Intermediated Technology Use in Developing Communities

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ABSTRACT

We describe a prevalent mode of information access in low-income communities of the developing world—*intermediated interactions*. They enable persons for whom technology is inaccessible due to non-literacy, lack of technology-operation skills, or financial constraints, to benefit from technologies through digitally skilled users—thus, expanding the reach of technologies. Reporting the results of our ethnography in two urban slums of Bangalore, India, we present three distinct intermediated interactions: inputting intent into the device in *proximate enabling*, interpretation of device output in *proximate translation*, and both input of intent and interpretation of output in *surrogate usage.* We present some requirements and challenges in interface design of these interactions and explain how they are different from direct interactions. We then explain the broader effects of these interactions on low-income communities, and present some implications for design.

Author Keywords

ICT4D, HCI4D, urban slums, intermediated interactions, human-mediated computer interaction

ACM Classification Keywords

H5.m. Information interfaces and presentation (*e.g.*, HCI): Miscellaneous.

INTRODUCTION

Human-computer interaction, as the name suggests, is concerned with direct interactions between the user and computer (see fig. 1, top). Many applications are designed for personal use and private ownership [17]. They assume textual and digital literacy. However, in many contexts, use is not direct; intermediation by another person occurs when the primary user is not capable of using a device entirely on their own. For example, many people rely on experts in the family to help them set up home networks [10] or to figure out how to use the Internet [19].

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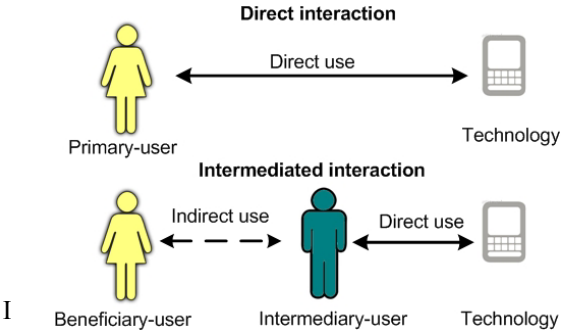

Figure 1. Direct and intermediated interactions

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In the developing world, informal help goes far beyond spot assistance and is a *fundamental* enabler of technology use and access for a vast number of people. Reporting the results of our ethnographic study in two urban slums of Bangalore, India, we explain how literate members with technology-operation skills enable technology use for persons whose technology access is affected by factors such as non-literacy, non-numeracy, lack of digital operation skills, financial constraints affecting technology ownership, and socio-cultural and empowerment issues including gender, employment, and social status. *Intermediated interactions* enable technology use for such persons by means of a third party (see fig. 1, bottom). In our findings, for example, unconnected households routed information from the Internet through intermediary NGO members. These intermediated interactions coexist with the traditional one-to-one, direct interactions.

Individual ownership of technology, textual literacy, and digital literacy are not necessarily the norm in the developing world. For example, despite the recent figures on steady growth of mobile phones in India [3], the aggregate number of devices owned is still small. Telecom penetration is 36% [4] with a literacy rate of 66% [5], with the penetration for poorer communities being even less. While many people lack textual and digital literacy, low-income communities are diverse and often include at least some literate members with technology-operation skills. These members overcome some of the above deficits and act as *bridges* between technology and community members lacking these skills.

In the developing world, many technologies that are perceived as "single user" in the West are involved in more complex human-mediated relations that we need to understand. This suggests a serious re-examination of current designs and design assumptions if they are to cater to the needs and existing technological practices of the developing world.

We seek to understand intermediation in day-to-day technology usage practices in economically disadvantaged neighbourhoods of India. We uncovered several distinct forms of intermediated interactions: intermediation in inputting intent into the device in *proximate enabling*; intermediation in interpretation of device output in *proximate translation*; and intermediation in both input of intent and interpretation of output in *surrogate usage*. We examine some of the consequences for user interface design, and the broader effects of intermediated interactions. Finally, we suggest some implications for design of intermediated interactions.

RELATED WORK

Intermediation in ICT4D: Human mediators constitute an important part of information and communication technologies for global development (ICT4D) projects, because they transfer technological benefits to grassroots levels, ensure that projects run smoothly, and contribute to their sustainability. Digital Green [13] and Babajob [1] are some projects where field staff contributed to data collection and information dissemination. Medhi *et al.* note the importance of intermediaries in job-search systems for the developing world [21]. James discussed the importance of intermediaries in reaching "non-user beneficiaries" in development projects [18]. However, the information needs of the community were placed ahead of those of individual persons.

In a study of multiuser interactions in India, Parikh[23] defined secondary users as "those having only partial or no physical access to computing devices, who must interact with information resources via a proxy primary user who has the required access rights and skills," particularly in the context of ICT4D interventions and commercial services. For example, commercial kiosk operators helped secondary users (local villagers) access and print information from the Internet. Sukumaran examined changes in trust in source based on positioning of the intermediary or the user, noting that beneficiaries tended to prefer balanced conditions between intermediary and technology [29]. Positioning is more broadly construed as location of access (remote and collocated) in our work.

We add the very real case of intermediation in the ecology of slum habitats, that occurs "in-situ" and organically. Our goal in this endeavour is to study the information and communication needs that occur in economically disadvantaged settings and the various technologies, practices, actors, and relationships involved in fulfilling them.

Intermediation in HCI: Previous studies in HCI have investigated the role of technical experts in enabling usage of devices. Answer Garden 2 combined technical and human resources to create a collaborative help program for answering questions [6]. HomeNet examined the role of "family gurus" (typically teens) in providing assistance in Internet usage [19]. The gurus acted as bridges between computer users and external help desks, solving technical issues.

Another thread of investigation examines setting up home networks, where technically knowledgeable users assist family members in setting up networks [10]. Poole *et al.* examined the factors involved in giving and taking informal help in tech support [24]. The cost and know-how in seeking formal resources motivated help-seekers to look for informal help within social networks, whereas reputation, technical expertise and obligation motivated help-givers to provide help. In our study also, beneficiaries relied on social networks for informal help. Eveland *et al.* described the importance of "high providers" (helpers) in linking help seekers to resources for CSCW applications [12]. They found that users ask for help from those nearby and from people with similar work tasks in preference to more remote but much more expert users/help staff.

Our study examines intermediation in resource-poor settings, where beneficiaries lacked literacy and technology-operation skills. We examine the role of intermediation in fundamentally *enabling* technology usage where it was previously impossible, not just in trouble-shooting technical issues. We examine communities of slums, broadening the scope of investigation from the unit of domestic household to the neighbourhood.

METHODOLOGY

Two urban slums in Bangalore—Ragigudda and Nakalbandi—were chosen as the sites of investigation. We partnered with a local non-governmental organization for domestic worker rights, Stree Jagruti Samiti, which has built excellent rapport with the slum inhabitants for the past 17 years. The slum communities were located in the heart of the city. Roughly 2000 households constituted each slum. Houses varied in size from 100-200 square feet. Resource constraints resulted in maximum utilization of real estate by cramming in objects within each household, open doors for ventilation, and activity on the by-lanes and doorsteps. As a result, an openly social environment was fostered.

Demographics and Methods: We employed participant observation in gathering background data. We spent time in NGO meetings, activist demonstrations, homes, temples, and near water pumps, where informants tended to relax and chitchat. Semi-structured interviews and surveys were employed to understand technology usage and development issues. We gathered socio-economic data to understand family structures, sources of income, education levels, assets, and other demographic backgrounds of our informants. We limit our focus to women in order to understand the complex interplay between technology access and social order. In the families we studied, women were financially independent yet tolerated abusive and sometimes violent treatment. Our investigation was designed to better understand how these women's roles shaped their technology use.

Twenty-two women served as primary informants in our ethnographic study. We interacted with them for 110 hours through interviews and spending time in the communities. They ranged in age from 26-68 years. Twenty women were employed as domestic help or cooks, working daily between 2-3 households, and in hostels and offices. One was a part-time masseuse and the other a part-time seamstress. Eighteen of the women wove garlands of flowers and sold handkerchiefs and snacks for extra income. None of them were educated beyond high school. We also interviewed 9 children and 5 men when visiting the women's homes. The children ranged in age from 5-22 years. The men ranged in age from 26-60 years. Four children had graduated from college. Two of them worked as call-centre employees. Many children were enrolled in school, while some others had dropped out to contribute to the household income. The men were not educated beyond high school, and were employed in the informal sector (non-tax paying, low capital economic sector), comprising plumbers, electricians, construction workers, and in one case, security guard). Average family income was from Rs5000-8000 ($100-170 USD) per month. All interviews were audio-recorded, transcribed, and anonymized. All names are pseudonyms, to protect the actual identities of informants. Informants were recruited through snowball sampling. Utensils and bedspreads were provided as gifts.

Finally, we also asked five persons to maintain "a day in the life of-" photo diaries using analogue cameras [9]. They were asked to capture photos of people, places, activities, and technologies (cooking, transportation, technologies at work, and domestic appliances) that they engaged with during the course of a day. This helped us understand technological, personal, and social aspects of the informants' lives that could not be clearly verbalized in interviews.

HUMAN-MEDIATED COMPUTER INTERACTION

In direct interactions (fig. 1, top), the person extracting value from a technology directly manipulates the technology. In intermediated interactions (fig. 1, bottom), an intermediary-user translates the beneficiary-user's intentions to an interface command or task.

Mediation in Activity Theory: In order to explain intermediated interactions, a useful comparison could be drawn with the related term *mediation*. Mediation forms one of the core principles of Activity Theory, which is an approach to understand individual human beings as well as the social entities they compose, in their natural everyday circumstances. The concept of *activity* is fundamental to its analysis, which not only signifies human activity but also activity of any subject in general. This theory holds that—"all human experience is shaped by the tools and sign systems we use. Mediating tools connect us organically and intimately to the world; they are not merely filters or channels through which experience is carried" [22]. Human activity is mediated by tools, both external (like a hammer or scissors) and internal (like concepts or heuristics). The subject user acts on an object through a mediating tool (see fig. 2, left). From this

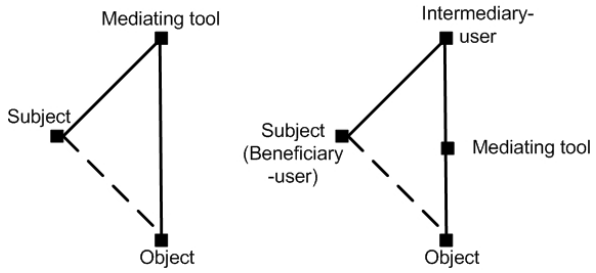

Figure 2. (left) Mediation of technology, (right) intermediation through intermediary-user.

perspective, intermediation creates *second-order mediation*; the subject acts through the additional layer of the intermediary-user, who in turn applies a mediating tool, to an interface object (see fig. 2, right). In intermediated interactions, the subject is the user seeking technology assistance, acting on a goal object through the intermediary-user who operates a mediating tool. Intermediation is when mediation is enabled by other users. Human-mediated computer interaction suggests that a layer is to be negotiated between the beneficiary-user and technology.

We refer to a person possessing technology-operation skills and possibly textual literacy, who enables technology usage for other persons, as an "intermediary-user." We refer to a person who derives value out of technologies through third parties, typically affected by non-literacy, non-numeracy, lack of digital operation skills, financial constraints, and socio-cultural and empowerment issues, as a "beneficiary-user". The intermediary-user supports the interaction in various ways, by handling some or all of the direct manipulation of the interface. The interaction depends on the intermediary-user; it would not succeed without the intermediary-user.

Use and users: Human-mediated computer interaction forces us to rethink the concept of "user." Bannon defines a user as "someone who uses a particular computer system or application" [7], but in our case "use" is split between at least two people: beneficiary-users instigate the interaction and derive direct value from it, while intermediary-users often are closer to directly interacting with the device.

Studies of intermediation in community development projects tend view the beneficiary as being a passive recipient of information from the intermediary, in commercial or developmental contexts. Our study reveals that (i) beneficiary-users were highly *resourceful* in finding the appropriate intermediary-users for the right tasks. For example, Gauri, 52, sought out the help of her 8-year old grandson in operating her mobile phone, and her 10th-grade educated neighbour in operating the VCD player. Beneficiary-users seek help based on prior rapport and trust. (ii) They exhibited *agency* in controlling the interaction process, not passively receiving information, and reciprocated the favour, leading to a peer-to-peer model [8].

An intermediary-user operates the system for the benefit of a beneficiary-user, and she may derive value out of the second-order effects of the interaction, through direct information gain, reputation management, sense of doing good, or welfare

of community. These users were typically young (school-going to mid-thirties), but older intermediary-users were not uncommon. Intermediary-users were skilled at operating particular technologies or applications (mobile phone recharge, sending/reading SMS, storing contacts, etc.), or possessed particular technology-operation skills (access, evaluate, debug, simplify, translate and so on). The actors involved in intermediation are diverse and comprise the organic everyday of the slum communities, as opposed to interventions by the state or nation. They live, work, and contribute to these communities.

It is important to consider a broader definition of use in intermediated interactions that scales beyond the simple notion of the human accessing the interface, to one that encompasses the wider socio-technical system. Use of a system by a beneficiary-user implies (i) *participation* with the system, by having a say over the purpose of the interaction, as well as providing feedback to the intermediary-user to influence the input. (ii) A degree of social, cultural, or economic *usefulness* of technology is maintained, which could be driven by recreation, livelihood, or communication needs. In other words, intermediated use of technology mirrored everyday activities and needs in our sites, as we note in [26]. Sen [27] is helpful here—it is neither the possession of commodities, nor their utility, but the person's *capability* to combine the two that determines their standard of living. Here, resourcefulness in leveraging social networks for technology use contributes to a relatively higher standard of living.

FACTORS MOTIVATING INTERMEDIATED INTERACTIONS

Intermediated interactions reflect the state of uneven textual and digital literacies in a community. So long as they remain, intermediated interaction will continue. Despite an individual's limitations, the overall community typically possesses a greater amount of digital proficiency that could be considered its collective digital proficiency. Some of the factors that drove intermediated interactions in our sites were:

Fear of the technology: A combination of unfamiliarity with technology and lack of self-efficacy intimidates many people lacking technology-operation skills from direct usage. The effort of acquiring the skills required to operate the device is also perceived as high. The easiest alternative, then, is to find a technologically skilled person.

Saroja, 67: "*My son recently purchased a phone for the family. My husband and daughter-in-law leave the phone at home when they head to work. I don't know how to use it to make calls. I am a woman of those days. These* (technologies) *are too hard to handle. I ask my young neighbour to dial my calls."*

Lack of textual literacy, numeracy, or digital operation skills: Non-literacy limits the ability of some users to understand the features, functions, and outputs of technologies. Numeracy is an essential skill in number-based operations, such as dialling phone numbers and operating menus. This is further compounded by the skills required to operate technologies. For example, Sujatha, 49, was non-literate but numerate, and could read the time from a wall-clock but not set the alarm.

Habits of dependency*:* Pre-existing habits of dependency, not always regarding technology, transfer to device interactions. Factors such as age, lack of self esteem, social order gave rise to dependencies on other community members. Local experts acted as enablers of information and communication access, through existing relationships. For example, Vijaya, 65, depended on her son for financing her monthly expenses, and turned to him for help with using her mobile phone.

Cost of owning a technology*:* The cost of ownership of a device was sometimes forbidding — not just in terms of initial purchase, but also in maintenance, subscriptions, updating, or repairs. Among the families we interviewed, with an average income of Rs 5000, roughly Rs.4500 was channelled into basics such as food, education, rent, groceries, and electricity, leaving little for phones and PCs. This was further compounded by expenditure on alcoholism.

Access constraints*:* Age, gender, and financial capability influenced access to technologies. Women, elderly, and children were less prone to owning technologies: 36% (N=8) of the women owned phones, as compared to 82% (N=18) of their husbands (note that the sample included domestic workers, who were employed and financially independent). Intermediated interactions helped in overcoming access constraints, by expanding the resource base through device and skill sharing.

Shobana, 42:*"We only have one phone, and my husband carries it to work. So if I want to make a phone call during the day, I have to either walk to the PCO (paid telephone) or borrow my neighbour's phone, so I just use my neighbour's phone."*

INTERACTION MECHANISMS

We present three interaction mechanisms uncovered in our sites — remote access in *surrogate usage* implying access "on behalf of" or "in benefit of" in inputting and interpretation, collocated access in *proximate enabling* in inputting of device output, and collocated access in *proximate translation* or interpretation of output. These mechanisms vary with respect to intermediation in access, ownership, and skills in operating technology. These mechanisms reflect our findings; it is possible for permutations of these interactions to exist elsewhere. They are examples of intermediation and not a neat partition of all possibilities; the boundaries between them are porous. Our findings reflect that intermediary-users were conversant in multiple technologies in the slum setting (typically mobile phones, VCD players, televisions, radio, and home theatre), but the usual case was that of being skilled at using a specific technology. Categories are not fixed; therefore, a surrogate intermediary-user could also serve as a proximate enabler in another scenario. We considered various (i) *relationships* between actors, such as family members, non-family peers, and non-family experts; (ii) *locations* of intermediation, such as home, public spaces, and work places; (iii) situations of *use*, such as information requests and communication needs; and (iv) situations of *impact*, such as communication with family members in native villages, networking for job opportunities, and recreational usage.

1. Surrogate usage

Lakshmi, 22, a call centre employee, was among the rare few to be educated past high school in Ragigudda. Computers had not yet penetrated into the community. However, her sister, Bhagya, and brother, Vijay, routed their computer-specific information needs through her.

Lakshmi*: "I was lucky to attend college, and my mother has worked really hard to make this happen. I also attended computer classes to keep up with the times. I have done well for myself by joining a call centre. When my sister wants information on the latest Vijay (actor in the Tamil film industry) movie, or my brother on cricket scores, I use my computer at work to look that up. I call him up because he wants instant scores"*

In this case, Lakshmi acted as a surrogate to seek her family's information needs. The defining characteristic here is that the beneficiary-user never came in direct contact with the technology. In this kind of *surrogate usage,* the beneficiary-user depends on intermediary-users for technology access. The intermediary-user in turn relies on 1) technology-operation skills, and 2) physical or financial access to technologies unavailable to the beneficiary. Beneficiary-users were aware of the function and purpose of technologies, and identified the right intermediary-users for specific tasks. This model overcame technology deficits, creating last-mile connections between the technology and unconnected communities, through intermediary-users.

Surrogate usage expands the information boundaries of the community otherwise closed to it. With the increasing interest among the younger generations to acquire technology-operation skills, and subsequently finding jobs in the information technology sector, or being able to access cyber cafes, this modality finds a home in communities of uneven technology penetration and technology-operation skills.

Information needs were sometimes identified by the intermediary-users themselves. Sharanya, an NGO worker, doubled up as a surrogate intermediary-user by consulting the Internet to meet information demands coming from the community of women who were her NGO members (fig. 3).

Figure 3. Sharanya reads out to the women from printouts.

Sharanya*: "Sometimes I am not in a position to advise the women on certain topics, such as reproductive problems. In such cases, I look up medical websites, take printouts, and read them out to the community."*

2. Proximate enabling

Sushila, 45, a mother of three, never attended school. Her job as a domestic worker brought her in close contact with her employer, a retired government officer.

Sushila*: "My daughter lives in Senji, Tamil Nadu. When she was here last, she put (stored) her name in the phone (Contacts list). I belong to the old generation, and did not attend school. These (technologies) are very difficult to use. So whenever I want to make a phone call, I get my employer to get my daughter's number from the phone and dial the number. She also ends the call once I finish talking. If I am at home, I ask my youngest daughter."*

We see how Sushila was able to use the mobile phone through her employer's *proximate enabling*. The complexity of the user interface was hidden from her in the usage. The interaction was actively motivated by Sushila, but was made possible only by the intermediary-user. The beneficiary-user might have physical access to the technology, but does not know how to use it.

Limited operational knowledge or unfamiliarity with using certain interfaces resulted in dependencies on digitally capable members for application navigation. Intermediary-users in proximate settings, such as family members, neighbours, colleagues, or employers often bridge the skills gap, by rendering certain interactions possible, such as in user interface navigation, and presenting the desired state of interaction to the beneficiary-user. They shield some of the UI complexity from the beneficiary-user, but allow the beneficiary-user use some of the application directly.

Proximate enabling allowed users lacking technology-operation skills, with access to technologies, to successfully use technology. This hybrid interaction created a direct engagement during use of technology. Although the steps to achieve an interaction were obscured to the beneficiary-user, she knew about the outcome of the interaction.

When Lakshmi helped her mother watch movies*: "My mother knows nothing about playing audio CDs in our stereo, but she loves to listen to music. Sometimes when her chores are done, or after a long argument with my father, she wants to relax. She will then ask me to play her favourite music—old songs from MGR movies."*

3. Proximate translation

Janaki, 35, mother of three, was educated in the regional language medium of instruction (Kannada) up to 10th-grade. She recently purchased a DVD player, which was primarily used for playing audio CDs of devotional songs. She narrated an incident where her sister had mailed her a Video CD of a hit Tamil film freshly-released into the gray market.

Janaki*: "From my earlier experience with using the buttons on the DVD player, I knew how to eject the tray and insert the disc. I hit the mukkonam* (triangle—play button) *and a coloured box* (menu) *showed-up on the TV which I could not understand. Fortunately, my friend Suguna's 10-year old son was around, and he was able to play the menu. I watched what he did—he pressed the mel pakkam kuri* (Up-arrow), *pressed the vattam* (circle) *button, and then the mukkonam* (play button). *From then onwards, every time I played the disc, I remembered that."*

Here, the 10-year old enabled Janaki's usage of the television player. Her technology-operation skills and textual literacy were not adequate enough for her to operate the DVD player entirely on her own. We see a rote memorization of the procedure to play a video CD. Janaki used her existing digital literacy to make sense of the boy's actions with the DVD player. This procedural knowledge would then be applied to future encounters with VCDs. The limiting case, however, is a differently-designed menu, with different order of options or extra options. Here, Janaki's digital literacy would have to be extrapolated, failing which, help is always at hand in the form of an intermediary-user.

Proximate translation is characterized by operational knowledge and inability to understand system output. The beneficiary-user has some technology-operation skills, but lacking textual literacy, runs into an interactional *cul de sac*, when device output is unfamiliar. The intermediary-user functions as a translator of system output to a more familiar, verbal form.

Proximate translation enables beneficiary-users with access to and operational knowledge of using technologies to use them. They rely upon the intermediary-user's translation skills and ability to simplify the interface or information output.

When we interviewed Mythili, 30, her mobile phone started beeping. Due to an increase in income from working for an extra household, Mythili had recently subscribed to a new cellular plan, after leaving her phone unused for 5 months. She initially ignored the beeps, but started paying attention to them the third time. She used her judgment and hit the centre button, but was unable to understand the text message's contents. She immediately yelled out for her 12-year old daughter, Priya, and proudly mentioned to us,

Mythili*: "She learns English in school! She can understand everything!"* Priya was then assigned the task of reading out the SMS. The mobile service provider had kindly reminded Mythili that she had a balance of Rs5 left.

A LOOK AT THE INTERMEDIATED USER INTERFACE

The intermediated "user interface" is a combination of the intermediating channel and the actual device user interface (see fig. 4). To work with the system, the beneficiary-user has to control and assess the state of the system. Hence, there is a dependency on the intermediary-user to mediate the input or the feedback. Under interaction analysis, we consider the *process* of handling input and output of the interface, and under information analysis, we consider the *actual* input and output. We consider some of the traditional heuristics of user interface design and the resulting design mismatches of intermediated interactions under the direct interaction designs.

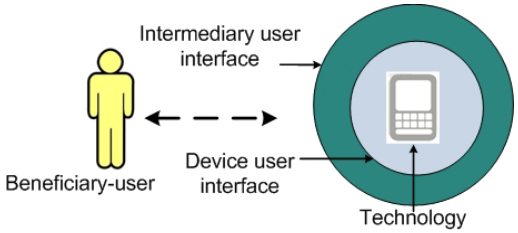

Figure 4. The intermediated user interface

Interaction analysis

The usefulness and usability of the system is determined by the "skill" of the intermediary in simplifying the interface and information, inasmuch as it depends upon the actual interface itself. The following are some factors to consider in the user experience and interaction of intermediated interactions.

Engagement

Standard, direct interactions are first-person interactions in that they allow the user to directly manipulate the technology. Intermediated interactions create a degree of separation from the technology, instead, spurring indirect engagement. They create a wider rift in the "gulf of execution" [16] by increasing the gap between goal formulation and the means to execute it—the beneficiary-user has to communicate the high level information goal to the intermediary-user, who then has to break down the goals into intent, and perform interface tasks accordingly, and translate the results for the beneficiary-user. Because the beneficiary-user may be unable to evaluate the system output, perception and interpretation lie in the hands of the intermediary-user. The evaluation check is performed on the oral information provided by the intermediary-user.

Availability

Direct interactions allow "anytime" and sometimes "anywhere" usage of devices, due to the personal, private, or portable nature of device usage. In contrast, intermediated interactions are limited by the availability of the intermediary-user. The number of digitally skilled members is gradually increasing with education and career choices; nevertheless, they remain scarce in these communities. This is further constrained by the nature of the relationship between the two sets of users, which can either allow or inhibit the possibility of an interaction at a given time and place. Furthermore, the intermediary-user is not always present in the neighbourhood, in which case the beneficiary-user may have to wait or find another locally skilled person. Interactions are negotiated and constructed around the intermediary-user's availability.

Janaki: *"Sometimes when Suguna and Sangeetha's families are not in town, I feel uncomfortable asking other women or children here to help me with playing DVDs. Then I just put it off until they return."*

Lakshmi's sister, 18:*"If not for Lakshmi, I would not ask anyone else to lookup film releases. There are not many people here working with computers."*

Usability

Usability in direct interactions is concerned with ease of use of computing applications. In intermediated interactions, in addition to the first-order usability of the application towards the direct user, two more dimensions of usability need further examination—the human relationship between the intermediary-user and the beneficiary-user, which can inhibit or promote access, and the second-order usability of the application for the beneficiary-user. An asymmetry of interactions is created due to the control by the intermediary-user. They may do more to hide the complexity of the interfaces, instead of explaining their interactions with the technology. In turn, this abstraction makes interactions far more "usable" for the beneficiary-user.

Shankar, 25, an intermediary-user: "*Whenever they (neighbours) call me for help, I just perform the tasks. The other day, it had rained heavily and I was called for ghost correction on TV. I helped them out, but I did not give them details on how to do it. It might have confused them.*"

Information analysis

Interpretation and translation of information at both the input and output ends is carried out by the intermediary-user. The following subsections examine the consequences of conversion of information from a technological medium (of the device) to a non-technological medium (once translated to the beneficiary-user).

Accuracy

Information accuracy in direct interactions depends entirely upon the accuracy of the information source, *i.e.,* computing application. Intermediation adds an onus of information accuracy to the intermediary-user. Even if the information source has high veracity, specificity, and quality of content, the intermediary-user packages the information into an oral format. Therefore, the accuracy of information is dependent upon the intermediary-user's technology-operation skill sophistication, and his comprehension, interpretation, and translation of information to the beneficiary-user. Despite the best efforts of the intermediary-user, information loss does occur in this transfer process. Lack of consistency and resultant errors may pose serious problems to the beneficiary-user, depending upon the nature of information.

In the case of surrogates, the information travel distance is increased since the intermediary-user transports the information. This adds an additional layer of information loss over the already susceptible information transfer. The retention format of the intermediary-user plays an important role in reducing information loss. Printouts (like we see in Sharanya's case), phone calls (like in Lakshmi's case), and word of mouth were typically employed, with the second and third being lossier formats than the first. Physical memory aids like slips of paper were also employed. There are varying degrees of information quality loss corresponding to retention format as well as distance from technology. Proximate interactions are less influenced by information travel distance than their surrogate counterparts.

Storage

Direct interactions permit the ability to create and re-create interactions. The limited repeatability of intermediated interactions is overcome by physical storage. Once the beneficiary-user received information, it was accumulated in human memory instead of technological media. Numeracy was also seen, but without textual literacy it was only constraining. Sushila: "*I can write phone numbers on the wall, but not names* (she is numerate but non-literate). *My daughter, in Senji, has added some relatives' numbers to the phone* (address book)*, which is useless because I cannot read. I ask my neighbours for help."* Therefore, her dependency on the intermediary-user continued to be sustained for information retrieval, in addition to technology usage.

Privacy

In direct interactions, privacy concerns lie in large part in securing information on the system side (such as encrypting data or deleting cookies) and sometimes in guarding the physical space of the user from intrusion. The human mediated nature of intermediated interactions immediately implies that privacy is socially constructed between the intermediary-user and beneficiary-user. The actions involved in creating an interaction varied anywhere from looking up a contact from the Address Book to reading out printouts on health problems. Here, the privacy concerns are not just limited to revealing of the content to the intermediary-user, but also involve more complex nuances of social dynamics, power relations, and gender.

Shankaramma, 65: *"Usually I ask my grandson or daughter to make the phone call (dial the number) and I speak to relatives in my native village near Madurai. But I will not ask my neighbour, since she may overhear and spread rumours."*

DISCUSSION

So far we have illustrated the various intermediated interaction paradigms and the interface-level challenges in designing for them. In this section, we list the broader effects of intermediation in a community. We describe how these interactions are reciprocated and sustained, how the benefits are distributed, and the learning that results from the process.

A give-and-take economy

A sharing economy evolves in human-mediated computer interaction. The intermediation process facilitates exchange of values. A shared infrastructure is created through individual ownership. Characteristics of a gift economy [20] are visible—a notion of reciprocity is maintained rather than a *quid pro quo*. For example, when we asked Janaki how she perceived help from her neighbours,

Janaki: *"When Suguna or Sangeetha helps me out, I may not be as talented as them in operating these devices, but I try to return the favour in other ways. I take care of their children when they are late from work, or share my food with them, sometimes."*

However, the reciprocity is not always on a one-to-one basis, and not mandatory. Reciprocity also manifests as diffusion to other members of the community, *i.e.* passing relevant and valuable information to co-members who may also benefit from it, through word-of-mouth. For example, members active within the NGO would transmit the information collected from meetings to non-attendees. Although the intermediary-user does not always directly benefit from intermediation, social capital— infrastructure of social relations as well as the information that is transmitted between actors via their social networks [15]—helps in sustaining the interactions. The motivations also vary according to the nature of the relationship between the intermediary-user and the beneficiary-user—activists, employers, colleagues, friends, neighbours, or family members are all differently motivated to provide access, such as investment in labour skills, altruism, activism, and social ties. Recognition, reputation, and social good are drivers for contributing to the shared economy [8]. Recommendations of local technology experts are provided by

community members, expanding as well as strengthening social networks. Intermediated interactions are atomic and limited to a bounded social network. This is because intermediation is a local process, requiring a social foundation of trust and familiarity. Stickiness in information distribution is seen in distributing information only within these bounds.

Human relations set the foundation for intermediation. Interpersonal and institutional trusts are prerequisites for intermediated interactions. The setting of the slum fosters a shared understanding of context and stratum, contributing to institutional trust. Interpersonal trust between the two sets of users help in guiding the beneficiary-users to the appropriate intermediary-users. Together, these trusts influence the information flows and channels. Recommendations from members of the community are used to find new intermediary-users. These interactions build upon associative trust and shared institutional context. Relationships with intermediary-users grow and strengthen with time.

Chandrika, 46: "*When we bought this* (stereo system), *I could not figure out how to use it. I did not know whom to ask for help either. My sister, who lives in the neighbourhood, mentioned that the grocery store owner's son usually helps them with electronics. So I went up to him and asked him for help. Ever since then we always run to him for electronics!*"

The multiplier effect

Intermediated access creates a multiplier effect for the benefits of technologies through sharing. With a bare minimum of technologies, intermediary-users act as gateways between unconnected households and ICTs. For example, a great number of people actually benefit from mobile phones, even when there are so few. In Ragigudda, among the 12 women we interviewed, only two of them possessed their own phones. Even in households with sufficient technology penetration in Nakalbandi, not everyone was positioned to enjoy access to technology. Most husbands owned mobile phones and carried them to work. However, the women not only borrowed but also sought the help of their neighbours and employers in fulfilling their communication needs. Thus, intermediation helps in extending the benefits of technologies to a wide range of users. The Grameen Village Phone is built upon the model of sharing one phone with an entire village, where the telephone operator is a permanent intermediary [28]. Intermediation overcomes highly stratified power structures that stymie the community members from access.

The secondary diffusion of information contributes to its extensive reach. For example, due to the space constraints in slums, interactions were often carried out on doorsteps or communal spaces such as temples and water pumps. Accumulation of groups of bystanders was common. In addition, active members helped in diffusion of information.

Digital habituation and skill building

Proximate access to technology and demonstrative actions of technology usage sometimes led to learning by observing. Janaki's case in *Proximate translation* is an example of digital habituation, *i.e.*, it allowed her to respond to the VCD player spontaneously and engage in a slow process of familiarization with the technology, as she learned basic navigation features and what the technology could be used for [25]. By watching the actions of the intermediary-user, Janaki was able to map tasks to function, and memorize the sequence for future use. Collocated intermediated use, whether conspicuously demonstrative or not, exhibits the sequence of steps in executing a task, when the technology is collocated. Over time, it may lead to an internalization of the actions required. The familiar face of the intermediary-user also reduces the barrier to learning the actions. However, dependencies on intermediary-users may continue to be sustained, as these persons are easy to find. The threshold for independent use is a function of interest, ease of learning the task, and necessity to learn the task. It also depends upon the capability for ownership of the device.

THOUGHTS ON DESIGN

We posit that a prevalent mode of access in low-income communities will continue to remain intermediated, although leaps occur with increased literacy. In this section, we ask how we can design systems differently to better support intermediated interactions. The challenge is to design under resource constraints such as obsolete technologies, irregular infrastructures, grey market goods, low literacies, and uneven familiarity with user interfaces.

Design for multiple users

Intermediated interactions involve multiple sets of users—the intermediary-user and the beneficiary-user(s). In addition, there are various intermediary-users (different experts for different devices), and this affects how and where people take part in such interactions. Designing for the intermediated ecosystem broadens the scope of design from use, users, and products to access, beneficiary-users, and co-created systems. Much of use in the developing world is underscored by sharing of resources. An interesting avenue for future work would be to consider the design requirements and possibilities for supporting a more engaging, interactive, and efficient model for multiple users, across various technologies.

Positioning and reorientation: Overcrowding from increased migration in the slums evolved into congested spaces, fitting in roughly 4-7 family members into each household. The likelihood of finding a digitally capable person was enhanced by both the sheer number of inhabitants and the compact nature of settlements. Space constraints shaped groups into shoulder-to-shoulder formations. Positioning and directional orientation of technology can allow better "sharing" of an interface across multiple users [29]. They can also indicate the state of the system and attribute the user, for example, the intermediary-user can turn the mobile screen orientation around upon a key press, to indicate that an operation is done and the beneficiary-user can proceed to use the system.

Persistence and storage: Design must take into account that sharing implies a changing set of users and contexts of use. By allowing portability of information, history of use and stored information could persist. Combining the physical and digital could be one possible way. For example, as we noted earlier, numbers were noted on the walls without meta-information.

By porting the numbers to a tiny booklet instead, and designing a slot on a mobile phone to hold it, transactions become portable and memory-enabled. Numeracy of the beneficiary-user could be augmented by the textual literacy of the intermediary-user, and this could be used in keeping track of phone calls, aided by the intermediary-user, in maintaining an address book, or in recording talk time. An NGO field officer could prescribe and write the name of a fertilizer which could be taken to the nearest outlet for purchase. This is in line with existing practices and a simple increment to the existing design, which could add to the storage, transparency, and engagement of the interaction. In addition, this supports various literacies through mutual assistance and social solidarity—the foundation of intermediated interactions.

Design for symmetrical engagement

Intermediated interaction involves the co-existence of three interactions—the intermediary-user-computer interaction, the intermediary-user-beneficiary-user interaction, and the beneficiary-user-computer interaction. Only the first interaction is traditionally designed for. "Absent presence" is seen here [14]: although the beneficiary-user is physically a part of the experience of using the technology, the intermediary-user is part of the inside space, excluding the beneficiary-user into the outside space. Inasmuch as the beneficiary-user drives the interaction, she still has to wait for the intermediary-user to finish the interaction, and explain when done. The challenge here is to design for equitable engagement between the three entities.

Legibility: Legibility in interactions can contribute to better comprehension of system actions by the beneficiary-user. The use of visual and auditory cues [23] can help the secondary user "see" the interface output. Existing infrastructure, with a few enhancements, could be used to create more engaging interfaces. For example, with the addition of a low-cost processing unit, a television could be used to map and render operations on a DVD player as corresponding animations, or text messages could be automatically converted to voice, which may eventually build up to learning by the beneficiary-user. Interfaces must be designed in formats readable by both sets of users. Symbolic literacy could be leveraged by extracting representations, resemblances, and components of the physical world and combining them with technologies. Greater transparency and usability may, in turn, create more trusting social bonds between the users. Legibility in interface design may also lead to error reduction in translation of system output by intermediary-user or interpretation by the beneficiary-user. Feedback from the beneficiary-user may contribute to a more positive environment.

Involve the beneficiary-user: Creating user experiences that allow the beneficiary-user to take part in interactions, could allow us to conceive more engaging experiences. In incremental steps, this could also lead to digital habituation and skill building. Since many of the operations are routine, such as playing media, retrieving content, and calling people, and certain devices are marked for sharing, these experiences could be automated.

Rethinking metrics for access through use

The previous sections in this paper illustrate that intermediated interactions increase the range of use and users of technologies. This suggests a re-examination of current indicators of technology access and use.

Technology access is not just ownership: Prevailing statistics of technology access and penetration quantify ownership—telephone numbers, Internet subscription, or device ownership. This represents only part of the picture, because intermediated interactions expand the reach of the resource to a wider cross-section of users. If a locality has X% mobile phone penetration (quantified by ownership), then Y% of people also benefit from the device due to intermediated interactions, and Z% benefit from the beneficiary-users through word-of-mouth interactions. These secondary Y% and tertiary Z% uptakes of technology broaden its reach, penetration, and use. In the tertiary level, information diffuses among individuals and collectives. Thus, the "collective access" is increased, and information reaches wider audiences through sharing and intermediation. The beneficiary-user or secondary user is an active driver of the technology.

Ownership statistics distort realities by not counting those who may use technology but not have the capability to own it. Recall that only 36% of the women owned their phones, and the rest of the women used technology through intermediation. Non-ownership does not necessarily imply digital exclusion. Sharing mechanisms help in extending technology benefits to a wide range of people.

Limitations of the user/non-user dichotomy: The dichotomy of use and non-use conceptualizes use as direct use and non-use as lack of use. It reinforces the concept of digital divide, by counting users as X% with, non-users as Y% without [11]. Some regard the divide as one that leads to inequities, whereas others consider it to be a symptom, not a cause of the inequities [2]. Whatever be the case, this divide/dichotomy does not clearly unfold as a binary in developing communities, where the user is a direct user, beneficiary-user, or tertiary user, and the non-user is degrees away (conceptually) from the user. At the level of the tertiary user, the scope and quantification of use becomes fuzzy.

We propose a new metric for quantifying access, by moving away from ownership paradigm to measuring the ability to benefit from use. This inclusive quantification provides a more realistic metric that reflects use as-is in developing communities. A breakdown of the dichotomy requires a quantitative-qualitative bridging exercise [11]. Studying intermediation opens us up to the possibility of users, non-users, and all those in-between who benefit from technologies.

CONCLUSION

Although technology users everywhere make use of intermediaries from time to time, intermediated interaction appears to be more pronounced and more deeply embedded in low-income communities. Even if access to and familiarity with the technologies is limited to a few individuals, demand for their benefits exists across the community. Thus,

intermediated interactions increase the number of people who can benefit from these technologies.

We have presented three distinct intermediated interactions in low-income communities: intermediation in inputting intent into the device in *proximate enabling*; intermediation in interpretation of device output in *proximate translation*; and intermediation in both inputs of intent and interpretation of output in *surrogate usage*. While we spent 4 months doing in-depth observations in the slums, a great direction for future research is in longitudinal studies and cross-cultural studies. Intermediated interactions pull apart the standard notion of a user into a beneficiary-user and an intermediary-user, who each fulfil different roles that a single, direct user would fulfil entirely by herself. This fact opens the door to a wide range of new research for HCI, whether it is in understanding how such usage proceeds, or to design UIs that cater simultaneously to two, users who are not peers with respect to the technology. In turn, such research could help lower barriers to technology-based services for many people in the developing world.

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