2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC)
Banff Center, Banff, Canada, October 5-8, 2017

Mobile Text Entry Challenges Among Low-Income Users in a Developing Country

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***Abstract*—This paper presents results of a survey that explored the challenges low-income mobile users of Dhaka, Bangladesh (*N* = 131) face in mobile text entry. Results revealed that all users use the Bengali language at some capacity to compose text, yet many (are forced to) write with the Roman alphabet. Both feature phone and smartphone users feel that the existing text entry techniques are difficult to learn and use. The fact that some knowledge of the English language is necessary, even to use many popular Bengali text entry techniques, frustrates them as it compromises their entry speed and accuracy. Results also suggest that mobile phones and mobile text entry are more popular among younger and educated users. Further, smartphone users spend more time and engage in more text entry episodes than feature phone users.**

Keywords—Text entry; texting; typing; keyboards; developing world; mobile devices; SMS; low-income individuals; ICT4D.

I. Introduction

Mobile phones have become an important part of everyday life for some in the developing world. A recent survey revealed that users in the developing world are using their mobile devices for a variety of purposes, especially for texting and taking pictures [1]. However, mobile users in the developing regions, especially the ones within the low-income brackets, face many challenges in mobile text entry. It is evident that modern consumer electronics usually enter a developing market at a much-advanced stage, primarily because creating the demand for a novel technology requires relatively more time in these regions [2]. This reduces the likelihood of skill transfer from an older technology to a newer one. For instance, most smartphone users in the developed world were already familiar with personal computers, the Internet, and owned a feature phone before purchasing a smartphone [3]. Their experience with these technologies made it easier for them to upgrade to a smartphone. In contrast, many low-income users in the developing regions were exposed to smartphones directly [4], [5]. They, therefore, required extra efforts to learn how to operate these devices. Many of the users were also not familiar with the common text entry techniques, such as Multi-tap and Qwerty.

Although it may seem straightforward to experts, the task of text entry is difficult since it requires both cognitive and motor skills. Text entry on mobile devices is even more difficult due to the smaller key sizes and the absence of haptic feedback on touchscreens [6]. Besides, most text entry techniques are designed for wealthier markets, under the assumption that the technological conditions, resources, and infrastructures available to the users are stable, reliable, and affordable, when the reality is often quite the opposite. Besides, the fact that most text entry techniques are designed for the English language also makes text entry difficult for users with no/minimal prior knowledge of the language.

Most popular international text entry techniques either use a transcription or transliteration method to automatically convert Latin script to non-Latin scripts or map non-Latin characters to a Latin keyboard based on phonemes [7]. Both methods assume some knowledge of the Latin alphabet that many users might not possess. Therefore, learning how to input text on mobile devices could involve a significant amount of time and effort.

Researchers are attempting to address this issue by developing novel text entry techniques that do not require the knowledge of the Latin alphabet. Educators and social workers, alternatively, are introducing special training programs in deprived regions for teaching English and different mobile technologies. However, an understanding of these users' needs, desires, expectations, and challenges with mobile text entry is essential for both initiatives to be successful. To address this, here we present results of a survey that explored mobile text entry behaviors and challenges among low-income individuals in Dhaka, Bangladesh.

II. Related Work

Several researchers have studied texting behaviors globally [8], regionally [9], and in the developing world [1], [10]. Some have also studied the effects of mobile banking [11], [12], mobile healthcare [13], mobile learning [14], mobile communities [10], [15], and mobile Internet [16], [17] on low-income individuals in different developing regions. Many have also focused on the socio-economic impact of mobile technologies [5], [10], [18], [19].

Kreutzer [16] investigated online and digital media usage on mobile phones among low-income urban youth in Cape Town, South Africa. He distributed a detailed questionnaire to all grade-11 students at nine public schools in the city's most deprived areas. Results revealed that about 87% of the students used mobile phones daily to make phone calls or to send texts. However, this work focused only on the Internet and digital media usage, hence did not provide much information on their text entry behaviors.

Ureta conducted a study in Santiago, Chile [5] to investigate the impact of mobile technologies on low-income individuals' physical mobility. Results revealed that text messaging was almost nonexistent in the communicative practices of the users.

This work was supported in part by NSERC, the Canada Research Chairs (CRC) program, the Canada Foundation for Innovation (CFI), and the Ontario Ministry of Research and Innovation (MRI)

Acknowledging that this contradicts the trends observed in most developing nations, he concluded that this is likely due to illiteracy and antiquity of the phones. Similar studies in sub-Saharan African communities yielded comparable results [18].

The Philippines has become known as "the text capital of the world". In 2001, they processed about 65.4 million texts a day, more than all of Europe. Pertierra [10] studied the social consequences of this "addiction" and argued that texting in the Philippines is *"a cultural response to the disaggregative effects of modern life"*, therefore cannot be generalized to all developing regions. To our knowledge, no work has investigated low-income mobile users' text entry behaviors and challenges in a developing region.

III. A Survey

We conducted a survey in Dhaka, Bangladesh to investigate low-income mobile users' text entry challenges. The survey also investigated their mobile phone usage and texting behaviors to identify any potential relationships between these and their age, gender, educational attainment, and household size.

A. Location

We picked Dhaka for the survey since it is the densest city of Bangladesh [20], one of the fastest growing mobile markets in the world [21]. "Low-income" is the dominant income group in the country, representing about 59% of the 153 million population [22]. Besides, like most developing countries, Bangladesh has a low educational attainment rate [23], which means literate people in the country can barely read and write their native language, Bengali [20]. All these make our survey in the region relevant.

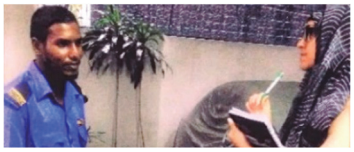

Fig. 1. A low-income mobile user (male, 42 years) participating in the survey.

B. Low-Income Individuals

In the survey, we identify "low-income" individuals based on the criteria set by the World Bank. That is, individuals with a daily per capita income between US $2 and US $10 [24]. All dollar amounts in this paper represent 2015 prices. We converted all local amounts to 2015 Purchasing Power Parity (PPP) dollars [2] to equalize the purchasing power of the two currencies by considering the cost of living and inflation differences. Note that the survey does not include "poor", signifying individuals living on US $2 or less daily, since they typically do not possess the purchasing power to own a mobile phone.

C. Methodology

We recruited participants from the densest areas of the city. We randomly approached potential volunteers at common gathering places, such as tea stalls and grocery markets. First, we explained our survey to the ones that self-identified themselves as low-income individuals, and then collected their consents. We then screened them for age, mobile phone ownership, and education. They all had to be adults, owners of at least one mobile phone, and primary-school educated as a minimum to make sure that they can read and write in Bengali. Anyone who could not meet these criteria was excluded from the survey. We then separated a volunteer from the crowd to conduct the survey in private to eliminate any potential effects of collective influence.

First, the survey asked participants about their age, gender, education, household size. It then extended the questions to their mobile phone usage and text entry behaviors. They were asked about the technique(s) they used for text entry and the challengers, if any, they faced with these techniques. The survey used a semi-structured questionnaire. It used some predetermined sets of questions and answers (particularly for the demographics and the mobile phone usage related inquiries), and some subjective questions to inquire about participants' text entry behaviors and challenges. The survey was carried out verbally, in Bengali. All responses were recorded using a mobile phone or pen-and-paper, and then translated and transcribed to English. We often inspected participants' mobile phones to verify their responses to text entry technique related questions since many of them were unable to name the techniques they used.

D. Participants

We surveyed 643 mobile phone users over the period of three months. Then, we manually excluded all participants that did not satisfy the World Bank's criteria for low-income individuals. We also removed the participants that responded that they never input text on their mobile phones or did not respond to all questions. Finally, we considered 131 low-income mobile users for the final analysis.

Participants' age ranged from 19 to 57 years, on average 25.9 years (SD = 6.6). About 95.4% of them were right-handed, 3.8% (N = 5) were left-handed, and the remaining 0.8% (N = 1) were ambidextrous. Their average daily income was PPP $7.43 (SD = 1.5), and average household size was 4.6 (SD = 1.8). TABLE I displays participant demographics.

Here and henceforth in this document, "N" signifies the total number of participants in a group, "NA" signifies not applicable, "Primary", "Junior", "Secondary", "Higher-secondary", and "Post-secondary" signifies grade 1-4, 5-8, 9-10, 11-12, and above higher secondary level education, respectively, finally all values inside the brackets signify ±1 standard deviation (SD).

TABLE I. Participant Demographics

Age	**N**	**%**	**Gender**	***N***	**%**
19-29	104	79.39	*Male*	107	81.68
30-39	19	14.50	*Female*	24	18.32
40-49	6	4.58			
50 or above	2	1.53			
Education	**N**	**%**	**Household Size**	***N***	**%**
Primary	12	9.16	*1-2*	12	9.16
Junior	28	21.37	*3-4*	56	42.75
Secondary	28	21.37	*5 or above*	63	48.09
Higher-secondary	33	25.19			
Post-secondary	30	22.90			

IV. Results

Results revealed that participants were almost equally divided in terms of the types of mobile phones they owned. About 53.44% (N = 70) of the participants owned a feature phone, while about 46.56% (N = 61) owned a smartphone. Interestingly, about 51.5%

of the feature phone users responded that they did not want to switch to a smartphone, believing that it would not enhance their mobile experience. The remaining 22.7% and 25.8% feature phone owners responded that they had plans to switch to a smartphone within six months and one year, respectively. TABLE II presents statistics on mobile phone ownerships.

TABLE II. FEATURE AND SMARTPHONE OWNERSHIPS BY AGE, GENDER, EDUCATION, AND HOUSEHOLD SIZE

Age	**Feature** (%)	**Smart** (%)	**Gender**	**Feature** (%)	**Smart** (%)
19-29	39.69	39.69	*Male*	43.51	38.17
30-39	8.4	6.11	*Female*	9.92	8.4
40-49	4.58	0			
50 or above	0.76	0.76			
Education	**Feature** (%)	**Smart** (%)	**Household Size**	**Feature** (%)	**Smart** (%)
Primary	7.63	1.53	*1-2*	3.05	6.11
Junior	15.27	6.11	*3-4*	25.95	16.79
Secondary	10.69	10.69	*5 or above*	24.43	23.66
Higher-secondary	13.74	11.45			
Post-secondary	6.11	16.79			

A. Feature Phones and Smartphones

In the following sections, we present the data from the feature phone and smartphone users separately since they usually use different interaction methods (i.e., tactile buttons vs. multi-touch, respectively) and do not share all features and functionalities. Both types provide basic functionalities, such as calling, camera, Internet access, and media player, yet unlike smartphones, feature phones do not enable highly integrated apps and multitasking.

Note that some mobile phones, principally manufactured for the developing regions, use either a low-cost touchscreen or a hybrid of tactile buttons and a low-cost touchscreen, and provide the support for some popular apps, such as Facebook and Skype. We considered these type of mobile phones, often referred to as "basic phones", as feature phones since they do not fully support highly integrated apps and/or multitasking.

TABLE III. PARTICIPANTS' AVERAGE EXPERIENCE WITH MOBILE PHONES (IN YEARS)

Age	**Feature** (Hour)	**Smart** (Hour)	**Gender**	**Feature** (Hour)	**Smart** (Hour)
19-29	5.85 (2.9)	4.83 (3.1)	*Male*	6.35 (2.8)	5.1 (3.2)
30-39	7.54 (3.9)	5.25 (3.2)	*Female*	5.0 (4.9)	4.36 (2.9)
40-49	5.33 (4.5)	NA			
50 or above	8.0 (NA)	10 (NA)			
Education	**Feature** (Hour)	**Smart** (Hour)	**Household Size**	**Feature** (Hour)	**Smart** (Hour)
Primary	3.0 (1.8)	4.5 (2.1)	*1-2*	5.5 (2.4)	4.87 (4.6)
Junior	5.4 (2.8)	3.12 (1.8)	*3-4*	5.65 (3.6)	4.77 (2.5)
Secondary	7.64 (3.2)	6.07 (2.8)	*5 or above*	6.66 (3.1)	5.13 (3.2)
Higher-secondary	6.72 (3.2)	4.4 (3.9)			
Post-secondary	7.62 (3.6)	5.36 (3.1)			

B. Mobile Phone Usage

Most of the participants were experienced mobile phone users. Feature and smartphone users owned their devices for 6.1 (SD = 3.3) and 4.9 (SD = 3.1) years, respectively. They also used their mobile phones daily: feature phone owners for roughly 3.3 (SD = 2.3) hours and smartphone owners for roughly 4.6 (SD = 2.2) hours on average. TABLE III and TABLE IV display participants' average experience with mobile phones and daily mobile phone usage, respectively.

TABLE IV. PARTICIPANTS' AVERAGE MOBILE PHONE USAGE PER DAY (IN HOURS)

Age	**Feature** (Hour)	**Smart** (Hour)	**Gender**	**Feature** (Hour)	**Smart** (Hour)
19-29	3.46 (2.2)	4.71 (2.3)	*Male*	3.42 (2.5)	4.38 (2.3)
30-39	2.45 (2.1)	3.62 (1.8)	*Female*	2.92 (1.3)	5.54 (1.4)
40-49	4.0 (3.52)	NA			
50 or above	2.0 (NA)	6 (NA)			
Education	**Feature** (Hour)	**Smart** (Hour)	**Household Size**	**Feature** (Hour)	**Smart** (Hour)
Primary	2.7 (1.6)	4 (0)	*1-2*	2.5 (0.6)	3.5 (1.1)
Junior	3.0 (1.9)	4 (1.6)	*3-4*	3.38 (2.3)	4.97 (2.6)
Secondary	2.93 (2.8)	3.96 (2.4)	*5 or above*	3.37 (2.4)	4.6 (2.1)
Higher-secondary	4.17 (2.5)	4.33 (1.9)			
Post-secondary	3.75 (2.5)	5.43 (2.5)			

All participants (100%) used their mobile phones to make calls. The screening process also made sure that they all (100%) used their phones to input text. In addition, 75.71% of the feature phone and 100% of the smartphone owners responded that they also used their devices for other activities, such as to play media contents or to take pictures (TABLE V).

TABLE V. THE MOST POPULAR MOBILE ACTIVITIES AMONG THE PARTICIPANTS. THE VALUES DO NOT ADD UP TO 100%, SINCE MANY USERS PERFORMED MULTIPLE MOBILE ACTIVITIES

Mobile Activities	**Feature** *N* = 53 (%)	**Total Mentions**	**Smart** *N* = 61 (%)	**Total Mentions**
Listening to radio broadcasting	39.62	21	16.39	10
Play multimedia contents	32.08	17	9.84	6
Take pictures	22.64	12	49.18	30
Access the Internet	16.98	9	31.14	19
Use mobile apps, including games	11.32	6	16.39	10

C. Text Entry Behaviors

Feature phone and smartphone users reported on average 7.4 (SD = 14.2) and 16.8 (SD = 35.7) daily mobile text entry episodes, including sending text messages and posting on social networking websites. Reportedly, feature phone and smartphone users spent on average 1.26 (SD = 1.8) and 1.27 (SD = 1.25) hours for these daily episodes, respectively. TABLE VI and TABLE VII present daily average text entry episodes and average time spent in these episodes, respectively.

TABLE VI. AVERAGE MOBILE TEXT ENTRY EPISODES PER DAY

Age	**Feature**	**Smart**	**Gender**	**Feature**	**Smart**
19-29	9.29 (16.1)	18.92 (38.3)	*Male*	7.82 (15.4)	16.48 (37.2)
30-39	1.73 (1.1)	NA	*Female*	5.38 (6.97)	18.27 (29.5)
40-49	2.17 (1.2)	4.75 (3.4)			
50 or above	1.0 (NA)	3 (NA)			
Education	**Feature**	**Smart**	**Household Size**	**Feature**	**Smart**
Primary	12.3 (30.9)	1.5 (0.7)	*1-2*	27 (48.7)	9.37 (4.9)
Junior	2.75 (2.38)	2.75 (1.3)	*3-4*	6.73 (9.9)	29.27 (53.4)
Secondary	8.57 (14.0)	8.64 (12.3)	*5 or above*	5.59 (7.9)	9.87 (19.3)
Higher-secondary	7.28 (7.3)	10.27 (12.7)			
Post-secondary	10.87 (11.5)	32.95 (54.7)			

TABLE VII. AVERAGE TIME SPENT (IN HOURS) EVERY DAY IN MOBILE TEXT ENTRY EPISODES

Age	Feature (Hour)	Smart (Hour)	Gender	Feature (Hour)	Smart (Hour)
19-29	1.47 (2.0)	1.33 (1.3)	*Male*	1.39 (1.9)	1.18 (1.2)
30-39	0.62 (0.9)	1.02 (0.7)	*Female*	0.71 (0.5)	1.68 (1.3)
40-49	0.81 (0.7)	NA			
50 or above	0.08 (NA)	0.5 (NA)			
Education	**Feature (Hour)**	**Smart (Hour)**	**Household Size**	**Feature (Hour)**	**Smart (Hour)**
Primary	1.1 (0.9)	1.5 (0.7)	*1-2*	1.62 (1.1)	1.29 (0.9)
Junior	1.24 (1.4)	0.77 (0.3)	*3-4*	1.18 (1.7)	1.41 (1.5)
Secondary	1.22 (2.5)	0.76 (0.6)	*5 or above*	1.3 (1.9)	1.17 (1.1)
Higher-secondary	1.39 (2.2)	1.06 (1.5)			
Post-secondary	1.28 (1.1)	1.9 (1.4)			

D. Text Entry Techniques

Data showed that most mobile users (~70%) used Multi-tap, T9, and Qwerty to input text on their devices. The remaining ~30% used a variety of Bengali text entry techniques, including Nokia Bangla, Nokia Bangla Lite, Nokia Bangla Qwerty, TSITS, Mayabi, Ridmik, and UniBijoy. Since the survey failed to find a technique(s) that dominates Bengali text entry, we categorized all text entry techniques into three groups for better presentation: *unambiguous*, *ambiguous*, and *transcription*.

Unambiguous techniques, such as Qwerty, assign dedicated keys to each character, therefore usually require one keystroke to enter one character. Ambiguous techniques, such as Multi-tap, map multiple characters onto one key, thus either require users to disambiguate the input by performing a sequence of tasks (e.g., multiple taps) or use a software-level disambiguation method (e.g., a decoder) [6]. Transcription techniques, in contrast, use phonemic methods to convert one writing system into another, e.g., from English to Bengali [7]. Expectedly, most unambiguous techniques were used with physical/virtual Qwerty, ambiguous techniques were used with physical/virtual half-Qwerty and the standard 12-key keypad and transcription techniques were used with physical/virtual Qwerty and half-Qwerty keyboard layouts. TABLE VIII displays the most common types of keypads and keyboards and text entry techniques used on mobile devices.

TABLE VIII. THE MOST COMMON KEYPAD AND KEYBOARD LAYOUTS AND TEXT ENTRY TECHNIQUES USED ON MOBILE PHONES. A PREVIOUS WORK [6] REVIEWED SOME OF THESE TEXT ENTRY TECHNIQUES

Keypad/ Keyboard	Feature (%)	Smart (%)	Text Entry Technique	Feature (%)	Smart (%)
Qwerty	7.14	45.9	*English Unambiguous (e.g., Qwerty)*	7.14	70.49
Virtual Qwerty	7.14	37.7	*English Ambiguous (e.g., Multi-tap)*	60.01	8.2
Half-Qwerty	11.43	6.56	*Bengali Unambiguous (e.g., UniBijoy)*	NA	13.11
Virtual Half-Qwerty	1.43	NA	*Bengali Ambiguous (e.g., Nokia Bangla)*	27.14	1.64
12-Key	67.14	NA	*Bengali Transcription (i.e., Mayabi)*	5.71	6.56
Virtual 12-Key	5.71	9.84			

1) Typing Language and Scripts

All participants (100%) responded that they use the Bengali language at some capacity to compose text. About 64.7% of them used Bengali almost exclusively, except for some commonly used English words (e.g., "Hello") and phrases (e.g., "I love you"). The remaining 35.3% used Bengali, together with various dialects of Bengali (i.e., Chittagonian and Sylheti) and/or English. Yet, about 72.9% of them used the Latin script to write in Bengali. The remaining 27.1% used the Bengali script. TABLE IX shows the languages and scripts used in mobile text entry.

TABLE IX. THE LANGUAGES AND WRITING SCRIPTS USED IN MOBILE TEXT ENTRY. HERE, "BN" SIGNIFIES THE BENGALI LANGUAGE AND SCRIPT,"EN" SIGNIFIES THE COMBINATION OF THE ENGLISH AND THE BENGALI LANGUAGES, AND "LN" SIGNIFIES THE LATIN SCRIPT

Text Entry Technique	Language				Writing Script			
	Feature		Smart		Feature		Smart	
	BN (%)	EN (%)	BN (%)	EN (%)	BN (%)	LN (%)	BN (%)	LN (%)
English Unambiguous	4.29	2.86	27.86	44.25	NA	7.14	NA	70.49
English Ambiguous	47.14	12.86	6.56	1.64	NA	60.01	NA	8.2
Bengali Unambiguous	NA	NA	9.84	3.28	NA	NA	13.11	NA
Bengali Ambiguous	21.43	5.71	1.64	NA	27.14	NA	1.64	NA
Bengali Transcription	5.71	NA	4.93	NA	5.71	NA	6.56	NA

2) Text Entry Challenges

All feature phone users (100%) and almost all smartphone users (98.6%) expressed their dissatisfaction with mobile text entry. Only one smartphone user (female, 26 years, post-secondary level education) was completely satisfied with mobile text entry. We identified several reoccurring themes in their responses and comments, which are presented in TABLE X.

TABLE X. USER REPORTED DIFFICULTIES WITH MOBILE TEXT ENTRY. HERE, "TECHNIQUE" IMPLY A TEXT ENTRY TECHNIQUE AND "LAYOUT" IMPLY A KEYPAD OR A KEYBOARD LAYOUT. NOTE THAT THE VALUES DO NOT ADD UP TO 100%, SINCE MANY USERS COMPLAINED ABOUT MULTIPLE ASPECTS OF THEIR KEYPAD, KEYBOARD, AND TEXT ENTRY TECHNIQUES

Challenges	Feature (%)	Smart (%)
1. *It takes too much time to input text*	35.71	24.6
2. *The technique is difficult to use*	22.86	18.03
3. *The layout is difficult to learn / The layout is poorly designed*	21.43	14.75
4. *I frequently make mistakes with the technique / The technique is unreliable*	17.14	27.87
5. *The technique is difficult to learn / It is difficult to learn all functionalities*	15.71	9.84
6. *The technique requires some knowledge of English / I would prefer inputting in Bengali / There is no efficient Bengali technique*	15.71	21.31
7. *No challenges*	NA	1.64

V. DISCUSSION

Data showed that most mobile phone owners were relatively younger, educated, and individuals with larger household sizes (TABLE II). They also used their mobile phones more frequently than the other users (TABLE IV). This is most probably because younger, higher educated people are better equipped to take the

full advantage of mobile phones, making these devices more desirable to them. Relevantly, 19-29 years old participants had a relatively higher educational attainment rate than the other age groups. Roughly 55.8% of them had either higher-secondary or post-secondary education. Individuals with larger household sizes, on the other hand, were most probably dependent on their mobile phones, particularly text messages, to communicate with the other members of the household.

No definite pattern was observed in terms of smartphone ownership (TABLE II). Participants were almost equally divided regarding the types of mobile phones they owned. However, data revealed that smartphone users used their devices more frequently than feature phone users (TABLE IV). We speculate that this is because smartphones offer a whole lot more features than feature phones. TABLE V also supports this assumption, where one can see that considerably more smartphone users engaged in mobile activities than feature phone users, i.e., taking pictures, accessing Internet, and using native apps.

Surprisingly, about half of the feature phone owners responded that they did not want to switch to a smartphone, believing that it would not extend/enhance their mobile experience. For example, one participant (female, 50 years) responded, *"[There is no point switching to a smartphone as] my current phone is enough to keep in touch with my family"*. The other half wanted to switch within a year, providing that they become more affordable.

We acknowledge that smartphones could eventually replace feature phones as smartphones become more affordable and the educational attainment rate of a country increases. But it is also possible that feature phones will make a comeback in the developed world due to their straightforwardness, durability, and relatively longer battery life [25], [26].

A. Mobile Phone Usage

Data revealed that participants spent about the same amount of time for text entry with feature and smartphones (TABLE VII). However, they reported almost twice as many daily text entry episodes with smartphones than with feature phones (TABLE VI). This suggests that it took them substantially more time to input text with feature phones than smartphones. In other words, text entry with feature phones was more difficult. TABLE X also supports this assumption, where one can see that comparatively more feature phone users complained about the usability (#2) and learnability (#3) of the input techniques for feature phones. This also suggests that smartphone users were more comfortable with mobile text entry than feature phone users. However, we recommend caution interpreting these results since text entry metrics are usually difficult to self-report.

Furthermore, data showed that mobile text entry was more popular among younger and educated users. Comparatively, they reported more daily text entry episodes (TABLE VI) and daily mobile usage for text entry (TABLE VII). These findings are comparable to the trends observed in the mobile ownership data (discussed above), and we speculate that the same factors have contributed towards this (e.g., they were better equipped to learn and use mobile text entry techniques than the other users).

Interestingly, no definite pattern was observed in terms of the household size, although users with larger household sizes used their mobile phones more frequently than the other users (TABLE IV). This could be because these users relied more on phone calls to communicate with the household members than text messaging.

B. Text Entry Techniques

As expected, data revealed that the majority of the feature phones were equipped with either a physical or virtual standard 12-key mobile keypad (72.8%), while the majority of the smartphones were equipped with a physical or virtual Qwerty keyboard (83.6%). Interestingly, some users used ambiguous text entry techniques, such as Multi-tap, on smartphones. This is most probably because they learned these techniques as feature phone users and kept on using those even after switching to smartphones. TABLE VIII shows a complete list of keypad and keyboard layouts used on these devices.

All participants (100%) responded that they used Bengali at some capacity to compose text. This is unsurprising since Bengali is the national and official language of Bangladesh. However, interestingly, the majority of the participants used the Latin script to write Bengali (TABLE IX). This could be because of either the unavailability or the inaccessibility (i.e., difficulty to discover and install) of more efficient and easy-to-learn Bengali text entry techniques.

All feature phone users reported some challenges with mobile text entry (TABLE X). Many felt that it took them too much time to input text on mobile devices. Many also complained that they frequently made mistakes when inputting text. For instance, one participant (male, 47 years) commented, *"Entering text [on my mobile phone] is very time consuming"*. This could be because many participants found it difficult to master all features of a text entry technique, hence difficult to use. The fact that almost all mobile keypads are designed for English, while the majority of the users wrote in Bengali (TABLE IX) could have contribute towards this as well. Relevantly, many participants felt that the keypads are poorly designed. For instance, one participant (male, 29 years) noted, *"My [text entry] performance could improve with a better designed keypad"*. However, the ones who used a Bengali keypad and/or a Bengali text entry technique also made similar complaints. One user of a Bengali ambiguous text entry technique (male, 38 years), for instance, stated, *"Text entry [with this technique] is very difficult"*.

Many smartphone users were also frustrated with their text entry speed and accuracy (TABLE X). For instance, one participant (female, 22 years) commented, *"It's [mobile text entry is] time consuming"*. But comparatively, a larger number of participants expressed their dissatisfaction with the fact that their technique requires some knowledge of English. This is probably because many popular Bengali techniques for smartphones require users to write Bengali using the Roman alphabet for conversion. This could make text entry more challenging for some users. For instance, one user of a Bengali transcription technique (male, 26 years) noted, *"[It is so difficult to input in Bengali that] I am discouraged to send text messages"*.

We deliberately designed the survey to be brief since it was conducted in public spaces. Hence, the results presented here merely scratch the surface of the subject. Nevertheless, our work suggests that low-income mobile users in developing countries

face many challenges in mobile text entry. We hope this work will inspire further research to explore the matter further, and the design and development of more accessible text entry techniques to provide these users with a better mobile text entry experience. The findings are also of interest to the ICT4D (Information and Communications Technologies for Development) community, as difficulties in inputting text on mobile devices could restrict or limit users' access to various mobile apps and services.

VI. Conclusion

We conducted a survey in Dhaka, Bangladesh to investigate the challenges low-income mobile users face in mobile text entry. The survey involved 131 low-income individuals. Results showed that all users used the Bengali language at some capacity to compose text, but many (were forced to) write with the Roman alphabet. Both feature and smartphone users felt that the existing text entry techniques are difficult to learn and use. The fact that some knowledge of the English language is necessary, even to use some popular Bengali text entry techniques, frustrated them. Some believed that this reduced their entry speed and accuracy.

Additionally, the results revealed that participants were almost equally split in terms feature phone and smartphone ownerships, and about half of the feature phone owners did not want to switch to a smartphone, believing that it would not enhance their mobile experience. Further, results showed that mobile phones and mobile text entry were more popular among younger and educated users. Smartphone users spent more time and engaged in more text entry episodes than feature phone users, presumably because they found text entry on smartphones relatively easier than the feature phone users. They also participated in relatively more mobile activities, apart from calling and texting, than the feature phone users.

VII. Future Work

In the future, we will conduct focus groups and case studies to further investigate the factors that affect low-income mobile users' text entry behaviors. We will also extend our investigation to rural areas. It is likely that we will observe different text entry behaviors among low-income users in rural areas, because of their limited access to mobile technologies, mobile network, and the Internet. Finally, based on the findings of our research, we will attempt to develop novel text entry techniques targeted at low-income mobile users in the developing world.

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