

Mada's effort in the localization of Assistive Technology and Digital Accessibility A Gateway to Sustainable Inclusivity

Achraf Othman

Mada Qatar Assistive Technology Center, Doha, P.O. Box 24230, Qatar
aothman@mada.org.qa

Abstract- The role of technology in promoting inclusivity for individuals with disabilities is increasingly recognized in today's digital age. However, a critical aspect often overlooked is the intersection of localization, assistive technology, and digital accessibility in fostering a sustainable and inclusive digital environment. This paper aims to elucidate the importance of localization in assistive technology and how it is intrinsically linked to the broader goals of sustainability. An exemplary initiative in this realm is Mada's series of projects, including the Tawasol Symbols, Unified Arabic Braille, Jumla Sign Language, WCAG 2.1 Arabic Authorized Translation, and the Mada Glossary. These endeavors are geared towards localizing assistive technologies and solutions to cater to the specific needs of the State of Qatar and the Arab region.

Keywords- Localization; Assistive Technology; Digital Accessibility; Sustainability; Inclusivity

1. Introduction

The digital age, as an outcome of the fourth industrial revolution, marked by unprecedented technological advancements and global connectivity, offers profound opportunities for societal transformation where artificial intelligence became a key stone in all domains [1]. At the heart of this evolution lies the potential to foster inclusivity and bridge the divides that have historically marginalized certain segments of the population, notably individuals with disabilities. The democratizing power of technology has made it possible for these individuals to access, participate, and contribute to the digital realm in ways previously unimagined. However, while the potential of technology as a force for good is universally acknowledged, its real-world implications and benefits are not uniformly distributed. For technology to be truly inclusive, it must resonate with the cultural, linguistic, and individual needs of its users. A one-size-fits-all approach, though often convenient, can inadvertently overlook the unique challenges and requirements of specific communities or regions [2].

Assistive technology refers to any device, software, or equipment specifically designed or adapted to maintain, increase, or improve the functional capabilities of individuals with disabilities. It encompasses a wide range of tools, from simple adaptive devices such as ergonomic grips or magnifying glasses to more sophisticated digital solutions like screen readers, voice recognition systems, and customized computer interfaces. The primary purpose of assistive technology is to enhance the independence, productivity, and participation of people with disabilities in everyday tasks and activities [3].

Enter the concept of localization – the process of adapting a product or content to meet the language, cultural, and other requirements of a specific target market or region. In the context of assistive technology, localization transcends mere translation. It encompasses the adaptation of technological tools to ensure that they are culturally appropriate, sensitive, and effective in meeting the unique needs of individuals with disabilities in different regions.

The State of Qatar recognizes the profound impact of digital inclusivity on societal well-being and economic prosperity. And at the forefront of this movement in Qatar is Mada, the Qatar Assistive Technology Center. Through its groundbreaking initiatives, Mada has championed the cause of digital accessibility, ensuring that technological advancements are not just widespread but also deeply rooted in the local context.

This paper delves deep into the symbiotic relationship between assistive technology, digital accessibility, and localization. Using Mada's pioneering projects as a lens, we will explore how tailored technological solutions can drive sustainable inclusivity in the digital realm.

2. The Imperative of Localization for Assistive Technology

The experience of disability is not a monolithic one; it is inherently influenced by the cultural and linguistic contexts in which individuals with disabilities find themselves. Cultural norms, values, and societal structures play a pivotal role in how disability is perceived and experienced across various communities and regions. At the core of understanding disability is the recognition that every culture has its own set of beliefs and practices concerning health, well-being, and disability. These beliefs often determine the level of societal acceptance, access to resources, and overall quality of life for individuals with disabilities [4].

Linguistic diversity further complicates the disability experience. Language not only shapes how we communicate but also how we perceive the world and our place within it [5]. For individuals with disabilities, the availability of assistive technologies and services in their native languages can significantly impact their ability to engage with digital platforms and their broader communities. A lack of localized assistive tools can inadvertently exclude non-English speakers or those from linguistically diverse backgrounds from fully accessing digital content [6]. Moreover, certain languages might have rich vocabularies and terminologies for expressing various sensory experiences, emotional states, or physical conditions which can be pivotal in designing assistive tools [7]. Not accounting for this linguistic diversity can lead to a misrepresentation or misunderstanding of the disability experience for many.

To ensure true inclusivity, it is paramount to consider the rich tapestry of cultural and linguistic diversity present within the global disability community. Doing so not only promotes greater equity but also enriches our collective understanding of the myriad ways disability can be experienced and addressed across various contexts.

The lack of localization often results in tools that, while technically functional, can prove ineffective or even detrimental when applied in diverse cultural and linguistic contexts. Here are a selection of case studies highlighting the pitfalls of non-localized assistive technologies:

- **Screen Readers and Non-English Web Content:** A notable example is the experience of non-English speakers with popular screen readers that primarily cater to English-speaking audiences. When deployed on websites with content in languages that follow different

syntactic or grammatical rules, these screen readers often mispronounce words or read content out of its intended order. Such discrepancies can confuse users, rendering the digital content inaccessible or incomprehensible [8].

- **Voice-Activated Systems in Diverse Accents:** Voice recognition technologies, when not localized for diverse accents or dialects, often struggle to decipher and process commands accurately. For instance, users from regions with distinct accents, like parts of Africa or Southeast Asia, have reported challenges in using voice-activated systems that are not trained on their specific vocal nuances. This lack of localization hampers their ability to interact with the technology effectively and might lead to feelings of exclusion [9].
- **Mobility Aids in Varied Terrains:** Assistive devices like wheelchairs or mobility aids designed primarily for urban, flat terrains might prove ineffective or even dangerous in rural or rugged landscapes. For instance, a standard wheelchair designed for paved roads can be challenging to maneuver on sandy or rocky terrains prevalent in parts of the Middle East or certain African countries. Such non-localized designs could potentially put users at risk of accidents.
- **Digital Platforms with Non-localized User Interfaces:** Digital platforms designed without considering regional customs or usability practices can be perplexing for users. For instance, a digital educational tool using left-to-right reading order might disorient users from cultures accustomed to right-to-left scripts, such as Arabic. This might make the tool less effective as an educational resource and might inadvertently marginalize users from certain linguistic backgrounds.

While assistive technologies aim to bridge accessibility gaps, a lack of localization can inadvertently widen these gaps. The above case studies underscore the necessity of tailoring assistive tools to specific cultural and linguistic needs to ensure they are truly inclusive and effective.

3. The significance of region-specific disability regulations and standards

Building on the observations from the previous section, which highlighted the challenges of non-localized assistive technologies, it becomes evident that the diverse cultural, social, and linguistic fabric of the world cannot be addressed with a one-size-fits-all approach. Rather, it necessitates region-specific regulations and standards tailored for the unique needs of individuals with disabilities within different contexts. These region-centric guidelines not only offer solutions to the pitfalls of non-localized technologies but also play a pivotal role in shaping the technological, infrastructural, and societal landscapes to be more inclusive.

Figure 1 shows a visual representation that encapsulates the five critical dimensions discussed in this section: the need for Customized Technical Requirements, the importance of Socio-Cultural Appropriateness, the drive towards Enabling Accessible Infrastructure, the intertwining Economic and Policy Implications, and the role of Advocacy and Awareness in reinforcing region-specific disability regulations and standards. The figure underscores the multifaceted nature of these dimensions and their collective significance in formulating effective and inclusive policies for individuals with disabilities.

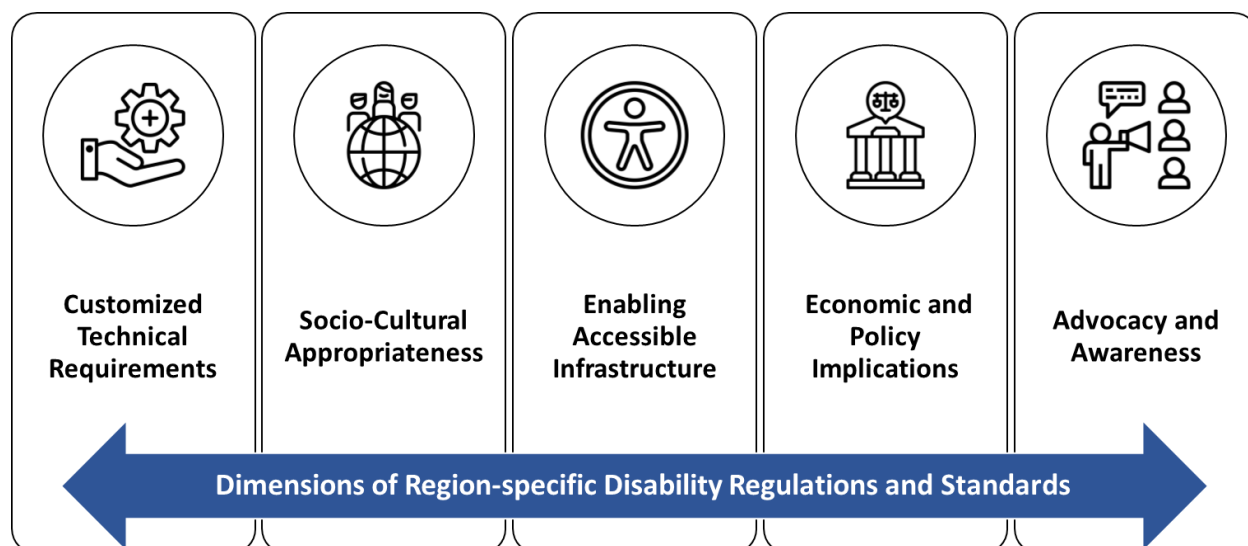


Figure 1. *Dimensions of Region-specific Disability Regulations and Standards*

In addressing the unique challenges and needs tied to each region's culture, geography, and demographics, region-specific disability standards play a pivotal role. These standards ensure that technological solutions, such as assistive devices adapted for colder climates or speech recognition software in multi-linguistic regions, cater specifically to local users. Moreover, when crafted with a deep understanding of local beliefs, customs, and societal norms, these standards are more likely to be embraced by communities. This is particularly evident in regions where stigmas associated with disabilities exist, necessitating discreet assistive tools or those incorporating local symbols and designs. Infrastructure development too is influenced by these guidelines, leading to features like accessible beaches in coastal areas or enhanced public transport facilities in urban regions. Economically, the adoption of local standards has far-reaching implications on governmental policies, efficient fund allocation, and spurring innovation in the assistive technology sector. Such standards offer businesses a clearer framework to cater to the often-underserved market of individuals with disabilities in specific regions. Beyond the tangible, these regulations also fortify advocacy efforts, offering structured pathways for advocacy groups to rally around and amplifying awareness about inclusivity and the varied challenges faced by individuals with disabilities [10].

4. Sustainability through Inclusive Digital Environments

The dialogue around sustainability has evolved to encompass more than just environmental considerations; it now significantly intertwines with the social and economic fabric of our society. At the heart of the social dimension of sustainability lies the core tenet of inclusivity. True sustainability can only be achieved when all members of society, including those with disabilities, are included in the developmental narrative. Inclusivity ensures that policies, technologies, and infrastructures are designed to cater to the broadest range of users, promoting equitable opportunities and ensuring that no one is left behind.

The economic implications of this inclusive approach are profound. Localized digital accessibility opens doors to an often-neglected market segment. The global community of individuals with disabilities is vast, and their needs present a myriad of opportunities for innovation and economic growth. By focusing on creating digital tools that are accessible and tailored to specific regional

needs, businesses can tap into this untapped market potential. This not only leads to increased revenue streams but also promotes the development of a more diversified and resilient economic ecosystem. Furthermore, when businesses cater to this segment, they inherently foster a culture of innovation, as the challenges presented by diverse needs often necessitate out-of-the-box solutions.

Lastly, the nexus between digital inclusivity and environmental sustainability is undeniable. For many in the disabled community, physical mobility can pose significant challenges. Digital tools that are accessible and tailored to their needs can reduce the necessity for physical travel, thereby diminishing carbon footprints. For instance, a visually impaired individual might benefit from an app that provides detailed auditory descriptions of their surroundings, allowing them to navigate unfamiliar territories without the need for a personal guide. Similarly, digital platforms that enable remote work or offer educational resources can diminish the environmental impact by reducing the need for transport and infrastructure. By promoting digital accessibility, we inadvertently support environmental sustainability goals, crafting a world that is more inclusive and greener.

In essence, the pursuit of inclusive digital environments is not just a noble endeavor but a holistic approach to sustainability. It interlaces the social obligation of inclusivity with the economic potential of innovation and the imperative of environmental responsibility. As we move forward in the digital age, ensuring that our tools and platforms are accessible to all becomes paramount in our collective journey towards a sustainable future.

5. Successful Integration of Localization in Assistive Technology from Mada Center

The importance of localized assistive technologies cannot be understated, as evident from our earlier discussions on the significance of region-specific regulations, sustainability through inclusive digital environments, and the various dimensions shaping accessibility. Nestled within this complex mosaic of technological and sociocultural considerations is the pioneering work of Mada Qatar Assistive Technology through the different streams of Mada Innovation Program [11]. Their endeavors offer a blueprint for how localization can be adeptly integrated into assistive technologies, ensuring that tools are not only functional but also deeply resonant with the target audience's cultural, linguistic, and societal context. Mada Center's commitment to this cause is evident in its diverse range of solutions, each meticulously tailored to address specific challenges faced by the Arabic-speaking disability community. These solutions include: Tawasol Symbols, Unified Arabic Braille, Jumla Sign Language, WCAG 2.1 Arabic Authorized Translation, and the Mada Glossary.

The success stories from Mada exemplify the profound impact of localization in assistive technology. Their solutions not only bridge technological gaps but also cultural, linguistic, and societal divides. As we journey forward in the realm of digital accessibility, the efforts of institutions like Mada Center illuminate the path, underscoring the importance of holistic, localized solutions. The subsequent sections delve deeper into each of these localized solutions, shedding light on their development, implementation, and impact.

5.1. Tawasol Symbols

A pictorial communication system, Tawasol Symbols are designed keeping in mind the cultural nuances of the Arab world, ensuring that individuals with communication difficulties can express themselves effectively and authentically within their cultural milieu.

The Tawasol Symbols project's aim was to develop a freely available Arabic Symbol Dictionary suitable for use by individuals who have a wide range of communication and language difficulties and to develop a set of symbols that are culturally, linguistically, and environmentally appropriate for AAC users in Qatar and the Arab countries [12]. The Tawasol Symbol dictionary contains until today 1600 localized symbols [13]. There are many reasons for introducing a new set of localized symbols in the Arab World such as the vast differences in linguistic structures between the Arabic and English languages, which can be confusing and generate fragmented sentences, as illustrated in Figure 2.



Figure 1. *Differences in structure between Arabic and English languages*

In 2020, Mada Center launched a new initiative to provide researchers working on the use of Augmented Reality to improve communication skills of children on ASD. The aim of the project is designing a set of existing symbols in three dimensions. The library is useful to develop new applications using Augmented Reality technology. The 3D symbols are provided under the creative commons license. Until today, 200 3D symbols are available for download.



Figure 4. *An example of a 3D Tawasol Symbol from different angles*

5.2. Unified Arabic Braille

Addressing the challenge of multiple Braille systems across the Arab world, the Unified Arabic Braille initiative aims to standardize the Braille script for Arabic, enhancing its accessibility and

usability across the region [14]. The Unified Arabic Braille Portal from Mada Center, Qatar, aims to develop the Arabic Braille table in math and science signs/ symbols, as well as to develop the first eight-dots Arabic computer braille table to take advantage of its multiple features, such as writing or reading a single code in a single cell and supporting some computer signs. Braille is the only way that enables blind or blind-deaf people who have difficulty accessing printed materials to read and write using assistive technology. The portal will benefit the blind, deaf-blind people, experts, teachers, students, software developers, and assistive technology manufacturers in Qatar and abroad [15].

5.3. JUMLA Sign Language

Recognizing the diversity and richness of sign languages, Jumla offers a unified approach tailored for the Qatari/Arabic-speaking deaf community, ensuring that communication barriers are minimized, and cultural relevancy is maintained. As well as all spoken languages, Sign Languages SL have structured grammar and syntax. Even though it is visual, multi-dimensional and mainly based on gestures, sign languages follow specific grammatical rules. Consequently, the automatic generation of sign language should follow these rules. It's for this reason that Mada works on the development of a new framework that aims to support researchers and developers to create new innovative tools for the deaf. The objective is essentially to create tools that enhance the development of software using grammatically validated sentences. The main features of the project are: (1) a localized sign language virtual interpreter (avatar) called BuHamad [16] (2) a dataset containing more than 6300 sentences in sign language [17] (3) tools and codes for sign language annotations, synthesis and recognition [18].

5.4. WCAG 2.1 Arabic Authorized Translation

Accessibility guidelines are pivotal in shaping inclusive digital landscapes. Mada Center's translation of the Web Content Accessibility Guidelines (WCAG) 2.1 into Arabic ensures that web developers and designers in the Arab world have a clear roadmap to create inclusive digital platforms.

Since January 2020, Mada led the Authorized Arabic Translation of WCAG 2.1 with the support of W3C Chapters of GCC and Morocco and the Reviewers' Committee members from 49 organizations. Web Content Accessibility Guidelines cover a wide range of recommendations for making Web content more accessible. Following these guidelines will make content more accessible to a wider range of people with disabilities, including accommodations for blindness and low vision, deafness and hearing loss, limited movement, speech disabilities, photosensitivity, and combinations of these, and some accommodations for learning disabilities and cognitive limitations; but will not address every user need for people with these disabilities. These guidelines address the accessibility of web content on desktops, laptops, tablets, and mobile devices. Following these guidelines will also often make Web content more usable to users in general.

5.5. Mada Glossary

Language is a powerful tool, and the Mada Glossary serves as a repository of terms related to digital accessibility, ensuring that discussions and initiatives in the field are grounded in clarity and mutual understanding [3]. The main objective of developing the glossary is to promote

innovation in the Arabic language in various fields of technology. The glossary provides a list of terms in Arabic and English to help stakeholders, experts, innovators, parents, users, teachers, students, therapists, and related institutions understand key terms related to ICT, digital accessibility, and Assistive Technology (AT) to achieve the Mada's vision to improve ICT accessibility. Subsequently, effectively unleashing the potential of all persons with disabilities and the elderly through capacity-building and supporting the development of accessible digital platforms in Qatar and the world. The glossary includes technical terms that could be used in developing scientific papers and general articles by authors to produce scientific and academic resource content in Arabic among other languages.

Due to the infancy of Arabic digital resources related to ICT and digital access for persons with disabilities, Mada sought to launch a specialized glossary to improve the knowledge and quality resources of assistive technology solutions in the Arabic language. This will help establish a more well-versed society in line with the Fourth Industrial Revolution, artificial intelligence, and all that is new in the field of innovation. Furthermore, this resource will help raise awareness related to inclusive digital accessibility and highlight the role of Mada as a key contributor towards capacity building in the field of Digital Accessibility and AT in Qatar and the region.

Mada's Glossary consists of 354 terms, each of which provides a concise definition of matters related to persons with disabilities, accessibility, and technology. Mada seeks to expand this project to its next stages by adding more terms available in various languages. The resource is now available online, free of charge, through Mada's web presence, providing a much-needed resource for People with Disabilities, caregivers, therapists, technologists, policymakers and academics interested in the field.

6. Challenges and Opportunities

As regions and societies navigate the intricacies of creating inclusive environments, they are met with both hurdles and prospects for innovation. Understanding these challenges and opportunities is instrumental in shaping a future where technology truly serves all.

6.1. Challenges

- **Diverse Needs Within Disability Communities:** Disability is not monolithic. The spectrum of needs within the community is vast, and designing one-size-fits-all solutions can often lead to exclusionary practices.
- **Rapid Technological Advancement:** As technology evolves at an unprecedented pace, there is a constant race to ensure that assistive tools and platforms remain updated, relevant, and accessible.
- **Cultural and Linguistic Differences:** The nuances of different cultures and languages can pose significant barriers, as discussed in our sections on localization. Finding universally accepted symbols, terms, or gestures can be a daunting task.
- **Financial Constraints:** Developing assistive technologies, especially those that are highly specialized, can be capital intensive. Moreover, ensuring that these technologies are affordable for all can be a significant challenge.

- **Lack of Awareness:** Many regions still lack a comprehensive understanding of the importance of digital accessibility, leading to slow adoption rates and limited advocacy.

6.2. Opportunities

- **Interdisciplinary Collaboration:** The intersection of technology, sociology, linguistics, and design offers fertile ground for interdisciplinary collaborations, leading to innovative solutions.
- **Growing Market Potential:** As discussed in our sections on economic implications, the disabled community represents a significant yet untapped market segment. Catering to their needs can unlock vast economic potential.
- **Environmental Sustainability:** As highlighted earlier, digital tools have the potential to promote environmental sustainability. Assistive technologies can reduce physical mobility needs, leading to decreased carbon footprints.
- **Global Communities and Knowledge Sharing:** With the rise of global communication platforms, there's an unprecedented opportunity for knowledge exchange. Best practices, successes, and learnings can be shared across borders, accelerating progress.
- **Empowerment and Advocacy:** Assistive technologies can play a pivotal role in empowering individuals, giving them a voice, and amplifying their advocacy efforts.

While the journey towards universal digital accessibility is fraught with challenges, it is also replete with opportunities for growth, innovation, and positive societal change. By acknowledging these dual facets and navigating them with intention, a more inclusive digital future can be realized.

7. Recommendations for a Sustainable and Inclusive Digital Future

As we look towards shaping a future that harmonizes digital inclusion with sustainability, certain proactive steps become paramount to ensure that our vision aligns with practical implementations. Central to this is the establishment of frameworks for global collaboration on localized assistive technologies. The diverse needs of different regions, influenced by cultural, linguistic, and geographical considerations, require collective brainstorming and solution development. Pooling resources, expertise, and experiences from across the world can lead to the design of tools that are both universally functional and locally resonant. Such collaborations could take the form of international consortiums, digital knowledge-sharing platforms, or even regular global symposiums dedicated to the cause.

Simultaneously, it is imperative to advance research on the complex interplay between digital accessibility, localization, and sustainability. The relationships between these domains are intricate and multifaceted, warranting in-depth studies to understand their nuances and intersections. Such research can not only guide policy-making and technological development but can also shed light on unforeseen challenges and opportunities. By fostering academic and industry partnerships, we can ensure that the research remains grounded in real-world needs while pushing the boundaries of theoretical exploration.

Lastly, the significance of advocacy and awareness cannot be understated. The advancements in assistive technologies and the strides towards localization can only achieve their desired impact if

they are accompanied by a broader societal understanding and appreciation. Advocacy and awareness campaigns can play a pivotal role in this regard, disseminating information, challenging existing biases, and building a strong case for the importance of localization in assistive tools. Such campaigns, while highlighting the tangible benefits, should also appeal to the collective conscience, underscoring the moral imperative of creating a world that is inclusive and sustainable for all.

In essence, our journey towards a sustainable and inclusive digital future is not a solitary endeavor. It requires collaborative efforts, rigorous research, and a shared vision. By prioritizing global collaborations, fostering research, and championing the cause through advocacy, we can pave the way for a digital landscape where everyone, irrespective of their abilities or location, can thrive.

8. Conclusion

The digital realm, with its vast expanse and rapid evolution, presents a unique dichotomy. On one hand, it holds the unparalleled potential to bridge divides, enable communication, and provide tools that can transform lives. On the other hand, it poses the risk of deepening disparities if not approached with intention and foresight. The discourse on assistive technologies, localization, and sustainability is a testament to this intricate dance between potential and responsibility. Throughout our exploration, it became evident that true digital accessibility isn't merely about creating tools; it's about ensuring these tools resonate with their users, both functionally and culturally. The pioneering efforts of entities like Mada Center Qatar underscore the profound impact of thoughtful localization in assistive technology, illuminating the path for others to follow.

Moreover, the symbiotic relationship between inclusivity and sustainability offers a compelling narrative for the future. As we work towards creating a world that is digitally inclusive, we inadvertently craft a blueprint for sustainability, ensuring that our actions today have positive reverberations for generations to come. However, the path forward isn't without its challenges. From understanding diverse needs to navigating rapid technological advancements and cultural nuances, the journey is complex. Yet, it's within these complexities that opportunities for collaboration, innovation, and growth emerge.

As we conclude, it's essential to remember that the quest for a sustainable and inclusive digital future is ongoing. It demands persistence, collaboration, and a shared vision. But with concerted efforts, guided by the recommendations and insights discussed, we can indeed create a digital world where everyone finds a place, a voice, and an opportunity to thrive.

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