

Computing beyond Gender-Imposed Limits

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ABSTRACT

Gender inequality has long been on the list of factors that impose limits on the potential of computing, in ways that have been more and less obvious. Drawing on ethnographic findings from marginalized communities in Bangladesh, we analyze the impact of gender inequality on the stages of user research, design, deployment, and use of computing technologies. We conclude with a discussion of how a combination of design, policy, and/or theoretical approaches might supply us with tools to combat the challenges faced in these stages in order to bring about greater equity and participation in the world of computing.

CCS Concepts

•Human-centered computing → Human-computer interaction;

Keywords

ICTD; Gender

1. INTRODUCTION

Gender inequality has long been on the list of factors that impose limits on the potential of computing. The participation of women in the stages of user research, design, deployment, and use of computing technologies has been historically limited, also limiting the potential of the technologies in question. Even though recent decades have seen a growing focus on the development of information and communication technologies (ICTs) for addressing women's needs, the impact of these technologies remains limited due to limiting gender norms, defeating - to large degree - the underlying motivations for the conceptualization and design of these technologies. For example, a multitude of applications have been designed to provide women users with on-the-spot assistance in situations of sexual harassment - *e.g.*, Hollaback [38], Safetipin [42],

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Harrassmap [37], Protibadi [1], Maya Apa [40], etc. There are also private helplines that provide counseling support to women in order to prevent suicides [39]. The effectiveness of these applications, however, may be limited by a diversity of factors that draw on prevalent gender norms. To list some - women's access to physical spaces that encourage technology use may be limited [20], they may have limited access to technological devices [7], and when access is available the use may be forcibly shaped according to gender norms [1], perhaps further adversely impacting women's participation by setting the stage for women to be teased, harassed, and/or objectified [10, 13].

In this paper, we focus on technological interventions that specifically aim to address the needs of women, drawing on findings from our ethnographic engagements in marginalized Bangladeshi settings. Our research situates itself in the field of Information and Communication Technologies and Development (ICTD), one of the agendas of which has been to lead us towards a more informed and nuanced understanding of infrastructural limits [9] and how these might impact technology's potential [6]. This understanding needs also to be bolstered by an appreciation of how social and cultural factors contribute towards limiting this potential, which is what our paper aims to achieve.

We discuss the distinct aspects of limited women's participation and the resultant impact on the effectiveness of the technological interventions in question. First, user research - if the inputs of targeted women are not taken into account, for example, because women who have been historically marginalized may not be comfortable voicing their struggles or discussing their lives with strangers, then the task of designing for them becomes a challenge. Natarajan and Parikh [25] found this, for instance, in their ethnographic study of women living with HIV in South India, as they highlighted the stories that go untold when the barriers to sharing are less understood.

Second comes design - it is still largely men who are designing and developing the technologies for women to use. This brings us to the thorny issue of teaching more women the skills related to design and development. Women are frequently discouraged from attending engineering schools. For those who do attend, the attrition rates remain high in many developing countries (see [18]). And for those who graduate with these degrees and join the computing world professionally, there are a host of well-documented challenges that they must contend with [30]. These challenges must be consistently addressed if women's participation in the design

and development of technologies for their use (or for others') is to grow.

Third, there is the challenge of deploying or introducing technologies to women. Even the process of securing access to women may be viewed with suspicion. Kumar et al. [21] found in the case of their maternal and newborn health interventions in rural India that men remained suspicious of the health videos that were being shown to the women, thereby limiting the access of these women to the health information being provided. Bringing the men on board took time and was critical for the uptake of the project.

Finally, the sustained use of technologies - we found - also suffers on account of women's participation. The perceived utility of these technologies may be eclipsed by the long-term usability of the technology. For example, our first two authors [1] found that the use of technology by women is both conditioned and limited by a male-dominated and conservative Bangladeshi society. This study shows that such impositions are frequently detrimental to the proper functioning of a technical system to help women combat sexual harassment. It also suggests that a comprehensive change in societal norms and values is required to make such technology work for women.

We used a grounded theory approach [11] to analyze our ethnographic data and outline the above four areas of concern, which we found to be suffering on account of limited participation of women. After presenting the Bangladeshi context in which our efforts have been situated, we discuss how our findings convey this limited participation, and proceed to recommend ways in which increased participation could be targeted, using a combination of design, policy, and theory-based approaches.

2. ICT AND GENDER IN BANGLADESH

"Digital Bangladesh" is a recent ICT initiative and its official roadmap was developed and championed by the present government in 2008 [27]. Under this plan, there are nation-wide initiatives on integrating ICTs (infrastructure development and service delivery) in critical socio-economic sectors such as education, health, agriculture, and law enforcement. For all highlighted domains in the Digital Bangladesh program, there are executable action plans, which in turn help the state to achieve its proposed goals. Accompanying these long-term plans are several other policies (e.g., ICT policy, Broadband Policy) and acts or laws (e.g., ICT Act, Cyber Law, etc.), ideally enabling different wings of the public and private sectors to work together smoothly towards a sustainable, knowledge-based economy.

When it comes to gender-friendly policy formulation and implementation, the Bangladeshi government has had a mixed performance. On the one hand, the country is a star performer among developing nations in achieving its Millennium Development Goals (MDGs) [41]. According to its official MDG performance report, Bangladesh has already achieved gender parity in primary and secondary education. There are also funding and action plans in place to assist female students in securing financial support for higher studies. Women in Bangladesh are also encouraged to actively take part in the political process at the community level and upwards. The reality, however, is far less rosy when it comes to evidence-based policy performance evaluation, especially when this evaluation is done through the lenses of gender equality and social equity. Even in the post-MDG era, there continues to be widespread discrimination and violence against women and girls in Bangladesh (in social settings, workplaces, households, etc.) [44]. One of the newly adopted Sustainable Development Goals (SDGs), SDG #5 - *Achieve gender equality and empower all women and girls* - is especially focused on gender issues for achieving these objectives.

A key target of SDG #5 is to ensure the enhanced use of technology, specifically ICTs, to promote women's empowerment. Until now, we have not seen any significant gender-streamlining of ICT-related policies in Bangladesh based on such directives. Under Digital Bangladesh-inspired strategies and working goals, the issues of gender, equitable access, gender-friendly content development did come up [45]. Unfortunately, those words were not supported by tangible action plans with specific time frames and/or focus areas. Different ministries tend to take initiatives based on their own agendas and there is little coordination between their actions. Recently, the ICT division declared its intention to launch mobile training labs for training 50,000 women [26]. However, there are no specific plans to date that aim to address questions regarding specific trainings and the level of ICT integration, among other things.

The absence of appropriate ICT policies to ensure a gender-friendly environment around technology forces us to rethink the relationship between gender and ICT in Bangladesh in particular and developing world contexts in general. In Bangladesh, laws and policies are not strict enough to effectively combat gender-based violence, marginalization, and inequity. And for the ones that do exist, they are not consistently enforced. Any pragmatic initiative must therefore reduce dependencies on government-provided infrastructural supports, and approach the design, use, and participation around technology from social and cultural viewpoints [1].

3. LIMITS IN USER RESEARCH

Before a technology is designed or deployed, there is typically a period of needs assessment that identifies the desired affordances of this proposed technical solution. We focus now on this process of articulation of design objectives and constraints. Irani et al. [16], in their proposal of a postcolonial computing lens for design, have highlighted the disconnect between the target users and the designers and technologists that must be resolved before the design goals are articulated effectively and meaningfully, within the contexts of ICTD research. Good design relies on a solid understanding of targeted use and users.

The data collection methods we employ aim to elicit user accounts and opinions in different formats. For example, interviews - structured and otherwise - are a popular tool for understanding target users and their needs to be addressed. In ethnomethodological work, observations are crucial. Researchers here observe the participants as they perform certain tasks, and based on their observations, they take notes that they then analyze using different tools. In conversation analysis, researchers focus on how participants are talking, in addition to what they are saying. More recently, research on online communities has aimed to understand phenomena based on what people post on social media or blogs. After collecting shared written texts, photos, and/or videos, researchers conduct their analysis. There are many other methods for collecting data and understanding people. However, most of this data comes from participants' expressions in different forms. These methods do not work well where there is no data available. A fundamental limit of computing is that we cannot design for people who are silent and invisible in society.

There are several challenges that come in the way of advancing computing to address sensitive issues with women, even after necessary and laborious IRB approvals have been procured. *Protibadi* - that the first and second authors worked on - made an effort to understand sexual harassment from the victim's point of view, using an online survey form that was circulated over social media to invite participation [1]. Participants did not need to disclose their identity and were free to discuss their experiences. Although all of the female participants said that they had gone through differ-

ent forms of sexual harassment, none of them provided any details. One participant said, *"You will hardly find any Bangladeshi girl who has traveled on the streets and not experienced sexual harassment. Some women are brave enough to talk about it, while others remain silent for many reasons."*

When we tried to recruit participants for individual interviews, we chose three universities in Dhaka. One female faculty member from each of these three universities invited participants for interviews. Even after a year of advertising, we were only able to recruit 11 participants. In one university, the advertisement flyer was torn and the faculty member was laughed at by her male colleagues. Some female students signed up for the interview, but then did not show up. Some of them came, but then decided they did not want to talk. Some of them left the interview in the middle. A couple of them completed the interview but then asked the interviewer to delete the interview. We respected each of their requests. The 11 interviews that we received disclosed some information that could feed our design. However, we realized that it was equally important to be cognizant of the 'silence', the lack of data. How might we factor that into our technology design?

Silence and invisibility have a deep connection with the fundamental limit on knowledge construction posed by 'otherness'. The postcolonial scholar Said, in his book titled 'Orientalism' [29], criticized this gap in the process of knowledge construction. Said showed how the West failed to construct knowledge about the Middle East because the 'otherness' always came in the way of their understanding. Scholars of Subaltern Studies have also questioned the Marxist theory of historical materialism for knowledge construction. They pointed out that history itself was written by the hands of powerful people, and the voice of marginalized people was missing there [23]. Subaltern scholar, Gayatri Spivak, asked, *"Can the subaltern speak?"* [32]. She claimed that even languages, whose structure was heavily influenced by the male dominated society, and the protocols for using these languages impose limits for women to express their emotions. Using an example of a young widow in colonized India, Spivak depicted how the medium of language was impeding colonized women from expressing themselves. Similar limits also exist in other modalities of communication, which we often consider as primary sources of collecting data and understanding people. These limits come in the way of building an understanding of women and their lives in diverse developing world contexts, which duly affects the design process in significant ways.

4. LIMITS IN DESIGN

One significant factor that brings about the lack of women's perspectives in the design and development of computing technologies is the limited participation of women in the technological workforce. This in turn is shaped by the small number of women learning computing skills, touched upon by several researchers - including those working in the West [5, 28]. There are two sets of experiences we draw on here. First, we touch upon the case of a formal undergraduate program in Electrical and Computer Engineering at a top school in Dhaka. Next, we discuss observations from a mobile phone repairs center.

In the first case, undergraduate female students of the Electrical and Computer Engineering department were enrolled in hands-on courses where laboratory tools or machinery were used. A series of interviews revealed concerns of female undergraduate students such as lack of confidence. Those were followed by small group discussions that took a closer look at challenges and opportunities. In terms of facilities, opportunities, and access, male and female students received similar privileges. However, female un-



Figure 1: A corridor in Gulistan Underground mobile phone repair market highlights the absence of women in this profession.

dergraduate students frequently refrained from asking questions or showing partial solutions, and admitted that they were afraid of making mistakes. One participant, in particular, shared her fear of machines from childhood when her parents would let her brother handle many things freely while she was kept away from them. Another participant shared that women were not considered to be as skilled at handling machines as others. One female computer engineer from a public institution shared her experiences thus: *"When a boy copied code from me, sir assumed I copied the code from him - I could only convince him through my hard work later on."* Female students tend to work as hard as the male students, differing from them only in the fear of making mistakes - as they shared. A similar comment was shared by a male engineering student: *"When any of us (male students) burn an IC, we are fine, while they (female students) get scared as they would be punished!"* Female students also prefer not to ask questions, as shared by many. One female student shared her experiences as: *"In my first year, I would even cry in my room if I could not understand code, but I would not ask a question - things are better now."*

Our second case is that of an informal computing education site - a mobile phone repair training center in Dhaka. The profession of mobile phone repairing is predominantly male. In our three months' ethnography at ten different repair sites in Dhaka, we did not find a single female repairer at work. However, the first author met one female trainee at a mobile phone repair training center as his classmate. She was the only female student in a class of 30 students. Many of the repair-related tasks needed to be performed by more than one student; students often paired up to make a team. In such cases, the members of a team needed to work at close contact. However, the male instructor of the training center was not comfortable allowing female students to work closely with their male classmates. This often led to uncomfortable situations for that student. Often times, she could not complete her tasks properly and would stay back after class to make up for them. Her learning experience, she shared, was impacted by the instructor's attitude towards gender in the workplace. Like this young woman, there are many other women in Bangladesh, who struggle to collaborate with their male co-workers in these workplace settings due to overriding social norms.

These examples underscore the role played by social and cultural norms towards limiting the participation of women in design and development environments, particularly in settings where patriarchal forces are more intensely present. In LIMITS 2015, Nardi

emphasized similar challenges of unequal distribution of resources and labor in the market [24]. Here, we focus on gender-based discrimination and deepen our understanding in the market of digital production. Our findings do not only demonstrate how women are being deprived of the benefits of digital job markets as workers, but also depict how their absence is affecting digital products and recreating greater bias.

5. LIMITING DEPLOYMENT AND USE

In this section we turn to the constraints that limit the use of technologies by women, especially in some developing countries where social and cultural norms do not necessarily support equal rights of men and women in every aspect of life. For this, we pick the case of technologies that are designed to support women to combat sexual harassment. There are two reasons for this choice. First, the problem of sexual harassment itself demonstrates the practice of power exercise by one gender over another. Women's participation in public places is severely affected by sexual harassment, which in turn imposes a spatial labor division based on gender that often turns to an obstacle toward building a free and participatory work environment for sustainable development [24]. Second, the success of the computing technologies that have been designed to support women to fight sexual harassment is dependent on social and cultural limits. Hence, this case reveals a facet of limits that is inseparable with sustainability, the central concern of the LIMITS community.

Gender-based violence is a widely prevalent and global problem. It is particularly deep-seated in parts of the developing world where social and cultural norms place women at a greater comparative disadvantage. In the West, a modest number of technologies have been developed to address women's safety in different ways. For example, the *Hollaback!* project created a platform for women to blog about harassment they had suffered and reach out for support [38]. *Harassmap* maps harassment incidents along with stories to create public awareness [37]. *Safetipin*, *Circle of Six*, and other applications are also trying to provide women with different kinds of support [42, 35, 12]. These technologies are likely to be more effective in western settings, where women have relatively greater freedom of expression and mobility, and the infrastructure is willing to support this too. For example, *Protibadi* incorporated a mobile phone application, a website, and a Facebook page for women to combat sexual harassment [1]. Users of this system could ask for help from friends nearby via the mobile phone application. They could report a harassment incident, which would appear visually on a map of Dhaka (the capital city of Bangladesh where *Protibadi* was deployed). They could also blog and report harassment that would be shared publicly via the Facebook page. Though initially this application was downloaded widely, the enthusiasm for it soon began to fade.

Many *Protibadi* users were embarrassed to ask for help from others on the spot. They saw this as being harassed for the second time, as the 'helpers' repeatedly asked for a description of the harassment incident. The geographic visualization of the incidents also became problematic. A number of *Protibadi* users mentioned that the map was a tool to scare women away from public places. These women also mentioned that when their guardians/family members saw a large number of harassment incidents on the map, they would impose further restrictions on the women's freedom of movement. As a result, the women were in danger of losing even the minimal freedom they had to move across public places. The sharing of incidents of harassment was not very helpful either and there were frequent instances of victim-blaming. For example, there was the case of a *Protibadi* user reporting against verbal abuse from a random person on the street as she had not covered her head with a

scarf. A large number of men *and women* blamed the victim for disrespecting the religion and culture in the comments section of that post, resulting in a debate of more than 600 comments. Many *Protibadi* users disliked this nature of backlash and some of them began to limit their reporting.

These kinds of limits on the use of technologies by the women of Bangladesh reflect the broader picture of misogynistic behaviors over technological systems across the country that leverage the weak law and policy infrastructure of Bangladesh. Cyber crimes against women related to blackmailing, revenge porn, social network accounts hacking, and online bullying are on the rise at a rapid rate in the last couple of years. The government has set up complaint cells for such online crimes and slowly the victims are coming out to complain. Still, many of the affected ones remain silent due to the fear of social embarrassment and their negative perception of the law and order agencies' ability to ensure women's safety online. There are several recent reports of incidents in which women's harassment has been video-taped and the videos leaked online. In addition, there is a trend of creating fake Facebook profiles (mainly of women users) and spreading false news about other people's private lives, sexual orientation, or social interactions. These incidents support Kentaro Toyama's amplification theory that suggests that technology, if not designed with a deep understanding of the context, tends to amplify existing social disconnects [34]. Computing efforts can try to address these deep-seated social issues, but they will have to do so gradually and iteratively, and with an enhanced understanding of socio-cultural constraints. Several researchers have suggested that there needs to be a big change in the society and culture of the country to end violence against women. Technology could play a role here in supporting moral education, combating marginalization, and enhancing critical reflections, so as to effect positive change in societal values such that women's use of technology is not limited thus.

Now why are these society-imposed limits important for sustainability, or why should they be a concern of the LIMITS community? Why is it important to understand the situation of women when we talk about sustainability? The answer has two parts to it. First, it helps us see sustainability and collapse from a different lens. The impending threat of collapse, the constraints in resource, and the urge for sustainability may not have equal impact on men and women in many societies. Furthermore, when resources are limited, men are often taking the advantage of exploiting women by exercising power-politics. As a result, women are often experiencing more 'limits' than men. This conceptualization allows us to question some of the limits we have around and the politics surrounding them. While the limits of natural resources may not always be questioned, their distribution among the members of humankind is often a political agenda and should be treated politically. Second, the constrained use of technologies by women allows us to think about our approach towards sustainability. An acceptance of the existing limits imposed by society upon women may lead us towards an approach not aligned with the spirit of liberal democracy and feminism. On the other hand, if our goal of sustainable development supports equality and participation, our approach should incorporate diminishing any kind of marginalization to any woman on earth. In the following sections, we advance our arguments in support of the latter, and explicate the associated challenges and possible solutions.

6. APPLYING FEMINIST THEORIES

We now ask whether there are theoretical tools that might leave us better-equipped to address the process of designing for women *in spite of* prevalent gender inequality. Sengers et al. [31] introduced

the notion of Reflective Design, to stress the importance of reflection on unconscious values embedded in computing. We suggest the incorporation of feminist reflexivity as suggested by Bardzell's [3] framework in order to reflect on the processes of design and iteration. Bardzell and Bardzell [4] also identify ICTD as a potential application area in their rejection of the notion of a 'universal' design. This fits well with our ideology of situating our design in the context of local cultural practices that allow for factoring in the constraints imposed by gender inequality. The take on Feminist HCI that they offer is also presented in Dimond's [12] research on a social movement organization working to end street harassment. Kumar and Anderson [21] adapt this take to the rural Indian context where patriarchal forces are pervasive. These works offer examples of approaches that can aid us in developing a richer understanding of and a reflexive viewpoint towards the limits imposed by gender inequality on computing. Certainly, they are to be developed further, since the work mentioned above largely took place in western settings where the social and cultural climate is starkly different.

Besides revealing important political biases integrated with the core assumptions around the design and development of computing technologies, and providing novel and alternative ways of 'making', feminism helps us conceptualize the HCI discipline from a broader critical perspective. Feminist theories advance arguments around the politics of visibility, representation, identity, and reproduction in this discipline that are often absent in mainstream discussions around production (design) and consumption (use). Feminism questions the values and standards surrounding technology, and examines why some objects, actions, and attitudes are better rewarded than others. Thus, feminism analyzes the interplay between technology and identity, drawing our attention to power dynamics around technology.

Highlighting the politics of visibility is one feminist agenda that raises important questions around our value systems with regards to technology. Historically, in male-dominated societies, domestic works done by women, including cooking and child rearing, have often been made invisible and not been recognized as 'work' that should be compensated. As a result, millions of women around the world, even after working hard at their homes, are not 'paid' for their work. The detachment of their work from mainstream economy is underscored by a social process of rendering their works invisible. Both the hiding of women behind the *purdah* (curtain) and ignoring the art and craft involved in their domestic works have advanced this process. There is a recent effort to extend this argument to the world of technology that finds that there are also many important technical works that are less valued and often made invisible. For example, feminism observes that the history of HCI is centered on 'design and use' and has rarely shed any light until recently to several other important interactions with technologies including maintenance, repair, and recycling. The worthy contributions of people in those professions are often 'invisible' in HCI [17].

The politics of invisibility allows us to conceptualize how marginalization happens to different communities other than women, as well. There are different communities whose works are ignored, neglected, and devalued in society and we often do not "see" their contribution because they are made invisible. For example, our three months' long ethnography in Dhaka, Bangladesh, at ten different repair sites, revealed the two-layered process involved in making repair works invisible [15]. First, the contribution of the repairers - the marks of fixing - have been stigmatized and society tends towards hiding those. Even the quality of a repair task is often judged based on how few marks of fixing are visible on the device. Second, the repairers themselves are often hidden from the formal presentation of technology. The showrooms that sell new

electronic products usually stand at the front side of the markets, and the repairers work in the back. In the shops that offer both new electronics and repair service, the repairers usually sit in a corner. Gulistan Underground Market, the biggest repair market for mobile phone repair in Dhaka, is located underground and is invisible from the outside. The art and craft that they possess are seldom exposed to general people. This invisibility contributes to the low valuation of repair works both economically and socially. Most repairers are not well paid and do not have high social status. In the Gulistan Underground Market, hundreds of mobile phone repairers work in dark, hot, and humid conditions. Many of them have to leave their job early because they lose their eyesight working on fine objects with insufficient light and inadequate tools. They are not even called 'engineers', a 'distinction' that can only be earned by achieving a certificate from a high-end university. However, in practice, many repairers help the formal 'engineers' in solving critical technical problems in exchange for some money. We asked the repairers if they would like to see their children in the profession of repair. None of them were interested.

Like repairers, there are many other low-income communities that are engaged with technology, including electronic waste collectors, electronic recyclers, crowd-workers, and freelance software developers, who heavily contribute to technology but their contributions are rarely recognized. Adopting a feminist standpoint can help us conceptualize the politics that creates a standard against these marginalized professions. A creative deconstruction that stems from this feminist criticism can suggest a novel economy by rendering the invisible parts of the technology cycle visible and by recognizing the contributions of marginalized people [2]. A feminist agenda for computing is essentially an agenda of removing systematic marginalization - gender-based or otherwise - that advances the discipline towards a practice of greater equality and freedom. While this facet of feminist movement in the technology world is largely inspired by a goal of removing marginalization in the working process, this is also essentially related to the interest of women. Giving equal importance to every part of the technology cycle should develop a platform for recognizing and valuing many contributions that women often make, but remain hidden. Furthermore, such movement will raise the agenda for a free and fair working atmosphere and equal participation of masculine and feminine forces in every layer of technology design, development, use, maintenance, education, repair, and recycling.

7. DISCUSSION

In this paper, we have depicted the gender-imposed limits on computing for women, especially in developing countries, and discussed why we should take those seriously. We opened our discussion by pointing out the ineffectiveness of the Bangladeshi government in providing proper laws, policies, and law-enforcing support to protect gender rights around ICT. We then discussed how the use of technology is often limited by a number of social and cultural factors associated with gender identity. We deepened our discussion in this regard by discussing how designing technologies for women is often challenging for methodological reasons. We took our discussion to the participation of women in the technology industry and described the challenges women face in becoming computing professionals. Finally, we developed our arguments that support the necessity of strengthening feminist standpoints in ICT discourse to better reveal and hopefully reduce marginalization across levels. These discussions allow us to think about the relationship between women and technology in the context of developing countries in a number of actionable ways.

First, integrating sociocultural norms is essential for advancing

any technology. This straightforward notion becomes complicated when design becomes responsible for bringing changes in those values. For example, the failure of design interventions in combating sexual violence is often associated with the mismatch with established social norms. Under circumstances where women are marginalized due to age-old traditional beliefs practiced by the surrounding society, gaining social support to scaffold a revolutionary technology is unexpected. Here, we put forth two different strategies to confront such challenges. The first strategy is based on the libertarian feminist spirit of empowering individual women. This essentially means that women need to prepare themselves to design and develop the technologies that they deem necessary for them [14, 8]. This calls for strengthening technical education for women both in formal and informal contexts. In Bangladesh, social movements like ‘Code it, Girl!’ [36] are trying to develop alternative platforms for women so they can develop their skills for building technologies for their own needs. The worldwide initiative for developing open and democratic technologies can be helpful for such movements. At the same time, different kinds of DIY (‘Do It Yourself’) [22] initiatives can provide the platform for such empowerment of individuals including women. The second recommended strategy is based on the idea of ‘association’. According to this strategy, women could develop their ‘association’ among themselves and like-minded individuals. Then the sociotechnical association can produce values that would scaffold the designs and policies advanced for the betterment of women. These days, a number of women-only Facebook groups are trying to develop such associations among Bangladeshi women.

Second, we should focus on developing creative and alternative platforms for technology use and practice that can support women. For example, emphasizing human factors like art, beauty, passion for the design and practice of technologies may accentuate the necessity of incorporating virtues with technology that are often better possessed by women. By this we do not mean that women are the standard bearers of art, craft, and beauty, but we intend to emphasize the point that these virtues have often been ‘feminized’ and held back to impact on technologies in many cases. Criticism of the traditional advancement of technology towards achieving greater power, speed, and accuracy can allow scholars to think seriously about those values as alternatives [43]. That in turn should create more job opportunities for women in the tech industry. At the same time, focusing on oft-ignored human interactions with technologies like maintenance and repair may highlight women’s historical contribution in such activities. Art and media can play a crucial role in highlighting the labor, skills, and craft involved in such works. Similarly, the social stigmas around the used, broken, and repaired technologies needs to be mitigated through social campaigns. In the larger picture, we should re-examine all the values and standards that are associated with technologies, identify the marginalization by those, and design creative alternatives for them.

Third, this paper presents both the limits for women around computing and the optimism to overcome those. We have tried to stress that the limits are imposed on women by society, culture, religion, and technology itself. These limits are not trivial; rather they are widely prevalent, complex, inter-connected, and rooted in the history and tradition of a society. Sometimes these limits are so ingrained into the norms, values, and practices of a society that they may be hard even to conceptualize. All pragmatic approaches towards eliminating these limits hence require critical and reflective practices in technology. Also, these approaches have to be comprehensive and collaborative. Rather than focusing only on designing technical interventions or on running social campaigns among different communities, we need to coordinate our actions towards the

larger goal. Incorporating technology with the history, art, culture, and contemporary local movements of a society is important. At the same time, it is important to find the ‘residuality’ and marginalization through deep and engaged ethnography to reveal different material and temporal politics around science and technology [33]. Hence, overcoming the limits in computing for technology should be a comprehensive process comprised of technology, law, policy, criticism, participation, and education, among many others.

Finally, gender-based marginalization is essentially connected with the central concern of LIMITS community that cares about sustainable design with limited resources. For designing a sustainable solution, it is crucial to understand the limitations thoroughly. While resources are limited in general for all of humankind, some resources are more limited for some groups than others. This unequal distribution of opportunity and resources forms different kinds of constraints for different communities. In this paper, we intend to draw the attention of LIMITS community to this kind of inequality and marginalization. By providing an account of limited access for women in computing resources, this paper calls for re-assessing our hope for ‘computing with limits’ using a gender lens. At the same time, a feminist perspective essentially offers an alternative view of computing technologies. For example, focusing on oft-ignored tasks like repairing electronic devices and recycling discarded objects can directly impact sustainable living. If the current direction of technology is dominated by the modernist and misogynistic approaches, and that is quickly leading us toward a collapse, a feminist approach can provide us with tools for adding friction [19] and slowing down [43].

8. CONCLUSIONS

In this paper, we highlighted the limits imposed by gender inequality on computing in low-resource settings of the developing world, drawing on our empirical findings from Bangladesh in particular. We deconstructed this problem space to identify four potential areas of work. First, we highlighted that even when technologies are designed for women users in particular, they may not be adopted due to particular sociocultural norms that might limit their interaction. Second, we discussed that one factor impacting the design process is that women do not always have the freedom or the room to voice their needs in traditional needs assessment exercises that are organized to determine design goals. Third, we highlighted the fact that the participation of women in the design and development stages is acutely lacking, drawing on empirical findings. Fourth, we suggested that advancing our theoretical toolkit would be helpful towards better understanding and addressing the voices of women that are currently absent. We call for further research in each of these areas, especially in developing world settings such as ours, so that we can develop a less lopsided, more balanced view of what computing could achieve in order to circumvent the limits imposed by gender inequality in these under-studied parts of the world.

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