Smartphone adoption among visually impaired people in urban spaces: Cases from Seoul and Bangalore

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ABSTRACT
This survey of 101 working-age professionals in Seoul, South Korea, and Bangalore, India, examines the drivers and impediments in the adoption and use of smartphones among visually impaired residents in two urban settings. Using in-depth interviews with 10 respondents in each city, we found three factors that influence technology use. These are the initial transition experience, the role of the community in supporting accessibility, and the mobile device's relationship to independence in accessible technology use. These in turn are related to ways in which the capabilities of a device and its broader environment such as its apps relate to social interactions such as transit navigation and economic opportunities. Through the voices of visually impaired mobile users in both countries, we propose that designers examine mobile technologies within a broader context that includes a device's usability for individuals and extends to the social networks and public spaces and institutions that these devices facilitate access to.

CCS Concepts
• Human-centered computing → Accessibility → Accessibility theory, concepts and paradigms

Keywords
South Korea, India, screen readers, voiceover, talkback

1. INTRODUCTION
Smartphones running a variety of mobile apps are increasingly central to the daily experience of accessibility for people with vision impairments in various parts of the world. The shift from keypad-based feature phones running separately installed mobile screen readers that provide audio output to an integrated smartphone environment with accessibility features bundled into the mobile devices has been relatively swift. This has been in part a result of market factors. The increasing ubiquity of Android- and iOS-based touchscreen phones has gradually eased high-performing keypad-based phones out of the market. Additionally, better-quality speech synthesis and text magnification are now bundled with the off-the-shelf smartphones, hampering the market for separately purchased software for the keypad devices.

Alongside these developments, mobile apps have grown in importance as a means of conducting various social and economic functions from social networking to online purchasing and banking. Consequently, adopting a touchscreen smartphone and using mobile apps is becoming the standard for social participation on several fronts. In this work, we examine the drivers and challenges of the use of smartphones among people with vision impairments, particularly during the early phases of adopting touchscreen devices.

We look at Seoul and Bangalore, two disparate cities where access to services, accessible built environments, social attitudes toward independence, and the participation of people with disabilities in the labor market is significantly different. Both Seoul and Bangalore are densely populated urban agglomerations considered megacities. Seoul has an extended metropolitan population of about 25 million, almost half of all South Korea, whereas the greater metropolitan region around Bangalore has about 11 million residents.[1]

In Seoul the language of business and public interaction is predominantly Korean. Bangalore has a mix of languages in use — English is dominant in elite business, Kannada is the locally spoken dialect and language of government business, and both Tamil and Hindi/Urdu, two other Indian languages, are widely spoken and used in business and social interactions. One important distinction between the two cities from an accessibility perspective is the relatively recent growth of Bangalore as a major city — it has tripled in population over the last three decades, which has created significant pressures on its urban infrastructure. While there are no granular statistics on urban teledensity, South Korea had the world's highest rate of smartphone penetration at 88% in 2015, whereas India had only 17% [18]; though presumably this number is higher for urban areas with broadband coverage.[2]

In both cities, there are a number of accessibility-related non-profits such as disabled people's organizations (DPOs) that work with people with vision impairments. In Bangalore such organizations have played a very important role in the lives of people, in part because weaker government institutions have led to a general reliance on non-profits for service provision to people with disabilities [14, 20], but also because the city is a magnet for migrants coming from across the state and other parts of India. Seoul, in comparison, has traditionally been the main population hub of the region and has long had schools and training centers for people with vision impairments.

Despite these differences, several factors around accessibility make the cities comparable. Both are global economic centers

[1] http://worldpopulationreview.com/world-cities/

[2] http://yourstory.com/2015/07/mobile-internet-report-2015/ (citing http://www.iamai.in/media/details/4620)

with diverse labor market opportunities that attract workers from around their respective geographies. The two cities are densely packed and have bustling public transit systems, and also offer greater access than rural areas to institutions and resources for people with disabilities, facilitating social participation. Seoul's metro rail system is central to its public transit system, in addition to express and local buses as well as private taxis; Bangalore's metro rail system is relatively small, so commuters rely heavily on buses, cabs, and private vehicles. Both cities are traffic-heavy. In Bangalore, pedestrian safety is an issue, with street widening cutting into walkways and poor observance of traffic laws.

In both countries, long-standing negative cultural attitudes toward people with disabilities, particularly around the framing of disability as an impediment to social participation, have impacted the kinds of jobs blind people have traditionally had access to. In Korea, for instance, for much of the 20th century, blind people were widely trained to do massage work and there have been laws provisioning for such work [9]. India's history of channeling of people with disabilities also goes back several decades, and despite the expansion of technology-related economies, employment continues to be a major challenge for blind people, including in cities like Bangalore [8,16].

In addition to the social and economic benefits these larger cities hold for people with vision impairments, the two cities are generally hubs for technology adoption, and are important markets for new hardware products in their respective regions. In both locations we came across blind people using the latest in assistive devices. Likewise, the massive economies of the two cities have birthed software innovations including a range of apps that relate to citizen experiences with urban services.

However, while researchers have explored the reasons people adopt or reject technologies, they have not focused as much on people in emerging markets who are transitioning to new technologies that have a vital role in their community and independence. Therefore, our goal in this work was to bring together the practical concerns of urban professionals, focusing on three aspects — technology apprehensions, independence, and community living — and understand the place of technology in enabling these.

In this qualitative study, we used questionnaires and in-depth interviews to examine some of the ways people with vision impairments experience accessible technologies, and we related this to the evolving world of mobile devices in these two cities. We look at the use of smartphones within their social and cultural contexts, and examine their adoption from the aspects of individual independence and community support, both of which we find to be central to peoples' ability to successfully integrate these devices into their daily lives. Our data show that technical and infrastructural issues that impact peoples' ability to use technology are innately tied to the social conditions of technology access and use.

2. RELATED WORK

Much work has explored factors leading to the adoption or non-adoption of assistive technologies, with a focus on various user types and factors that influence adoption or lack thereof [7]. In this study, we are primarily concerned with the users themselves, and much work has shown that factors like frustration tolerance, fit into routine, and lack of stigma influence such adoption [3,21,22]. Kane et al. have shown that people with vision impairments deal with situational effects and device failures through their own adaptive strategies including modifying devices and using their environments in a variety of ways [6]. Other works have looked at how the use of assistive technology (AT) is mediated by adaptations that individuals must figure out for themselves, which in turn creates vulnerabilities and dependencies [2].

Other studies have argued for "in the wild" approaches, moving away from lab studies that raise important concerns about the real-world barriers that emerge in the lived experiences of people using accessible technologies [11,13,19]. Rodrigues et al., who looked specifically at mobile accessibility, found a range of challenges that we build on here, from early daunting prospects of AT use to continued learning through high reliance on others toward understanding the new paradigm of accessible interaction [19]. A growing body of work has also examined the social media interactions of people with vision impairments, exploring the size and nature of blind people's social networks [26]; receptiveness to micro-volunteering, an increasingly common means of engaging people with disabilities online [1]; sharing and content consumption behavior [23,24]; and the evolution of social network use by people with disabilities as the mainstream means of engagement moves to media sharing [12]. Our work builds on these by bringing an ethnographic perspective on smartphone adoption, as well as the social networking elements of technology management.

This work is a follow-up to an earlier, larger study [26] in which we found that people with disabilities in low- and middle-income countries are inhibited from using their accessible technologies to their full extent in large part because of persistent cultural attitudes toward disability, as well as the lack of institutions to support accessibility. In that study, Seoul was used as a comparison case, as a relatively wealthy country with a developed accessibility industry. This study identified a sense of independence as an important outcome of the use of mobile devices and found that the community of mobile users with vision impairments was an important part of the support ecosystem.

In this study, we follow up on the questions of community and independence, looking specifically at how the smartphone environment affects independence, and how the community plays a role as a driver and support system for smartphone use. In addition, we consider the factors that impact the early adoption and use of mobiles.

3. METHODS

3.1 Data Collection

We used a survey instrument and qualitative interviews in this study, following up from previous work on mobile use in low- and middle-income settings [15]. The survey instrument was administered to 50 participants in May 2014 in Seoul, and 51 participants in July–Nov 2015 in Bangalore. Following the surveys, interviews were conducted with 10 of the survey respondents each in Seoul and Bangalore. In both locations, the requirement for recruitment was that the individual participant was legally blind, and used a smartphone. The sample presented here from Bangalore is a subset of a larger sample of interviews of surveys that covered both smartphone and feature phone users.

The survey instrument included 180 questions, each survey was administered in person. The survey instrument was used to demographically profile respondents and to gather information on the means of acquiring the mobile device and the nature of

device use. The survey also asked respondents to self-assess the impact of mobile devices on their sense of income, economic and social participation, independence, and safety. In each city we recruited the first five respondents through local DPOs and worked outward by snowball sampling. Surveys and interviews were conducted in Korean in Seoul, and in English, Kannada, and Tamil in India.

3.2 Survey Data

We sampled a total of 101 persons, 50 in Seoul (38 male, 12 female, range 19-76 years, median age 33 years), 51 in Bangalore (34 male, 17 female, range 21-52 years, median age 30 years). Between 21 and 52 years old, median age of 30 years. As shown in Table 1, there was a high number of iPhones in Seoul, relative to all other brands, whereas in India, there was a wider spread of brands, but with 39 Android devices spread over various brands, and a comparatively smaller number of iPhones. In the overall sample, 53 devices ran on iOS, 47 on Android and 1 on Windows. We restricted our sample in this paper to smartphones. In India, there was a larger sample of feature phones, which we excluded from this dataset in keeping with the theme of smartphone adoption in this paper. One in every five devices in Bangalore was a used or donated device, whereas every single device in Seoul was purchased new.

Table 1. Sample description by type of mobile device

Location	Samsung (Galaxy)	iPhone (4, 5)	Moto (G, E)	LG	Other
Bangalore	20	11	12	0	8
Seoul	2	42	0	6	0
	22	53	12	6	8

Our survey shows longer prevalence of mobile device use in Seoul, partly because the relatively more recent expansion of the mobile market in India. The average device cost recorded in Bangalore is significantly less than that in Seoul, explained by the greater prevalence of iPhones — which tend to cost more — in Seoul (Table 2).

Table 2. Sample description by cost and years of use

Location	Bangalore	Seoul
Mean years using mobiles*	9.4 years	13.2 years
Median age of respondent	30 years	33 years
Median cost of mobile device	US$ 176.00	US$ 293.00
Median monthly spending	US$ 6.40	US$ 60.74
Monthly talk time (min.) *	60.0	22.5
Median personal income	US$ 416.00	US$ 1,350.00

* differences between groups significant at .05

The Indian monthly real per capita income is approximately US$ 127 (based on World Bank 2014 data), whereas in South Korea, the monthly per capita income in 2014 was approximately US$ 2,331. Notwithstanding the urban skew due to urban-rural inequalities, this still gives us a sense that the typical Indian respondent in the survey made more than three times the Indian average, whereas the typical Seoul respondent made about 57% of the national average (see Table 2). While the Seoul case is not entirely atypical (people with disabilities worldwide tend to on average earn less than people without), the Indian case is indicative of a larger skew in studying accessibility in low- and middle-income countries. Given that the cost of accessible mobile devices (in this case smartphones) can cost more than the monthly average wage in many countries, those with access to assistive technologies are often among the elites in that society.

3.3 Interview Data

Interviews lasted 30–60 minutes and were transcribed verbatim. Interview data were coded by researchers not involved in data collection using an open coding based on initial readings of all the interviews. We took a grounded theory approach and generated the themes through iterative reading of the transcripts, building up from those the key themes [4]. After the thematic coding, we used selections from interviews that helped highlight ways a certain idea related to design or technology adoption. Thus we do not use quantitative measures of thematic occurrences and instead use interview data as elucidative elements that help in understanding the identified themes. Although as qualitative researchers we play a biasing role in selecting themes, we extensively highlight the worlds of the respondents themselves and allow these to be central in addressing the arguments we make, an approach frequently used in qualitative studies in disability studies [5,10].

These themes were identified through an initial reading by the two researchers, who found that apprehension, community, and independence consistently appeared in surveys and interviews. The theme of apprehension around the initial touchscreen adoption appeared in open-ended questions in the survey and in the corresponding interview discussions about the early days of using smartphones. Discussions on community were significant because of the frequent mention of social media use as an attraction to smartphones. Issues around independence and inclusion were addressed in the survey but also emerged as recurrent themes in the interviews when respondents discussed the impact of the smartphones on their lives.

3.4 Limitations

As with many studies of accessibility, the results from this work cannot be extended to the population of people with visual impairments broadly, because there are no reliable statistics in either South Korea or India on what proportion of people have the accessible devices they need. As mentioned in the sample description, we can assume that the sampled respondents in India, in particular, are skewed toward the relatively wealthy within the population of people with disabilities. The interpretive analysis approach using open coding was designed to give readers insight into the practices of people around a certain technology rather than allow for broad generalizations. It is entirely likely that a different set of researchers examining our transcripts would come up with different themes worth exploring. Additionally, only about a fourth of the survey sample was female. This was a result of gendered factors that reduce women's access to both the means and institutions of accessible participation, as well as the logistical challenges that come in the way of recruitment [16]. We attempted to offset this by ensuring equitable participation of women in the interviews, and the primary interviewers in both locations were women.

4. FINDINGS

We divide the adoption issues into the three topical bins — the initial purchase, the online support community (in which we primarily examine people's social networks), and finally the role of the device in enabling independent management of activities.

4.1 Initial Transition

In Bangalore, one of the major drivers of the move to smartphones was the scaling back of app support for Symbian-based phones. The Nokia C and N series phone models were very popular in the community prior and were sold in the past through DPOs, which negotiated rates for the Talks screen-reading software with producers and offered bundled packages to buyers. We have discussed the role of the DPOs in influencing technology choices in previous work [26], but an unforeseen consequence of this is the growth of a support community for Symbian phones and Talks software, whose initial support by the DPOs grew to a larger community of users. So many people, like the interviewee quoted below, were using Symbian phones when technology needs began to shift.

> *I was using Symbian phone. Many apps were withdrawing support from Symbian phones. I was not able to do the same things with my phone that others were doing with their touch phones so I decided to switch to touch phone. The standard of living has changed — people who are using keypad phones are considered to be outdated. In order to mingle with others and to share file, I need to use touch phone.*
>
> *– Bangalore, 29 yrs, Samsung Galaxy*

For those whose instruments died, there was often no choice but to move to a touchscreen-based phone or scale backward to a basic mobile without any screen-reading capability. While transitions in and of themselves are challenging, the platform transition for people with vision impairments was not as straightforward as it generally is for sighted people. We found that respondents spoke of transitions as fundamental to the experience of having a vision impairment and being active in the workplace. Life experiences, therefore, were a proxy for the technology-switching experience, and were part of a foundational resilience that respondents felt they needed as technological transformations occurred.

> *Initially when I came to Bangalore, it was very lonely and very challenging for me. ... If both situations are compared, I think it has many similarities. It was very difficult for me to make a transition from keypad phone to touch phone because I was so comfortable with the keypad phone and I didn't know anything about the touch phone. Similarly, I think both the transitions are necessary to move forward in life.*
>
> *– Bangalore, 24 yrs, Nexus 5*

This is not to say that people welcomed transitions. Indeed, a number of users spoke of fears related to the transition because of the uncertainty of losing an existing means of doing something — i.e. connecting to digital information via a Symbian phone. Respondents recalled the initial joy at using a mobile device with a screen reader — an experience that many, particularly in Bangalore, first had as adults. In other words, they had spent much of their early lives without the experience of independently managing their own communications. Ties to one's mobile devices ran deep, and the thought of changing to touchscreens was daunting because the tactile nature of the keyboard was a visceral part of the accessible experience, especially for those who also used Braille interfaces.

In Seoul, we did not find the same device attachment to specific keypad-based phone models or to the installed screen-reading software. However the absence of DPOs in the purchase decision meant that there was greater reliance on online or informal sources. A small number of early adopters who had heard of iPhones drove an initial wave of smartphone purchases at a time when feature phones were still widely available and used.

> *[I found online] that a person with visual impairment was able to send a text in the U.S. I inquired Samsung if they offered these functions. But I was told that they had not developed such devices yet and there was no intention to develop it, either. [They said that] if there is a phone with those was available at the market, then they recommended me to go for it. So ... I purchased an iPhone right away.*
>
> *– Seoul 27 yrs, iPhone4*

There was a wave of iPhone purchases in Seoul in late 2010 following the Korea Telecom's release of the widely successful iPhone 4 model, coming at a period when smartphone purchases were growing rapidly in Korea l [17]. Word of the iPhone 3GS accessibility spread quickly in the community since it was among the first major touchscreen models with accessibility features.

Domestic smartphone brands like LG and Samsung dominated Korean markets in the early 2010s buoyed by high broadband penetration [25], yet their reach among people with vision impairments was undermined by inferior accessibility on Android Gingerbread phones. The initial period of switching to smartphones with pre-installed screen-readers was eventually crucial in shaping the longer-term adoption of smartphones in Korea, because to date the iOS phones remain in higher demand despite the relatively inexpensive Android-based brands. Ultimately the push factors for the transition to smartphones in Seoul were the applications for greater mobility.

> *People around me — senior friends, colleagues — persuaded me, but I did not change my mind. Then, I heard 'Seoul Bus Information' tells when a bus is coming in a few minutes. I did not believe it first. But the bus did come, which made me realize that we can share information in this way and can be connected. The incident drew me to a smartphone.*
>
> *– Seoul 30 yrs, iPhone5*

Pain points were important in the choice to transition, but the obsolescence of existing devices also drew another wave of transition. In Bangalore, many respondents noted putting off smartphone purchases till their existing devices stopped working because that had been the way they transitioned phones in the past, rather than switching devices for new capabilities. The push towards widespread smartphone adoption in India happened slightly later than in Korea, by which point Google upgraded accessibility in later versions of Android such as JellyBean.

Outside the actual acquisition of a new device, the initial use was noted as a challenge in both countries. Early adopters' experiences served as encouragement or causes for pause among subsequent users. Studies have shown what respondents here noted — that tutorials are insufficient in getting people functionally using their technology [21]. The initial weeks of transition to the touchscreen were difficult in both locations because of the lack of established sources of information on accessible use. Respondents reported having interface problems that could have been easily solved but instead persisted for several weeks because they did not know how to change a certain setting.

> *With every slight tilt in the angle, the display would keep shifting from portrait mode to landscape mode. I had such a tough time accessing the keys because the position of the keys*

would keep changing. It was such a great relief when a sighted colleague showed me how to lock the display in portrait mode. Likewise, I had great difficulty in ending a call. The phone automatically reduced the volume of TalkBack when a call was in progress and the volume would be restored only after the call was ended. But since I was a new user, I didn't know the position of the end button. It happened many times that the person on the other end did not end the call and I was unable to and it was no use taking the phone close to my ear to search for the end button because after a point, the phone would sense the proximity to my ear and stop talking completely.

– Bangalore, 35 yrs, Moto G

The fairly straightforward fix of keeping the phone locked on portrait mode remained an impediment for some users for several weeks who were unable to work out minor changes without going back to showroom. The locking screen problem was greatly impacted the user experience for someone who needed to move the device back and forth from their ears, as could be common for someone working without headphones or using a combination of zooming or some contrast setting alongside the screen reader, because this would cause the screen to switch orientation at each hand movement. Users with troubled initial transitions noted wanting to sell their phones and go back to basic phones, including those without any screen-reading capability.

It was very difficult in the beginning. I had difficulty in swiping in the right spot in order to take the call or swipe left to reject the call. Sometimes I didn't know which direction was up and which was down, so I would end up swiping in the wrong direction. Sometimes I would keep swiping to the right at the lower side of the mobile and realize later that the phone was topside down and by then the call would be over.

– Bangalore, 32 yrs, Moto E

In both locations respondents recalled arbitrary use of trial-and-error swipes during early use, necessitating failsafe options such as trying to be near a computer as much as possible, or having multiple active devices with their own SIM cards in case the user experience in one got too difficult to manage. Respondents reported starting off with a new phone without a data plan, simply using WiFi where available to get used to the device.

I use the N73 mainly for making and receiving calls and sending and receiving SMS messages. On My Moto G mobile, the first thing in the morning for me is to check time. I prefer to check time on Moto G because the phone reads out the time as soon as the screen is switched on, there is no need for any other keystroke ... I access WhatsApp on a daily basis. I also use the Moto G phone for booking cabs, or checking maps or listening to music — but these are not daily activities. …I can manage even if the Moto G phone is not around. Calls and messages are very important for me.

– Bangalore, 28 yrs, Moto G

In Bangalore it was fairly common for people to have multiple active telephony devices, whereas this was uncommon in Seoul. The use of multiple SIMs was a strategy, as we see in the quote above, to not lose one's control over critical tasks during the transition to a new device. This multiple SIM approach offers a failsafe in the transition process, but in countries such as the United States where instruments can be tied to phone companies, this strategy with transitions can be challenging.

Another reason the older feature phones persisted in India for a while was the perceived problems with phonebook features on Android devices, which were optimized for the visual form of Google contacts. Contacts were easier to add when someone called. The call log problem independently arose in conversation in Seoul as well. One benefit that the older keypad-based phones had was a fairly straightforward tactile means of reaching frequently called numbers, whereas the smartphones collapsed outgoing, incoming, and missed calls into a single screen where it could be harder to discern which was which.

The reason I used [the old] phones was that they were able to read a list of recent incoming and outgoing calls and messages. However, they could not read messages such as LMS or MMS. ... LG has manufactured feature phones targeting only visually impaired users. These products could read all the menus and it was not difficult for blind people to use, but its limitation was that I [as a consumer] had no freedom to choose other phones than these.

– Seoul 33 yrs, iPhone5

Table 3. Purchase Location

Location	Bangalore	Seoul
Purchased online	50.0%	46.0%
Purchased at store / showroom	48.0%	26.0%
Purchased at other locations	2.0%	28.0%
Purchased oneself	52.9%	54.2%
Purchased with assistance	47.1%	45.8%

Additionally, the mobile device is a significant investment. On average, in both countries, the cost of the device used by the individual was roughly a fourth of his or her monthly income. As we found in both countries, in addition to the consultation with others, roughly half the entire sample reported purchasing their device with the assistance of another person (Table 3). In India, respondents reported talking to DPOs and friends. In Seoul, friends and online searches were common means of getting a lot of information. The deliberative process involved in the purchase meant that choices changed midway through the purchase decision, including at the point of purchase at the store. This was truer for people considering various models of Android devices because with iPhones, there was a general sense of the product being fairly standardized. The Apple brand and service was discussed positively in both locations.

I had heard from people that Android phones had a lot of constraints when it came to accessibility. I went on online forums and followed discussions and posts in those forums. Through these forums I understood that iPhone was best in terms of accessibility but also there was good support from Apple in case of any difficulties. At that time, the iPhone was really beyond my budget but I thought it was really worth it. The low-priced models [run] outdated versions of Android and may not have enough memory for running more apps.

– Bangalore, 39 yrs, iPhone4

In addition to their reputation for having good support (see Table 4), iPhones presented an advantage over competitors in the lack of ads and needless software that device manufacturers installed onto Android devices. Already the initial transition was a difficult process, and many web products were either inaccessible or had a series of advertisements that acted as an

annoyance to users and were harder to get rid of on mobile devices than on a desktop screen reader where they could be tabbed away. Users discussed the iPhone in terms of a positive device use experience in their individual interactions and in their interaction with society as a whole. Interviewees indicated that iPhone is perceived as a desirable artifact across populations in society rather than as a specialized assistive device.

The first interaction with a touchscreen device, particularly one that involved making or receiving a voice call, helped in the decision to purchase. While the eventual use of smartphones was spread over voice and various apps, the first interaction with the interface taking or declining a call worked as a confidence booster.

Table 4. Mobile use challenges

Location	Android	iOS
One–two instances of problems requiring assistance monthly	28%	18%
More than two instances of problems requiring assistance monthly	19%	13%
Rare or no instances of needing assistance with phone monthly	53%	69%

4.2 Community Support

Interviewees in both cities mentioned the community of other mobile users as a central part of their experience of continued technology use. There were two ways in which community was typically talked about. First, there was the general notion of community as an outcome of mobile use — thus getting on a smartphone meant accessing networks that were only or primarily available on smartphones and expanding one's social community. In this sense, community meant both keeping in contact with existing connections and expanding to new ones. A second sense of community was in being online as a means of sharing and benefiting from others' technical knowledge.

The consultation process around smartphone adoption involved speaking to physical contacts or online networks. Social media helped build a community of people who shared their experiences and in some cases facilitated means for others to try a device.

> *When 80–90% of my friends, peer groups, students used iPhone, I was sure that I should buy it because it was confirmed that everybody could use it. I went to Apple store with my friend and listened to the explanation about the phone.*
>
> *– Seoul 27 yrs, iPhone4S*

The iPhone 4 built on a usability community of the relatively more challenging iPhone 3GS, which came in 2009, a time when there was far less awareness of touchscreen usability. This resulted in an early smartphone club in Seoul that served as a community resource. The iPhone was a widely used mainstream device, so information about it was more readily available (unlike earlier Symbian-based feature phones with AT, which had a smaller awareness base). However, there still seemed to be a lack of interest or expertise in the in-built accessibility features by the sighted community.

> *When iPhone 3GS was introduced, people had doubts about it. How well is it going to read, and are we going to use touch smartphones? Some risk-takers tried and they found out they could use it, so we created a smartphone club. Vision-impaired people were afraid of touching smartphones. Because able-bodied people would never be able to answer their questions, we decided to share the information, about VoiceOver, about which apps are accessible, etc. Now, we have about 1,000 members, and among some of them are Android users. We share our own tips, like iOS update was good, this phone is good at voice recognition and that this one isn't.*
>
> *– Seo34, iPhone5*

In India, the community of AT users was initially driven by the NGOs and DPOs because of their role in distributing Talks, a popular software for feature phones. DPOs held training sessions for Talks, and as Android devices became increasingly popular they started to offer classes in smartphone use. As a consequence, the groups of people who used Talks (and were frequently part of Facebook groups) started to coalesce around WhatsApp groups for smartphones. By design, to use the WhatsApp group, one had to get a smartphone.

> *I struggled very badly for the first two weeks at least. I used to keep checking online for tips to use Android phone. I came across a Facebook group for visually impaired Android users. Over there I saw a post for joining a WhatsApp group... I had learnt to use the phone by myself, [but] the way I was operating the phone was sometimes wrong and sometimes unnecessarily time consuming. ...I learnt to type in Hindi through voice. I also learnt about another screen reader called Shine Plus that is much better than TalkBack.*
>
> *– Bangalore, 29, Samsung Grand 2*

Online community resources in India were central to the dissemination of information around new apps such as ShinePlus, in the case above, as well as products in banking, online purchases, and input devices. Purchases of Bluetooth keyboards and local-language software were driven by discussions in online forums. On both Android and iOS platforms, some users quickly gained reputations as experts online by virtue of being regular contributors to forums. Such experts developed strategies on offering counsel to newbies, especially those who were entirely new to the smartphone environment. The following case highlights the fundamental challenge for guiding someone completely unfamiliar with the visual representation of menus — which could be the case even for someone who had experience using a desktop screen reader, because those also tend to have interactions structured around tabs rather than layouts.

> *iPhone has a layout with an array of 4-by-5 menus, which is a fixed feature when shifting through different pages. To give an example of the primary characteristics of apps, menus are on the bottom, whereas contents are shown on the top. As such, it seems difficult to make out the structure (on the operating environment itself) application of airdrop of iOS 7 will be extremely difficult for someone who has never known the Mac to understand, while I am familiar with the Mac. To explain this, I should let them talk about the data transfer thru P2P on wireless environment or Bluetooth.*
>
> *– Seoul 34 yrs, iPhone5*

Because iOS-based devices were preferred over Android in Seoul by respondents before iOS devices themselves became widely used in Korea, they faced a separate challenge of unfamiliarity with the Apple environment. This was in part

because people were generally more used to the Windows desktop environment because it supports the popular screen reader JAWS and other accessible software. Using an Apple product meant unlearning file management as they had known it, and familiarizing oneself with the iTunes environment. This turned out to be an issue for many users because sharing and storing media on phones, often from a diverse set of sources, is an important function of mobile devices. Consequently these users had discussions online to weigh the pros and cons of the iTunes environment, or had to deal with the challenges of data transfer after getting iPhones.

We found that people in both cities usually had some form of social media on their mobile device (though none of the eight Android users in Seoul used social media on their phones). In Bangalore, WhatsApp and Skype were regularly used on the mobile, whereas in Seoul, KakaoTalk was most commonly used. In India, access to social media was often cited as a motivator for wanting to switch to a smartphone, whereas in Seoul social media were more often viewed more as a perk of adoption than a driver (Table 5).

Table 5. Social Media Use

Location	Bangalore (n=51)	Seoul (n=50)
Social media (SM) use on mobile	84.3%	66.0%
"Always on" user of SM on mobile	33.6%	48.0%
Once daily user of SM on mobile	31.5%	4.0%
Irregular user of SM on mobile	19.5%	12.0%

However, in both countries, the preferred social media had evolved away from smaller, often local forum predominantly or solely used by visually-impaired citizens to larger globally dominant networks that were used in both sighted and screen-reader-accessible interfaces. In Bangalore, early accessibility discussions took place in social media forums such as InclusivePlanet and AccessIndia; in Seoul, NateOn and Cyworld were popular till Facebook became relatively dominant.

> *In the past, when it came to social life, Cyworld was generally the most popular one. But nowadays, since some of the well-known foreign social network services such as Facebook or Twitter are allowing the blind to interact with sighted people, they seem much more equipped with accessibility than our domestic services. As I am acquainted with many blind people, the majority of what we discuss [on Facebook] is related to anecdotes of how they were unfairly treated, followed by discussions about them.*
>
> *– Seoul 33 yrs, iPhone5*

The gradual adoption of these dominant social media options expanded individuals' social networks to the non-disabled. WhatsApp use featured very frequently in Bangalore as a benefit of being online. The popularity of WhatsApp broadly in India meant that most respondents had friends or family on WhatsApp groups that acted as a social network rather than just a messaging app. WhatsApp was also important because it replaced Skype, in India particularly. Skype, an early accessible app, was widely used in both locations in desktop environments. But WhatsApp offered not just the VoIP calling and texting, but also voice messaging, something Skype did not adapt to effectively.

As would be true for new or late social media users in any setting, the initial experience of joining Facebook or WhatsApp came as a bit of a surprise because users mentioned suddenly being deluged by friend requests, or in some cases finding their contact lists newly populated by people on social media. This was for many an entirely new form of network expansion. Social media enabled connections with new people and a means of staying in casual contact with existing contacts and weak ties. It also gave individuals proactive ability to initiate contact as opposed to waiting for someone to contact them.

> *I don't have many friends in the VI [vision impaired] community as I am a late blind person. My friends are mostly sighted. There is certainly a great increase in the number of friends, especially in the VI community, after I started accessing WhatsApp and Facebook and making friends among the blind community. I am making many friends, but I have also been able to strengthen existing friendships and keep in touch with old friends.*
>
> *– Bangalore, 39, iPhone4*

For individuals who had acquired a vision impairment late in life or who were in the process of losing sight, social media were a means of socializing with long-term AT users and coming to terms with the loss of sight.

4.3 Independence

Building on our own previous work in other parts of the world, including India, where independence has appeared as a recurrent theme, we explored ways it appeared in the transcripts from both cities. Blind people find restrictions on professional, personal, and transportational independence in both locations, but because of cultural norms around gender, these can be particularly more restrictive for women. Consequently, a number of conversations focused on how mobile phones can affect existing challenges to independent social participation.

> *Once, I left the office quite late. In order to take a town bus before closing, I had to take the subway around 11:30 pm. On the subway, there were few passengers but many drunk people. Then, one of the drunken people came next to me, just next to me, gibbering 'where are you going?' and 'I can take you home' like that. Then, honestly, I got off and then [said] 'I can go by myself' but he kept following me ... [this is why] family members want to know whereabouts and what I am doing.*
>
> *– Seoul 27 yrs, iPhone4*

Studies have shown that independence and safety are drivers for mobile phone adoption, including basic phones. We see in Table 6 the rating by gender and location of whether there has been a positive impact on safety and independence on a scale of 1–5, 1 being strongly disagree, 5 being strongly agree. Survey administrators explained safety as being related to one's sense of spatial or physical well-being, and independence was explained as one's ability to manage one's own affairs without mediation — thus including social interactions, transit, and workplaces.

Table 6. Perceived impact on safety and independence on ascending positive Likert scale of 1–5

Location	Gender	Safety	Independence
Bangalore	Male	4.23	4.82
Bangalore	Female	4.64	4.70
Seoul	Male	3.76	4.18
Seoul	Female	4.58	3.58

In both locations, we found positive relationships between mobile devices, and safety and independence on all counts, but some trends emerged. The differences in safety are high between male and female participants in both locations (p=.05, two-tailed t-test) — and while women may not necessarily feel entirely safe, the sense of the device adding to their feeling of physical and spatial well-being is clear and significantly greater than what males reported.

On independence, the difference between male and female is significant in Seoul (p=0.05), and the overall difference in sense of independence is significantly greater in Bangalore over Seoul (p=.05). We attribute the greater sense of independence in Bangalore to the lack of infrastructure - ie relatively lower "starting-point" for people with disabilities. Transportation is a case in point. While Seoul's public transit system that has been used independently by some in our sample for decades, Bangalore has traditionally had inaccessible buses due to crowding as well as poor pavement access due to informal vending and street widening. However, the last decade has seen the rise of app-based taxi services, which came up several times in conversation as a major benefit of smartphones.

> *The company policy does not permit female employees to directly call [company] drivers and does not provide employee contact details to cab drivers. If I have to call the cab driver, I have to call the company helpdesk and the helpdesk will facilitate the call with the driver with someone listening in to the call. … [Instead] Ola cabs offers rebates for disabled passengers. The challenge with this is that when booking a cab while opting for this rebate, it becomes even more difficult for the disabled person to get a ride as many cab drivers do not take passengers for whom they have to offer a rebate, [but] the Uber app is more accessible since Ola app has many different tabs. Once when I used TaxiForSure [another app] I was worried whether the booking was done or not. In TaxiForSure app, details such as confirmation, driver and car details and arrival status are sent as separate SMS. Since I was expecting the details to come through the app like the other two apps, I was worried. I found it quite tedious to keep switching between the cab app and the messaging app.*
>
> *– Bangalore, 32, iPhone5*

While cabs were frequently used (48 out of 50 reported regularly using taxis) in Seoul, the prices of these cab rides added up and the general preference was for the subway. The more frequent set of independence-related concerns included subway access, in particular transfers at subway stations. So while smartphones were seen as potentially replacing desktops for trip planning and transfers as well as managing the post-subway navigation in external environments, they didn't solve every problem.

> *So, before reaching the station, we call [a station escort service] first to let them know when I am reaching and make them ready to meet me. In this case, I can use this [SubwayHelper] app to call … In a totally unfamiliar station, I almost always tend to use the service, as well as in order to avoid being injured while traveling by myself, [as] the subway had changed their policy not to compensate the injuries when a person with visual impairment gets injured while traveling with metro on his/her own.*
>
> *Seoul 33yrs, iPhone5*

Although the SubwayHelper app was a way to independently manage the train station transfer, the legalese of injury was a reason to use human services like station escorts. The bus system was problematic in both cities for very different reasons. In Bangalore, respondents noted that buses were not announced at stops. Additionally, they said buses in Bangalore do not always stop exactly where they are meant to, making it necessary to use a sighted intermediary to board a bus — despite the city municipality's mobile app. In Seoul, the bus system was reported as more systematic, but there were problems accessing express buses, which were often in separate dedicated lanes, requiring riders to cross traffic in order to board.

> *Although bus system reads the number/name of each bus, it is not accurate. Special bus-only lanes were built through the center of main roads, thus I need to cross at a crosswalk. I have to be attentive and it might not be safe. People ride shuttle bus because the bus stops are on the sidewalk or near landmarks/subway stations; shuttle buses stops at the same spot. The sound of shuttle bus is somewhat different.*
>
> *– Seoul 27 yrs, iPhone4S*

While the mobiles were invariably crucial in the overall trip planning in both locations, granularity of information was a key missing element in both cities with regard to the actual on-the-ground navigation. Respondents in Seoul noted problems with deciding what to do at the moment of leaving a train car in the indoor environs of a station (turn left or right, how far to the next exit). The challenges in Bangalore in contrast were more related to outdoor challenges that need contextual awareness and the ability to navigate uncertainty. Respondents here reported problems with mapping apps because of incomplete street names or the use of non-colloquial formal names on maps, poor directional information, and difficulties with map feedback in moving vehicles because of problems anticipating navigation, which is optimized for visual following.

> *The app only speaks out information like name of the current road and next turn that needs to be taken — like the next right, left after 100 meters, etc. — it does not give voice output on distance, one way, time left to reach destination, etc. The only phrase it speaks other than these is to inform 'destination reached.'*
>
> *– Bangalore, 42 yrs, iPhone4*

For people with disabilities cultural attitudes toward disability are another barrier to workplace access — thus the ability to manage the commute or other basic expectations such as access to communications and office productivity tools are critical elements of accessibility and productivity. While in our interviews the discussions of productivity were aimed at the sense of what device adoption did for the users, conversations invariably veered toward the attitudes of employers toward

people with disabilities, and the pressure such attitudes put on people to constantly prove themselves.

> *Those jobs that are popular with visually impaired people, such as health keeper [massager], women are more advantageous in getting jobs, while administrative jobs that need social interactions are more occupied with men. Even with my workplace, there are 10 visually impaired people in total, of which two are female and eight are male.*
>
> *– Seoul, 33 yrs, iPhone5*

When people tried to move from occupations that people with disabilities have traditionally been channeled toward, they felt they had to make the case that the older views of disability were wrong. It mattered that they used the same devices, the same social networks as sighted people, and yet, given that a culture of accessibility was often lacking in the workplace, respondents were careful about how they handled accommodations. In Seoul, some respondents had access to paid or volunteer assistants, and working with assistants had its own challenges, both with the externally projected perception that the assistant is required for the individual to participate in work or social interactions, and in some cases the awkward relationship with the assistants themselves.

> *If I go an interview to somewhere for the first time, it would be out of question to find the location by myself. So I was accompanied with a personal assistant. Then, employer would say, 'Look, even for this interview, you needed something to take you here. How come, then, can you possibly commute every day? ... When personal assistants are accompanied, they are considered as helpers. It was the case as well when I was accompanied with my personal assistant ... personal assistants would also feel uneasy considering that they [see this as] work instead of which they are helpers.*
>
> *– Seoul 27 yrs, iPhone 5*

Respondents report greater comfort with navigating, after a first-time visit to places once they had a smartphone. Even if the devices were not used for actual navigations, the sense of having a failsafe on a device for wayfinding or communicating helped confidence. Smartphones enabled a few important transitions — reading mail had become a mobile activity, accessing most forms of digital information was better, though input came up repeatedly as a challenge. Reading long blocks of text was preferred on desktops because of granularity problems that are better managed using keyboard shortcuts on screen readers.

5. DISCUSSION

The discussions around the transition to smartphones are about the relationship of the individual tech user with the device architecture and the first-hand human complexities that accompany the adoption of a new device into one's life. The initial transition is difficult because of the new interface in and of itself, but such a change is also about giving up control over a past interface or means of doing things that one had learned, possibly at great personal cost. Demonstration effects of other technology users and first-hand interactions such as voice calls or brief swipe-and-tap interactions are physical means of relating to the technologies, but at a higher level these interactions are about individuals feeling reassured about their own ability to control their technology environments.

Here, the design challenge is to create easy-to-use early transition touchscreen interfaces. Offering transitional solutions such as thin tactile sheet covers to stick over touchscreens, designers can build training applications that incorporate basic haptic elements to adjust to the loss of keypad interactions can ease users into tap and swipe interactions.

Our second set of discussions here were around community are about the individual user's reliance on, and contribution to, a larger social network of people that is at once the driver and the outcome of assistive technologies. Here, our findings suggest that design of artifacts need to look beyond the individual as a consumer of technology to ways in which the collective that plays a role in technology choices as well as in the maintenance of technology. Here, we see design opportunity to better leverage social networks for tutorials on technology or to elicit feedback such as high level user experience information or even specific usability testing.

The final set of discussions here relates to the lived environment that the accessible technology is aimed at facilitating. Each mobile device and its hardware or capabilities impact the experiences of urban accessibility — this includes the possibilities that these open for access to social and economic inclusion. Here, we find that the challenges in Seoul and Bangalore are fairly distinct. In Seoul, managing a fast and complex transit system without needing to depend on others will require innovative design thinking that uses networking solutions to interact with the built environment alongside front-end design solutions that help users adapt to daily variations in commute needs. In Bangalore, on the other hand, the challenges of a much more open system may require deeper design thinking to work through multiple means of outdoor navigation. Managing auto-rickshaws (minicabs) or buses remain design challenges that are still far from being solved. Involving the crowd, through methods such as those used in the mobile apps like TapTapSee, that crowdsource internet users' input on visual environment for blind people using their smartphone cameras can be employed for outdoor wayfinding, or even locating companions for transit.

Studying the adoption challenges in peoples' own words helps us gauge ways to come up with design solutions that are not created in a vacuum but emerge through active discussions with the end-users themselves.

6. CONCLUSIONS

Qualitative research methods offer engineers means of more deeply understanding the communities that they design for. At the same time research should also serve as a forum for the community to relay back its experiences with accessibility. The lived experiences of people are highlighted here not to give a list of possible design directions, but rather to engage the technical community in a discourse around the breadth of ways in which accessibility is part of a broader ecosystem that individuals inhabit. Some of these discussions may indeed lead to new directions in technological development, and others may not. The hope here is to help create a culture of listening and actively engaging communities not with the sole intent of engineering or advancing science, but with a hope of partnering for broad-based accessibility.

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