Roles of Technology for Risk Communication and Community Engagement in Bangladesh during COVID-19 Pandemic

ANIK SINHA

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

NOVA AHMED

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

SABBIR AHMED

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

IFTI AZAD ABEER

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

RAHAT JAHANGIR RONY

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

ANIK SAHA

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

SYEDA SHABNAM KHAN

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

SHAJNUSH AMIR

Design Inclusion Access Lab, Department of Electrical and Computer Engineering, North South University, Dhaka, Bangladesh

SHABANA KHAN

Indian Research Academy, Delhi, India

The COVID-19 pandemic required handling a clear communication of risk and community engagement. A gap is noted in scholarly studies portraying strong community engagement for risk handling, particularly in resource constrained regions in HCI community. This study covers community engagement and its use of technology during COVID-19 through a qualitative study of Bangladesh. The study looks at marginalized communities who have struggled through the pandemic yet handled the difficult time through their effective problem solving, working together as a community

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when there was not enough support from authorities. It is a qualitative study during the pandemic consisting of 9 communities, presenting 58 participants (N=58, Female= 33, Male=23, Transgender =2) across four divisions of Bangladesh covering urban, semi urban, and rural regions. The study uncovers the challenges and close community structures. It also shows the enhanced and increased positive role of technology during the pandemic while referring to a few communities being digitally disconnected communities that could benefit from digital connectivity in the future through increased awareness and support.

CCS CONCEPTS • Human Computer Interaction → Empirical Study

Additional Keywords and Phrases: Risk Communication and Community Engagement, Marginalized Community, Indigenous Community, Resource Constraint, Technology, Covid-19 Pandemic.

1 INTRODUCTION

COVID-19 globally affects countries economically, socially, and health [24], where countries with limited resources suffer severely [47, 19]. Marginalized communities (low-income and highly low-income based on Pew Research Center [34]) are most affected in such regions, and there are challenges to clear communication and efficient resource management schemes. To fight this, there requires effective risk communication [46], defined as "the exchange of information among interested parties about nature, magnitude, significance, or control of a risk" [61]. This risk communication among such interested parties forms community engagement to achieve sustainable outcomes and deepen community relationships. Thus, during the pandemic, there was an immense need for risk communication and community engagement (RCCE), referring to "the processes and approaches to systematically consult, engage, and communicate with communities who are at risk, or whose practices affect risk" [17]. This research explores the RCCE and the role of technology in it from the perspective of a developing nation, Bangladesh, among the marginalized communities during the pandemic.

Many countries continued an effective risk communication approach through a traditional top-down approach. For example, authorities from top order communicate to general people in South-Asian countries [26]. A contemporary study has shown that the government of Indonesia issued a 'New Normal' after the implementation of partial lockdown through technology such as Twitter and social media platforms and people showed a positive perception towards it [63]. However, this top-down risk communication approach did not effectively work across marginalized and highly marginalized communities because it left the community voices away from the decision-making and information dissemination process. As we focus on Bangladesh, previous research on Ready-made Garment workers shows miscommunication, frustration, untrusted, and lost communication mechanisms during the pandemic [2]. In addition, they were disconnected within nearby communities and struggled to survive for lacking support [2, 62]. Communication was difficult for them as such marginalized communities in Bangladesh had limited technology resources, while authority shared risk communication through various technology platforms. This comes with a glimpse that there needs to be more risk communication to reach marginalized communities.

The marginalized communities required aware risk communication during the pandemic [4, 13, 44], as well as any difficult period, as such communities often indulge in misinformation and unclear directions because of the knowledge gap [5, 6, 29, 20]. Also, these communities face social barriers where women suffer the most in South Asian countries [55]. Their voices are not considered societally [58, 59], so incorporating better risk communication measures around communities is essential. This leaves an important area to be explored by the research community where RCCE brings opportunities for engaging communities during the pandemic in resource-constrained regions such as Bangladesh [5].

The research shows that strong community structure and technology support systems enabled effective ways to incorporate RCCE. Other research in India and Singapore shows RCCE-based excellent management [1, 33, 37]. As it is evident that RCCE is an effective tool, but the ubiquitous implementation of effective communication was missing in most developing countries. Moreover, more discussions from an HCI perspective should be needed regarding technology-enabled RCCE in developing country settings that could add dimensions to the RCCE aspect. This motivates us to explore the marginalized communities situation in Bangladesh who have been socially neglected also before the pandemic.

This study explores understanding marginalized communities' risk communication and community engagement during the COVID-19 pandemic, along with the possible role of technology involvement in better risk communication. We focused closely connected marginalized communities in Bangladesh in various aspects, such as cultural purposes (e.g., indigenous communities living in the same locality); to address social difficulties (e.g., transgender communities living away from the locality, Baul (folk singers) living in their own communities); to live near the same workplace (e.g., tea garden workers in the same factory living together) and physically hard to reach locations (e.g., such as the Chitmahal region, at the border of India and Bangladesh that has been disputed over a long time, and the community remains isolated and away from many facilities from local and country-level authorities), etc. We conducted an in-depth qualitative study among them, a total of 58 participants (N=58, Female =33, Male =23, Transgender =2) from urban, semi-urban, and rural regions of Bangladesh, covering four different divisions - Dhaka, Rangpur, Chattogram, and Sylhet. The communities shared their difficulties that were enhanced during the pandemic. These communities faced economic challenges with minimal support from authorities. At the same time, the risk communication was initiated based on their existing connectivity to handle the difficult time within their limited resources and support. Technology platforms played an essential role in their community engagement and information dissemination. Based on findings, we contribute to HCI literature that RCCE will be more effective when the design aligns with existing communities' values in bottom-up approaches to sustain for the long term and mitigate challenges such as resource constraints. An effective management and support system can be used to model a future disaster and risk-handling intervention. The research will equally contribute to seeking the attention of policy-level stakeholders to ensure the inclusion of the voices of these communities in effective and sustainable ways.

2 COMMUNITY ENGAGEMENT AND RISK COMMUNICATION (RCCE)

The Covid–19 pandemic showed the worldwide inequality in terms of effective healthcare measures, distribution of vaccinations, and inability to manage effective communication around good basic measuring (e.g., wearing of mask) to intense ones (e.g., taking the vaccine) in various countries [12, 39]. The vaccine inequality had affected the minorities in harsher ways considering economic, racial, and measures clearly showing the structural challenges [39]. The challenges are exacerbated in countries with unstable economic and political situations, as seen in Pakistan through uneven healthcare support [32]. The global picture significantly shows the vaccine disparity and healthcare crisis at a glance, impacting resource-constrained countries [27]. As a result, the communities from countries with lower resources were affected severely, making the global inequality clearly visible [12, 39].

The topic of risk communication and community engagement (RCCE) during the COVID-19 pandemic turned out to be an important topic considering its impact on healthcare management with limited resources. The World Health Organization (WHO) has provided guidelines about RCCE during public health challenges such as the COVID-19 pandemic [45]. WHO also presents how effective communication is important as a failure to do so may cause loss of

trust and, in the worst case, loss of life. Scholarly publications present the importance of transparency across internal and governmental risk communication systems [21]. There are illustrations of the components of effective and sustainable ways of RCCE that call for global solidarity and community engagement [38]. The existence of a task force working on RCCE principles, particularly taking into account evidence-based decisions in handling the pandemic, has shown great results in countries such as Taiwan, South Korea, etc. [38]. The baseline guidelines presented by WHO are discussed by suggesting to incorporate proactive communicative strategies [14].

The top down handling of decision making was similarly visible in other lower and lower-middle income countries defined by world bank [57], as seen in the African region [1, 56]. The risk communication practiced in this region was based on top-down authority imposed during the pandemic [35, 2, 3]. As a result of authority imposed decision making, the low income working communities faced confusion and shared about their inability to comprehend instructions at the initial stages of the pandemic [2, 3]. A study consisting of 13 countries of Africa consisting of Algeria, Angola, Cote d'Ivoire, The Democratic Republic of Congo, Ethiopia, Ghana, Mauritius, Nigeria, South Africa, Tanzania, Kenya, Uganda, and Zambia showed existing challenges such as mistrust in the Government, weak healthcare system, presence of misinformation in the study and exclusion of several vulnerable communities in the study [1]. A study conducted in Bangladesh refers to the top down information sharing and, in many ways, was challenging to implement, referring to the social distance instructions that were hard to implement in a densely populated country [26].

The scholarly study has emphasized how risk communication should be a pro-poor or pro-vulnerable community to ensure effectiveness [7]. A successful example where the top down approach of communication shifted to a human centric approach to include the comparatively vulnerable community showed effective RCCE among migrant workers in Singapore [37]. Similarly, Kerala in India has implemented the effective "Break the chain campaign" of handwashing and has been effective in risk communication [33].

Moreover, Information and communication technology (ICT) is the most effective tool for empowering underprivileged groups, particularly adolescents and women [30]. Technology is used as a bridge for solving the problems of minority communities from developing countries, although criticized in utopian societies through amplification theory [40]. However, increasing women's access to digital financial services (DFS), such as digital payment systems and mobile financial services, will help minority groups like women to make their own decisions regarding spending, savings, and financial risk [22]. A study on developing countries like Pakistan, where cultural, religious, and security concerns are evident, shows that decision making and own behalf action taking will help women access fintech services regardless of the availability of infrastructure and technology [23]. A scholarly study in Bangladesh showed that during the COVID-19 pandemic, regardless of gender among these communities, technology, and technology based services such as digital financial services adoption increased in day-to-day work and financial work [25]. Technology can open up opportunities for risk communication, although it has been studied in limited form in risk communication literature. The discussions show the existing gap in examples of successful RCCE within low income regions, particularly those that focus on marginalized groups.

3 METHODOLOGY

This qualitative research explores the challenges faced by communities in Bangladesh during the COVID-19 pandemic. The study conducted the qualitative interview of N=58 participants (Female = 33, Transgender = 2, Male = 23) of

different socioeconomic statuses from four regions of Bangladesh, e.g., Dhaka, Chattogram, Rangpur and Sylhet Divisions. There were 10 Focus Group Interviews in a semi-structured format. All necessary safety protocols for COVID-19 were strictly maintained. The data extraction method is presented in Appendix Table A1.

3.1 Participants' Demographic Information

3.1.1 Participants' Education Level

The education level of the participants shows the majority (around 64%) without any education at all. Few participants received formal degrees such as the secondary school certificate (SSC), higher school certificate (HSC), diploma degrees, undergraduate (Bachelor's) and Master's degree as shown in Figure 1. However, the variation in education level is not uniform which varies among communities.

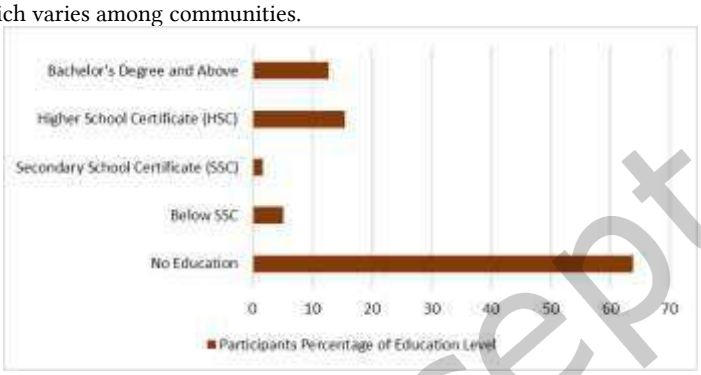


Figure 1: Education Level of Participants

A closer look at the communities shows that only few communities such as Khagrachari, Rakhine and Khasi communities had educational exposure while most of the other communities did not receive any education entirely as can be shown in Figure 2. The community oriented schematic shows various levels of education showing the lower education level stratifications considering Junior School Certificate at Class 8 prior to SSC examination and few dropping off prior to this certification exam. Most of the community showing no education. The lower level of education shows certain limitations the communities face in terms of risk communication for limited literacy.

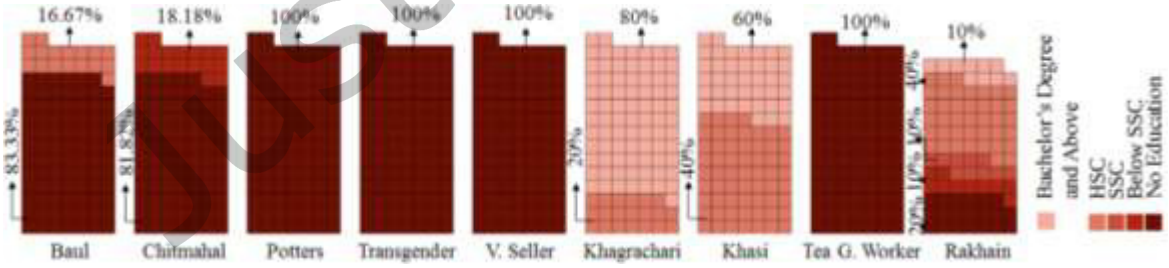


Figure 2: Education level of participants showing Individual Communities[1] (each block represents 1% percent)

[1] Among the 58 participants, there was 1 participant from the Rakhine group who did not specify her education.

3.1.2 *Financial Conditions of Participants*

Income levels of the communities based on Pew Research [34] show the majority of the communities residing in Poor or Low Income level as evident in Figure 3, representing the financial groups following Pew Research Center [34]. [2] The communities have variation in income levels as clearly presented in Figure 4. It must be noted that few participants were not comfortable with sharing their income level information which was respected during the research. The schematic shows lower income levels among tea garden workers, Rakhine community, and vegetable sellers.

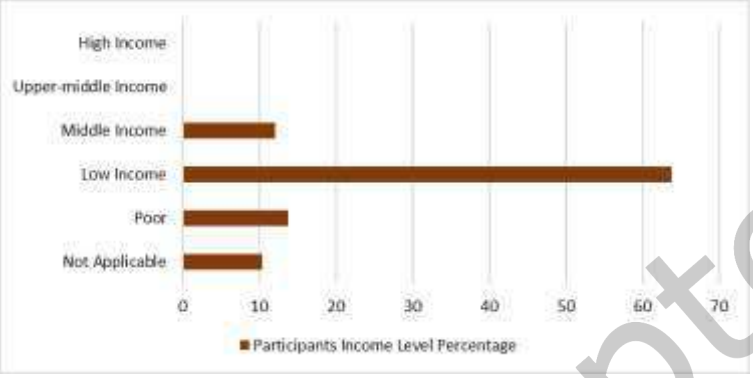


Figure 3: Income level of the population based on Pew Research Center [34].

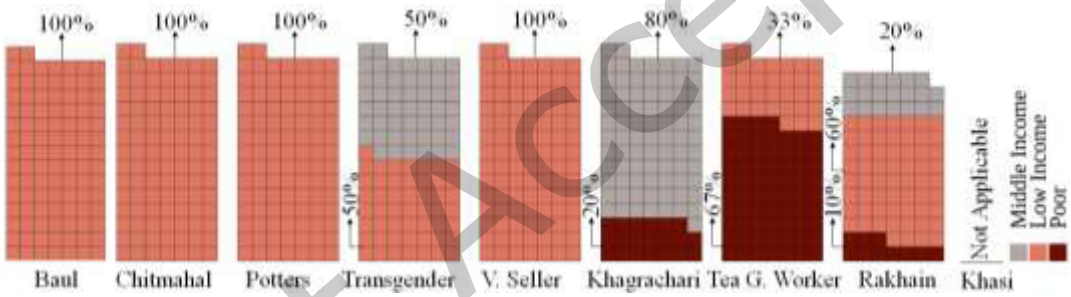


Figure 4: Income level of individual communities based on Pew Research Center [34]. (each block represents 1% percent)

3.1.3 *Area Specific Details*

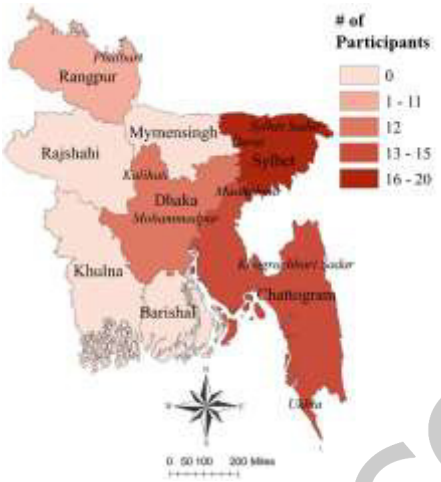
Dhaka Division: Dhaka is the metropolitan city and capital of Bangladesh. This study explored transgender and vegetable sellers from Dhaka urban area and a group of potters from rural areas in Balla village. We conducted the vegetable seller interview first from this region. Shown in figure 5.

Chattogram Division: Researchers have conducted a study in Cox's Bazar and Khagrachari, which are the one of the tourist spot of Bangladesh - the study took place in a semi urban region where the Rakhine, Chakma, Marma, and Tripura community lives. First, we went to Khagrachari and interviewed Chakma, Marma, and Tripura communities that are various indigenous communities.

[2] In the Khasi group, 5 participants and in the Rakhine group, 1 participant was a student and they did not have any personal income. Therefore, the income level classification was not applicable in case of those 6 participants.

Rangpur Division: The study was conducted at the border enclave region of the northern part of the country named the Dasiar Chhara. This enclave area merged with Bangladesh territory in 2015 [41]. In this area we consider the people who are living in the enclave area as our participants.

Sylhet Division: The study considered the main city of Sylhet (Sadar) for the khasi students' community for first interview and followed by the rural and remote tea garden state of Madhabpur, which is a sub-district of Habiganj and the semi urban region of Sunamganj (Derai) to reach out to the Baul singers [11] from Sylhet division. Baul artists are representative of the culture of traditional Bangladesh and their singing pattern is societal reality songs and theory of life.



Division	# of Participants	Groups
Rangpur	11	Chhitmahal
Dhaka	12	Potters, Vegetable Sellers, and Transgender
Chattogram	15	Rakhain and Khagrachari
Sylhet	20	Khasi, Tea Garden Workers, and Baul Singer

Figure 5: Map of Bangladesh presenting the 58 participants' living Upazila (Sub-district in italic text) and division.[3]

3.2 Participant Requirement

Focus group Interview using qualitative methods was used where each focus group was formed with 4 to 5 participants for a better discussion following the concept of mini group discussion [48, 49]. The participants were contacted through close connections, colleagues, and friends through various known connections following purposive sampling to ensure participants are from various economic levels and regional levels covering urban, semi urban, and rural regions [50, 51]. During the participant recruitment process researchers contacted Key Informants (KIs), who are locally trusted and connected with the communities. The participants preferred group interviews. Moreover, KI-shared participants will feel more comfortable in a group rather than talking individually. Each participant group included people from homogenous groups, e.g., similar professions, socioeconomic backgrounds who had common experiences [52]. As Dhaka is the capital city of Bangladesh and many people come from different regions for employment and education, we started by recruiting the participants from Dhaka in an effort to understand these groups. We went to the participant study area the day before the study. Prior to the study day, we discussed the locality's socio-cultural environment, lifestyle, and socioeconomic state with the local communicator or known contacts. There was higher participation from women, followed by men and transgender people. The participant's details are presented in Table 1.

[3] All the colors used in each figure of this paper is color blind safe which is verified through the accessibility tool of Adobe: https://color.adobe.com/create/color-accessibility.

Table 1. Participant Details

Community	Group ID, Participant #	Region and Profession	Participant count, Gender	Residence
Transgender	Gr 1, P1-P2	Urban, begging.	N=2, Transgender	Dhaka
Vegetable seller	Gr 2, P3-P7	Urban, small business.	N=5, Female	Dhaka
Potter community	Gr 3, P8-12	Rural, small business.	N=5, Female	Dhaka
Chitmahal residents, living in previously disputed land among India and Bangladesh	Gr 4, P13- 18	Rural, farmer.	N=6, Female	Rangpur (Enclave area)
	Gr 5, P19- 23	Rural, farmer.	N=5, Male	
Khagrachari (indigenous)	Gr 6, P24- 28	Semi urban, small business.	N=5, Male	Chattogram
Rakhine (indigenous)	Gr 7, P29- 33	Semi urban, small business.	N=5, Female	Chattogram
	Gr 8, P34- 37	Semi Urban	N=5, Male	
Tea garden worker (indigenous)	Gr 9, P38- 43	Rural, laborer.	N=6, Female	Sylhet
	Gr 10, P44- 46	Rural, laborer.	N=3, All Male	
Baul, folk singer	Gr 11, P47- 52	Semi Urban, singer.	N=6, Female =1, Male =5	Sylhet
Khasi (indigenous) community	Gr 12, P53- 57	Urban, student.	N=5, All Female	Sylhet

The participants were classified based on their income following the classification criteria of Pew Research Center. Among the 58 participants, most (53.4%) participants had low-income, 12.1% had middle-income, and 13.8% participants were poor. Among the remaining participants, 10.3% participants did not specify their income and 10.3% participants did not have any personal income and all of them were students.

3.3 Interview Method and Study Moderation

The COVID-19 pandemic was considered, and participants were asked about the preferred mode of interview - online or in-person. Furthermore, the participants were approached through close contacts and requested permission to engage in the interview topic and their preferred interview location and mode. We conducted in-person focus group interviews with five participants in each group, in places of their preference, mostly in the participants' residences or neighborhoods.

The interviews were interactive and participatory and were audio recorded with multiple recording devices to reduce missing data. Each interview took nearly 60-120 minutes on average, and around 50 hours of fieldwork was conducted, including participant management in a semi-structured questionnaire format. The questionnaire consisted of 12 questions (see Table 2 for sample questions). We asked our participants a series of questions focusing on study topics during the study. The researchers were interested in learning about the in-depth stories underlying the role of technology and risk communication during COVID-19. They preferred an open-ended questioning style that allows participants to share stories and anecdotes that can be further questioned based on their responses. Focus group interview is appealing because it can uncover complicated personal experiences, perceptions, opinions, and attitudes from participants. The generic format remained to seek stories and experiences around topics with follow-up notes based on person-specific details.

Table 2: Sample Interview Questions (translated from Bengali, the official language of Bangladesh)

Can you please share some details about your technology usage? Explain a little about the use of technology at your work.
How has technology use changed during Covid-19? If you could tell us the details.
During COVID-19, what was the social situation in your neighborhood? How did you maintain contact with your neighbors?

The interview medium was Bengali, the official language of Bangladesh and the native language of both the participants and the interviewers. Initially, one of the researchers moderated the interview, while the others took notes and assisted in asking follow-up questions based on participants' responses. The researchers' team led all of the interviews and qualitative study content analysis.

3.4 Qualitative Content Analysis

All the interviews conducted in the Bengali language were transcribed and translated into English for coding analysis. The researchers used the grounded theory method [53] for qualitative coding starting from importing the transcriptions on the Atlas.ti Cloud [54]. During the analysis phase, researchers jointly participated in initial coding from transcriptions, read the transcription line by line, focused thoroughly on the content of the interviews, and identified themes, participants' experiences, and their interactions that were highlighted repeatedly in the transcripts. The researchers contrasted and combined these initial codes to find high-level themes during the axial coding stage. The researchers developed a schematic diagram of codes during the study and refined it throughout the analysis process, to build links among the axial codes.

3.5 Research Ethics and Incentives and Safety Protocols

This research was IRB approved. The participants were adults and gave informed consent. We ensured participants' comfort and safety during the interview and were mindful of the communities' language barrier. Moreover, researchers respect the values and traditions of each community. The participants received gifts equivalent to BDT 1000 along with a takeaway meal for individual participants.

All the studies maintained social distancing and personal safety guidelines provided by the World Health Organization [46] and the Ministry of Health, Bangladesh [28]. Researchers provided face masks and hand sanitizers and made sure that all researchers and participants sanitized their hands and wore face masks before entering the room, keeping adequate social distance.

4 FINDINGS

The findings are presented in two major subsections- one focusing on understanding the participant's communities through their challenges and community connectivity, followed by a subsection emphasizing on technology usage.

4.1 Understanding the Communities and Their Challenges

The communities considered in this research were marginalized regarding technology access and community structure, as presented in the following subsections.

4.1.1 *The Communities Structure and their Risk Communication*

The variation in engagement during the COVID-19 pandemic and risk communication is summarized in Table 3. The communities shared how they have handled the risk communication and pandemic-related decision-making engaging in RCCE. It showed that three communities did not receive any country level support and one particular community did not receive any support from regional level or country level while all the communities engaged themselves to support their own communities during the pandemic to handle the adversaries. The risk communication was major part of community engagement as the participants shared about not being able to understand the severity of the pandemic getting information from various sources. All the communities unanimously agreed upon strong leadership (a leader who takes responsibility for their communities' well-being and sustainable development), as seen in the column "Community/Local Level Engagement" in Table 3. Regarding communication, the local community leaders (a respected and trusted person in the society or an elected person) played an essential role in sharing information. For example, the Rakhain community shared about support and clear directions to follow during the lockdown period to secure their communities.

The regional level support was received through local governance and organizations which was not available for two indigenous communities - one working as tea garden laborers while the other is the Khashi indigenous community that resides away from the city area. These communities shared about not feeling supported well although they remained close within their own localities in supporting and sharing information about the pandemic. Some of the communities referred to their marginalization and lack of support from authorities which required support within their communities. In contrast, others mentioned receiving support from local governance, as represented in darker color in Table 3. The lack of support from the *Regional Level* or *Country Level* affects communities such as Vegetable Sellers who shared about not receiving any higher order support apart from their surroundings. The challenges exacerbate as these communities are further excluded from digital connectivity, unable to access online digital resources for the risk communication process.

Across all the participants, the solid community-level engagement within individual groups was clearly evident as the participants shared. For example, the vegetable sellers expressed how they considered their own communities as families and mentioned: *"If we live, we will live together; if we die, we will die together." P6, Female, Age 18-29, Urban, Dhaka.* The transgender community referred to the support from local authorities and transgender leaders during the lockdown period, where the solvent ones would support the struggling individuals. Likewise, a few participants from various communities shared how the authorities have locked the entrance and exit within the community during the COVID-19 pandemic, which resulted in a safer internal environment. A Khagrachari participant shared the experience:

> "We have had neighbors who are helpless. We help them. During the corona, we worked as volunteers. We have distributed various reliefs. I was feeling a little weak myself. Even then, it worked like a charm as I am helping those who are unable to go outside. Many could not eat for two or three days. Some have eaten boiled banana trees. It would have been worse to see all this. In this corona period, many help those in whatever way they can. Things are like this." -P26, Male, Age 30-39, Sub-urban, Chattogram.

However, participants shared adverse situations constrained by the strict community guidelines. The entry and exit level restriction within local regions impacted two pregnant women in the Rakhine community who were not allowed to enter the village; shared as follows:

Table 3. A detailed table of engagement level and technology access of communities (the colored area shows the absence of resources)

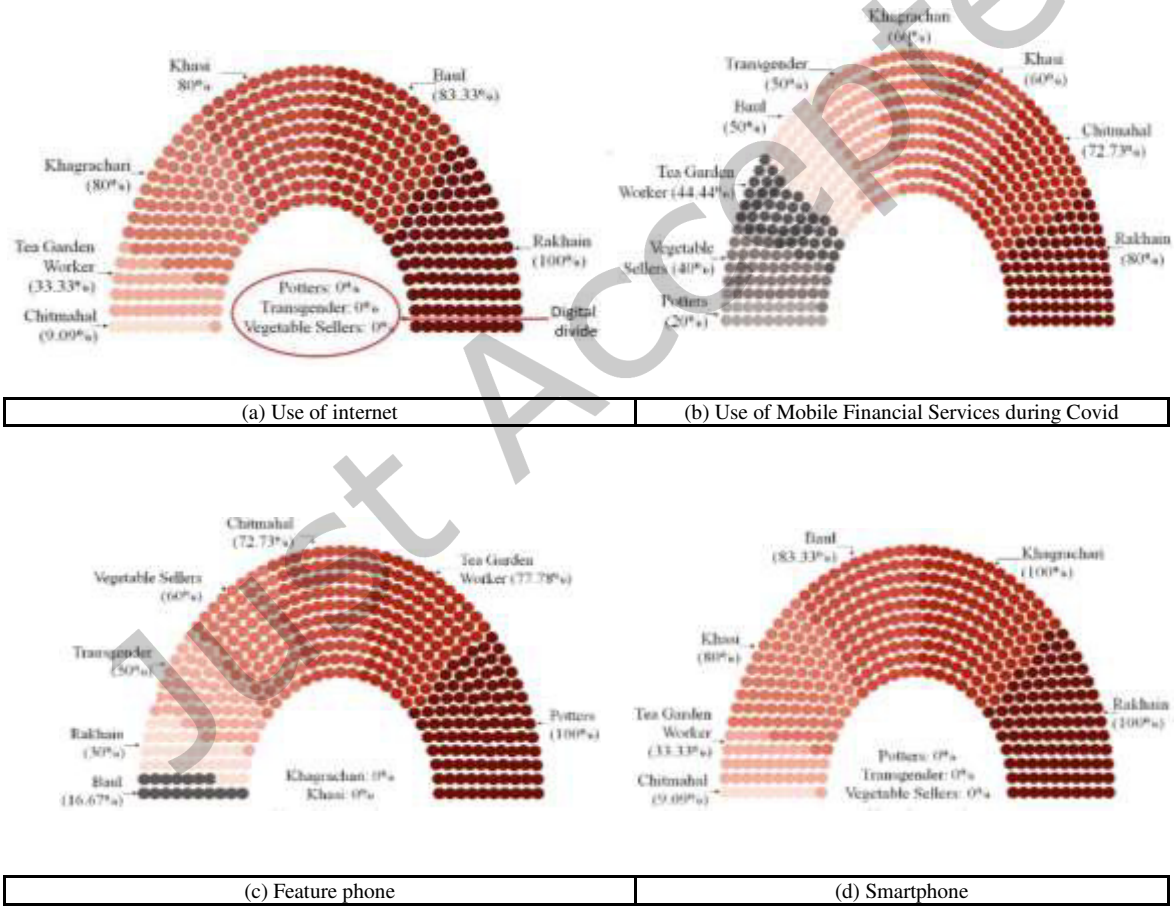
Community Information	Support from Community			Technology Engagement	
	Community/Local Level	Regional Level	Country Level	Technology Access	Technology Usage during Pandemic
Transgender	Strong support and leadership	Strong support	Received Govt. aid	Button mobile phone. No internet.	Basic communication with Phone
Vegetable Seller	Support in the community. Abused by Police. Stays together for increased security.	No Support	No Support	Button mobile phone. No internet. Agent based fintech.	Basic communication with Phone. Fintech to support family members.
Potter	Support in the community. Supports in adverse situations, natural disasters.	Strong support	Received Govt. aid	Button mobile phone. No internet.	Basic communication with Phone
Khasi, an indigenous community	Stays together in village, together when migrates to city	Local support continued	No Support	Smart phone, internet.	**Uses fintech.** Active social media user.
Rakhine, an indigenous community Male and Female	Stayed together, Pregnant women struggled for strong community regulations	Strong support.	Received Govt. aid	Smart phone, internet.	**Uses fintech.** Active social media user, learns from YouTube.
Various indigenous community from Khagrachari	Volunteered to ensure food for needy ones in the community.	Strong support	Received Govt. aid	Smart phone, internet.	**Uses fintech.** Fought for internet support. Active on social media.
Chitmahal, community living at previously disputed region, Male and Female	Strong community –did not wait for external support, solved problems within.	Strong support	Received basic Govt. aid	Button mobile phone. No internet.	Basic communication with Phone
Tea workers, indigenous community Male and Female	Strong community support and support from office	Strong support from local NGO	No Support	Button mobile phone. Uses minimal internet.	Basic communication with Phone. Fintech to receive money.
Baul, the folk singer community	Support each other using monetary and verbal support	Strong support from local and international community	Received Govt. aid	Smart phone, internet.	**Uses Fintech.** Active social media user, learns from YouTube.

"During Corona, my sister was pregnant. She came to us from outside this village. People will not allow her to enter the village. They wanted to put her in quarantine. [...]. If we come back to our main house, then people from the society will punish us." -P29, Female, Age 40-49, Sub-urban, Chattogram.

On the other hand, few communities did not receive any support from the country level or regional level, as has been shared by communities such as the vegetable sellers, tea garden workers, and Khasi community members. The communities living in the enclave area became part of Bangladesh in the last 6 years - they had been neglected before that period being in a disputed region that neither belonged to India nor Bangladesh. As the participants shared, this community felt disconnected from the leading country of its location and prior history. The tea garden workers shared similar disconnectivity, being located further from the mainland, and living in the mountains.

4.1.2 Limited Technological Access and Financial Condition

According to findings, the resource access diversity among communities can be seen in Figure 6, where the financially solvent and educated communities have better access to technology-based resources. compared to the other communities.



(a) Use of internet	(b) Use of Mobile Financial Services during Covid
(c) Feature phone	(d) Smartphone

Figure 6: Resource access diversity among communities.

The absence of the internet is clear in Figure 6-(a), which shows three different communities- Potters, Transgender, and Vegetable sellers who do not use the internet at all, two other communities, such as the tea garden worker and Chitmahal community have very few internet users among participants. We have found that only one community -the Rakhine community has participants who have 100% internet usage, while all other communities remain in between considering their internet usage. Mobile financial services (MFS) often using usage is used by at least one participant in all the groups of consideration as can be seen in Figure 6-(b) where none of the communities have all members using it (no community using it 0% and none using it 100%). The figure shows MFS usage during the COVID-19 pandemic, where it was used by at least one member from each community, referring to its necessity. It must be noted that most of the participants use mobile financial services through local agents, as the study presented.

The usage of Feature phones, as presented in Figure 6-(c), and the usage of smartphones, presented in Figure 6-(d), present complementary numbers, while the Potters group entirely uses feature phones and none use smartphones. In contrast, the Khagrachari group uses smartphones entirely and does not use feature phones. The different phone usage reflects the economic level along with internet accessibility.

Financial Condition: The financial condition was severely affected after the lockdown situation of the pandemic since many of the participants lost their regular earnings. The potters living in villages lost job offers and were not earning any money. They struggled as they did not have any savings. The same situation was shared by the Baul community, who earned it by singing folk songs at events, fairs, and concerts. They lost their entire source of income during the pandemic due to continued restrictions on public gatherings. A similar tone has been observed from a participant from the indigenous Khasi community who shared that she and her family faced problems when the lockdown was imposed as the family could not take care of their agricultural products shared as: *"The main problem is that our house is far from the cultivation land. My father was unable to take care of the plants. As there was none to look after the betel plants, it got damaged."* -P53, Female, Age 18-29, Urban, Sylhet. The communities' struggle was exacerbated after the pandemic-related lockdown, while many of the participants relied on short-term and long-term loans.

However, as we have seen in our studies, access to technology somewhat depends on financial circumstances. Financially non-solvent families get governmental aid through fintech during COVID-19, and through risk communication and community management, they have somehow managed the pandemic situation.

4.2 Role of Technology in Risk Communication and Community Engagement

Social media and other communication platforms helped in risk communication and community engagement during the Covid-19 lockdown. Social gatherings were prohibited, and the few community residents worked as volunteers to decide how the lockdown would be managed and implemented in the specific communities, how local aid would be distributed, and how they could assist elderly people who are vulnerable to Covid-19. According to participants, there was considerable use of financial technology known as fintech for cashless transactions throughout the pandemic and the usage of social media and video streaming applications for information gathering and knowledge sharing. They communicated by mobile SMS and the internet, including social media, video streaming sites, and television, as there were lockdowns everywhere they went. In this case, technology played a crucial role in risk communication by connecting the people with the government. The participants faced various issues throughout the epidemic; technology helped them to some extent, but it did not alleviate all of their concerns.

The participants unanimously shared about using mobile phones for basic communication, along with the majority sharing about fintech. Fintech, here, among the communities, referred to the mobile-based money transaction options mostly through mobile wallets. Mobile-based banking was not considered here. Most participants shared about using fintech, except for two communities - the communities engaged in the pottery business and those living in Chitmahal. Few communities use technology more extensively - they are involved in social media and use applications such as YouTube as learning sources. We discuss how the technology experiences in the following subsections:

4.2.1 Financial Technology during Pandemic and Community Support

Financial Technology, referred to as fintech, came as the major discussion point around how technology added value to the communities during the pandemic. It was because fintech had been popularized prior to the pandemic and added simple money transaction options for many marginalized ones who did not have access to formal banks as shared by the participants. Moreover, the pandemic related lockdown required strict protocols where fintech added provisions for contactless cash transactions.

During the pandemic and lockdown situation, participants shared sending and receiving the money to family members using fintech. The small business owners among the indigenous communities shared how fintech allowed them to continue contactless transactions. Few communities (e.g., Khasi community) were familiar with fintech prior to the pandemic, while many have started to use this technology to a greater extent. The participant members from the Rakhine community shared how they initiated fintech operations in their region during the lockdown. The baul community shared how they were supported with money during the pandemic. As a result of ongoing activities, the community was more fluent with fintech usage during this time.

The Government aid to support low income communities was dispersed using fintech, where the receivers received the money over their mobile phones. The list of community members was prepared by local Governance and community leaders. A participant shared the experience as follows:

> "I may not get the aid but the ones who are needy among us get the support from the government. Maybe one is sick and cannot live by himself. We are happy that the government is providing them support." -P20, Male, Age 50-65, Rural, Rangpur.

It must be noted that few of the participants from the Tripura community shared secondary experiences about being abused by middlemen during pandemic. We discuss the details in subsection 4.2.3.

The participants also mentioned that they collaborate to share their knowledge within the community during COVID-19 when they face any issues with mobile financial service (e.g., account block, new account opening). One of the participants from indigenous community shared "we went together in the customer care center (MFS service center) along with a young member from the community who can understand the technology if any issues happens to our account".

It must be noted that, the involvement of technology is often paired with certain misuse which impacts the marginalized communities directly as was shared from the study.

4.2.2 *Technology Learning, leading to Risk Communication*

The marginalization of communities of interest was obvious through limited internet access, which hampered technology literacy. However, the younger and more educated individuals shared their passion for and experience with advanced technology applications. The application of discussion included video streaming media such as YouTube as a resource repository and social media exposure.

One participant, P50 from the Baul community shared how he wished to earn money from his YouTube channel that he started with the help of a young community member. According to one of the Baul singers, P48, the Baul community singers perform live on social media during lockdown, passing along information they have related to COVID-19 which they learned from social media and television through their singing. Participants from the Rakhine community shared that they learned tailoring from YouTube. The participants have shared how their technology familiarity increased during the pandemic: *"I bought a mobile phone during the pandemic. I actually watch the news on YouTube. I also watch some tailoring videos and learn from there." -P24, Male, Age 30-39, Sub-urban, Chattogram.* A participant from the Chakma community shared how he learned a new cultivation technique from watching YouTube videos. As per his words, in hill tract areas, almonds were not cultivated previously, but with the help of YouTube and local government, he started cultivating almonds. The community people also connected with him. Local governments and agriculture departments monitor the full process every week through online video calling platforms where marginal communities were largely benefited.

> "I worked on my gardens. I watched a tutorial video from YouTube. I watched on video that almonds will be cultivated in hilly areas. I also started cultivating cauliflower. I also discussed with my friends about cultivating almonds. This is under process. I tried a few trees in my garden to see the results." -P25, Male, Age 30-39, Sub-urban, Chattogram.

One of the participants, P33, shared that they have learned how to wash hands in a proper way based on governmental guidelines through online video platforms. They also learned about making detergent-based low cost disinfectors through instruction from local authorities and community leaders using those technologies which broadly helped them to fight with pandemic and prevent infections.

The experience of learning from YouTube, however, was not always positive. A veterinary doctor from the same community shared about incidents when he had to treat sick animals who were given medicines by local people, suggested by YouTube.

4.2.3 *Connectivity, Information and Misinformation*

Technology is used for sharing and accessing information as well as staying connected to others as has been studied by scholars considering the similar geographic regions [36].

However, one participant working as a tea garden worker, shared about defeating corona by drinking ginger tea - a misinformation widely shared across the country using various social media platforms. The participant specifically mentioned about "*having the ginger tea that defeats corona*" in her conversation. It must be noted that most participants were unaware of such misinformation as they were not digitally well connected. The myth of vaccination, which is also spread through word-of-mouth and social media, was discussed in many groups in diverse ways. The young participants admitted that they were deceived because they had strong social media connections and had an impact over their parents. Though elder participants shared they were well informed about vaccination through central and local government risk communication.

As has been discussed, the majority of the low income participants are facing digital divide and cannot be reached through digital communication means as referred here as *digitally disconnected.* As the COVID-19 pandemic forced many to use technology to a wider extent, the digitally disconnected community remained further behind. Digital disconnectivity is often based on a lack of basic educational literacy and challenging economic conditions (as presented in Figures 1, Figure 2, and Figure 3). For example, the pottery makers, enclave area participants, and tea garden workers referred to being entirely disconnected from technology usage considering their lack of literacy and inability to afford mobile phones. It refers to the digitally disconnected community that remains further disconnected from various forms of support.

The pandemic time misinformation is often deliberate to abuse low-literate communities as the study shows. A participant shared how elderly and low literate individuals were misguided and misinformed about their requirements to receive Government aid through mobile wallet accounts such as bkash, Nagad etc. These individuals, not being aware of mobile wallet based transactions, ended up buying new phone sets, new SIM cards to receive their aid which was not the real scenario. The aid of 2500 BDT ended up in few hundreds after spending their aid money to buy the phone sets, SIM cards etc. One such experience is shared here as:

> "People need to pay extra money to withdraw COVID allowance. They get only 400-500 taka, but the government gives 2500 taka. bkash agents took 500 taka to open a bkash account. It's not only for bkash, Nagad included too. Union parishad sent a list for allowance, but then they asked for a new SIM card and new phone, so people needed to buy a new phone and sim card to get an allowance for the first time. They (agents) only do it to sell SIM cards. " -P26, Male, Age 30-39, Sub-urban, Chattogram.

The above quotation portrays mishandling of government aid at the local level where mobile financial service agents and other associated people charge extra money from the total aid by providing them misleading information.

Misuse and misinformation require great importance and attention for the future. Handling the misuse, and misinformation around technology on marginalized communities have a risk of creating a fear around technology that pushes them further away from using it as has been seen in contemporary studies taking place in South Asian regions [18. 60].

5 DISCUSSION

The disruptive and unforeseen nature of the COVID-19 pandemic has motivated a series of risk communication research including this qualitative research study. These works mostly aim to identify the gaps of risk communication infrastructures and the possible ways to improve the scenario through different measures. Researchers have focused on the country level communications and how different approaches (e.g., technology-driven or community-driven approaches) fared in coping with the pandemic [31, 42]. The community level aspects are also highlighted in risk communication literature where community engagement and bottom-up approach is emphasized to avoid confusions and cultural miscommunications [26]. However, the practices of the marginalized communities during the pandemic is underexplored in hitherto research. This study focuses on that aspect and also sheds light on the role technology plays for this community in risk communication. Although there is research work focusing on these communities, this study tries to address the gap of research works concerning technologies' role for marginalized communities in risk communication. This qualitative study involved N=58 participants from different socioeconomic backgrounds showing the communities' structures and challenges where limited technology exposure and low-financial states are prominent.

This study's findings further show that adopting fundamental and financial technology improves these communities' community engagement and leads to improvements in risk communication. These communities have worked among themselves, and supported each other.

5.1 Combining Technology and Community Engagement for Effective Risk Communication within *Marginalized* Communities

Risk communication literature has explored the different approaches to combat the pandemic situation. The technology-based approach from Singapore showed resilience in the containment of the disease while bottom-up digital solutions and innovative individual engagements aided in the process [42]. A technology-based solution has been discussed in the scholarly work from Thailand where bottom-up approach was implemented through a mobile self-screening application within the community during COVID-19 and improved their health [64]. Meanwhile, the collectivistic societal structure and grassroots management system enabled Vietnam to successfully cope with the first wave of COVID-19 [31]. We discuss the risk communication scenario in the context of Bangladesh in this subsection. It also discusses the ways to improve the infrastructure and possible technology and policy interventions for effective risk communication within the marginalized communities.

Figure 7 presents a schematic diagram showing the various resources available at the country level, regional level, and community level along with the challenges and opportunities it can provide in risk communication. The levels appeared directly from our study that showed how top down risk communication takes place initiating at the country level being pushed to community levels through regional level activities. For effective risk communication and strategy implementation, the communication across the various levels should be clear to ensure better implementation strategies at policy level as well as for effective technology implementation and dissemination for risk communication

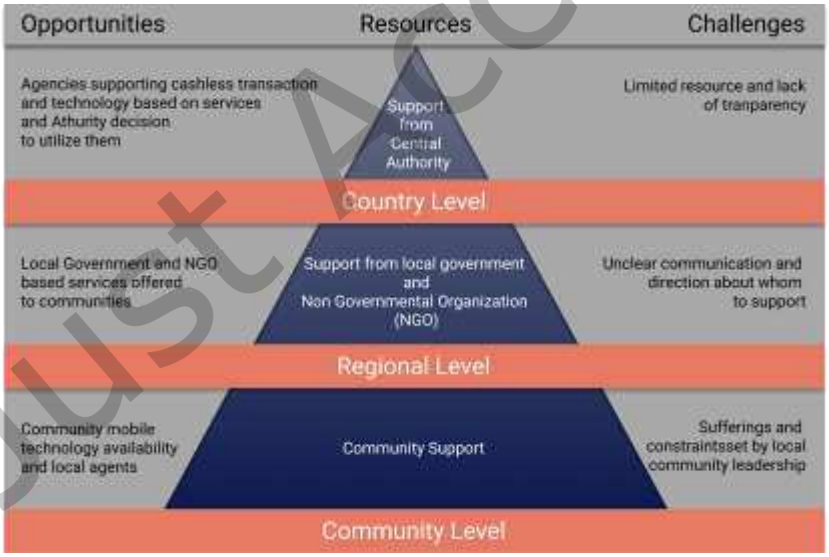


Figure 7. Community level, regional level and country level opportunities and challenges in risk communication

Community level: The bottom up communication method initiates from the local communities in *community level engagement* where the availability of community leaders and basic techniques are considered as opportunities. As

mentioned in the previous subsection, community level engagement helped in restricting the spread of COVID-19. However, there are often difficulties added when the local leadership follows strict and rigid guidelines (e.g., restriction to allow pregnant villagers to return to their parental homes amid lockdown).

The community level engagement can be improved using effective technology-based support where marginalized communities without technological support may be included through community-run programs. For example, there can be community level support to ensure connectivity and engagement of a particular community member who does not have a technological device. Local community youth and volunteers can play an important role here. Although such measures can enhance the technological access and connectivity of the marginalized communities, these communities are also prone to different negativity (e.g., misuse, misinformation etc.) as we found in our study. The possibility of misuse and misinformation, that are commonly targeted towards women and marginal communities, must be addressed carefully as this pushes communities away from technology engagement as contemporary studies have shown [18, 60].

From the policy perspective, the authorities must ensure ways to listen to the community voices prior to providing guidelines. The bottom up approach can provide sustainable engagement among community members, leaders and authorities compared to top down measures. Recent contemporary studies have shown how top down measures created confusion and miscommunication among authorities and communities [26]. A bottom up strategy is expected to significantly improve the communication scenario.

Regional Level: The regional authority's involvement is referred to as *regional level engagement which is above the locality taking a large number of people and region into the context.* The regional authorities such as organizations from local governance and non-governmental organizations (NGO) have played an important role in risk communication where the conversations were based on trust and prior engagement. This level of engagement considers local Governance and NGOs that are widely spread across the country adding to the advantages of this level through their existing communication infrastructure while the lack of clear communication is considered a limitation.

Regional level communication can be improved by addressing the lack of communication through technological development where local to regional level views need to be clearly shared. Technology can be effectively used to ensure transparent and clear communication. The summarized form of risk communication at regional level can be used during policy dialogues.

Country Level: The broader level guidelines at the national level about various safety protocols and governmental measures during the pandemic are referred to as *country level engagement.* The country level communication adds the highest levels of authorities adding the existing infrastructure and decision making capabilities as strengths. The limited resources are considered a challenge considering the case of Bangladesh. In general, top down approaches have been used at country level risk communication [26], which created confusion and miscommunication among minority communities [2, 3]. For example, existing studies have shown how the ready-made garment workers were not sure if they had to continue their work in factories or observe lockdown for lack of clarity in communication during the pandemic [3].

During the lockdown, the government of Bangladesh faced an unprecedented challenge as it had to reach out to its people remotely. Where technology was an effective possible option to reach out to the people. The government of

Bangladesh sent money through mobile financial services. However, the top down risk communication approach failed to understand the concerns of marginalized communities. It also was unable to reach communities without access to technology facing the digital divide. Similar findings were shared by contemporary researchers showing an existing digital divide that exists among various marginal communities [9].

The technology platform can enable bi-directional communication approach where authority can communicate to communities effectively and have options to understand where communities are struggling most. The communication must ensure technology platforms paired with existing non-technical forms of communication to ensure inclusion of marginalized communities. The clarity in risk communication can enable better understanding for policy intervention that can be a pathway towards combating future challenges.

This is how, strong connectivity and community engagement, combined with technology can allow effective risk communication despite having an under-prepared infrastructures for fighting against such an disruptive event like the COVID-19 pandemic. This phenomenon among the participants of this study, opens up a new dimension in risk communication research where the community enabled technology support can be utilized as a possible mechanism to boost the existing risk communication infrastructures through effective and sustainable design.

5.2 Community Engagement Sustained by Technology and Ensuring Leadership

Technology and fintech support people continuing risk communication during the pandemic in Bangladesh [25, 62], where developmental purposes are evident in marginalized communities [40, 62]. In this study, participants' communication was challenging during the pandemic. At that point, the technology worked as a positive enabler for where they could communicate with each other through their minimal access to technology (presented in Table 3 in the findings), which refers to their strong community engagement among themselves. This example shows that mobile phone usage has opened up ways to connect to others during difficult times. Such engagements sometimes were handled within smaller groups with minimal authority-level intervention. Also, distant family members and friends could support through fintech-based money transactions and verbal support. We have seen participants in hill tracts start cultivating different fruits at the community level through support from the local government and online. This shows technology helps them access such points, leading them to change their lifestyle at the community level. So technology offers resources to add opportunities among the communities [62]. However, the study also shows the mishandling of technology among the communities could result in loosen up moralities of community engagement. At this point, Ahmed et al. suggested that technology adds value in the communities so that technology access points should be trusted and verified, and there will also be a feature for aware information sharing [62]. Moreover, there is a requirement for awareness concentration regarding implementing technology that will improve community engagement.

Community engagement through this study's findings is important as it helps grow community leadership. This community leadership is effective in risk communication as the community leader could engage the community in fighting difficult situations. It is also possible to have numerous implementation strategies. For example, we have seen that the Rakhine community imposed personal lockdown beyond authority lockdown; they did not let anyone enter their community during the pandemic, and some took such strict initiatives. So, ensuring closed entry and exit points at localities is a strategy by community engagement and leadership. Similarly, a community engagement initiative was successful during the Pandemic in Kerala, India, where a large community kitchen ensured food for the sick people in

that region [37]. Moreover, community engagement can improve the community's society and create a role of social leaders within the community.

6 CONCLUSION

The study covers marginalized participants across four divisions of Bangladesh facing societal and economic hardship. The participants have demonstrated great connectivity and risk communication approaches during the COVID-19 pandemic when there was not enough support from authorities. The local community engagement and bottom up approach to risk communication present an example of effective risk coping strategies among communities struggling with low resources. The study also showed how technology was incorporated during the pandemic time within the low-resource settings while discussing newer ways of technological and policy interventions for the marginalized community. The lessons learned from this research emphasize the need of exploring the prospect of technology support to these communities. They can be greatly benefitted through the technologies. However, their voices often go unheard by the technology designers and policy makers. Further research can be conducted in the human-centered design aspects for the risk communication of marginalized communities in low-resource contexts to build upon this research work.

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APPENDICIES

A. *Data extraction for quantitative analysis:* We extracted quantitative values regarding demographic characteristics (e.g., education), technology usage (e.g., smartphone), and banking which were related to this study and for which quantitative data was possible to extract from the transcripts. All of the quantitative values of the variables (e.g., MFS usage) used in our study were extracted from the transcripts and listening to the recorded audio.

Table A.1: Classification of the participants based on their income. N/A denotes the economic status which is not available in the classification criteria of Pew Research Center. BDT: Bangladeshi Taka, USD: United States Dollar.

Economic Status	Per Day Income (USD) Based on Pew Research Center	Monthly Income (BDT) (Pew Research Center)
Poor	<= $2	5,088.12
Low income	$2.01 - $10	5,113.56 - 25,440.6
Lower-middle income	N/A	N/A
Middle income	$10.01 - $20	25,466.04 - 50,881.2
Upper-middle income	$20.01 - $50	50,906.64 - 127,203
High income	> $50	> 127,203

B. Terminologies

Table B.2 refers to the terminologies that are used throughout the paper.

Terminology	Explanation
bKash	A popular mobile wallet service
Nagad	Another popular mobile wallet service
Feature phone/ Button phone	Mobile phone that operates based on physical T9 keypads, not a smartphone.
MFS	Mobile Financial Service
MFS Agent	MFS service facilitator in the local Community and directly works with the customers.
DFS	Digital Financial Service
Baul	A traditional Bengali singer community