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The Role of ICTs for Evaluating Access and Mobility of Refugees Using Assistive Devices: Case Study of Rohingya Camps in Cox's Bazar

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ABSTRACT

This paper reflects on the role of ICT tools and their support in a project addressing the mobility needs of refugees with physical disabilities. The authors share those observations and their solutions to improve the understanding of working with Rohingyas, one of the most vulnerable groups, on the border of Myanmar and Bangladesh, a conflict-prone and highly volatile zone. The team used a range of ICT collaboration and communication tools, such as: 1) audio-visual recordings to remotely assess refugees using assistive devices; 2) 3D printed plastic molds to develop customized crutch shoes for refugees; and 3) customized assistive devices, mass-produced by transferring CAD files from the engineering laboratories in South Korea and Greece to the barefoot workshops in Cox's Bazar. However, many of the key tasks were not accomplished using ICTs. This research reflected on the critical disconnections discovered in different phases addressing issues related to the project's communication, design, knowledge transfer, production, and device usage by the beneficiaries. Even with such challenges, this research project on assistive devices using ICTs for marginalized refugees became successful. According to our observations, success came due to hiring a local ICT expert with contextualized technical and cultural knowledge, engaging equitably with the local engineers for field-level productions, and collaborating with refugee beneficiaries for their feedback on ICT-based accessible, assistive products.

Keywords: Disability, Refugees, ICTs, Assistive Technology

1. INTRODUCTION AND BACKGROUND OF RESEARCH

This research explores the effectiveness of ICTs in improving the lives of refugees with physical disabilities by supporting their mobility needs in resource-stripped and conflict-prone areas. UNHCR figures show that as of May 2022 there are more than 100 million forcibly displaced people by persecution, conflict, and violence worldwide (UNHCR, 2022). Along with that, 15% of the world's population, experiences some form of disability, and disability prevalence is higher in developing countries (Priddy, 2019; World Bank, 2022). Applying WHO estimated to the UNHCR figures suggests that as of 2022 there are at least 15 million disabled among forcibly displaced people. This intersectionality affects a large portion of the world population putting them at great risk and disadvantage.

The Convention on the Rights of Persons with Disabilities has been invoked as an international human rights treaty of the United Nations intended to protect the rights and dignity of persons with disabilities (Bantekas, 2018; Pyaneandee, 2019). One of the Convention's guiding principles is accessibility defined as providing access to people using assistive technology. As of April 2022, the Convention has 163 signatories and 185 parties. Many countries signed the Convention; among them is Bangladesh, the country housing refugees who are participants in this study. Bangladesh signed and ratified the Convention on the Rights of Persons with Disabilities in 2007 (Rochette et al., 2022). Bangladesh also houses millions of refugees and among them Rohingya refugees from Myanmar.

The Rohingya have faced decades-long persecution from the Myanmar government. A Muslim ethnic minority living in the western Rakhine State of Myanmar, the Rohingya are considered to be one of the most victimized populations in the world. The Rohingya have had their citizenship revoked, and are not allowed to vote. In addition, the Myanmar government has strict laws regulating the Rohingyas' ability to marry, work and own property. Starting in 2017, the Myanmar army began a new violent campaign against the Rohingya population living in Rakhine State after clashes with alleged Rohingya militants. Fleeing torture, physical violence, rape, and murder, over one million Rohingya refugees have relocated to neighboring Bangladesh (BBC, 2020).

Refugees with disabilities are often forgotten during the acute crises of human displacement and suffer additional disadvantages (Crock et al., 2022; Priddy, 2019). Refugees under any circumstance face tremendous obstacles, but these challenges are amplified for refugees with disabilities. For example, people with physical disabilities are two to four times more likely to be killed or injured in natural disasters (Quaill, 2017). Sexual and gender-based violence (SGBV) also disproportionately impacts those with disabilities (UNHCR., 2019). Mobility concerns for Rohingya refugees with physical disabilities are notably pressing in refugee camps in Bangladesh – for example in the Cox’s Bazar area where the current study population resides. The area where camps are built is prone to cyclones, monsoons, and flooding; all of which contribute to landslides. Steep, muddy, and unstable terrain in these camps makes walking between shelters and facilities close to impossible for refugees with physical disabilities (Human Rights Watch, 2018).

The project described in this paper was funded by the Humanitarian Grant: “Creating Hope in Conflict” in early 2020 before the changes in circumstances created by Covid-19. The team working on this project was international and the onset of Covid-19 imposed restrictions disrupted the initial plan. To address the mobility challenges faced by Rohingya refugees with physical disabilities, a team of researchers from three universities (South Korea, USA, and Greece) and a Bangladeshi NGO, Youth Power in Social Action (YPSA), have worked to design an alternate crutch/cane shoe/tip in order to provide a safer option for the disabled or injured refugees who walk in challenging environments. The alternate crutch shoe, having a wider surface area and made from a more flexible material, is better suited to the terrain of refugee camps in Cox’s Bazar. Creating a better understanding of the intersections of physical disability and forced displacement, medical care, safety, aid access, and inclusion requires close consultation with participants directly impacted by physical disability. Through baseline surveys and interviews with Rohingya refugees with physical disabilities, the project team is able to better tailor their services to fit specific needs.

The contribution of this paper is our reflection on the role of ICT tools and their support in the mobility needs of refugees with physical disabilities. We share those observations and our solutions in the hope of improving an understanding of working with vulnerable groups in

conflict zones among unpredictable constraints. The organization of the paper is as follows. The next section presents a literature review followed by a section on the research questions and approach. We group our observations around questions that explore:

- What are the key challenges for implementing ICT based AT ideas in the refugee camps?
- Effective communication and collaboration strategies between the Assistive Technology (AT) designers and engineers of Global North and South
- Key challenges for ICT based AT design and implementation in the refugee camps

Reflections on these above-mentioned issues are discussed in section four called key observations. Along with describing each key observation, we discuss its impact on the process of implementation of the innovation. Section five summarizes key observations and concludes by giving recommendations for practitioners in the ICT and Assistive Technology fields.

2. LITERATURE REVIEW

2.1 PHYSICAL ACCESS

The physical layout and infrastructure of camps impede access for persons with disabilities to facilities and services, including schools, health clinics, latrines, water points, bathing facilities, and food distribution points. Difficulties with physical access and the poor design of camp buildings, including shelters, affected all aspects of daily life and increased the isolation of persons with disabilities (Reilly, 2010) (Mirza, 2014). Barriers to accessing humanitarian assistance programs increase their risks, including the risk of violence, abuse, and exploitation (Pearce, 2017).

In 2013, a large study by HelpAge International and Handicap International collected data in Jordan and Lebanon in order to provide robust evidence and data on the numbers and needs of older, disabled, and injured refugees and refugees affected by chronic diseases, and to offer the opportunity to compare their needs with those of the wider refugee population (HelpAge International report, 2013). The two NGOs were able to recruit a large sample and the final data collection resulted in clusters of 429 people in Jordan and 478 people in Lebanon.

The challenges of collecting accurate data on impairment and disability in humanitarian emergencies are starkly illustrated by the unavailability of data in Lebanon. At the time of the survey, just 1.4% of refugees registered by UNHCR in Lebanon were recorded as having a disability (Skinner, 2014). The survey found that one in 15 Syrian refugees in Jordan has been injured as a result of the war, and one in 30 refugees in Lebanon (HelpAge International report, 2013). Half of the surveyed refugees affected by impairment, injury, and non-communicable disease reported at least one frequent sign of psychological distress: changes in emotional state, behavior, relationships, or cognition. The older population was disproportionately affected with more than 65% reporting such signs, three times more than the general refugee population (Skinner, 2014).

2.2 ACCESS TO ASSISTIVE TECHNOLOGY (AT)

The availability of innovative advances in AT can enhance the quality of life of poor people with disabilities, not only refugees. Particularly at risk are women, children, and the elderly, as well as people who live in resource-scarce and remote areas in low- and middle-income countries (du Toit et al., 2018). Whittaker et al. (2021) conduct a survey of literature about AT provision and find little evidence of effective mechanisms for such provision in humanitarian settings. The small body of academic literature that describes AT provision in humanitarian settings provides examples of some small-scale provisions, delivered predominantly by NGOs (Whittaker et al., 2021). This lack of solutions implies a deficiency in humanitarian response to provide people with AT to which they have a right, and which could enable their access to basic services (Whittaker et al., 2021).

A lack of high-quality disability data has been recognized by World Health Organization, which designed a Brief Model Disability Survey (MDS) (WHO, 2021). In 2018, this survey has been administered in face-to-face household interviews in India, the Lao People's Democratic Republic, and Tajikistan, and included a module dedicated to the use and need of AT (Lee & Lee, 2019). The results show that the need for AT increases as the level of disability increases. In the Lao People's Democratic Republic and Tajikistan, approximately 30% of people with severe disabilities report not having AT but needing them. The corresponding figure for India is 18% (Lee & Lee, 2019). In North Syria, the most commonly used AT are mobility products (51%),

including crutches, walking sticks, walking frames, and wheelchairs (Boggs et al., 2019). In addition, in Syria, lower limb amputations are significantly higher than other mobility impairments (Boggs et al., 2019).

There have been previous studies in Bangladesh related to access to AT, Pryor et al. (2018) measured unmet AT needs in order to understand their characteristics and current access patterns in Bangladesh. They estimated that 7.1% of the studied population used any AT, and the use was positively associated with age and self-reported functional difficulty. The proportion of people using AT is higher for mobility than for sensory and cognitive difficulties. Among all the people with functional difficulty, 71% self-reported an unmet need for AT (Pryor et al., 2018).

It is essential to recognize that most research and development efforts in the AT field have been focused on serving users in high-income environments, aimed at high-tech solutions for optimal performance (WHO, 2017a; WHO 2017b). Little attention has been paid to the development of low-cost assistive devices, for which there is a much greater need, creating an ever-increasing gap in assistive technology access ((WHO, 2017a; WHO 2017b). We could not find in the literature many attempts at a low-tech solution. Two initiatives that stand out are a multi-legged walking cane (Roulstone, 1998) and the African Disability Scooter (May-Teerink, 1999). The scooter was developed for lower-limb amputees and aims to improve mobility in a variety of terrains. However, the initial scooters have been expensive and as such unaffordable to low-income users (May-Teerink, 1999).

The next section looks into the role of ICT tools for refugees and discusses a new concept of data justice when related to refugees and IDPs.

2.3 USING ICT TOOLS IN REFUGEE CAMPS

Mobile phones are one of the most common ICT tools refugees use because they are portable and small while allowing access to communication with family and friends and information critical to the people fleeing their own countries. There is extensive literature on the importance of mobile phones for inclusion for internally displaced people (IDP) and refugees (Bisimwa et al., 2018; Mahoney & Siyambalapitiya, 2017; Tai et al., 2022). For example, one recent study from

Nigeria examines how IDPs in Africa use mobile phones to enhance their social inclusion (Dasuki & Effah, 2022). The authors employ Sen's Capability Approach as the theoretical lens and a qualitative case study as a methodology to show enhancement in individual and collective capabilities. Another study, also based on the capability approach and qualitative analysis of fifteen interviews with Syrian refugees in Germany, reveals dependencies between the properties of ICTs and their use and ties it to the processes of social inclusion (AbuJarour & Krasnova, 2017).

ICT tools have been also used by language service providers for interpreting in diverse settings, such as migration contexts or cross-cultural communication in emergency and humanitarian settings (Atabekova et al., 2018). Furthermore, one way to provide access to higher education for refugees is through online and/or blended learning (Gladwell et al., 2016). Reinprecht et al. (2021) present results from a survey of 350 secondary-level educated Syrian refugees in Jordan and Lebanon. The authors show how adopting online learning materials to permit smartphone learning with low bandwidth would significantly increase the potential pool of online education students. The study concludes that it is important to make online learning accessible via older smartphones and to create low-bandwidth learning materials and downloadable content (Reinprecht et al., 2021). However, the provision of fast and affordable Internet connections is still a critical factor for the success of educational programs.

Digital data collection and its use could pose a major issue for refugees and IDPs. To that goal, it is important to discuss a recent immersion of data justice as a key structure to discuss the intersection of datafication and society and its connection with social justice (Dencik & Sanchez-Monedero, 2022). Data justice is defined as fairness in the way people are made visible, represented, and treated as an outcome of their digital data (Taylor, 2017). Using a data justice lens, Martin and Taylor (2021) explore regimes in two country contexts in which large displaced populations are present: Uganda and Bangladesh. Since governments must manage the inclusion of new groups into the existing systems, people of disputed citizenship (the case of the Rohingya in Bangladesh) do not fit neatly into those systems. In Bangladesh, the SIM registration process requires prospective subscribers to show a copy of their national ID cards or passports to activate a mobile connection (Hussain et al., 2020; Ahmed et al., 2017). Rohingya refugees' legal access

to SIM cards in Bangladesh is extremely challenging mainly because they have no such forms of ID. That leads not only to a lack of access to telecom services but also to severe challenges in accessing financial and other services. In addition, the Bangladeshi regulator banned the sale of SIMs to the Rohingya and criminalized the provision of previously registered SIMs (CBS news, 2017). Furthermore, since connectivity is shared within neighborhoods, blocking or throttling cellular service in geographical areas where Rohingya camps are located, for example in Cox's Bazar, affects more than just the refugees, it affects the host communities also (Rahman, 2019).

3. RESEARCH QUESTIONS

The project started in early 2020 at the start of the Covid-19 outbreak. The only way to communicate with the implementation site and local partners was by using ICT tools such as online communication and remote monitoring. After spending two years working under Covid-19 restrictions and relying on ICTs tools, we have many observations on the usefulness of ICT tools for supporting refugees with physical disabilities. As our research team sought ways to support refugees with physical mobility issues, we pose our primary research question:

Can ICTs support the mobility needs that will lead to improvements in the lives of refugees with physical disabilities?

In order to answer this question in the context of the Rohingyas in the world's largest refugee camp, we sought answers to the following questions:

- What is the role of ICT tools in the evaluation of access and mobility of disabled refugees?
 - How effective are the remote assessments of the needs of refugees who use assistive technology (AT) in conflict zones?
- How do we ensure effective communication and collaborations between the AT designers and engineers of Global North and South?
- What are the key challenges for implementing ICT based AT ideas in the refugee camps?
- What are the refugees' primary concerns and disconnections with the newly innovated ATs in Rohingya refugee camps?

4. KEY OBSERVATIONS

4.1 OBSERVATION: ICTS FOR COMMUNICATING WITH THE FIELD

In this section, we focused on the effectiveness, challenges, and solutions using ICTs for our multifaceted communication needs in this research. The primary research inquiry at this stage is:

- *What is the role of ICT tools in the evaluation of access and mobility of disabled refugees?*
 - *How effective are the remote assessments of the needs of refugees who use assistive technology (AT) in conflict zones?*

4.1.1 INITIAL RESEARCH PLAN

The team for this research project was a multinational team with its members spread over four countries on three different continents. The PI and the research lab were located in the Republic of Korea, the engineer in charge of the 3D-printed crutch shoes was based in Greece, and the refugee and ICT4D expert was in the USA. The field-level partners and the main research implementation areas, the Rohingya refugee camps, were situated in Cox's Bazar, Bangladesh. The original project plan was for the team members to visit the implementation site on multiple occasions. The first visit was supposed to be in June 2020 as a kickoff meeting. The team was planning to visit the site before designing the prototype to get a sense of the terrain and the obstacles refugees in the camp in Cox's Bazar experience. The next step was the baseline study done by the local partner to collect information from the disabled and injured people in the camp about the sources of their disability, length of use of AT, and main obstacles in the camps. There were also plans for human resource development of the partner organization by sending some key Bangladeshi NGO officials to the Republic of Korea for higher training on 3D printing and AT innovations.

4.1.2 COVID-SHUT DOWNS AND EVOLVED RESEARCH PLAN

The Covid-19 pandemic and the related worldwide shutdowns affected the initial research plan significantly, especially at the field level. Amidst Covid-19 restrictions, it took a long time, almost one year from the start of the project. The in-person baseline study was postponed and the core research team was unable to visit the refugee camps during the initiation stage of this research. The team had to rely on remote communication for research redesign and

implementation between stakeholders based in multiple countries. Due to less reliable and slower internet connectivity, communications related to information sharing, co-ideation, co-design, and co-implementation planning became significantly more challenging. Instead of meetings, we had to rely on audio-visual recordings, conversations, and idea sharing using Google docs and other mutually used social media platforms. Beyond the issues with the quality of the connectivity on the Bangladeshi side, we faced challenges with person-to-person communication. Two of the Co-PIs neither could speak Bengali (the main language of Bangladesh, spoken by YPSA officials) nor the Rohingya language (the lingua franca for the refugees). The English proficiency level of the local partners was also not high, thus making the overall communication over the internet time-consuming and less productive. Data collection from refugees turned out to be more challenging. Rohingyas do not have any official set of alphabets for the written version of their language. Such a language barrier meant that our field-level researchers, the Rohingya participants, and our team outside Bangladesh were required to work with live, impromptu translations between English, Bengali, and Rohingya languages while conducting the baseline study or any other research-related conversations.

However, the application of ICT tools was limited to help with the data collection for the initial baseline study. The in-depth communication was much needed with the affected Rohingya refugees for disseminating information on our possible AT solutions and for collecting their personal feedback. This process was delayed until the last quarter of 2020 when one team member was able to visit the site for this research for the very first time. We were able to visit the site only two times, in September 2021 and June 2022. In September 2021, video recordings were taken and in June 2022, interview data was gathered. The only way to have access to Rohingya refugees is by visiting the refugee camps in person. Rohingya refugees' legal access to SIM cards in Bangladesh is extremely challenging (Hussain et al., 2020) and the only way to use ICT tools in the camp is to bring your own, and even at that point, you will have the obstacle of access to the reliable network (Rahman, 2019).

4.1.3 ICT AND NON-ICT SOLUTIONS

The previous sub-sections highlighted the major communication challenges that emerged due to Covid shutdowns, Rohingya language translation issues, and the relative novelty of 3D printers

within Bangladesh. Most of these problems were successfully addressed after the in-person, face-to-face communications were reinitiated at the end of 2020. A local ICT expert was hired, who successfully took over the training and initial prototyping (more on this in the later sections) using the 3D printer. The multi-level human resource development initiative in place of the in-person visits of the research lab in South Korea eventually became effective as more culturally and linguistically appropriate training content was applied by the new hire. The visiting Co-PI also conducted several in-person workshops with the key people from YPSA and the Rohingya refugee communities to develop and implement more sustainable research strategies in the face of physical and resource mobilization uncertainties due to Covid-19.

4.2 OBSERVATION: COLLABORATION BETWEEN THE GLOBAL SOUTH AND NORTH ENGINEERS

In this section, we focused on the challenges, confusions, and workarounds during the communication and collaboration stages between the research engineers from South Korea, the USA, Greece, and the workshop engineers from Bangladesh. The primary research inquiry at this stage is:

How do we ensure effective communication and collaboration between the AT designers and engineers of Global North and South?

4.2.1 SUPPLY CHAIN AND SUPPORT STRUCTURE FOR 3D PRINTING

In order to ensure the success of this research, successful procurement, and usage of a 3D printer needed to be ensured. The project revolved around designing and developing prototypes using 3D printers. The team faced multi-faceted challenges in this entire process. In early 2020, Bangladesh lacked a market and support ecosystem for 3D printers. Hardly any people with expertise in 3D printing were available to assist with our project in the local context.

Purchasing a 3D printer was a challenge on its own. To our surprise, Bangladesh did not have supplier nor a support for 3D printing technology. After several months we were able to find a Chinese importer who charged an acceptable price and procure one printer for our partner YPSA. The bigger issue was the technical expertise to operate it and support to maintain it. Several iterations of online, synchronous, and asynchronous training for operating the 3D printers were

not successful. As a result, the 3D printer alongside its printing materials was left unused until the in-person visit of one of our Co-PIs in the field in the last quarter of 2020.

Figure 1 shows one of the Co-PIs, professor Hussain, a local ICT expert and member of YPSA around the 3D printer in the YPSA office.



Figure 1 Visit to the YPSA office

4.2.2 SOURCING OF LIQUID RUBBER

At the pre-Covid planning phase of this research, the plan was to procure liquid rubber (Smooth-On), required for making the customized crutch shoes using the 3D printed molds.

Unfortunately, during the global shutdown, the local suppliers were unable to meet the need. All the regional suppliers' websites did not have substantial and helpful information for placing a large order involving international shipping. Alternative solutions were either unavailable or too costly to be incorporated into the research budget. One of the Co-PIs eventually had to physically deliver two boxes of this chemical to initiate the customized crutch shoe prototyping (more about this in the next section).

4.2.3 PROTOTYPING PHASE

This was arguably the most time-consuming and complex period of this research. As mentioned earlier, there had been challenges with the human resource development process regarding the 3D printer operation and management process. The local partner, YPSA's primary strength lies within development project planning, resource mobilization, and implementation at the field level, even in the remotest of places. However, its ICT section failed to initiate the 3D printer operations required to print the customized molds. This added to the unavailability of liquid rubber for use with the 3D-printed molds causing around a 6 to 8-month-long delay in the overall project timeline.

Figure 2 shows the output from pouring silicon rubber material into a 3D printed mold using low pressure to produce the crutch shoes, which are then used for prototype testing.

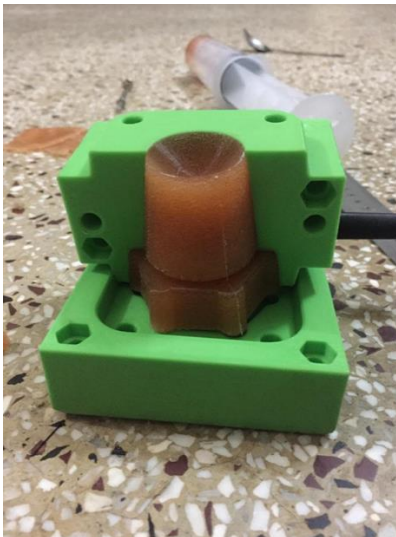


Figure 2 Prototype of rubber shoes using a 3D mold

4.2.4 TECHNICAL COMMUNICATION (CONFUSION) BETWEEN COMMUNITIES

Technical specifications use a particular language that both sides have to speak fluently and understand each other. The team eventually found that there is a significant need for translation on that front also. As per the research design, after the initial prototyping and beta-testing of different 3D printed crutch shoes are done in the refugee camps, the plan had been to work with a local workshop to mass produce the crutch shoe model preferred by the majority of the refugees with disability. A workshop was selected as well with the help of the newly hired local engineer after evaluating multiple similar options. However, there had been some significant

dissimilarities in terms of technical requirements and production protocols between the Korean and Greek laboratories (where the engineers of this research team are based) and the Bangladeshi workshop. At one hand, the local workshop's technical leads were informally trained and highly efficient in their localized innovations and productions. They were not required to follow any formal lab-based technical specifications for designing any metal mold for AT devices. On the other hand, the research engineers were insisting upon following some measurement criteria followed internationally. The design for the shoe and the mold had been done as 3D Computer-aided design (CAD) files, which are standard in any Western lab. However, programs such as AutoCAD, SolidWorks, or Fusion 360 are all proprietary and the local workshop had to redo all the specs of the design in the Open-source version such as FreeCAD or OpenSCAD.

4.2.5 BAREFOOT TECHNOLOGICAL SOLUTIONS

In order to speed up the much-delayed process, the research team physically mailed 3D-printed molds to Bangladesh from their laboratories in Korea and Greece. Eventually, two things were taking place in parallel. The local engineer was leading the training and printing of crutch shoe molds in the 3D printer, using field-level data. At the same time, liquid rubber brought through a Co-PI was used with the 3D printed molds (mailed from other countries) to produce and disseminate multiple models of crutch shoes for beta-testing and data collection from the beneficiaries in the refugee camps. Led by the local engineer, who is familiar with both types of work, and helped with technical, cultural, and contextual translations and transformations, the team eventually managed to come up with effective technological solutions to produce locally developed AT outputs that are in compliance with international requirements.

4.3 OBSERVATION: FEEDBACK FROM THE FIELD ON ICT INNOVATIONS

In this section, we focused on the feedback from the field, especially from the crutch shoe users about the challenges they are facing, and their overall thoughts on the AT innovation. The primary research inquiry at this stage is:

What are the key challenges for implementing ICT based AT ideas in the refugee camps?

What are the refugees' primary concerns and disconnections with the newly innovated ATs in Rohingya refugee camps?

4.3.1 CONVERGING AND CONFLICTING EXPECTATIONS

The refugee participants of this research used conventional crutches designed for the flat and prepared ground. As such they are not ideal for the muddy and uneven ground conditions at the camps in Cox's Bazar. In the field research phase, one of the primary goals was to measure the stability of a person walking with a crutch. To that purpose, gait analysis was used, which is an assessment of the manner of walking done by observing a person walking in a straight line. Because the participants in the camp were dressed in loose clothing it was quite difficult to accurately estimate the movement of the center of gravity of the crutch user's body, as it is standard practice in a gait analysis with multiple video cameras. There were explicit restrictions on visiting hours inside the camp (due to Covid) and also on using high-end video cameras inside the camp. Hence, two mobile phone cameras were used to track only the left ankles of the participating disabled refugees to estimate their gait. The lighting in the makeshift video recording in the camp was dim, making it harder to do video recording. In addition to the restrictions against camp visitation and high-end audio-visual documentation, refugee women participants refused to be video recorded while walking with the crutches. Their traditional attires covering their entire body hindered data collection for the gait analyses.

Figure 3 shows one NGO volunteer attaching prototypes to the refugee crutches.



Figure 3 Volunteer attaching crutch shoes to crutches of a refugee

4.3.2 ASSISTIVE TECHNOLOGY THROUGH REFUGEES' LENSES

The users' feedback had been a critically important part of this research as the beneficiaries use and evaluate different versions of the customized crutch shoes, which were developed to ease their accessibility challenges. Initially, the general users showed skepticism towards the innovations. Long-term and in-depth observation as well as documentation of users' reactions helped to develop an in-depth understanding of beneficiaries' minds and feedback. The users evaluated the different versions of the crutch shoes based on the following criteria: their daily needs; the type of terrains for daily traversals; the type of seasons they experience while living in the camps; and their gendered social expectations. The first three lenses for feedback were somewhat expected and had already been incorporated in redesigning process of Assistive Technology or 3D-printed, customized crutch shoes.

However, the last one related to gendered social expectations was not incorporated at the initial ideation, design, and product development phases. The researchers and their local partners did not realize the significance of conservative socio-religious norms against women in playing a part with accessibility in the camp areas. The in-person interviews of the beneficiaries (male and female) shed light on this issue. Initially, it was very hard to interact with refugee women, who had used the customized crutch shoes distributed by the local partner, YPSA. All of the women respondents were interviewed after several rescheduling. Female social workers of YPSA were specifically mobilized to interact with the Rohingya women beneficiaries. Eventually, steep terrains, unsafe roads, possible loss of other economic opportunities, and public harassment for using crutches were identified by the female users as key reasons behind their absence.

Furthermore, the female beneficiaries highlighted the social stigma of using crutches as women users to be the primary reason hindering their mobility aided by any AT. When inquired, many of the male beneficiaries also shared similar views. According to several of the male respondents, women with disabilities need to stay at home and should not move outside using crutches, as that would look bad for their society. Presently, dimensions related to gendered inclusion are being incorporated for future iterations of this 3D printed AT development and dissemination process.

5. CONCLUSION

This paper presents many observations and findings from the field that impacted the project on improving mobility aid of disabled refugees in the Cox's Bazar camps in Bangladesh. Since the project started during the Covid-19 pandemic, which forced the whole world to rely on digital technologies to communicate, the fieldwork was affected considerably, and the team had to make some significant adjustments.

Our first main observation was related to the issues regarding using ICTs for communication in the field. The team used ICT tools, such as video recordings taken by the field workers and shared on the cloud with the team members, to remotely assess refugees who use assistive technology (AT) in a conflict zone, and refugee camps in Cox's Bazar. Another tool essential for the project was a 3D printer, and its use in the field was enabled by hiring a local ICT expert to take over the initial prototyping. However, ICT tools were of limited use to help with the data collection for the baseline study mainly because of the language and alphabet of Rohingya refugees.

Next, we discussed our observations on the issues of effective communication and collaboration between the AT designers and engineers from the Global North and South. That included problems with the supply chain of 3D printers and other necessary supplies. Along with the supply chain, confusion in communication and preferences for property versus open-source software were problematic.

Finally, we discussed the requirements of AT through the lens of refugee users and their expectations. Cultural and societal obstacles in participation were hindering women disproportionately, not allowing them to test the prototype on a gender-diverse sample. The team is currently addressing that issue by recruiting more female field researchers in order to expand the pool of female participants and users for the innovation.

The overall conclusion is that ICT tools allowed the project team to conduct an assessment and implementation of the humanitarian intervention. However, for several tasks, it was critical to have in-person communication and to send one of the team members to the field.

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