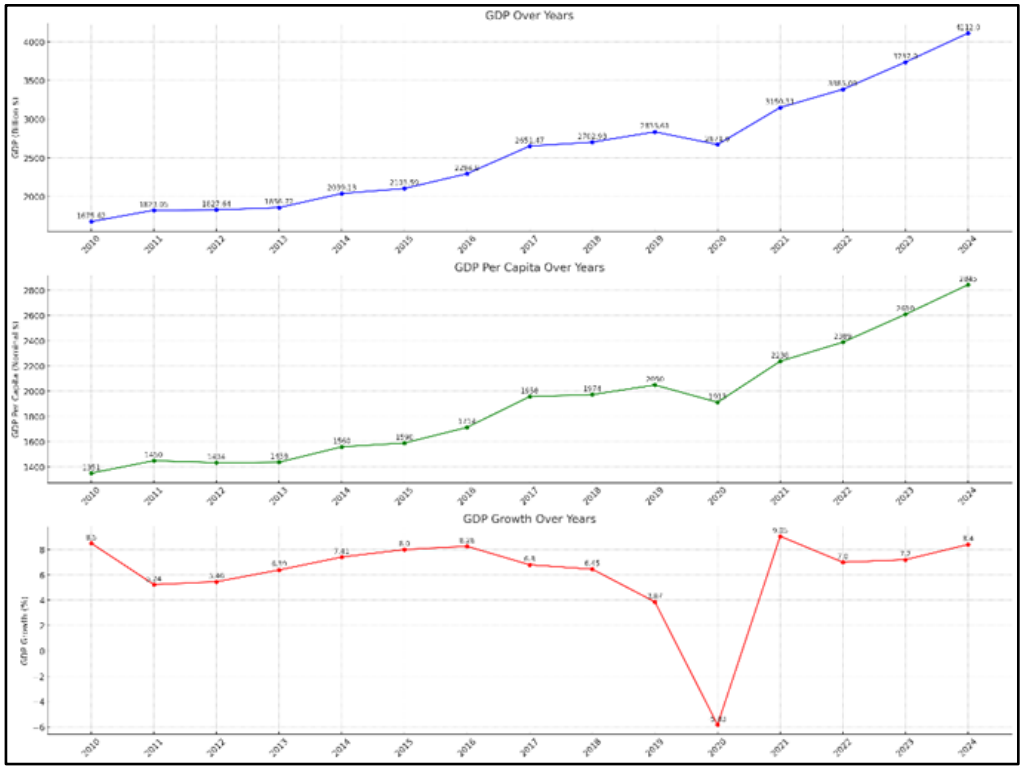

Fig. 12. India Economic Indicators, 2010-2024 Data Source: [102]

Inflation, which peaked at 7.8% in April 2022 due to global disruptions and the Russia-Ukraine conflict, remains a concern (Fig. 13). However, India's inflation rate eased to 4.83% in April 2024, an 11-month low, staying within the RBI's 2-6% tolerance band for the eighth month [104]. RBI Governor Shaktikanta Das is committed to reducing inflation to 4% despite ongoing uncertainties, and 74% of Indians say inflation is impacting their long-term plans [105].

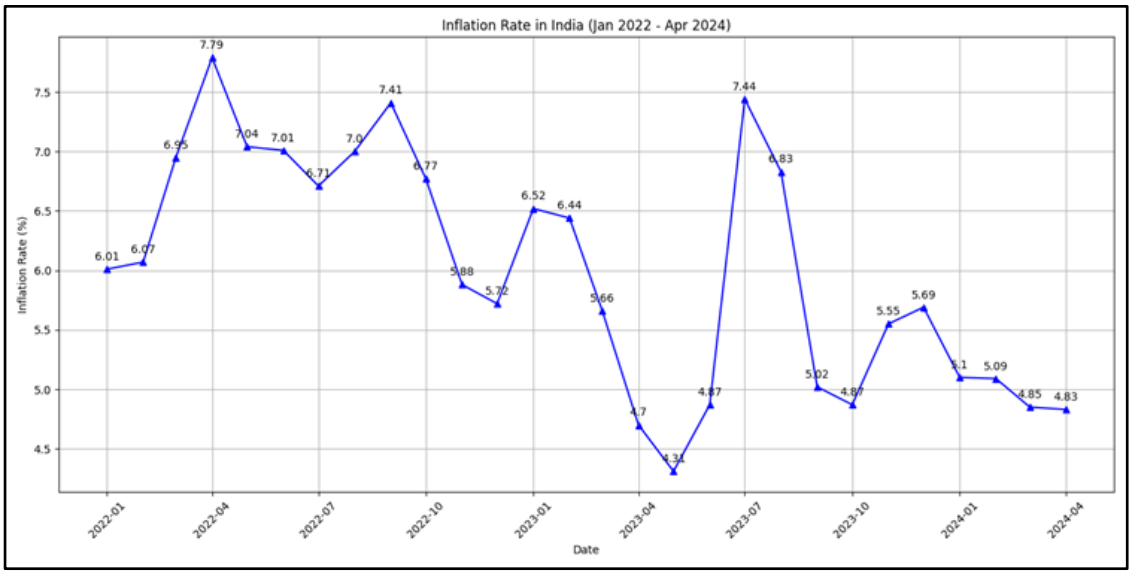

Fig. 13. India monthly inflation rates from January 2022 to April 2024 [104]

Unemployment improved to 7.64% in March 2024 from 8.01% in February [106], as shown in Figure 14. Urban unemployment and duration are higher than rural, youth unemployment is four times the national rate and lasts over a month longer [107]. States like Haryana (30.6%) and Rajasthan (24.5%) have the highest rates [108].

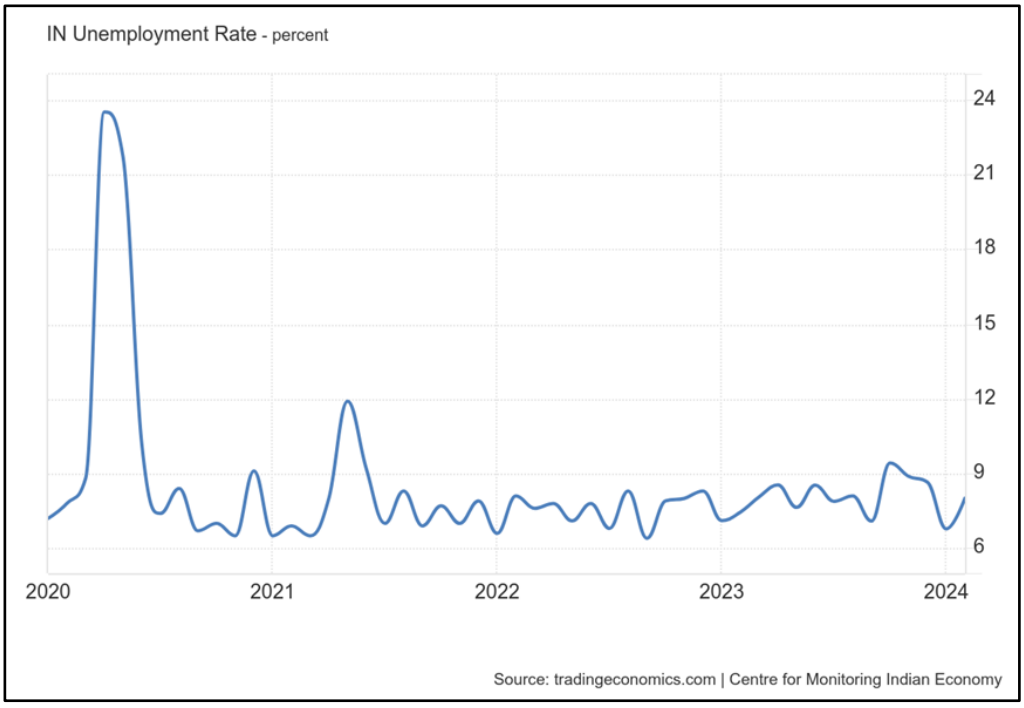

Fig. 14. India's unemployment rate from 2020 to 2024, showing a peak in 2020 and fluctuations within the 6-10% range. [106]

PwDs face significant financial burdens. About 20.32% of household monthly expenditure is on disability care, pushing 57.1% into catastrophic health expenditure [109]. Nearly 19.1% of households fall below the poverty line due to these costs [109]. Employment rates for disabled individuals are significantly lower, 20% for women and 32% for men [110].

The demand for assistive technology is rising, but there have been significant challenges. For instance, India's ALIMCO produces low-cost assistive devices for PwD, but the COVID-19 pandemic severely disrupted its production processes, which led to operational losses [111]. ALIMCO adapted by decentralising distribution and ensuring employee well-being through full salaries and vaccinations, achieving profit post-pandemic.

Likert Score: 1

C. Social Factors

United Kingdom

There are significant inequalities between disabled and non-disabled people in the UK. ONS statistics from 2021 show that disabled people face worse outcomes across the board, including in education, employment, home ownership, well-being, and crime victimhood (Fig. 15). Disabled people are significantly more likely to live in poverty [112] and face additional average costs of 975 GBP a month [113].

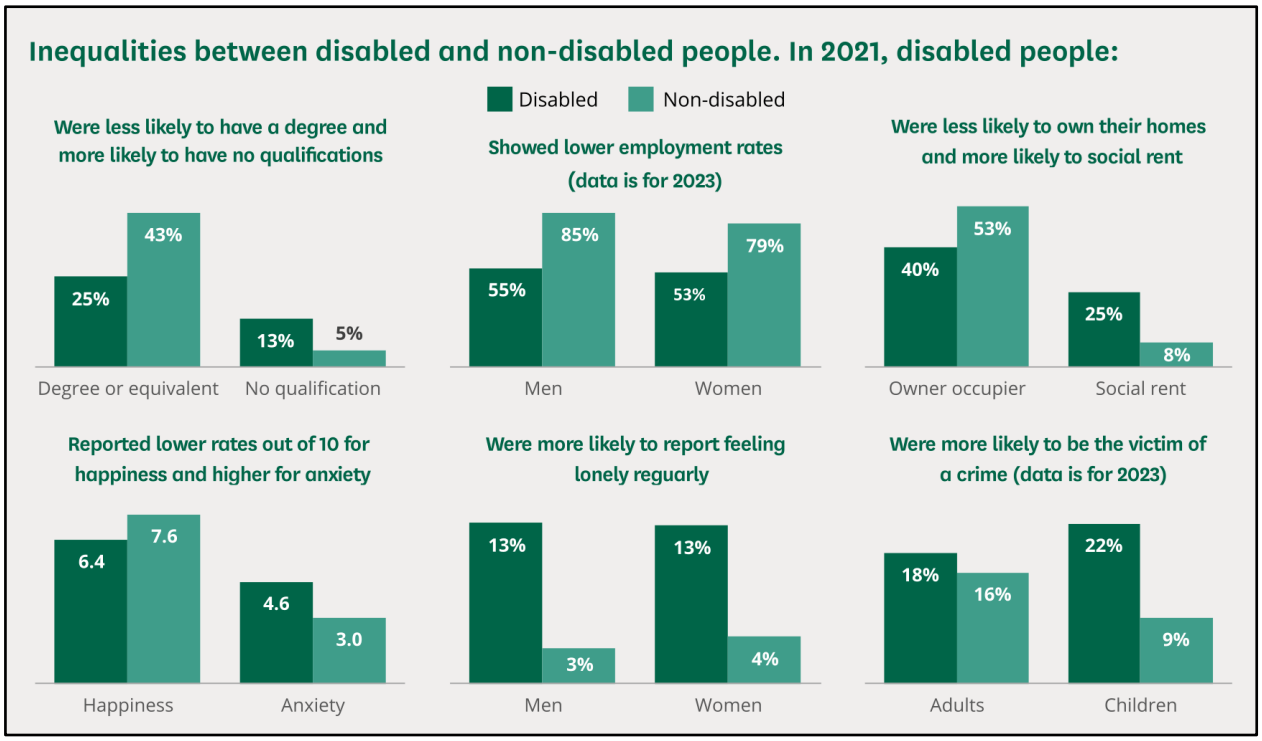

Fig. 15. Inequalities between disabled and non-disabled people in the UK [23]

Nevertheless, the UK has strong disability advocacy groups, including the nine organisations comprising the Disability Charities Consortium, which helps represent disabled people and advise the Disability Unit [114]. These groups are focused on advocacy, e.g. a Disability Manifesto from Deaf and Disabled People's Organisations (DDPOs) encourages the next government to end austerity [115]. Some, like Scope, also provide help navigating the processes for procuring AT [116].

Demographic trends in the UK predict a significantly ageing population over the next 40 years—the number of people 65-79 is expected to increase 30% by 2063, and the

number of people over 80 is expected to more than double. Ageing populations are more likely to be disabled: by the age of 70-74, a third of women and a quarter of men are disabled [117]. Thus, these predicted demographic shifts represent a real increase in long-term demand for assistive technologies; as the number of working-age adults also decreases, the UK will need to increasingly leverage technology to support its population, driving the adoption of DigAT in the long run.

In addition, the Covid-19 pandemic introduced additional stresses for the disabled population in the UK. Disabled people reported lower levels of well-being and reduced access to care and treatment due to the pandemic [118]. Novel challenges such as long COVID and long waiting lists for medical treatment may increase the prevalence of people with long-term health conditions that may inhibit their participation in society and the workforce, contributing to an increase in economic inactivity [119].

Likert Score: 2

United States

Disabled Americans face similar inequalities in terms of education attainment, employment, social stigma and poverty as mentioned in the UK case. However, an ageing population and a tradition of civic activism create a receptive environment for US adoption of DigAT [120]. From a demographic perspective, the US Census Bureau found that 16 percent of Americans were older than 65 years of age [121]. Older people are more likely to vote and given their higher prevalence of disability, the next decade could see the growth of an influential constituency for government support of DigAT adoption. Additionally, the growth of an older population would expand the market for AT.

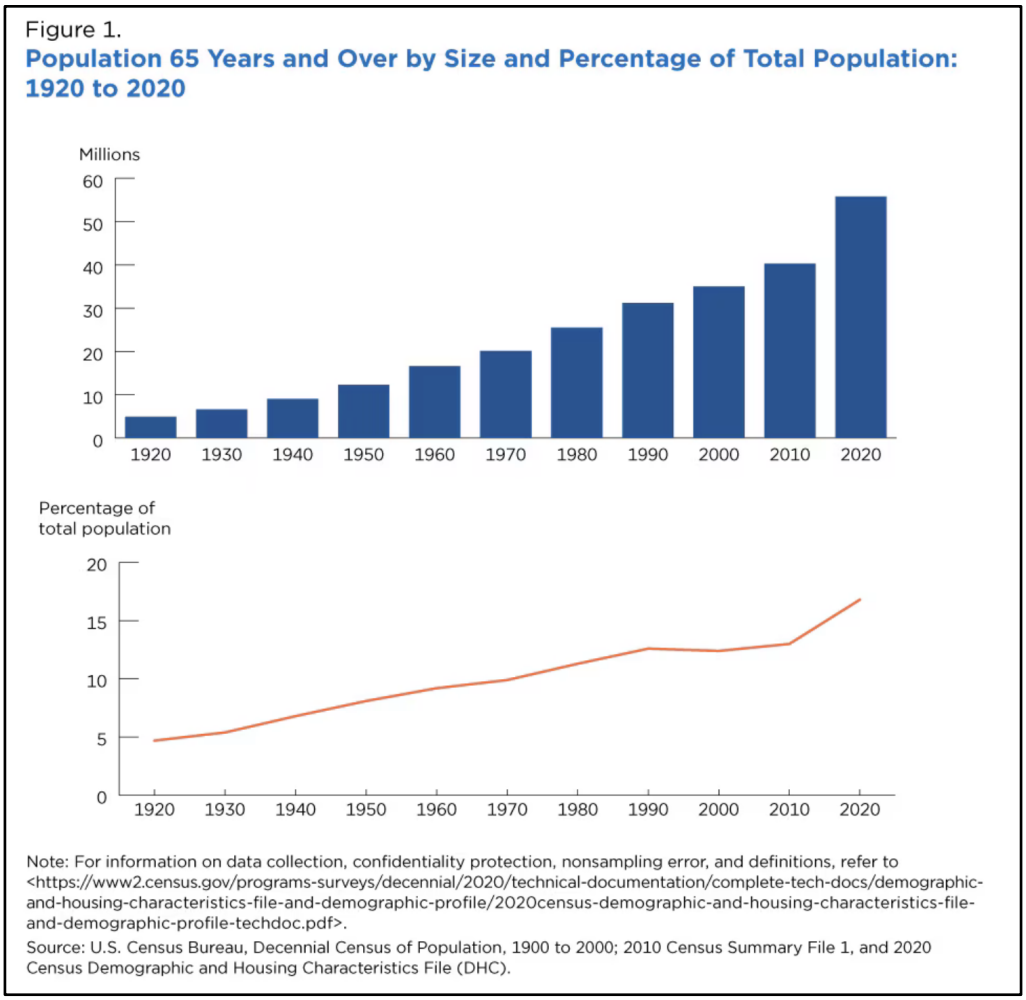

Fig. 16. US Population Ageing Trend [121]

Additionally, nearly 50 percent of US military veterans are over the age of 65, and this population is more likely to be disabled (42 percent) than their civilian peer cohort (33 percent) [122], [123, p. 1,6]. Among US civilians, support for veterans remains strong [124]. A 2021 study found that adult Americans were more supportive about addressing homelessness and PTSD in veterans compared to non-veterans [125]. While the government already provides more employment, financial and healthcare support for veterans than civilians via the Department of Veterans Affairs, positive public attitudes toward veterans could bolster DigAT adoption among this demographic and perhaps more broadly.

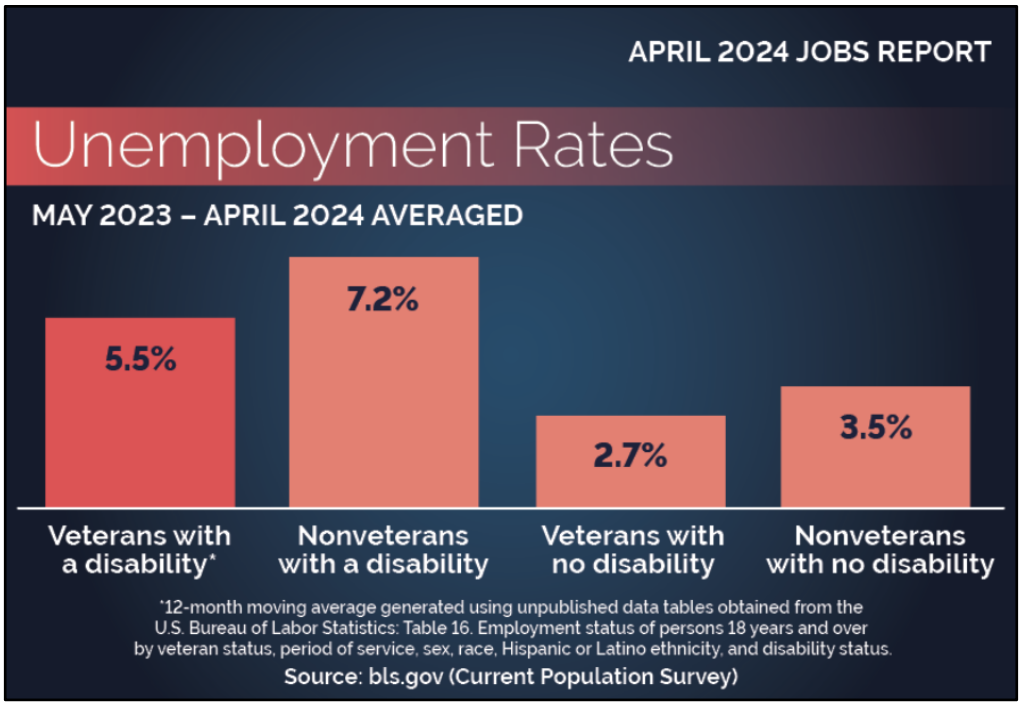

Fig. 17. Unemployment rates based on veteran status and disability [126]

Disability advocacy has a long history in the United States, beginning in the 1800s but burgeoned into an influential, well-organised political force in the 1960s alongside the Civil Rights Movement [120]. The effectiveness of their advocacy is reflected in the successive passage of landmark US disability and accessibility legislation that began in the 1970s and continues to the present day [114]. Prominent advocacy groups and collectives are numerous and include the ADA Network and National Association of the Deaf [127]. Their political influence is reflected not only in legislation but also in important initiatives like W3C Web Accessibility Initiative and lawsuits to enforce accessibility requirements [128], [129].

Likert Score: 2

Kenya

Social stigma is a major barrier in Kenya; religious interpretations of disabilities as "curses" heightens discrimination and social isolation [97]. Use of AT helps identify those with disabilities and may expose them to these risks. A 2021 GDI hub focus group study in Kenya found that participants without disabilities believed assistive technologies could only help overcome stigma while those with disabilities said assistive technologies could also increase stigma due to the identification effect [97].

This finding qualifies the role of disability prevalence in determining demand for DigAT, revealing that stigma may reduce uptake despite medical need.

Understanding the impact of social stigma underscores the importance of advocacy. Kenya has a long history of disability activism and a strong civil society network [130]. inABLE Africa, for example, has established AT labs all over Kenya to help blind students develop computer skills [131]. Survey research reveals that inABLE students had higher digital literacy and higher self-esteem than non-inABLE students [132]. Other organisations advocate for inclusion through addressing sectoral concerns: KICTaNET advances ICT reforms like establishing community networks to increase rural connectivity and support digital accessibility for PwDs at the local level [133].

While disability advocacy in Kenya is strong, the assistive tech ecosystem is fragmented, fuelling issues of access. A 2024 network analysis in Kenya showed that government ministries and agencies, as well as organisations of persons with disabilities, play a central role in coordinating the assistive technology ecosystem (Fig. 18) [100]. The analysis suggests that the ecosystem would benefit from deeper collaboration beyond simple communication to promote access to assistive technologies. It further highlights the government's potential to fill this role through developing specific AT policies, supporting local innovators in AT development, and controlling import taxes on AT and related supplies.

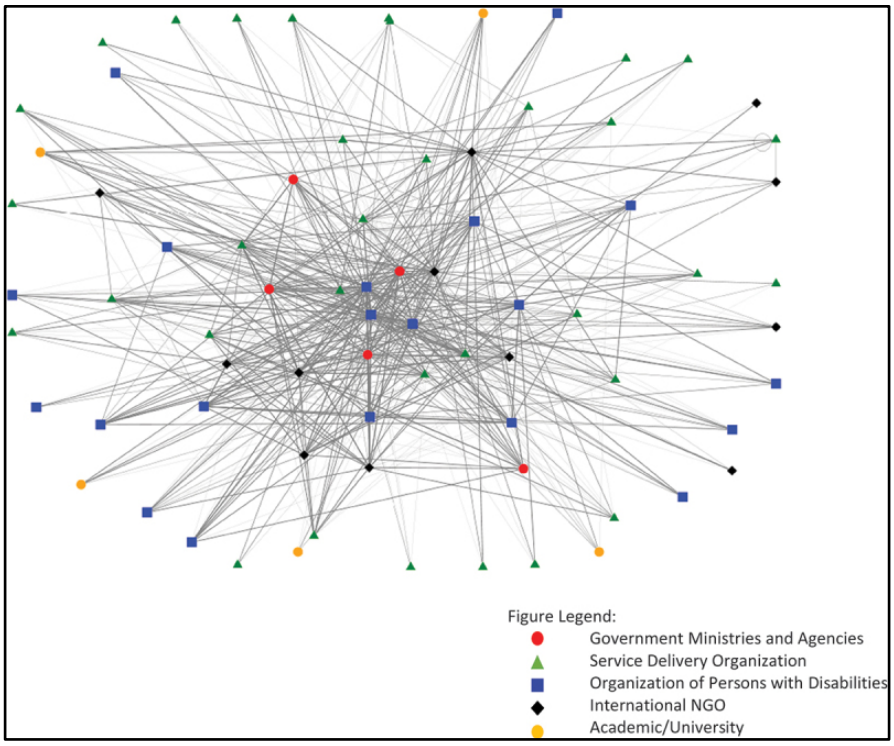

Fig. 18. 2024 Network Analysis of Kenya's Assistive Tech Ecosystem [100]

Likert Score: 1

India

India has a robust disability rights advocacy ecosystem. The National Centre for Promotion of Employment for Disabled People (NCPEDP) promotes employment, accessibility, and disability rights by collaborating with various sectors [134]. The National Disability Network aims to expand to 592 districts, uniting disability groups to influence policies and advocate for rights. The National Committee on the Rights of Persons with Disabilities (NCRPD) campaigns to include disability in the national agenda and improve accessibility in transport and communications. The Disability Rights Group has influenced key legislation, including the Disability Act 1995 and the creation of the Department of Disability Affairs and the ISLRTC.

However, there are still significant challenges facing PwDs. For instance, children with disabilities face barriers in accessing quality education. A 2019 UNESCO report states that three-fourths of children with disabilities aged five and one-fourth aged 5-19 do not attend any educational institution [135]. Teacher training for inclusive

education is inadequate and infrastructure and services often fail to meet RPwD Act standards [136].

Inclusion is also a major issue; India's top corporations have only 0.3% PwD employees. Nifty 50 data shows only five private companies and four public-sector organisations exceed 1% PwD, despite the RPwD Act's 4% requirement [137]. Stigma is pervasive; research shows 74% of visibly disabled employees believe they can't attain positions of seniority, 93% feel they must suppress their personality, and 43% experience negative attention from colleagues [138].

In healthcare, Universal Health Coverage often excludes people with disabilities, leading to high treatment costs and poor service availability [136]. During COVID-19, 73% of disabled people faced severe hardships, including financial crises (57%), lack of access to food (13%), and healthcare (9%) [139]. India's ageing population, projected to be 20% by 2050 (Fig. 19) [140], increases disability prevalence and assistive technology needs.

Likert Score: 1

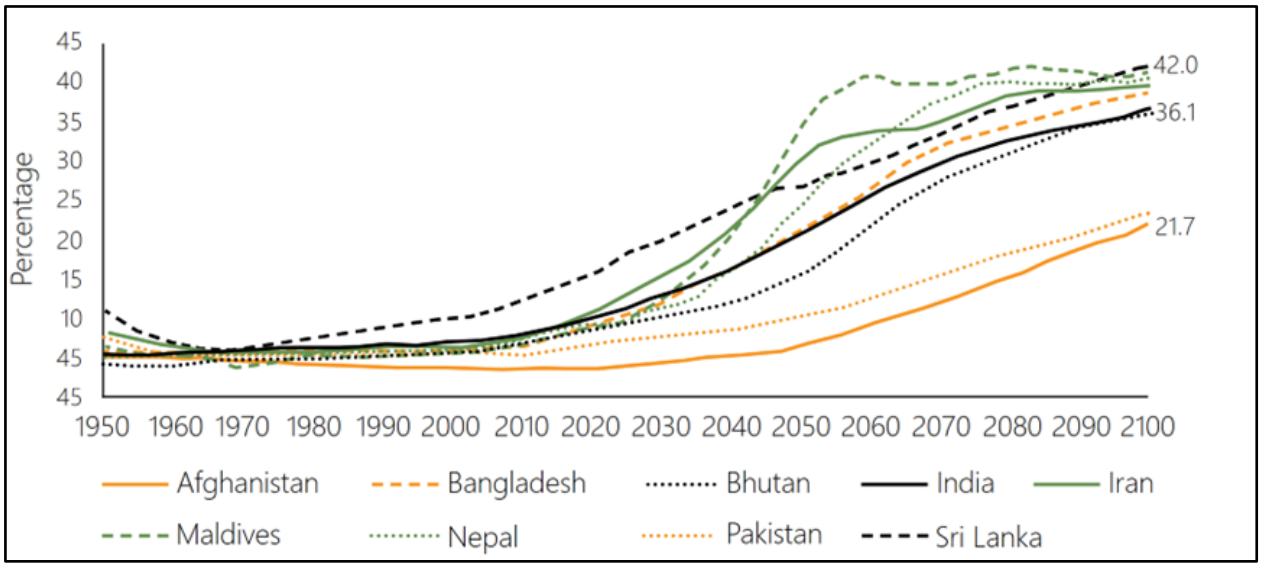

Fig. 19. Demographic ageing in South Asia. *This graph illustrates the percentage of the population aged 60 and above across South Asian countries 1950-2100. India, represented by the black line, shows a continuous increase in its elderly population, reaching approximately 20% in 2050 and 36.1% by 2100, showing significant demographic shifts and the need for assistive technologies for the ageing population.* [140] [141]

D. Technological Factors

United Kingdom

The UK has a strong tradition of science and engineering research with its stable of top-tier universities. According to data from Dealroom, it leads Europe in innovation as measured by both VC investment as well as number of unicorns [142]. This ecosystem is consistent with the triple helix model of innovation, relying on the interplay between universities, government, and the private sector to develop, support, and commercialise new technologies [143].

For funding new DigAT projects, the UK utilises multiple sources including UK Research and Innovation (UKRI), the Engineering and Physical Sciences Research Council (EPSRC) and Innovate UK, which runs an Inclusive Innovation Award programme [139]. The National Institute for Health and Care Research (NIHR) tracks grants for assistive technology research and development work, representing funding in the tens of millions across multiple categories (Fig. 20) [144]. UK projects also have access to the Horizon Europe research and innovation programme starting in 2024, with a €95.5 billion budget between 2021 and 2027 [145].

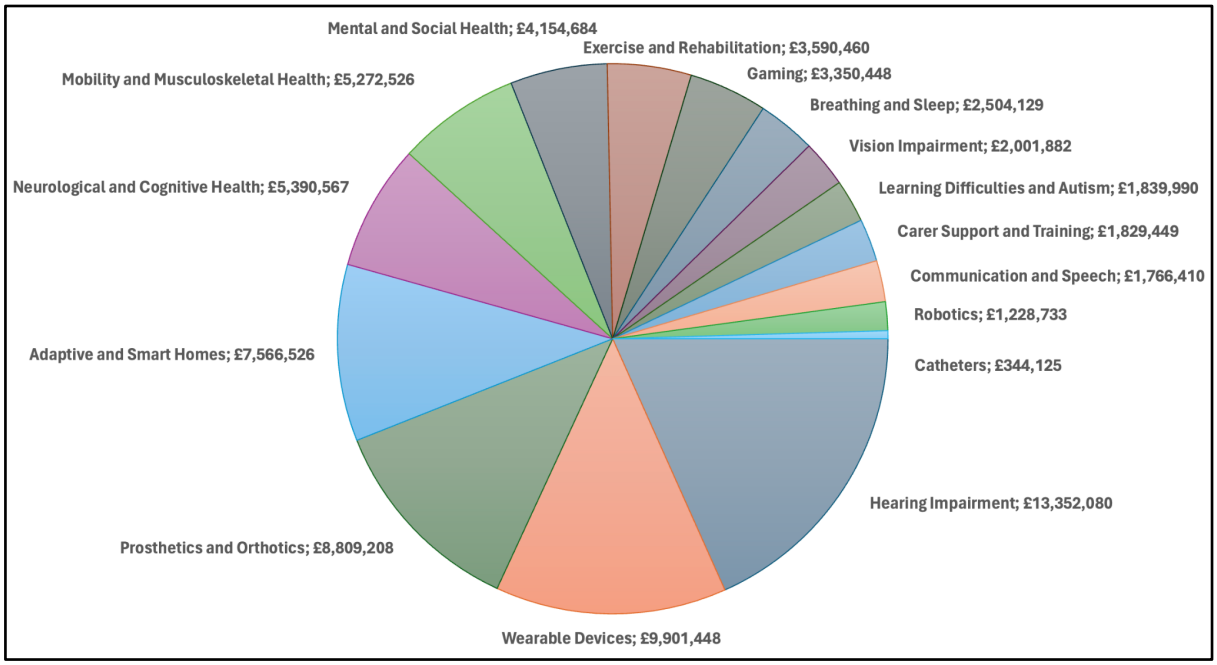

Fig. 20 Breakdown of NIHR-tracked funding for assistive technology research and development work: 2022 to 2023. Data source: [144]

However, a key gap is funding for commercialization and growth-stage start-ups—larger funding rounds have decreased in volume and number since peaking in 2021 (Fig. 21) [146], [147]. Corporate investment in start-ups is limited, and interviews revealed that government grants and funds rarely grant follow-on funding to researchers or start-ups. Especially for healthcare-related technologies, there are issues with commercialisation, and given the nascent stage of DigAT these issues may increase barriers to the adoption of home-grown solutions. The UK innovation ecosystem as it stands may not be sufficient to drive scaled innovation and production of DigAT, resulting in supply-side challenges such as high costs and limited deployment.

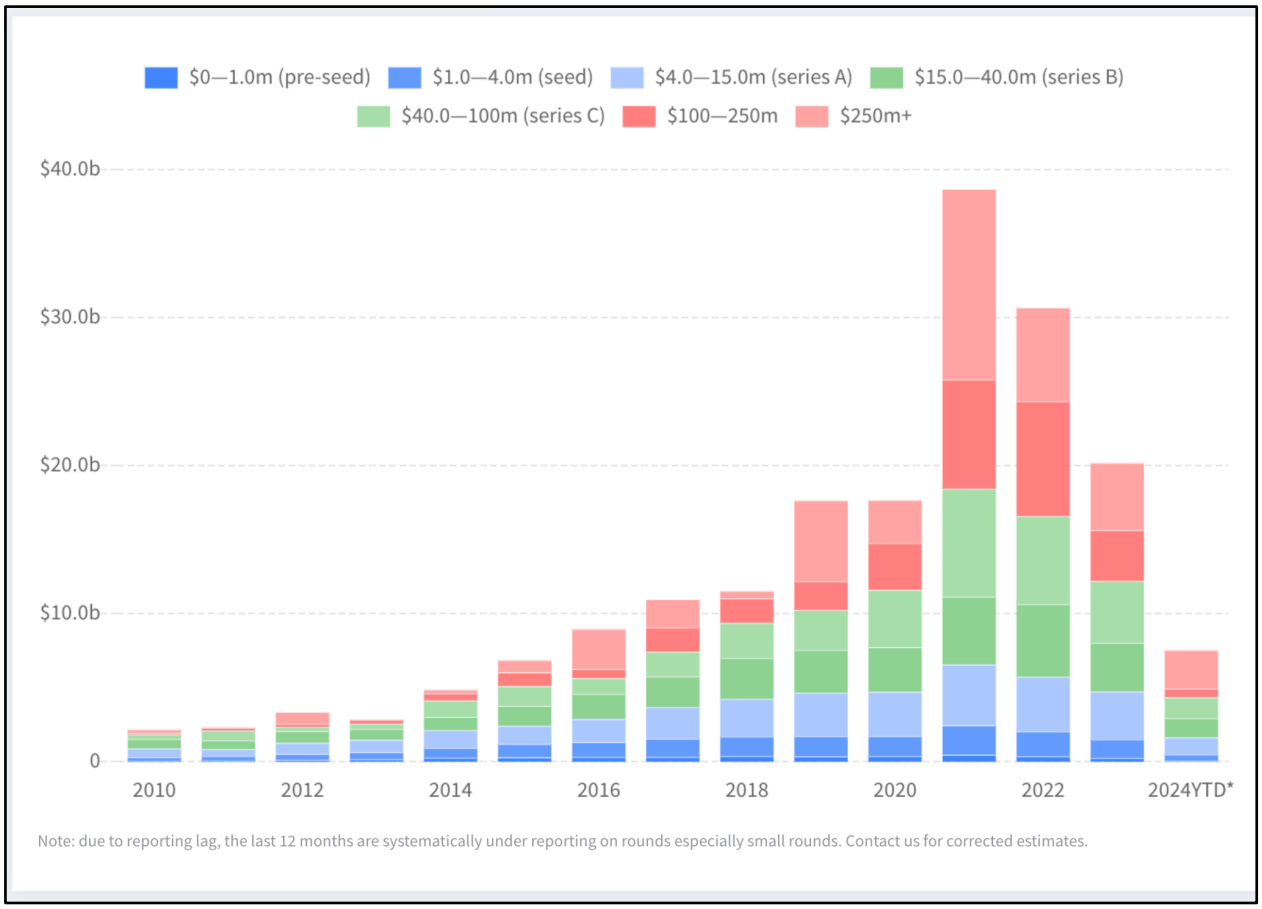

Fig. 21. VC funding round volume in the UK, grouped by round size [146]

To support the adoption of DigAT across the UK, especially in home care settings for applications like smart home or web-based technologies, digital infrastructure is crucial. In April 2024, 81% of the UK had access to gigabit broadband under Project Gigabit, on track to meet the 85% coverage target by 2025; however, this coverage

varies significantly by region, with Scotland, the South West of England, and Wales significantly trailing the average [148]. Further investing in digital infrastructure to serve all UK residents will be crucial to support the rollout of DigAT.

Likert Score: 2

United States

The home of a globally leading tech sector, the United States is currently a top-five destination for AT patent applications (alongside China, South Korea, Japan and the EU) and boasts specialised AT companies [4, p. 15]. The US is also at the frontier of emerging technologies and emerging AT. This includes brain computer interfaces (BCI), augmented reality, autonomous vehicles among others [4]. Consequently, the US is well-positioned to become a leader in developing and innovating new DigAT.

Additionally, the US boasts a premier venture capital (VC) ecosystem for ICT (Fig. 22), which is critical for funding new emerging technologies as VC firms have a higher risk appetite than banks. The sophistication of the US ecosystem is such that there are disability-tech specific American VC funds (e.g. Autism Impact Fund) which project the market will grow to USD 40bn by 2030 [149] [150].

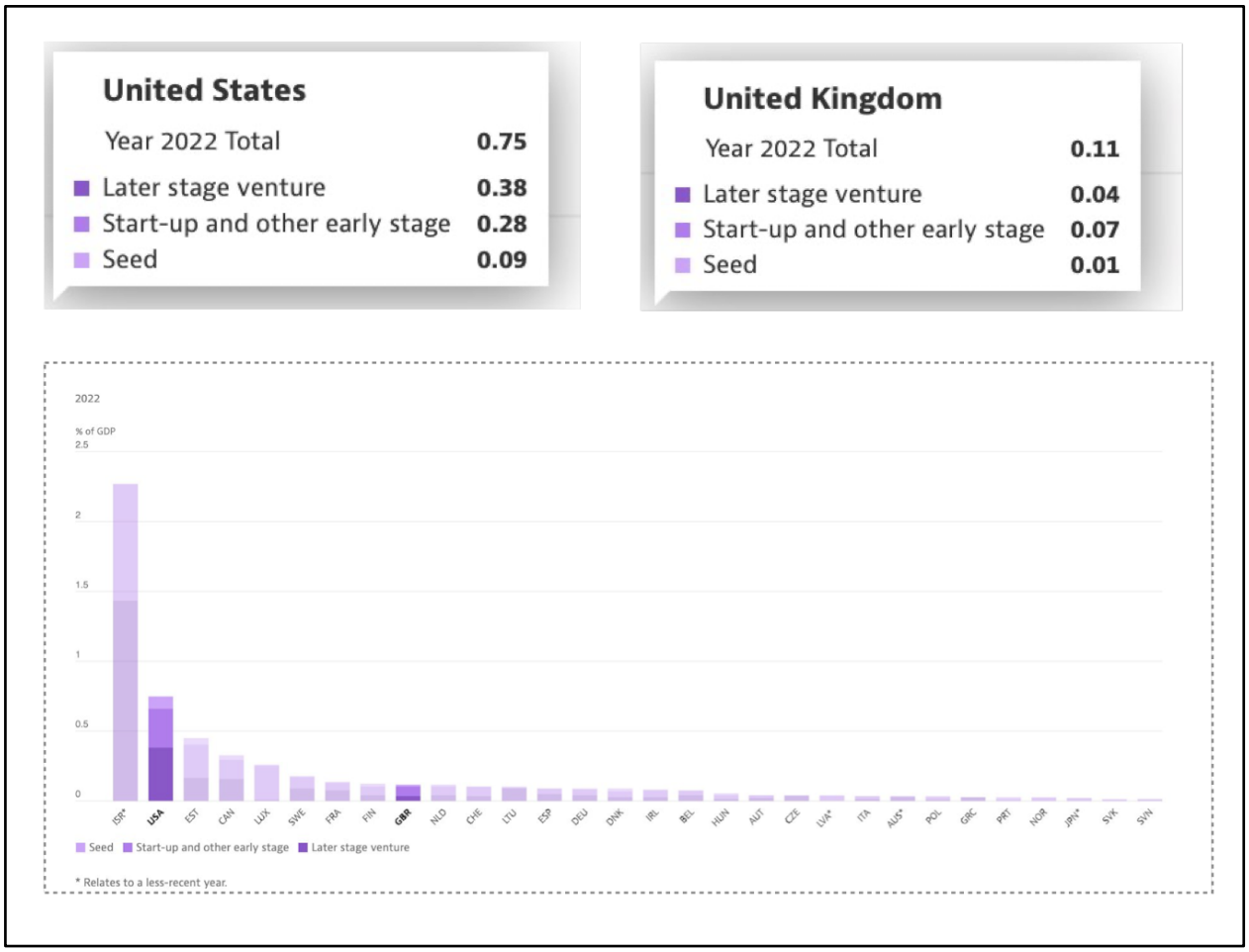

Fig. 22. Venture capital investment in the ICT sector as a share of GDP [151]

However, it is unclear whether disability is centred within US tech innovation. While companies like Waymo have partnered with disability advocacy groups [152], there are recent examples of companies like Google (also an Alphabet company like Waymo) facing discrimination lawsuits from disabled employees while centring accessible and inclusive design in their marketing campaigns [153]. Neuralink, Elon Musk's BCI company, promotes benefits for paralyzed individuals while facing scrutiny from the federal government, including from the FDA for its experimentation with animals [154], [155]. Moreover, as previously mentioned, the ICT industry has campaigned to relax federal accessibility procurement requirements, indicating a lukewarm commitment to accessibility [156]. However, the US scores a 3 on the technology factor, given the overall strength of its tech and innovation sector which facilitates DigAT adoption.

Likert Score: 3

Kenya

Kenya is a growing technology hub that has earned its epithet "Silicon Savannah" [157]. The country is home to a strong ICT sector enabled by state-of-the-art submarine fibre optic cables, internationally recognized domestic start-ups like M-Pesa, and R&D centres for multiple multinational corporations. Most recently, Microsoft and G24 invested $1 billion USD in a comprehensive digital initiative in Kenya that includes local language AI model development and AI digital skills training [158]. This only enhances Kenya's growth potential as a country whose capital city, Nairobi, already boasts an estimated $1 billion tech ecosystem [157].

These broader investments are reflected in targeted support for DigAT. In 2019, Kenya launched Africa's first AT accelerator, Innovate Now, in partnership with UK AT 2030 and the GDIHub, to support early-stage start-ups [159]. The Ministry of Health also established a Centre of Excellence with WHO on assistive technologies headquartered at the Jomo Kenyatta University of Technology [160]. The Centre of Excellence facilitates technology transfers and knowledge spillovers that enhance domestic manufacturing of DigAT while training university students to become professionals in the field. Kenya now has the most DigAT solutions on the continent [161], with the most common products reported as information devices at 20%, followed by mobility aids at 13% [100]. These products range from AI4KSL's AI solution that translates spoken English to Kenyan Sign Language for deaf users to Totosci's cane that uses smartphone image recognition to support visually impaired individuals [161].

Still, critical challenges exist. Interviewees shared that sustainable financing is limited, particularly at the growth stage. Furthermore, the dearth of structured local data impedes development of AI tools that are tailored to the local context [162], increasing reliance on foreign multinational corporations.

In sum, Kenya's DigAT ecosystem is promising but there are still critical funding and data gaps that are barriers to growth.

Likert Score: 2

India

India's AT ecosystem thrives on the triple helix model. A good example is the collaboration between the Centre for Assistive Technology and Innovation (CATI) and AT developers and its links with top institutions like the Indian Institutes of Technology (IITs), Indian Institutes of Management, and National Institutes of Technology for technology and product development. CATI also fosters AT entrepreneurship by engaging students and start-ups through internships and joint activities [74]. In addition to DEPwD support, the government also backs DigAT innovation through the Department of Science and Technology (DST) [163] and policies like Make in India and Digital India [164]. International collaborations further strengthen the AT ecosystem, especially through IIT Madras' TTK Center for Rehabilitation Research and Device Development (R2D2), which partners with various institutions such as the GDI Hub [165]. Notably, the government plans to create an "Assistive Technology Hub" to make India a leader in AT R&D [166].

India's AT sector receives funding from university grants and partnerships like SICA, government grants and CSR initiatives [167]. The AssisTech Foundation (ATF) aids start-ups in scaling and market entry [168]. However, India's AT start-ups face a fragmented ecosystem [169], lack mainstream recognition, and have limited market access [170]. These challenges mean that innovative research within universities often fails to reach commercialization.

Advancements in AI and ICT drive the future of AT development in India. Companies like NeuroLeap develop brain-computer interfaces [171], and Wysa [172] offers personalised services. Wearable devices and smart prosthetics are also advancing, such as Robo Bionics' Grippy [173]. Additionally, AR and VR technologies are being applied; for example, Vifr Tech, a member of ATF Cohort 5 acceleration program, uses VR in its Halara platform for the special education and training of individuals with neurodevelopmental conditions, including autism [174].

While the Indian technology ecosystem is growing quickly, its support of DigAT and accessibility in various contexts is not yet fully mature.

Likert Scale: 2

E. Legal Factors

United Kingdom

The UK's legislative history on disability stretches back to the Second World War [175]. Major legislation includes the 1944 Disability Employment Act, the 1970 Chronically Sick and Disabled Persons Act, the 1986 Disabled Persons Act; and the Disability Discrimination Act 1995. Subsequently, the 1995 Act was rolled into the Equality Act 2010 to bring consistency across anti-discrimination laws and the processes surrounding them (e.g. complaints) [176]. However, the UK has no legislation specifically targeting assistive technology. Public bodies are required to provide their content and services in accessible formats by the Public Sector Bodies Accessibility Regulations 2018 (PSAR) [177], but such provisions do not formally apply to private sector businesses. Instead, the accessibility of businesses is covered by the "reasonable adjustments" provision of the Equality Act.

The UK ratified the UN Convention of the Rights of Persons with Disabilities in 2009, thereby agreeing to protect and promote the human rights of disabled people [178]. However, in 2016 the UK was investigated by the UN Committee on the Rights of Persons with Disabilities (UN CRPD); the Committee found that "grave and systemic violations" of disabled people's rights had taken place due to the UK's welfare reforms [179]. The government in 2016 largely dismissed these findings. In April 2024, the UN CRPD conducted a follow-up investigation and found that "no significant progress" has been made to rectify the 2016-era violations and documented evidence of regression [180]. Put into context with the government's recent push for additional benefit reforms, these violations represent peril for the nation's disabled people and their ability to access the employment, services, and assistive technology that they require and deserve. According to the Digital Accessibility Rights Evaluation (DARE) Index from the Global Initiative for Inclusive ICTs, the UK's capacity to implement accessible ICT is significantly lacking, placing it at a global ranking of 14 in 2020 (Fig. 23) [181]. As a result, there are concerns that the UN CRPD has not been sufficiently integrated into the UK's domestic legislation, and advances in legal protections are a key part of the Disabled People's Manifesto [115].

Likert Score: 1

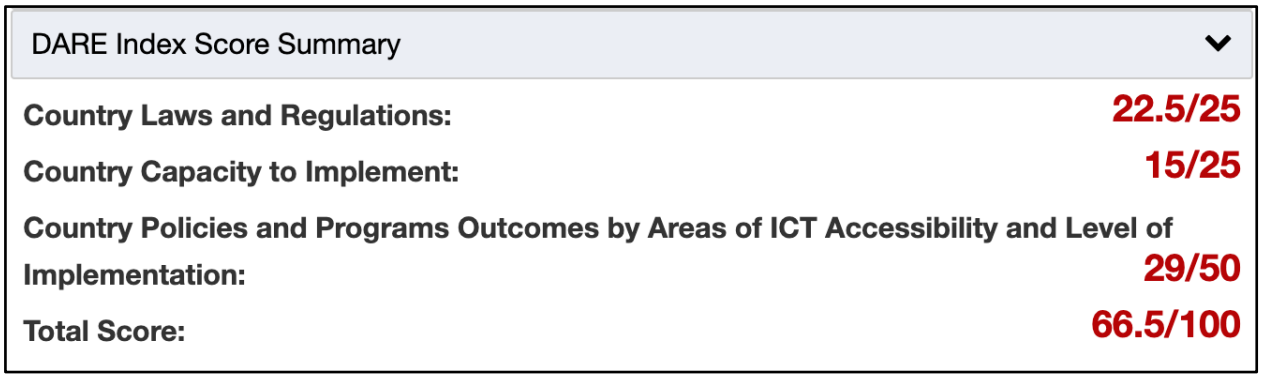

Fig. 23 DARE Index Score Summary, United Kingdom [181]

United States

Disability rights and accessibility are encoded into US federal law, with major legislation passed beginning in the 1970s followed by periodic revision. For example, the 1973 Rehabilitation Act was amended in 1998 to include Section 508, which requires federal agencies to ensure that their information technology is accessible and designates the Federal Communications Commission (FCC) as the appropriate regulator [56]. The landmark Americans with Disability Act (1990) marked a historic achievement for disability advocates by outlawing discrimination and mandating appropriate accessibility. With respect to ICT, the 2010 Communications and Video Accessibility Act (CVAA) "update[d] federal communications law to increase the access of persons with disabilities to modern communications" [39]. In 2023, a successor to CVAA was introduced by Senator Ed Markey (D-MA) and Representative Ana Eshoo (D-CA) to ensure access to emerging technologies for disabled Americans [182].

Despite robust legislative frameworks for disability and accessibility, it remains a question whether US law is keeping up with the rapid pace of technological innovation. The convergence trend observed by the WIPO between "technologies, disciplines, and markets" may complicate the legislative and regulatory frameworks in place [4, p. 14]. For example, while AT are traditionally external devices, implant-based AT can be internal and more akin to medical devices, which fall under different regulatory jurisdictions (FDA) and requirements [4, p. 14]. Nevertheless, the case of Neuralink offers some evidence that the existing frameworks are adequate. In

response to safety and transparency concerns, the US Securities and Exchange Commission was requested to investigate Neuralink, and the FDA has issued citations, demonstrating existing regulatory mechanisms can conduct oversight over an emerging AT company [155], [183]. Furthermore, Neuralink has had to secure FDA compliance for continued testing of its BCI technology [184]. While US regulatory and legislative frameworks may be challenged by emerging DigAT, with adequate enforcement and oversight, existing regulatory regimes may be robust enough to meet the challenge. The US legal factor scores a 2 to indicate the robustness of legal protections for disability and accessibility.

Likert Score: 2

Kenya

Kenya has built an increasingly comprehensive legislative framework around disability rights. The government initially outlined these rights in the aforementioned 2003 Disability Act [61]. Kenya's 2010 Constitution codifies protections by outlawing discrimination and asserting the right to access education, facilities, and information, and specifically grants persons with disabilities the entitlement to assistive devices [58]. Kenya ratified the UN Convention of Rights of Persons with Disability (CRPD) in 2008 and replaced the 2003 Act with the 2021 Disability Bill to facilitate compliance with the Convention [61].

While Kenya lacks specific AT laws, it has integrated accessibility considerations into ICT sector legislation. The 2010 Universal Access and Service Regulation and 2016 Access to Information Act build upon the Constitution to promote universal access to information and establish procedures for citizens to lodge complaints and receive assistance [185]. The National 2019 ICT Policy has a 12-point section (6.1.4) on accessibility, which includes requirements on early-stage inclusive design and government website accessibility [186]; the 2020 ICT Guidelines aim to support the implementation of this policy [185].

The fourth schedule in the 2010 Constitution grants counties the authority to enact local laws in compliance with the Constitution and international agreements, including the CRPD. A 2022 legal review found promising advances in this direction,

like Nairobi aligning the definition of disability with CRPD and Kisumu establishing a disability development fund. However, concerns persist regarding inconsistent interpretations of disabilities and lack of county-level implementation [187].

The 2020 DARE index ranks Kenya as 11th globally with a score of 70/100 (Fig. 24) [188]. Opportunities for improvement primarily reside in implementation, which is an area of focus in the 2022-2026 Rehabilitative Services and Assistive Technology strategy. In sum, Kenya has a strong legal framework on digital accessibility with opportunities to create specific AT legislation and improve implementation.

Likert Score: 2

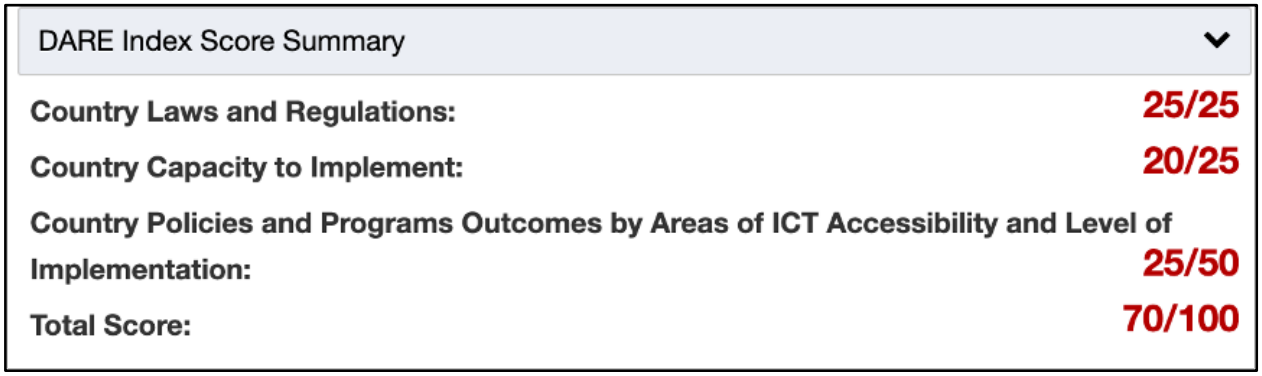

Fig. 24. DARE Index Score Summary, Kenya [188]

India

Overall, India has a comprehensive legal system but faces implementation challenges.

The 1995 Persons with Disabilities Act (PDA) marked India's first major disability rights legislation [189]. In 2007, India ratified the UNCRPD, shifting from a medical to a social view of disability [2]. The 2016 RPwD Act replaced the PDA to align with the UNCRPD and address its shortcomings [190]. It expands the set of recognized disabilities to 21, guarantees free education for children with disabilities, and mandates adaptive facilities. The Act also prohibits discrimination, ensures legal equality, mandates accessibility, and provides access to social security, healthcare, and property rights [191]. However, Arman Ali, Executive Director of NCPEDP, notes

that the RPwD Act remains largely unimplemented, with over 15 states yet to draft necessary rules in 2020 [136].

The Digital Personal Data Protection Act (DPDPA), passed in August 2023, is India's first comprehensive data protection law. It governs digital personal data processing for services offered to individuals in India, both domestically and internationally [192]. Unlike the GDPR, it is more consent-centric, applies uniformly to all personal data, and sets the age of consent at 18 [193]. Requirements include obtaining consent, granting data principals rights to access, correction, erasure, and conducting data protection impact assessments [192].

IP Protection is also robust. Patents, under the Patents Act, 1970 (amended in 2005), have a 20-year term and follow a "first-to-file" system [194]. Trademarks, under the Trade Marks Act, 1999, are valid for 10 years and can be renewed indefinitely [195]. Copyrights, under the Copyright Act, 1957 (amended in 2012), are protected for the author's life plus 60 years [194]. Designs, under the Designs Act, 2000, are protected for 10 years, renewable for 5 years [195].

Likert Score: 2

IV. Discussion

A. PESTL Analysis Key Takeaways

Our comparative PESTL analysis yields four observations that cut across the four considered jurisdictions.

First, while disability rights and accessibility enjoy broad support, governments struggle with implementation and enforcement. Countries take unique approaches to address this common challenge. Kenya's 2022-2026 Strategic Plan, for example, centralises the role of the government as the key coordinator of the AT ecosystem. County-level legislation is inconsistent but aims to enhance implementation at the local level. In the US, while sweeping federal legislation on disability rights and accessibility exists, funding and enforcement also remains uneven. Similarly, the UK's track record on safeguarding the rights and well-being of disabled people is weak; ensuring that the provisions of the UN CRPD and Equality Act are upheld is of paramount importance; without a baseline of equal rights for disabled people, other approaches to incentivize DigAT will struggle.

Second, promotion of the overall innovation ecosystem is important to facilitate the development, commercialisation, and roll-out of DigAT and other emerging technologies. The better-developed venture capital ecosystem in the United States includes targeted funds that are specifically tailored to incentivise innovation in mission-oriented areas like disability tech—an example in the UK is Ada Ventures, which has healthy ageing as one of its focus areas [196]. In both the US and UK, DigAT is not centred as a primary focus of the technology ecosystem, so governments could provide incentives to help crowd-in private investment or initiate public-private partnerships in the technology funding ecosystem. There are large economic benefits associated with investing in assistive technology—DigAT that increases well-being and independence can result in significant cost-savings on social care and medical expenses as well as higher productivity [197]. As a result, it is worthwhile for countries to invest in this space—for instance, in Nairobi and Bangalore, Kenya and

India's respective tech hubs, we can see the growth of disability tech-oriented start-ups alongside conventional technologies.

Third, the use of inclusive design practices in the development of emerging technologies (including DigAT) is crucial to ensure that their improvements for quality-of-life and economic productivity are shared across the population regardless of disability. Inclusive design refers to the practice of developing mainstream technologies such that they are accessible and useful for users with varying levels of functional capabilities (Fig. 25) [198]. Interviewees emphasised that consulting disabled people early in the design process rather than retrofitting technologies post-release helps identify real pain points and create solutions that serve a wider user base. These shifts can produce a "curb-cut effect", where the larger population benefits from small design changes like parents with strollers benefitting from the curb-cuts advocated by wheelchair users in 1970's California [199]. Participatory design (PD) is one approach that facilitates inclusion by actively involving end-users in creating technology. A 2018 Study in Western Kenya showed the promise of PD through using a Do-It-Yourself (DIY) DigAT prototyping platform that allowed users to modify tools to their application [200]. This approach not only increased participant engagement but also serves as a low-tech solution in resource-limited areas.

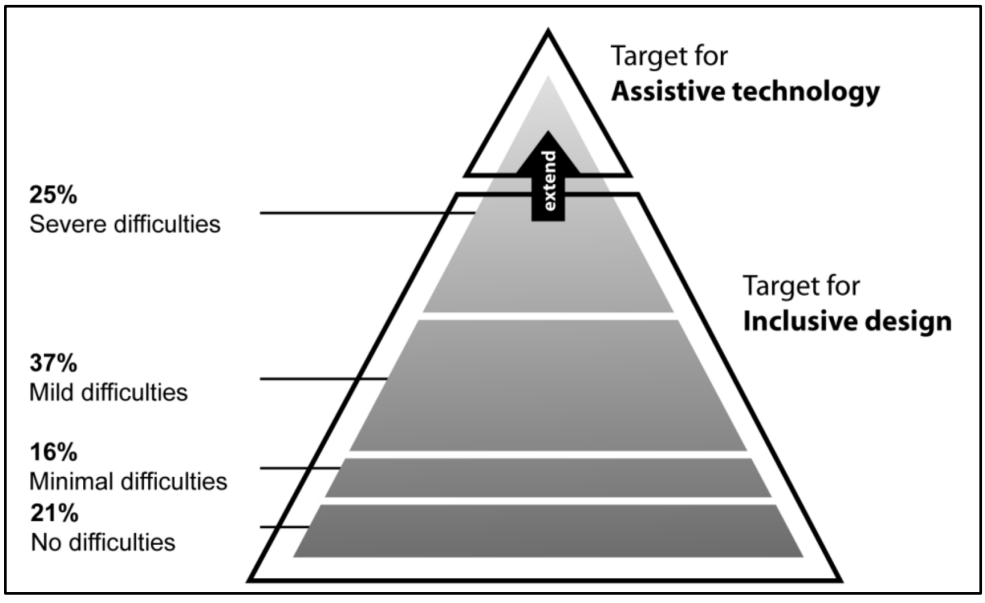

Fig. 25. Inclusive Design Pyramid [198]

Finally, the health of the overall economy has implications for DigAT adoption. The UK government's long-standing austerity policies and the cost-of-living crisis compound pre-existing inequalities and barriers to the access and adoption of DigAT. There are serious financial costs associated with being disabled in the UK, and disabled people have been disproportionately impacted by the reforms to welfare benefits, with many ending up near or in poverty. These challenges are not unique to the UK—both Kenya and India experience significant levels of poverty, especially among disabled people, which limits their ability to access DigAT. In contrast, the United States has had a strong recovery from the pandemic and can therefore spend more on disability payments, thereby potentially generating more demand for DigAT. These considerations are crucial to support DigAT—without a sufficiently strong economic foundation, adoption of DigAT may languish despite its benefits.

B. Ethical Considerations

As emerging assistive technologies such as intelligent AT become commercially available, it is crucial to ensure that technology does not outpace ethical considerations, given the vulnerability of end users.

Product Development: Informed Consent and Data Bias

The development of emerging technologies, whether mainstream or assistive, pose significant ethical questions with real-world implications. Inclusive design practices help integrate perspectives of end-users; however, to collect this information, it is critical for developers to abide by research ethics guidelines. Informed consent is one key tenet that is particularly important when working with disabled individuals to ensure transparency and prevent exploitation [201]. Novel technologies like Neural Interfaces can challenge whether informed consent is a strong enough safeguard in the context of cognition augmentation of users with mental disabilities [202].

On the other hand, creating significant barriers to the inclusion of disabled people in testing may threaten the value of emerging tools. For example, the performance of AI-enabled AT is strongly correlated with the amount of data on which the models are trained [203]. Data on disabled people is already limited due to population prevalence, leading to well-documented issues on biased datasets [162]. Open-source initiatives can be used to increase access to data and enhance participation of communities with varying ability levels. Still, this must be balanced with considerations of data privacy.

Product Use: Data Privacy and Trust

Data privacy is another key DigAT ethical issue due to the increasing convergence of AT with medical technologies. For example, wearables that track health statistics about users, Internet-of-Thing (IoT) devices that monitor home environments, and implant-based technologies all pose serious privacy concerns [204]. The collection of detailed data could lead to the use of personally identifiable information (PII) and personal health information (PHI) to identify individuals based on specific information, habits, or behaviours. Even without a security breach, the ownership and usage of this data is a serious ethical concern: private-sector companies might

claim the right to freely use or even sell such data without their users' consent [205]. Even the NHS has been urged to sell its "anonymised" data to increase funding and private-sector innovation, though this has faced significant criticism [206]. This presents a trade-off between the use of new technologies for quality-of-life improvements and trust and privacy concerns, which are notable barriers for elderly people [207]. As noted by Dr Hamied Haroon in an interview, DigAT presents both great promise and peril, and should be proactively managed in terms of ethical considerations.

Equitable Access

There is also the well-documented issue of equitable access to emerging technology, including DigAT. Disparities in access exist across incomes, regions, and protected characteristics like race, age, and gender.

In general, disabled people suffer from disproportionate levels of poverty. When emerging technologies are in the early stages of the innovation diffusion model, they are likely expensive [208]. Disabled people, with higher costs and lower disposable income on average, are less likely to have access to these technologies, especially if they must purchase it themselves [209]. For example, 36.9% of surveyed people in India indicated affordability being a major barrier to assistive tech and 90.9% of users purchase devices privately with only 4.9% receiving government support [210].

In addition, regional and global disparities in access to digital infrastructure have significant impact—for instance, over 70% of Kenyans with mobile phones have feature phones, which lack the necessary components to benefit from the most modern smartphone-based DigAT [162].

Ecosystem Misalignment

Ethical issues also arise from the significant philosophical differences between the viewpoints of disability advocacy groups and the developers of these technologies. Technologists' drive for constant optimization has translated into the transhumanist and "biohacking" movements popular among influential Silicon Valley figures to enhance human cognitive and physical abilities through human-machine hybridisation [211]. This attitude may pose serious conflicts with disability advocates'

proposed social model of disability. In this model, individuals do not possess disabilities that need fixing; rather, society disables people through its hostile barriers to accessibility. This viewpoint contrasts with the quest to build a human-machine cyborg, in which the human mind and body are considered inherently deficient compared to the perceived superiority of machines.

This drive toward optimization is shared by the Effective Altruism movement, a philosophy that has gained traction among influential members of the tech community (including the leaders of Anthropic, a top generative AI company) [212]. EA principles are based on optimization of resources and effort to do the most good for the most people–a utilitarian view that has led to friction with disability advocates [213]. Prominent EA advocates have stated attitudes towards disabled people that have been criticised as eugenicist [214].

As AT increasingly converges with general purpose tech to become enhancing rather than assistive, this philosophical divide between the tech and disability community may become a serious ethical conflict. It raises questions such as whether uptake of enhancing emerging technologies for disabled persons will become obligatory, whether opting out will be stigmatised, and whether we face the erasure of an important aspect of human diversity. Already, there are questions about whether ultrasound screening technology for Down Syndrome and allowing for pregnancy termination in cases where the foetus is found to have the disability constitutes a form of discriminatory eugenics [215].

C. Policy Recommendations

Integrating the key takeaways and ethics discussion, we focus our recommendations on two main themes we identified in our research: the design and development of DigAT and the effective distribution and roll-out of DigAT. We propose four recommendations for how the UK could better support its DigAT ecosystem.

First, the UK should enhance the implementation and enforcement of legislation to support the economic resilience, independent living, and access to DigAT of disabled people. Economic stability is crucial for the successful distribution of DigAT—if disabled people are struggling to buy weekly necessities or pay rent, demand for assistive technologies will likely suffer. Consulting with DPOs to advance policies can increase the financial independence of disabled people while supporting the adoption of DigAT. Better engagement with local authorities and market innovators could help solve critical issues like cost constraints and last mile service provision. Standardised guidelines for implementing accessibility regulation will be essential to promote consistent enforcement, quality assurance, ecosystem coordination, and monitoring. As a matter of national pride, the UK should heavily focus on improving its treatment of disabled people and conclude its investigation under the UN CRPD.

Second, the UK should work to further promote its strong innovation ecosystem, with a particular focus on incentivising the research and commercialisation of DigAT. This may call for the adoption of a "mission-oriented" approach to innovation policy [216]—focusing on market-shaping and creation by incentivising the public and private funding, resources, and activity towards desired goals rather than fixing market failures [217]. Concretely, this requires public investment along the whole innovation chain, not only at the fundamental research level. This "mission-oriented" approach could help fill the gap in scale-up funding for start-ups, especially in more niche industries like DigAT. To this end, the UK could use public investment funds to more clearly signal government priorities and thereby crowd-in private investment and innovation. Prizes also offer a method to set up mission-oriented policies—the Longitude Prize on Dementia is a good example [218]. Government procurement could play a large role as well—by streamlining the provision of DigAT through the health and social care systems, resources could be channelled to support innovation

solutions and limit market fragmentation [197].To reiterate, it is crucial that these policies that set strategic direction involve end users, especially disabled people and DPOs, in order to effectively incorporate their viewpoints and verify that the targeted outcomes are truly desirable.

Third, the UK should include disabled people's voices throughout the development of regulations and technologies. Adopting a consultative approach in the development of DigAT regulation will be crucial to ensure policies effectively serve the needs of the disabled community. For instance, the UK should engage with the Disability Charities Consortium, the Disabled People's Manifesto, and other DPOs to ensure a regulatory approach of co-production of policies and programmes at both the national and local levels. This participatory design principle extends to product and service development as well—the UK could strongly encourage or even mandate that technology companies engage in inclusive design practices as part of their standard product design process for any technology meant to serve the wide population. The above-mentioned issues of informed consent and equitable access are key considerations in this process and will need to be balanced against the potential of top-down regulatory requirements to discourage innovation.

Finally, the UK should work to improve the efficiency, consistency, and scale of the systems for the provision and procurement of AT across the nation. By investing in these systems, the UK can promote equal access to DigAT, better enforce accessibility requirements for procured technologies, and improve coordination among the various actors. As an example, the Accessibility Passport initiative from Make Things Accessible provides a toolkit to standardise processes for ensuring accessibility in public procurement [219] and could be used as a blueprint for a consistent, accessible procurement process across all levels of government. A network analysis of the UK government's role in procurement processes would also be useful to understand its current position and inform approaches to better streamline communications and implementation in the AT ecosystem.

D. Conclusion

In sum, this report provides a policy factors assessment of the DigAT ecosystem in four distinct country cases to provide recommendations for the UK's adoption of DigAT. Given the rapid pace of technological advancement, particularly the introduction of emerging technologies such as AI into DigAT, it is critical for UK policymakers to strike a balance between encouraging the adoption of DigAT (via innovation and procurement policies) and ensuring that ethics and safety considerations are built into the development, use and regulation of DigAT. Proactive collaboration with disability advocacy groups and incentivizing industry actors to do so are key for the UK government to successfully navigate this policy challenge. Strengthening implementation and enforcement of existing regulatory frameworks would go a long way toward facilitating responsible DigAT adoption. Perhaps the most critical challenge for the UK government is to address the cost-of-living crisis and reconsider austerity policies as they disproportionately impact the disabled community's quality-of-life and ability to access DigAT.

For further research, we suggest that the comparative PESTL analysis be extended to other jurisdictions of interest, such as the EU, South Korea, Japan and China, given their advanced tech sectors and similar levels of economic development to the UK. It may also be insightful to create a complete PESTL-based policy factors index for more comprehensive, quantitative comparisons.

We hope that this international comparative analysis will provide a useful background in the context of the Royal Society's larger project on Digital Assistive Technologies and that the policy recommendations facilitate responsible and equitable DigAT adoption in the UK.

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