Understanding Negotiation in Airtime Sharing in Low-income Microenterprises

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ABSTRACT

Shared access to airtime is a prominent mode of connectivity access in the developing world. We seek to understand airtime sharing among low-income microenterprises in India (small, low-capital businesses, such as flower sellers and milkmen), that constitute 90% of the total enterprises in India. We introduce social *negotiation* as the foundation of airtime sharing. We highlight negotiation mechanisms in the microenterprise, showing how shared resources are used towards personal interests amidst tensions and value conflicts, by adapting, modifying, subverting, and repurposing airtime. We then explore the design space of airtime and bandwidth sharing in low-income communities, including designing for negotiation and improving readability of airtime.

Author Keywords

HCI4D; ICT4D; Microenterprises; negotiation; sharing; airtime; bandwidth; India

ACM Classification Keywords

H.5.0 [Information interfaces and presentation]: General

INTRODUCTION

Airtime is the unit of connectivity for mobile phones. Airtime connectivity profoundly impacts its users, especially in the developing world where mobiles are major ICTs, e.g., by leading to livelihood productivity gains [12] and amplifying social networking [11]. In Human Computer Interaction, airtime connectivity is assumed to be readily available to individual subscribers on their personal and private devices. However, in developing countries, the connectivity infrastructure is fraught with high ownership costs [3,18]. For example, in the United States, airtime expenditure is 2% of the average income of lowest income segment; in contrast, despite being the fastest growing mobile market in the world [21], airtime costs in India can be greater than 10% of the average low income[1]. Shared access or multiple users for a single airtime resource is a prominent mode of phone use in these contexts.

Our paper is the first to study airtime sharing in the commercial enterprise in the developing world. We report the results of our fieldwork on airtime sharing practices in a spectrum of 58 microenterprises in two cities in southern India. In India, a country of over 1.2 billion people, microenterprises account for over 90% of the total enterprises [22]. Airtime impacts several functions of the microenterprise, such as procurement and sales of goods; and better price information exchange [5]. Understanding the usage practices and design space of airtime sharing in the microenterprise could impact the livelihoods of millions of people in the developing world. We seek to understand how airtime is shared, apportioned, and controlled among member of an enterprise, supplementing, complementing, or opposing the rules of an enterprise. Sharing airtime bits across a network pipe leads to new tensions, negotiations, and usage practices. Our study points to the foundational phenomenon of *negotiation* in airtime sharing—wherein multiple users repurpose airtime usage towards personal interests—by taking advantage of the opacity of airtime in showing usage of multiple users, and cost and infrastructure constraints.

We present a spectrum of airtime sharing practices across informal enterprises in the wild—sharing airtime, airtime subsidy, and device provision. We show how accountability and subterfuge of employees, airtime economics, and access control are negotiation mechanisms in the enterprise. Airtime sharing is fundamentally *bandwidth* sharing and the design space is relevant for various kinds of bandwidth sharing, beyond just the microenterprise and developing world. We feel our primary contribution is the introduction of negotiation as the foundation of airtime sharing in the microenterprise. We contribute to the HCI for Development (HCI4D) discourse on livelihoods by providing an account of technology access and benefit through airtime sharing in

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[1] The average annual income of the lowest quintile in the USA was $22,629[1]. The average cellular package is $40[2]. The average annual Indian income of a microenterprise employee in our study was Rs. 36000 (800 USD) whereas the Arjun Sengupta report[3] estimates that 77% of Indians live on less than Rs. 7300 (162 USD) a year. Average airtime costs were Rs. 300 (6.66 USD) per month in our study.

[1]www.nytimes.com/packages/html/national/20050515_CLASS_GRAPHIC/index_01.html
[2] www.att.com
[3] http://nceuis.nic.in/Condition_of_workers_sep_2007.pdf

the microenterprise. Finally, we discuss design for airtime and bandwidth sharing in low-income communities.

In the remainder of this paper, we report the results of our survey and fieldwork on airtime sharing practices among 58 microenterprises in India. We situate our research amongst other contributions on technology sharing, explaining how non-remunerative sharing takes place in commercial environments. We provide a brief orientation to the airtime landscape in India, followed by a characterization of the types of microenterprises we studied. We then present our findings on the various ways in which negotiation takes place in airtime sharing, such as tracking, seepage between home and work domains, and economics of airtime. We conclude with some thoughts on design, including designing for negotiation and shared usage.

BACKGROUND
Negotiation
Negotiation is the "discussion between two or more parties with the apparent aim of resolving a divergence of interests" [14]. Fisher *et al.,* note that a good negotiation should satisfy three criteria: produce a wise agreement if agreement is possible, be efficient, and not damage the relationship between the parties [9]. In a related strand in HCI, Gaver *et al.,* call for ambiguity in system design, arguing that leaving interpretation open to people allows for greater conceptual grappling and deeper, personal relations with the system [10]. Aoki and Woodruff note that while participants in an interaction observe and account for the actions of others, it is not always desirable for all parties to be able to account accurately and precisely [1]. The ambiguity discourse offers us relevant concepts like openness in interpretation, which we extend in our work.

We define negotiation in airtime sharing as the repurposing of airtime usage towards personal interests, amidst shared interests. Negotiation occurs when there are conflicting technological goals, user interests, or activities. When there is a gap between the expected social norm and the user's action, the subsequent process of achieving the user's expected goal or a compromised version of the goal is negotiation. For example, while the microenterprise expects the employee to use his airtime for professional calls, the employee may also repurpose airtime towards making personal calls. An employee's daughter may also call her boyfriend surreptitiously on her mother's phone. The daughter may account for her usage by claiming to make a call to a client or supplier. It is not just the *process* of achieving the goal, but also the supporting *narratives*, *tensions*, and *re-alignments* in interactions that constitute a negotiation. Negotiations are built upon trust and social understandings. They are ongoing dialogues, with constant back-and-forth between the two parties, be they between employer-employee, family members, or coworkers.

Studies of sharing of technology
Previous studies in HCI have examined technology and content sharing among multiple users. Karlson *et al.,*

describe how users are selective about the kind of smart phone function or content they want to share [13]. Brush and Inkpen observed technology sharing in domestic environments, noting that families wish to have a shared device with personal profiles [2]. Voida *et al.,* discuss music sharing in iTunes in a corporate environment, highlighting how impression management was an important part of sharing [19].

Previous ICTD studies have predominantly focused on the household and village communities. In her examination of shared access of mobiles among Ghanian households, Burrell describes multiple roles in mobile phone usage—the user, purchaser, owner, possessor, or operator [3]. Donner *et al.*, in their study of urban middle-class Indian families, argue that mobile sharing is born not merely out of economics, but may also be influenced by cultural factors [6]. Sambasivan *et al.,* describe intermediated usage, a shared usage phenomenon in low-income communities where digitally skilled users enable technology use to those without devices or necessary skills [17]. The Grameen "Village Phone" extends technology sharing to village communities through paid phones [8].

Yet, little is known empirically about sharing in the low-income enterprise, where sharing is neither borne out of tight family structures nor remunerative. It is in this context that we wish to explore how microenterprises share airtime, the ways in which they share, and what the notion of airtime sharing means to them.

Airtime technology
We refer to the credit (measured in minutes) used for services spent on the phone as airtime[1]. In the UK and USA, airtime refers to the minutes spent on a call, whereas in India, airtime is fungible—it is currency for a number of services, such as outgoing calls (incoming calls are free), SMS, MMS, mobile Internet, ringtones, data, and subscription alerts. As of March 2011, airtime was provided by sixteen Cellular Service Providers (CSPs) in India, covering 811.59m subscribers, out of which 381.40m used data on their mobiles [21]. Airtime can be loaded on a phone in two ways: postpaid and prepaid.

Post-paid airtime:
Post-paid connections charge the subscriber on a monthly basis. These are similar to cellular plans common in countries like the USA, except that the subscriber sets a maximum credit limit on the account. Postpaid airtime can only be purchased at dedicated CSP outlets. The postpaid model offers the subscriber an option to view per-call billing history on a monthly basis for a fee.

Pre-paid airtime:
Prepaid subscribers dominate the Indian airtime landscape, comprising 96.81% and 95.30% of the GSM and CDMA

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[2] Note that airtime is different from talk-time, which is the maximum expected duration a fully charged battery is expected to last under perfect conditions.
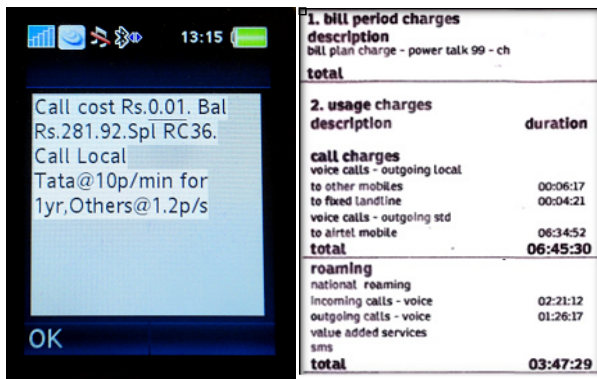
Figure 1. (Left) Prepaid and (right) postpaid notifications

total subscriber base [21]. Pre-paid airtime allows a variety of tailor-made recharge coupons with different denominations, starting at as low as Rs. 10 (0.25 USD). Mobile Internet is available both as integrated with prepaid and in standalone packages, starting at Rs. 9 (0.20 USD) for 10 MB, making access affordable. Usage tracking in pre-paid is fairly limited. The CSP sends out notifications after terminating every call, reflecting the current airtime balance, previous call duration and expense (see figure 1).

Microenterprises

Microenterprises are major employers in both developed and developing countries, spanning both formal and informal economies [23]. They are significant in number in developing countries where the informal economy is significant in employment and GDP. In India, they account for over 90% of the total enterprises and 45% of the manufacturing output [22]. Microenterprises typically have low capital, no legal status, produce goods and services for sale in the marketplace, and do not completely account their activities [23]. The International Labor Union defines microenterprises as enterprises with 25 workers or less [23] whereas the European Union caps the number at less than 10 [24]. In our study, we define a microenterprise as an urban, non-farm enterprise; with 10 or less employees; without a formal payroll; and sometimes tax-paying.

RESEARCH DESIGN

In order to understand the landscape of informal (non-tax paying, low capital) businesses, we decided to study a continuum of microenterprises in Bangalore and Chennai. Using revenue as a defining axis, we approached five income brackets of microenterprises, which we call *tiers*. As we go from tiers one to five, monthly revenues increase in a scalar fashion (Rs. 2,500, Rs. 5,000, Rs. 10,000, Rs. 18,000, and Rs. 40,000). Tier one businesses were highly informal with family members as employees (e.g., street-side vegetable-sellers) whereas tier five businesses were nearing formality with formal employees (e.g., computer businesses). This scheme offers a range of social structures, formality, technology ecologies and usage, employee strength, and organization. All our field studies were carried out in Tamil, Kannada, and Hindi by the first author.
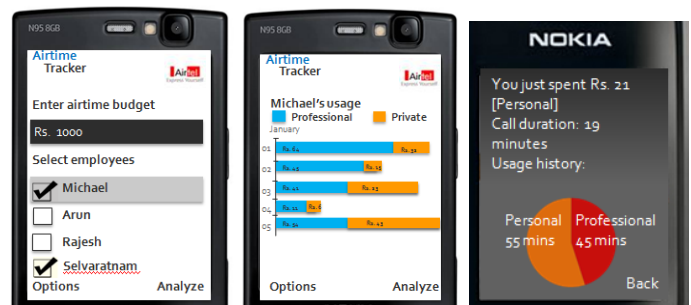

Figure 2. Design concepts for the employer and employee

Survey

We conducted a preliminary survey to understand the socio-economic profiles and technology practices of the microenterprise spectrum. Our goal was to study diverse microenterprises and not limit ourselves to a particular type, commodity, or service. We were interested in eliciting data on socio-economic profiles, household consumption, ICT ownership (appliances, phones, Internet, & PCs), sharing behavior, and communication ecology in the enterprise. To explore this, we surveyed 58 microenterprises. The survey exercise took us two months to complete.

Fieldwork

We conducted a qualitative field study to further understand the social protocol, workflow, technological practices, and airtime sharing. We conducted intensive field observations and open-ended interviews with 10 microenterprises (two in each tier) for three months.

Design provocations

Based on our results from the fieldwork, we were interested in using airtime as a lens to study sharing of technology, social relations, and economics. To this end, we employed two methods, One, we took design concepts to provoke participants and elicit their reactions and broader feelings on airtime sharing (Figure 2). We designed concepts for the employer, to track their employees' usage; and for the employee, to balance their personal-professional usage. Two, we designed paper-based diaries to understand a "day-in-the-life-of" mobile phones among multiple users (Figure 3). Diaries probed into who the user of the mobile was, features used, whether it was a business or family call, location of usage, duration of usage, and airtime balance at the end of the day. Diaries were partitioned into three-hour slots from morning to night, and lasted a weekend and two weekdays. Seven participants out of our initial pool were recruited. We offered airtime recharges as incentives.

MICROENTERPRISE CHARACTERIZATION

We studied a continuum of microenterprises to understand the transition points across each tier and to sketch out the trajectory of microenterprises to small-and-medium enterprises. Based on our survey and interview findings, we characterize each tier as follows (see Table 1 and Figure 4).

Tier one (T1)

T1 businesses are informal street-side businesses such as flower-sellers and vegetable-sellers. They are run by family members who each help out with the various aspects of

Aug 22nd Monday		Who used? பூஸ் பண்ணது யாரு ?	Purpose எதுக்கு	Business/ Family call? தொழில்/ குடும்பம்	Location எடம்	Duration எவ்ளோ நேரம்
	1		☎ ✉ 🔊 📷	Business / Family		
6:00 - 9:00	2		☎ ✉ 🔊 📷	Business / Family		
	3		☎ ✉ 🔊 📷	Business / Family		
	4		☎ ✉ 🔊 📷	Business / Family		
	5		☎ ✉ 🔊 📷	Business / Family		
	6		☎ ✉ 🔊 📷	Business / Family		

Figure 3. Mobile phone diaries

running a store. T1 businesses do not pay a monthly rent. However, locations are fixed due to social negotiations and understandings. T1 businesses do not maintain financial records. As we see in Figure 4, most of the infrastructure equipment is portable, like baskets and plastic sheets. T1 microenterprises are usually run by middle-aged women who have studied up to the 5th grade.

Mobile phones are the only information technology used by T1. Almost every mobile is a low-end, basic phone, used mainly for phone calls, low-resolution photos, and radio. Although every family member owns their mobile phone, usage is frequently shared among multiple users. T1 businesses form sharing communes of mobile phones and other resources with neighboring enterprises, with a technology expert in every commune (more detail in the next section) [17].

Tier two (T2)
T2 businesses are street-side businesses, but are no longer family-run. They are more formalized than T1 enterprises, with at least one formal employee. Examples include purse and jewellery stores. T2 businesses pay a monthly rent for their spot on the street and the store equipment is portable (wooden supports). Record-keeping is done on pieces of paper. The employer visits the store once in a day or few days, and this necessitates phone calls from employees every night to check-in the day's sales. The employee is responsible for all the activities of running the store, from sales to procurement of goods. Employees are typically young males who have studied up to 8th grade.

In T2, mobile phones are the only information technology used. Mobile Internet (GPRS) connectivity is used for

entertainment (multimedia and games downloads). A typical mobile in T2 is a dual-SIM feature (multimedia) phone. One SIM card is used for personal calls and the other for professional calls. Similar to T1, sharing communes with neighboring microenterprises are formed. In addition, these communes are derived from religion (we observed two Muslim communes).

Tier three (T3)
For T3, we were interested in coordination businesses with a major mobility component. We studied milkmen, *iron-wallahs* (steam-iron pushcarts), newspaper stands, and mobile tea shops. In contrast to T2, 2-3 delivery boys are employed at specific times of the day to deliver the goods to the customers, e.g., the milk and newspaper delivery usually deliver in early mornings. The store remains open throughout the day, usually run solely by the employer. A monthly rent is usually paid. Record-keeping is more formal than in T2, and is maintained in ledgers. Employees are typically young males educated up to 10th grade.

Similar to T2, the average mobile is a feature (multimedia) phone with mobile Internet (3G), used primarily for phone calls and entertainment. Unlike T1 and T2, sharing of technology is restricted to coworkers.

Tier four (T4)
T4 microenterprises are regular grocery and wholesale stores such as grocery stores, tailoring stores, and pharmacies. Unlike the previous tiers, T4 stores have concrete storefronts with shutters. A monthly rent is paid. Similar to T3, financial records are maintained in ledgers. Two-three young males are employed in running the store, and the employer is co-present. There is a small delivery component at certain times of the day. Employees are typically young males educated up to the 12th grade.

T4 includes more technologies than the other tiers, such as individual mobile phones, landlines, and personal computers. A typical mobile phone of an employee is a low-end smart phone with mobile Internet (3G), used primarily for Orkut, Facebook, and personal e-mail. Technology sharing with coworkers is frequent.

Figure 4: Sample microenterprises in tiers 1- 5

Tier five (T5)

In contrast to the above tiers, T5 microenterprises are at the cusp of formality, e.g, mobile phone and computer hardware retail and services. Similar to T4, a monthly rent is paid for a permanent concrete store. The workforce is larger than the other tiers, typically constituted by ten employees, including 1-2 family members that hold key positions. Employees are men and women who have graduated from college.

In T5 for the first time, we see heavy use of high-end technologies for work, such as multiplr landlines, mobile phones with mobile Internet (3G and Wi-fi), and PCs with broadband. Unlike the previous tiers, a typical mobile is a high-end smart phone. Employees use two mobile phones each—one for personal use and one for professional use. For the first time, an official e-mail address is used; e-mail is supported by mail clients like Outlook and IM clients like GoogleTalk. T5 record-keeping is done on MS-Excel and Tally. Sharing with coworkers is seen.

SHARING ECOLOGY IN THE MICROENTERPRISE

Airtime sharing practices and the social norms around them extend from and modify the existing ways of sharing non-technological goods in the microenterprise, such as sharing a cup of tea or lunch, looking after each other's shops, borrowing bicycles, as well as other cultural productions such as gossip and humor.

Values in airtime sharing

Airtime sharing is built upon a shared value system and cultural understandings. We encountered a range of values underpinning the airtime sharing ethos including trust, reciprocity, symbolism, and communal shareholding. Depending on who was sharing what with whom, values varied. Motivations to share at work varied from social ties to obligations to colleagues. For example, Raman, a young

employer in T2 shared his Nokia C7 with his employees so he could "*make them feel comfortable, make them feel that he is like their elder brother* […] *unlike older bosses who are not very friendly with employees*." In contrast, Mohammed, an employer in T3 was hesitant about sharing his mobile, stating that, "I already pay my employees, so I offer my phone to them only when they ask me. It's not nice to say "no"." In T1 we observed that sharing in businesses was largely motivated by family ties. Airtime sharing was reciprocated in the form of favors, content, and gifts.

Location, timing, and users:

Shared access to airtime varied with time and location of both the owner and the borrower, as a result of varying relationships, devices, communication needs, and accountabilities across different spaces. For example, 6 am sharing was different from 6 pm sharing; sharing in the street-side shop was different from sharing in one's home. The results of our mobile diary exercise show that all seven participants shared their phones at home with their family and at work, including two participants in T1 whose family members were also coworkers. On average, two family members and one colleague shared the mobile every day.

A total of 302 calls were made by the participants, out of which 176 were professional and 126 were personal calls. Calls were dialed across home, work, supplier stores, delivery locations, temples, and relatives. Professional calls were more frequent during mornings and nights. They tended to be short in length (avg. of 2 minutes) and were largely coordination calls for deliveries. Airtime sharing with coworkers was seen. Personal calls were made during afternoons and nights, and tended to be longer (avg. call length = 4 minutes), but fewer. Airtime was shared heavily with family members at nights. Our findings point to seepages between personal and professional airtime usage.

	Monthly revenue	# Employees	Education	Modal mobile	Year when first mobile was purchased	Mobile Internet penetration and predominant type	Internet penetration and predominant type	Pay for employee airtime	Shared airtime at work
Tier one *(n=19)*	Rs. 2500 (55 USD)	1	5th grade (regional)	Nokia 2600	2008	5.26% (n=1), GPRS	Work = 0, Home = 0	100% (n=19)	100% (n=19)
Tier two *(n=17)*	Rs. 5000 (110 USD)	1	8th grade (regional)	Nokia 5235	2006	41.18% (n=7), GPRS	Work = 0, Home = 23.53% (n=4) Broadband wired	88.23% (n=15)	100% (n=17)
Tier three *(n=7)*	Rs. 10000 (222 USD)	2	10th grade (regional)	Nokia 5530 Express Music	2006	42.86% (n=3), 3G	Work = 0, Home = 28.57% (n=2), Broadband wired	85.71% (n=6)	85.71% (n=6)
Tier four *(n=5)*	Rs. 18000 (400 USD)	2	12th grade (regional)	Samsung Corby	2004	80% (n=4), 3G	Work = 60% (n=3), Home = 80% (n=4) Broadband wired & datacard	80% (n=4)	100% (n=5)
Tier five *(n=10)*	Rs. 40000 (889 USD)	10	College (English-medium)	Nokia C6-01	2003	100% (n=10), 3G and Wi-fi	Work = 100% (n=10), Home = 81.82% (n=9) Broadband Wi-fi	100% (n=10)	100% (n=10)

Table 1: Characteristics of the microenterprises we studied

TYPOLOGY OF SHARING IN MICROENTERPRISES

We limit sharing to instances where shared usage happened more than once or on a recurring basis. We present a range of technology sharing within the microenterprises (Table 2).

Shared airtime

Shared airtime occurs when multiple users share a connection or airtime minutes. Airtime may be shared either by allocating a particular device as the shared instrument or by freely sharing all instruments for calls. Shared airtime is independent of device ownership, i.e., each user may own their device and SIM card yet share airtime on other phones. Shared usage occurs throughout the five tiers, but is pronounced in T1, which consists of family members. In other tiers that are more formal, shared airtime coexists with professional sharing. Rules of access govern shared airtime usage. For example, the mother keeps a watchful eye on the son's usage of the phone.

Airtime subsidy

Airtime subsidy occurs when the employer provides a nominal amount of money every month to the employee towards professional airtime. An allowance of Rs. 200-300 (5-7 USD) is provided each month. Employees own their mobiles and SIM cards. Airtime subsidy comes with an expectation that the employee will make instrumental (professional) use of the subsidy. In T2, employees purchase dual-SIM phones and use one SIM towards personal and the other towards professional calls. In T3 and T4, employees own a mobile each, and the subsidy is used to top-up the existing airtime minutes.

Device provision

In the case of T5, dedicated mobile phones with postpaid connections are handed over to the employee for professional calls. In addition, employees own personal mobile phones. Shared devices allow tighter control for the employer. There is some understanding between employers and employees that a certain percentage of phone calls is towards personal purposes.

Trajectory of microenterprises:

As we move from T1 to T5, we notice a change in devices, technology behavior, and practices (Table 1). Technologies become more sophisticated with each tier, although the big leap from personal to productive use of Internet happens only in T5. We see shifts in airtime technology from prepaid to postpaid; in device models from low-end to high-end smart phones; and in infrastructure from WAP to Wi-fi/3G. Technologies shape the negotiation process: with more capabilities and skills, there are stronger accountabilities, novel responses to accountabilities, and complex accounts of usage.

NEGOTIATION MECHANISMS

Shared access in low-income communities is a site of contestation, where a technological resource is shared among multiple users with various capabilities and interests. The personal and professional coexist in microenterprises, resulting in further conflicts and tensions.

Negotiation in the microenterprise entails activities that modify and stretch the properties of technology towards gainful use, amidst checks and balances, rules of access, and cost constraints. In our study, airtime negotiation revealed itself as a set of complex practices. Salient among them were four negotiation mechanisms: accountability of employees, subterfuge of employees, the economics of airtime, and access control.

Accountability

By accountability we refer to the ways in which the employee is obligated to use airtime towards professional purposes and the checks and balances involved in doing so.

Tracking airtime

Enterprises had several ways to maintain airtime expenditure within limits. Since prepaid airtime offers limited means to track airtime, employers checked on their employees through conspicuous and "innocuous" means. Employers in T2 and T3 sometimes checked on dialed numbers in the phone. Anbu, an employer in T2, noted, "*I give Rajesh [his employee] an allowance of Rs. 300. […] Sometimes when I see him, I ask if I can borrow his phone to call, but look up the dialed numbers.*" Airtime tracking was more common in T1. Since members shared a device for work, there was increased surveillance in checking recent calls.

In T5, airtime tracking was better supported by the CSP. Selva, a manager, gave out five post-paid phones to his marketing employees. Monthly bills usually came up to Rs. 5000 (110 USD) per phone. Selva pointed to the Airtel CSP bill and said, "*I could trace individual calls by requesting a detailed call history from Airtel for an additional Rs. 30.*" He went on to add, "*I usually don't do it [...] not unless the bill is outrageous. I allow anywhere between Rs. 250 – 750 on personal calls per month.*" He detected personal calls on the list by looking at call lengths and frequencies. He noted, "*Relatives from native villages usually want to talk for a long time and don't hang up. Professional calls don't last longer than 2 minutes. One usually just coordinates when and where to meet.*" In reality, however, he did *not* request detailed call history for phones. Accountability belies the nuances of social understandings and trust, wherein Selva *allowed* personal calls and did not check calls unless the bill skyrocketed.

We created a design provocation to help employers allocate airtime to employees and track individual usage (Figure 2). Our design was deliberately "extreme" in being intrusive and violating privacies of employees. We were interested in understanding the social context and values that airtime sharing is embedded in, not a response to the usability of our designs. While the sentiment of apportioning resources and knowing how airtime was used struck a chord with the employers ["*good to see how productive they are*"], they seemed ambivalent about the idea of tracking minutiae of employee usage ["*not sure if I need to know so much*"].

Limiting calls beforehand

As a preemptive measure, some employers provided airtime by estimating the number of professional calls for the

month. In T3 and T4, the frequency and timing of communication were estimated to calculate airtime minutes. Swarna, owner of a vegetable wholesale store, noted, "My delivery boys call up our customers to first decide the *time to deliver. They call me next to notify whether it is done or not. Sometimes I make the calls to customers on my phone. This is cheaper for the boys and makes my life easier. I give them Rs. 200 per month regularly because they cannot possibly exceed the amount even if they make five calls a day.*" In practice, airtime sharing rested in a gray area where Swarna could guess the number of professional calls, but saved her delivery boys a little money by allowing them to borrow her phone.

Reportage

In a few stores in T2, employers required daily and weekly reports of airtime usage from the employee. Shahul Hameed, owner of a street-side jewelry store, sometimes asked his employee how he had spent his day's airtime during the daily sales report. Employers were not interested in accuracy in reportage; rather they made an attenuated enquiry into usage as an accountability check, yet respecting the social relationships. As a repeated social process, this became a less effective means to check usage, as employees learned to invent narratives to account for usage, as we shall see in the next section.

Subterfuge

As an oppositional move to counter the employer's ways of airtime accounting, employees created inventive ways to camouflage their personal usage. It should be noted that in these cases, employees "stole" resources provided by the employer, but this adjusted itself within the social context or the employee provided tales to cover such usage.

Deleting phone numbers

Since prepaid does not provide detailed accounts of usage and the CSP notifications after each call are transient (they disappear after 'OK' is pressed), deleting numbers was a commonly employed strategy. In T2, Sugan was paid for professional airtime but used the minutes to call his village friends and those working on the same street to coordinate lunch or to chit-chat. Sugan regularly deleted his friends' numbers from call history on his phone, leaving behind only family and professional calls. He told us, "*Sometimes owner Sir visits and uses my phone to make calls* […] *I don't want him to think that I am gossiping here. I want him to know how hardworking I am. Family is OK. It shows that I talk to my mother and father, but friends* […] *he may think I am wasting time.*" Sugan maintained an impression of being a diligent employee by appropriating the phone content to his advantage. Negotiations in airtime sharing are concerned with what *kind* and how *much* information to reveal.

Exploiting illiteracy

In the lower tiers, where employers were educated in the regional language or were non-literate, employees crafted their usage stories to avoid raising suspicion. Contacts were generally not stored on the phone due to non-literacy or complexity of the phone interface. Phone numbers were either freshly dialed or retrieved from the phone history.

Ammulu, daughter of one of the flower-sellers in T1, was a heavy phone user. She attended school and helped out her mother in the evenings. Ammulu had a boyfriend from the neighboring school. "*My mother asks me, "Whose number is this?" My mother does not know how to read English. I tell her it is one of the customers or flower suppliers. Since my mother may eventually recognize the number, I alternate between my boyfriend's mobile and his best friend's number that I have stored as different supplier names. I only call him when I am at work.*" Ammulu created a perfectly logical narrative for her mother, taking into account how her mother may recognize names and numbers through symbolic literacy and numeracy; the credibility in calling professional contacts; and economizing her and her boyfriend's airtime by taking turns—all without raising an eyebrow.

Misnaming contacts

In T5, where employers had college degrees, storing contact names was a common practice. In enterprises where employees were expected to submit weekly reports, employees forged friends' and family names as supply chain contacts like customers, suppliers, or company agents. In the words of Satish, an employee in T5, "*If my boss checks my calls, he will see that I have been calling only my clients and agents.*" When asked if his employer would suspect, he replied, "*No. I store friends and family as frequently dialed clients* [...] *I differentiate like Arun Airtel* [customer] *and Arun Reliance* [brother]. *So instead of three calls to Arun, my boss would see four.*" We see how T5 employees and Ammulu leveraged the legitimacy of professional contacts to camouflage and negotiate personal use.

Self-regulation

Employees negotiated, managed and regulated their usage of airtime through self-created personal-professional quotas. These quotas were usually informally fixed per month. In the words of Sugan: "*Each month I use about 30 minutes of airtime to call my family. My boss pays me Rs. 300 per month. But when I exceed 30-35 minutes, I start using my personal SIM. I want to be true to my conscience and job.*" Sugan created a moral threshold above which surreptitious usage of professional airtime for personal calls became "wrong." Within this self-regulated framework, airtime quotas were carried over from one month to another. Sugan added, "*But if I use only 10 minutes this month, I will try to use 50 minutes next month to made up for it.*" Sugan's words were echoed by Akhil, a T2 employee, "*Arre* [Oh]*, my boss does not even pay me enough to survive. I have to care of a wife and three kids in Rajasthan. So I try to be make good use of* [justify] *the minutes he gives me, but after that it is for my calls to family.*"

Our designs for employees were created keeping in mind the delicate, inconspicuous balance between personal and professional airtime. Employees responded positively to the idea of differentiating and tracking the two, saying "*warning SMS would help me adjust my usage*" and "*would be useful*". Such responses point to the problematic nature of current airtime technology in supporting different *kinds* of use, that coexist, but are siloed into public and private.

Economics

As we have seen, airtime sharing is negotiated by the push and pull of employers and employees. But how is the valuable resource of airtime managed with multiple users amidst cost and device constraints? Recall that airtime expenditure constitutes over 10% of the employee's salary.

Airtime repurposing (switching SIMS)

Different CSPs charge differently for calls, motivating employees to switch between networks to keep costs minimal. In T2, dual-SIM phones used SIMs from two different CSPs. Vijay, an employee, swapped between two SIMs. His professional SIM (subsidized) had cheaper calling rates, whereas his personal SIM had lower SMS rates. So he tended to send text messages and get incoming calls on the personal SIM and make outgoing, including personal, calls, on the professional SIM. Arul in T5 owned a personal phone and used a postpaid work mobile. He received missed calls on the personal phone and called the person back using the work mobile or landline.

Reading usage

Given the constraints of limited resources, low incomes, and opacity of airtime usage information in prepaid airtime, we found that microenterprises went to extra lengths to make airtime usage more visible and cost-effective. When an airtime pipe was shared, keeping track of individual and total usages became important to keep costs down. One of the commonly employed techniques in T1-T3 was to jot down minutes spent in a notebook. Alongside the name of the person who made the call, the dialed phone number and whether it was a local or STD call were noted.

Our informants had several ways of discerning airtime usage. When the balance notification showed a drastic decrease, Pushpa, an owner in T1, immediately suspected her son of calling his friends when she was not around. She told us, "*Such* thiruttu [sneaky] *usage drives me mad. If I knew how much was spent by whom, I can show them proof and keep the costs low.*" In another case, Shekar, an employee in T5, told us how he figured his son used the phone while he was taking a bath. The phone battery had drained out suddenly and the instrument was warm.

Access control

Airtime sharing, like other forms of communal sharing, is governed by rules of access. Negotiation involves ways of creating adherence to the rules, as well as the transgression and circumvention of them without damaging the social relationships among multiple parties involved.

Physical access

Many informants reported exercising additional control over usage through physical presence. According to Ammulu, her mother made it hard for her to make personal calls, because, "*she is always around me, so I can't call my boyfriend whenever.*" Shanthi, an employer in T4 told us, "*I allow my employees to borrow my phone, but I am present when they make calls [...] sitting at the cash counter* […] *they cannot exploit the phone when I am there.*" In T5, some employers

required phones to be returned at the end of each day. The device boundaries were the data boundaries, since anyone using the device had access to all the data stored on it.

Permissiveness and exclusivity

Some of our informants reflected upon social conventions of permission before sharing. Permission control was largely seen in co-worker relations, and less so in families. Both employees and employers reported asking the other's permission before sharing a device, except when it was marked as a shared technology. In T1 and T2 where sharing communes were formed, airtime sharing outside of the communes was uncommon. Roles and privileges of access were evident—not everyone was allowed commensurate access to technologies. In T5 stores, postpaid phones were not shared with non-marketing employees. As shown elsewhere [16], sharing occurs freely within certain realms whereas tight control is exhibited in others.

THE DESIGN SPACE OF AIRTIME SHARING

Our study reveals how airtime sharing is a set of complex, conflicting, and contested practices. Airtime sharing is an instance of bandwidth sharing in general, where the utility of a volume of data is shared by multiple users. Understanding the design space in airtime sharing may be relevant to other kinds of bandwidth sharing, like shared cable/DSL Internet and TV and radio on-demand in the home. Interfaces for these infrastructures are typically designed for personal and private use, and suffer from scalability for supporting multiple users. Bandwidth is a scarce resource with usage caps in place in several countries [4]; multiple users for bandwidth calls for better representations of usage. Some questions emerge: what does it mean to share a connection? How can we design for multiple users when the subscription or profile is customized to the logged-in user? Moreover, the "user" is not a single person, but an address of a general entity (family, enterprise, or coworkers).

As more users in the developing world subscribe to data services (indeed our study points to the definite entry of mobile Internet (Table 1) and 100% airtime penetration among our informants), understanding the user and usage of these infrastructures is crucial to HCI. In the developing world, airtime sharing is a prominent mode of infrastructure access and coexists with direct ownership and usage. Our study points to problem areas in resource contention among multiple users, the conflict between personal usage and *expected* usage, economics of managing a constrained and valuable resource, and mechanisms to control access to the resource. We see how negotiation is a *fundamental* means to secure a resource for use and to stretch the use within socially accepted limits in a multi-user setting. Using negotiation as a design construct, we offer a few design concerns for both airtime and bandwidth sharing in HCI.

Designing for shared usage

Airtime sharing occurs when a network pipe is shared by multiple users. It occurs in several forms: one device,

multiple users; one device, multiple SIMs; and one SIM, multiple airtimes. Unlike using a dedicated device for home Internet sharing or TV viewing, airtime can be shared through multiple devices and multiple users, adding complexity to use. Whereas the owner of the device is typically the consumer in the personal-private model, we find a separation of ownership, authority, and usage in the shared use scenario. Differential access emerges from the negotiated configuration of who owns the device, who has authority, and who has usage.

Our findings point to a problem area in current bandwidth technology for apportionment, brokering, and management among multiple users. Resource management systems with social accountabilities may allow for better apportioning and tracking. Profiles have been suggested as a means to customize individual use on shared devices [15], but studies have shown that users do not always prefer profiles [2]. We suggest airtime quotas as an alternative approach. Allocating multiple users with individual airtime quotas and numeric passwords may help resolve contention and confusion in apportionment. The community may regulate information by deciding the quota limits, accountabilities, and penalties. A snapshot of the various users and their usage can help in understanding resource consumption. Such a system can scale up to other domains where bandwidth is shared, such as Internet and TV on-demand.

Shared usage is a complex socio-technical process. People create several rules of access to help distinguish between different types of relationships—be they professional coworkers, friends, family members, or strangers. Sharing depends upon the user, time of day, and location. As more devices become mobile, such as laptops, mobile phones, and tablets, application designers for bandwidth management should take context into account when designing for multiple users. In addition to the user's identity and their device model, when and where they use the device matters. For example, usage varies tremendously across home and work; usage depends on whether it is their own phone, employer's phone, or a family member's phone. How can we design services for personal use that can be used on professional phones, or vice versa? For example, can we create websites that consume bandwidth according to the facet of the phone used—a Facebook application that consumes less bandwidth if used on an employer's phone? A URL that appears inconspicuous to the employer? A missed call [7] application to communicate with friends on a family phone?

Improving readability of airtime
Current airtime systems are highly opaque in providing usage and expenditure information. As a result, people compensate for airtime tracking through non-technological means, such as notebooks, looking for drops in airtime balance, and checking battery levels. Such compensatory checking may provide imprecise readings. As noted earlier, airtime expenditure is substantial for the microenterprises

we studied (roughly 10% of the monthly income). Richer information systems for reading airtime balance are needed to save airtime amidst constraint. Current notifications in the prepaid model provide individual call statistics, whereas postpaid does not allow instantaneous tracking. An aggregate account of usage per day or week may help the user evaluate how airtime was spent and make decisions to spend the valuable resource constructively.

Our study points to certain parameters that may be useful to know in tracking: how much airtime was spent per day or week; dialed calls; call lengths; the breakdown of calls, messages, and data; and the current airtime balance. By visually reifying airtime spending, the user is presented with better tools for decision making on expenditure. The system can reside locally on the device and extract call logs to avoid network overheads. These parameters can be broadly applicable to improving readability of bandwidth in general, especially in emerging infrastructures like mobile Internet that suffer from opacity in showing usage.

Designing for negotiation
Broadband technologies like airtime and Internet are not neutral media; they are entrenched in the value systems of the users and designers. Any airtime design intervention should take into account the politics, ethics, and value conflicts embedded in the infrastructure. As political theorist Langdon Winner argued, "*the process of technological development is critical in determining the politics of an artifact; hence the importance of incorporating all stakeholders in it*" [20], a design solution for the microenterprise should arise from a dialogue with both employers and employees.

We propose negotiation as a design feature. Our findings show how the bulk of the sharing exchange is negotiated socially, by forging contacts, deleting calls, and creating narratives around airtime appropriation. A potentially dangerous solution to information asymmetry between various users (vis-à-vis the owner) is information transparency [1]. Design should be careful to not introduce friction or fear of the enterprise among employees. By showing less yet pertinent information and allowing room for social negotiation, design could prevent misuse of information. For example, while the employers were aware of employees making personal calls using professional airtime, knowing exactly who was called and how long the calls lasted may be incriminating to the employee. A safer approach may be to show aggregate call information instead of individual calls (instead of '*1 call to X for 50 minutes*', show '*5 calls today for a total of 120 minutes*').

A coarse-grained approach is one where the employer can assign upper limits for personal and professional calls and be notified when usage exceeds the quota. The system could support interpretation and dissembling in ways beneficial to the employer and employee. This is in line with the current practice of allowing personal calls within limits. By negotiating how many minutes could be spent on personal calls per month, a mechanism for compromise can

be built in, where the employee can negotiate with the employer if the personal quota is underused (carry forward to next month) or overused (ignore or deduct from salary) for the month. For the employees, showing personal/professional airtime usage and action items ('*you just exceeded 20% personal usage. Restrict your personal calls'*) resonated with their current methods of controlling personal quotas. By controlling the quantity and presentation of information and by introducing social negotiation, bandwidth systems can be rendered useful where multiple users, different domains, and cost constraints collide.

Contention arises in any shared technology usage, beyond just the microenterprise or airtime sharing. Whenever a resource is shared among multiple users, the technology is appropriated towards their personal interests. In some cases this involves explicit repurposing, such as using professional airtime towards personal calls, whereas in some others it is a customization of a device. Negotiation is highly relevant to the design of bandwidth sharing systems, where multiple users share an invisible infrastructure and interfaces can foreground selective aspects of usage, users, and analytics of the network.

CONCLUSION

Our paper explored airtime sharing practices in low-income microenterprises in India. Specifically, we examined the phenomenon of negotiation in airtime sharing. Our work shows us how shared resources are used towards personal interests amidst tensions and value conflicts, by adapting, modifying, subverting, and repurposing technology. By being sensitive to social relationships, practices, and values, negotiation in design allows room for diversity and individuality of multiple users by carefully balancing technological encoding with social dialogue. While microenterprises are sites of personal-professional conflicts, there is always a conflict of interest in shared systems. Our findings and design concerns have relevance for the developed world. They point to new ways for the HCI and UbiComp communities to think about shared use by designing social negotiation that goes beyond personal profiles. To HCI4D, we highlight emerging ways of accessing airtime and bandwidth in the microenterprise, where mobiles are the primary ICTs. Our study suggests that building negotiation, improving usage readability, and supporting resource management are important design concerns for bandwidth sharing systems.

ACKNOWLEDGMENTS

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