Examining the Use and Non-Use of Mobile Payment Systems for Merchant Payments in India

Aditya Vashistha
University of Washington
adityav@cs.washington.edu

Richard Anderson
University of Washington
anderson@cs.washington.edu

Shrirang Mare
University of Washington
shri@cs.washington.edu

ABSTRACT

Many countries across the globe are engaged in efforts to promote a cashless society. In India, there is a strong top-down push by the government and the private sector for mobile payments. In this work, we examine the benefits and pitfalls people perceive in using mobile payments for customer-merchant transactions. Through interviews with 19 customers and 15 merchants across rural, peri-urban, and urban India, we explore people's awareness about mobile payment systems, perceived trade-offs among different payment methods, and the security, privacy, and utility barriers in its adoption and use. Overall, we found that customers were interested in adopting mobile payments for referral rewards and sign-up incentives, but were hesitant to regularly use them, whereas merchants saw mobile payments as an unnecessary burden for their business. We discuss the nuanced views of customers and merchants, and offer recommendations to address the barriers in the use of mobile payments for customer-to-merchant transactions.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

Mobile payment systems; merchant payments; India; HCI4D.

ACM Reference Format:
Aditya Vashistha, Richard Anderson, and Shrirang Mare. 2019. Examining the Use and Non-Use of Mobile Payment Systems for Merchant Payments in India. In *ACM SIGCAS Conference on Computing and Sustainable Societies (COMPASS) (COMPASS '19), July 3–5, 2019, Accra, Ghana.* ACM, New York, NY, USA, 12 pages. https://doi.org/10.1145/3314344.3332499

1 INTRODUCTION

Mobile phones are playing a key role in extending the reach of financial services to poor people in low-resource environments, where access to banks is non-existent due to the prohibitively high cost of setting up traditional brick and mortar banking institutions [15, 22, 25, 39, 55]. For example, in 2017, 70% of bank account owners in developing economies conducted at least one digital transaction via their phone [16]. Mobile financial services—financial services delivered through mobile phones—offer several benefits including physical security of savings, no transportation cost, easier remittances and payments, and improved transparency and accountability.

In India, there has been a strong top-down push by the government and the private sector to improve people's access to digital payment services. For example, in 2016, the government demonetized the commonly used ₹500 and ₹1000 banknotes[1] creating cash scarcity, which pushed people to use digital payment services [3, 31]. The government also launched several other schemes such as *Lucky Grahak Yojana* and *Digi-Dhan Vyapar Yojana* [4] to improve the adoption of digital payment services. Private institutions in India also launched new mobile payment services and contributed to the rapid increase in the transaction value and volume of mobile payments. For example, *Tez* [13], a mobile payment service from Google launched in September 2017, processed the same number of digital transactions as the fourth largest bank in India [46]. In fact, digital payments in India are predicted to grow to USD 1 trillion in next five years due to massive growth of mobile payments [6].

While there is stupendous growth in mobile payments, a confounding reality is that about 70% of retail transactions by value are still conducted in cash [50]. This warrants a closer inspection of how people perceive mobile payment systems (benefits, limitations, and barriers) in the context of merchant payments. However, the research on mobile payments examining people's perceptions about its adoption barriers, usability, usefulness, and security risks is scarce. Existing studies either have examined the payments landscape before the advent of mobile payment systems in India (e.g., [28]) or were focused only on the perspectives of merchants in metropolitan Indian cities (e.g., [41]).

To fill this gap, we conducted semi-structured interviews and observations with 19 customers and 15 merchants in rural, peri-urban, and urban areas in India. We examine how aware and knowledgeable participants are about mobile payment systems, how they perceive trade-offs among different payment methods (e.g., cash, cards, Internet banking, mobile payments) in the context of customer-merchant transactions, and what barriers (e.g., usability, security, privacy, utility) they experience in the adoption and use of mobile payments. We found that, for example, customers were interested in using mobile payments, but were concerned about their lack of awareness, losing money, lack of good recourse, and general lack of support from merchants; small merchants saw mobile payments as an unnecessary burden to their business, especially when they felt customers were comfortable paying in cash; and merchants found it harder to pay their suppliers and laborers using mobile payments, and disliked the higher tax accountability that comes with using these systems.

[1] Indian currency Indian Rupee (₹) has an approximate conversion value of USD 1 = ₹ 70.

COMPASS '19, July 3–5, 2019, Accra, Ghana

ACM ISBN 978-1-4503-6714-1/19/07…$15.00
https://doi.org/10.1145/3314344.3332499

We discuss the lessons learned from the study and offer design recommendations on how to address the barriers that participants expressed in using mobile payment systems in the context of merchant payments.

2 RELATED WORK

We now situate our research in a body of related work examining research on mobile payment systems in developing regions and their use for merchant payments in India.

2.1 Mobile Payments in Developing Regions

Mobile-based financial services such as M-Pesa have leveraged the availability of basic mobile phones and on-the-ground agent networks to extend financial services to unbanked people in low-resource environments. Several HCI4D researchers have examined the usability and facilitating conditions for these services (e.g., [20, 36, 45]). For example, Mas and Morawczynski identified several factors that contributed to the success of M-Pesa [34]. Researchers have also investigated the privacy and security vulnerabilities in these services [21, 40, 42, 49], and have designed secure and usable authentication schemes [43, 44]. The phenomenal user growth of mobile financial services has also motivated researchers to examine how mobile payments can improve government-to-person payments in rural environments (e.g, [37]).

Recognizing the rapid increase in smartphone and Internet penetration in developing regions [1], several researchers have examined the potential (and drawbacks) of smartphone applications to deliver financial services to people in low-resource environments. For example, Ibtasam et al. found lack of knowledge and readiness to adopt mobile wallets among low-income people in Pakistan [23]. The Consultative Group to Assist the Poor (CGAP)—a global partnership of organizations that seek to advance financial inclusion—published user interface design recommendations to make smartphone-based mobile money applications more usable to low-literate and low-income people [5]. We contribute to this growing body of literature by characterizing the benefits and pitfalls of mobile payment systems in India with respect to their usability, security, and utility, and in comparison to other modes of payments such as cash, credit cards, and Internet banking.

2.2 Merchant Payments in India

Despite the rapid growth of mobile payment systems in India, there is a paucity of research examining factors influencing the adoption and use of mobile payment systems in the context of merchant payments. Kumar et al. conducted a series of ethnographic studies to examine payment practices of people in India and they reported several benefits (e.g., convenience, fast transactions) as well as limitations (e.g., challenges in managing change) of cash [28]. Although their work provides design recommendations on creating a usable m-payment service, the authors could not study people's view of mobile payment services since such services were not common at the time of their study. Krishnan and Siegel surveyed 200 families in Mumbai slums a month after demonetization and reported that 80% of the families were aware about cashless payment methods, but only 12% of the families knew a merchant who supported cashless payment [27]. Most closely related to our work is the study by Pal et al. with over 200 shopkeepers in metropolitan Indian cities to investigate the adoption and use of digital financial services post demonetization [41]. They reported a decrease in the use of digital payments once new banknotes became available. They also found that the nature and scope of transactions, type of products sold, and comfort with digital technologies impacted use of digital payments. Our work extends this research by focusing on mobile payments not just from the perspective of merchants, but also by taking into consideration the perceptions and preferences of customers. In addition, our work goes beyond the metropolitan cities and focuses on the customers and merchants in rural, peri-urban, and second-tier urban centers in India.

Table 1: Distribution of research activities across urban, peri-urban, and rural research sites.

Region	Interviews (participants)	Observations (hours)
Second-tier urban cities	14	5
Peri-urban small towns	9	3
Rural villages	11	4

3 RESEARCH QUESTIONS

In India, there is a strong push from government and the private sector for wide adoption and use of mobile payment services, but this raises several key questions such as what do the end users—the customers and the merchants—think about mobile payments, do they want to use mobile payments, and if so, what are their needs and how those needs are being met? Our overarching research goal is to understand how customers and merchants in India perceive mobile payment systems. In this work, we focus on the following research questions.

RQ1: How do customers and merchants use mobile payments?

RQ2: How do they perceive the usefulness of mobile payments?

RQ3: What are their perceived barriers in using mobile payments?

4 METHODS

We recruited people from rural and urban areas to investigate the costs and benefits in the use of mobile payment systems for merchant payments. We used snowball sampling on our personal networks to recruit users and non-users of mobile payment systems. Our research sites included two second-tier urban cities, three peri-urban small towns, and two rural villages in the states of Maharashtra and Rajasthan. Our mixed-methods approach included semi-structured interviews and observations. Table 1 shows the distribution of research activities across different research sites. Most research activities were conducted at participants' workplace, while a few were conducted at participants' home or public places. The study was approved by our institution's human subjects review board (IRB).

Interviews: We conducted semi-structured interviews with 19 customers and 15 merchants. Finance is a sensitive topic to discuss with outsiders. To ease participants to discuss their financial

practices, researchers have used different techniques such as index cards [58], wallet-opening exercises [19, 26, 33], financial biographies [58], and workshops [59]. Drawing from previous wallet studies, we requested participants to share the financial items they carry in their wallet and used those items to lead the interviews. The interviews explored several aspects including demographic information, financial background, use and non-use of mobile payments, perceived usability and usefulness of mobile payments, perceived risks and threats associated with mobile payments, and preferences for different merchant payment methods. The interviews were conducted in Marathi and Hindi, and lasted around 30 minutes on average. We audio recorded the interviews and also took detailed notes.

Observations: We also conducted 12 hours of participant observation at eight different shops. We observed merchant payments, customer-merchant interactions, non-verbal activities, and preferences for different payment methods for five hours at mobile phone shops because prior research has reported these shops as a focal point for people in low-resource environments to learn and experience new technologies [29, 30, 38, 57]. We also conducted another seven hours of observations at shops with high transaction rates such as grocery stores and pharmacies. We took notes and photos in-situ and later converted them to detailed field notes for analysis.

Analysis: We transcribed audio recordings, and translated interview transcripts and field notes to English. To analyze the data collected during interviews and observations, we engaged in regular discussions and iterated on our probes. We subjected our data to thematic analysis as outlined by Braun and Clarke [17] and rigorously categorized our codes to identify factors that affect the adoption and use of mobile payment systems for merchant payments. All authors participated in the coding process and iterated upon the codes until consensus was reached. Our first-level codes were specific, such as *"people preferred cashback rewards"* and *"people know phone PIN of others around them."* After several rounds of iteration, we condensed our codes into high-level themes, such as *"lack of knowledge," "oversharing,"* and *"fear of losing money."*

Participants: Among customers, 12 were male and seven were female. Among merchants, 14 were male and one was female. On average, participants were 31 years old. Sixteen participants had a bachelor's degree, another 16 finished high school, one finished secondary school, and one completed primary school.

The majority of participants (82%) used a smartphone and the Internet, while the rest used a basic phone or a feature phone without mobile Internet access. Ten customers had registered for a mobile payment service, and of those, three had used mobile payments at least once in the last one month. Nine customers never registered for a mobile payment service. Among merchants, ten accepted mobile payments in their stores, but the other five did not. All participants had a bank account and ATM cards, 21 used Internet banking, and only five owned a credit card. Figure 1 shows the distribution of users and non-users of mobile payment services, Internet banking services, and credit cards.

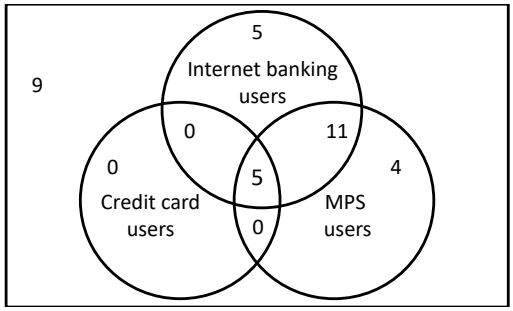

Figure 1: Distribution of the users and non-users of mobile payment systems (MPS), Internet banking, and credit cards.

5 FINDINGS

Our findings illustrate how customers and merchants use different payment systems, as well as their attitudes, experiences, concerns, and perceptions about mobile payments.

5.1 Modes of Payments

Our participants reported using four different modes for merchant payments: *cash* (the most heavily used mode), *cards* (debit and credit), *mobile payment services*, and *Internet banking* (the least used mode). Participants perceived cash as *"a universal payment method"* because all stores, including most online merchants, accept cash payments or support cash-on-delivery option. Participants preferred cash payments for transactions (1) of small-value that round-off to tens, (2) in small stores because they believed that micro merchants would not accept mobile payments or credit cards, (3) when merchants charged fees for card payments, or (4) when they perceived that merchants could *"misuse or clone"* their card, mobile, or banking information.

Other modes of payments offered some but not all the affordances of cash. For example, although credit cards work for both in-store as well as online merchant payments, participants noted how only a few in-store merchants encouraged card payments and many charged fees for small transactions. Similarly, although Internet banking is generally used with online merchants (rather than brick-and-motor in-store merchants), few participants reported using it with familiar in-store merchants by paying those merchants later via peer-to-peer online transaction. Long delays in adding a beneficiary and daily limits on adding new beneficiaries made Internet banking impractical for paying unfamiliar in-store merchants. Participants also noted some usability barriers in Internet banking (e.g., difficult to transact on phone browser). Most participants also faced challenges in getting credit cards (e.g., background credit checks) and using them (e.g., credit limits and scheduling bill payments). Some participants complained that mobile payments, Internet banking, and credit cards often have daily or monthly transaction limits—a restriction absent in cash transactions.

Most of our participants who used mobile payments, used wallet-based systems (e.g., Paytm, Ola Money), with only one participant reported using UPI-based system (e.g., PhonePe, Tez). The two mobile payment systems differ on how they manage customer funds. Wallet-based mobile payment systems provide bank-like accounts: a

customer maintains balance in his/her online wallet account, and all transactions are posted to the customer's online wallet. UPI-based mobile payment systems provide a transaction service to customers' existing bank accounts: customer's money stays in his/her bank account, and all transactions are posted directly to the customer's bank account. Thus, while both systems require a customer to have a phone and an active SIM card, UPI-based systems have an additional requirement—a customer should have a bank account. Almost all the participants did not know the differences between wallet-based and UPI-based mobile payment systems.

5.2 Use of Mobile Payments

Although all our participants were qualified to use a mobile payment service—they had a bank account, an active SIM card, and a phone—only a fraction were regular users of mobile payments: Twenty participants (58%) had enrolled for mobile payments, and only eight used them regularly. We asked users of mobile payments why they registered for these services? Participants gave three different reasons to register: convenience (n=14), offers (n=9), and encouragement by friends (n=6). Several participants in urban areas perceived mobile payments as a convenient tool for merchant payments (e.g., paying bills, buying mobile airtime from anywhere anytime). Online and mass media campaigns highlighting convenience of mobile payments, watching their friends use mobile payments easily, and word-of-mouth reviews from their personal networks motivated them to explore mobile payments. Most mobile payment services in India offer lucrative incentives to gain new subscribers [47]. Ten participants registered to avail these incentives, and out of those, six registered on multiple services to earn more rewards. In addition to offers on new sign ups, several services also provide cashback for successful referrals and for transactions with new users. These referral and transactional rewards also motivated some participants to encourage (or even force) their friends to register and use mobile payments.

> *"I made my cousin brother register and taught him how to earn free money. We would transfer money to each other, and both earn cashbacks. I earned ₹200 like that!"* — 34yr, Male, Urban, Customer

Participants reported using mobile payments for purchasing mobile airtime (n=14), paying bills (n=8), and buying movie tickets (n=7). Participants emphasized *"how convenient"* mobile payments were for these use cases compared to the alternative, which involved traveling to a payment center, waiting in queue, and making a payment. A participant stated:

> *"Paytm saves me a trip to get a mobile recharge or to pay my bills."* — 23yr, Male, Peri-urban, Customer

The use of mobile payments for online shopping was uncommon. Only a few participants, even in urban centers, shopped online and their preferred mode of payment was cash- or card-on-delivery because they did not trust online merchants. Some customers were unsure whether a product bought online will be delivered, and they were also concerned about *"the hassle of returning or exchanging the product"* if it did not meet their expectations. With cash- or card-on-delivery, participants delayed the payment until the product was delivered and inspected. Such affordances were missing from mobile payments as well as Internet banking. While discounts and incentives offered by mobile payment services prompted some people to use them for online shopping, a few participants in rural and peri-urban areas were wary about the legitimacy of discounts, primarily because of the lack of experience with both online shopping as well as mobile payments. They felt more comfortable using mobile payments either for small-value transactions or when encouraged by multiple people in their social network.

> *"How can Paytm offer a discount on the refrigerator when there is no discount in the showroom? Something is wrong. Maybe the refrigerator is used or has no guarantee."* — 53yr, Male, Rural, Customer

5.3 Perceived Usefulness of Mobile Payments

Customer perspective. We asked participants whether they thought mobile payments were useful and if so how. All participants perceived mobile payments as useful and convenient (e.g., *"no need to carry money"*), and mobile payment transactions as efficient and fast. Some participants thought that they might save more if they use mobile payments, because they felt *"digital is easier to save"* whereas *"cash is easier to spend."* This perception contradicts prior observations that people spend more when using digital payments (credit or debit cards) than cash [52]. Perhaps low usage of mobile payment systems, due to their limited use for online shopping and limited support from merchants in rural and peri-urban areas, created this perception among our participants. Participants also projected the benefits of mobile payments on non-users. For example, a participant elaborated how mobile payments (or digital payments in general) would lead to *"less crowd at the bank [to withdraw money or to transfer money]"*, or less crowd at the bill pay centers. These perceptions largely reflect participants' frustrations with the slow processes in financial institutions and their hope that digital transactions will somehow fix these issues. A participant in a small town echoed this sentiment: *"anything online is good. It makes things efficient and quick."*

Several participants perceived these services as useful not just to them (e.g., convenience, rewards) but also to the society, which echo the findings from prior work [41]. Participants considered mobile payments as instruments of social good and believed that *"mobile payments would lead to higher monitoring of economic activities"* which eventually would lead to eradication of black money. They believed that despite the usefulness of mobile payments, these services have not been yet adopted by many in-store merchants because merchants want to hide their sales by avoiding automatic creation of transaction logs, thereby skimming taxes. This *"mobile payments are good for the country"* view echo the nationalist message associated with the government's *'Digital India'* campaign [41].

Merchant perspective. In contrast to setting up Point of Sale machines that support credit and debit card payments, merchants found it much easier to support mobile payments, which require devices, hardware, and network already available to merchants. Setting up merchant gateways for mobile payments had no initial activation cost and wait time, two factors that prohibited micro merchants to support card-based payments. Merchants also perceived that supporting mobile payments will make them *"look modern*

and tech-savvy" and will also help them retain business of those customers who prefer to use mobile payments.

5.4 Barriers in Using Mobile Payments

Our analysis identified barriers encountered by current users as well as barriers perceived by non-users of mobile payment systems in the context of customer-to-merchant payments.

5.4.1 Customer Perspective of Barriers. We now present the barriers encountered or perceived by the customers and then (in Section 5.4.2) offer the perspectives of the merchants.

Economic consequences of making a mistake. A recurring reason among some participants, particularly from rural and peri-urban areas, for not using mobile payments was the *"fear of making a mistake"* during a mobile payment transaction and losing money. They attributed lack of familiarity and lack of knowledge for their fear of using mobile payments. Some non-users wondered if they could actually pay in a store with their smartphones and some were concerned that they would need to upgrade to a new smartphone model. Although some of these participants were generally comfortable exploring new smartphone apps, they were hesitant to try out mobile payment apps because they were afraid of *"accidentally sending money to a wrong person"* or *"accidentally paying more by typing an incorrect amount."* Although many services allow transactions to be reversed when parties involved in a transaction contact customer support center, some participants in urban areas and many participants in rural and peri-urban regions perceived customer support service as *"hopeless"*, which meant they saw transaction reversals as either impossible or *"too much of a hassle."* A few participants who had dealt with customer support for transaction reversals *"experienced anxiety"* while waiting for reversal of the failed transaction, which often took several days or weeks. A participant stated:

> *"I reserved train tickets at irctc.com. Although ₹4,500 was deducted, the transaction somehow failed. I contacted customer service for two weeks. I was anxious since ₹4,500 is a big amount."* — 32yr, Male, Urban

Participants in rural as well as urban areas were generally not concerned about mistakes when sending mobile money to friends as they expected *"full support [from friends] if they accidentally sent more money"*, but were unsure if a merchant will have the time and willingness to speak to customer service representatives if they accidentally sent more money to the merchant. The hesitation to use mobile payments does not seem related to formal education or level of familiarity with smartphones, at least among our participants. For example, two participants who completed only high school used mobile payments regularly, whereas seven participants who had graduate degrees and reported using smartphone regularly were skeptical of using mobile payments.

Some men and many women did not know how to use mobile payments. They were unsure who will help them *"learn the app, navigate the features, and troubleshoot."* Although they relied on their children to learn new apps (e.g., social media apps) on their phone, they expressed discomfort in seeking help from children to learn mobile payments because of the fear of losing money if their children made any mistake while teaching them. Participants expressed willingness to adopt mobile payments if people *"like them"* or *"around them"* used these services.

> *"Seeing is believing. If my office boy can use it, then I can use it as well."* — 65yr, Male, Urban

However, most non-users did not know anyone in their social network who used mobile payments for customer-merchant transactions. In contrast, many irregular as well as regular mobile payments users had a friend or colleague or an adult family member who alleviated their concerns.

Bad experience. Participants' own bad experiences with mobile payments or negative experiences of others made them even more hesitant to explore these services. In interviews, participants shared stories of how they or their friends lost money in transactions, had to deal with money being held for a few days (when the expectation was of an instant transfer), and experienced bad customer service when trying to revert a failed transaction. Bad experiences dissuade people from adopting mobile payments, particularly when they are new users. For example, two participants, one new-user and one accustomed user, in peri-urban areas had similar first-hand experience about losing money through failed transactions, but they had different reactions. Both participants reported losing money when they tried to pay for mobile airtime using Paytm. The new-user participant stated:

> *"I stay away from mobile payments now. After not receiving airtime, I tried contacting the customer service but they never helped. I never used Paytm again."* — 26yr, Male, Urban

While the new-user participant said he stopped using mobile payments because of the bad experience, the other participant, who had been using mobile payments for airtime recharges for a while without any issues, shrugged off the bad experience and said he still regularly uses mobile payments.

Unreliable network connectivity. Several participants were concerned that mobile payments will not work for merchant payments in areas with unreliable cellular network or if their smartphone was out of charge. For example, many participants in urban areas believed that their cellular network was unreliable for merchant payments, particularly in shops that were located in underground markets or inside malls.

> *"I had to climb and descend stairs several times to find network for paying someone in the underground market. We never have network when we need it. We can't count on it."* — 38yr, Female, Urban

Several participants owned cheap smartphones and reported that their smartphone battery lasts only a few hours, making it difficult for them to rely on mobile payments alone. Similarly, some participants in urban areas worried that mobile payments will not work at all during Internet outages, which have happened about 200 times in the last six years in India [10]. A customer noted his frustration:

> *"Internet blackouts happened 20 times in Rajasthan since last year. How would I pay then?"* — 44yr, Male, Urban

Participants concerns about unreliable network during mobile payment transactions stemmed from their bad experiences while using other digital payment systems such as debit and credit cards. Several

non-users and new users noted how they often face network issues on the merchant's side while using cards and how it often took longer to pay with cards since many older Point of Sale systems use a slow dial-up network.

While most mobile payment systems operate only on data networks (e.g., 3G, 4G), some providers support payments over non-data networks (e.g., voice, USSD), particularly for people in rural areas. For example, Paytm provides a toll-free Interactive Voice Response (IVR) system and NUUP, a UPI-based payment service, uses Unstructured Supplementary Service Data (USSD) channel to allow people to make payments without Internet access. However, none of our participants had heard about these features and services. When we explained how these services work, they expressed concerns about the usability of these services.

Lack of support from merchants. Participants in rural and peri-urban areas complained that only a few local shops support mobile payments because merchants have no incentives to accept mobile payments. They believed that merchants have to pay transaction fee on mobile payments, which is true for credit or debit payment, but not for some of the commonly used mobile payment services (e.g., Paytm).

> *"Merchants have to pay commission, and they do not want to lose money"* — 24yr, Female, Urban

Some participants felt that merchants purposely avoid using mobile payment systems so that they can transact in cash and sell *"candies and toffees"* instead of returning exact change. Many participants believed that merchants do not transact digitally, but instead transact in cash and provide hand-written illegible receipts to *"keep transactions untracked"* so that they can skim taxes. Participants in urban areas complained how *"such paper receipts are meaningless"* and result in no accountability. Additionally, some participants reported the introduction of Goods and Services Tax (GST) [7]—a policy meant to simplify and unify tax rules—as counterproductive to the adoption of mobile payments by merchants. Since the implementation of GST increased taxes on certain goods and services (e.g., personal care items, dining, lodging), customers now have to pay more to avail these goods and services. Participants reported that some local merchants of such goods and services preferred using cash so that they have control over how much GST to charge to their customers. While some merchants did so to increase their businesses, participants reported how exploitative merchants charged GST to customers on cash transactions to pocket more profits. A merchant corroborated these customers' observations on how a few merchants avoid using digital payments to skim taxes:

> *"The people in restaurant business are earning double due to this GST. They charge GST to customers, but do not keep any digital records to avoid taxes."* — 40yr, Male, Urban, Merchant

Poor KYC policy implementation. In efforts to regulate mobile wallets, the Indian government mandated strict *Know Your Customer* (KYC) for wallet-based mobile payment services. KYC process is required to send and receive money, to increase wallet balance and transaction limits, and to transfer money to a bank account. Several participants in villages, small towns, and cities expressed confusions and frustrations with the KYC process. For example, Paytm offers three types of KYC process—min KYC, self KYC, full KYC—each with varying validity and limits on wallet balance [11]. The KYC process involves submitting government issued identification documents online and an in-person verification where an agent would visit the customer to verify the documents. Most of the participants were unaware of these distinctions. Many participants expressed resentment over the in-person verification process as well as the long wait times associated with it.

> *"There is an irony that the KYC process of online payment services is done in-person. I am still waiting for over a month for someone to visit me for the verification."* — 31yr, Male, Urban, Customer

Several participants expressed concerns over submitting identification documents to mobile payment providers due to lack of trust in their abilities to keep documents secure. Many of them opted, like the following participant, for not using mobile payments.

> *"Why should I give my Aadhaar card*[2] *or passport to them? What would happen if they misuse it or someone steals my identification?"* — 37yr, Male, Peri-urban

Lack of need. Most non-users and irregular users of mobile payments did not feel the need to use these services for merchant payments, either online or in-store. These participants felt that their *"payment needs are fulfilled by cash and debit card."* Similar to the findings from Pal et al. [41], we found that once the new banknotes were available after the demonetization, participants reverted to using cash and found *"no need of mobile payments."* Moving to mobile payments meant extra effort to participants, particularly to those who were unsure about the benefits of mobile payments. While some participants were concerned about keeping and managing change, many participants comfortably carried fat wallets—cash, change, cards, receipts, photos of family and Indian deities, visiting cards of people they met, and even tobacco—and found limited value in using mobile payments.

While most women were unsure about the benefits of mobile payments to them, a woman in urban area highlighted how mobile payments could fit well in multiple rotating savings and credit association (ROSCA) groups in which they participated:

> *"Mobile would make it easier to collect payments from other women, which currently is so cumbersome. Some women submit creased or almost torn notes because they save them privately from their family."* — 61yr, Female, Urban, Customer

Intermediation and lack of agency. Some participants lacked the agency to use mobile payment systems. We found that the participation of older adults was often mediated through their adult children. Often, the intermediaries controlled the extent to which these users explored mobile payments ecosystem. For example, a participant set up Ola Money on his father's phone and taught him how to use it with Ola ride-sharing service, but he was hesitant to teach Paytm to his father because he worried that his elderly father would lose money by using Paytm incorrectly. According to him, Ola Money's tight integration with Ola made it *"simple and automatic"* to use for his elderly parent.

[2] Aadhaar is a 12-digit unique identity number for residents of India that is created based on their biometric and demographic data.

Among women participants, five out of seven were non-users of mobile payments. Although they had access to smartphone and the Internet, their male family members discounted their need or desire to use mobile payments. Although women participants reported having a say on *what* goods and services to buy, they expressed limited control on *how*, *where*, and *when* financial transactions take place. Three women participants reported that their male family members did most of the transactions. For these women, the agency to save, manage, and spend *physical* money themselves was more important than participating in *digital* economy.

5.4.2 Merchant Perspective on Barriers. The merchant participants in our study were primarily concerned with mobile payment systems reducing their business efficiency and increasing their accountability.

Need for cash float. All merchants expressed a strong need to keep excess cash at hand for paying their suppliers and workers on a daily basis. Merchants were worried that if most of their customer paid digitally, they would be strapped for cash to pay to their suppliers or workers who prefer payments in cash [41]. For this reason, merchants preferred cash transactions and found no incentive to accept mobile payments unless their supplier and workers also start accepting mobile payments.

> *"Everyone in the business cycle need to start using it, not just customers. I need to pay laborers and suppliers daily, and in cash."* — 45yr, Male, Peri-urban

Impact on business efficiency. Several merchants in peri-urban areas were hesitant to adopt mobile payments out of the fear of slowing themselves down due to network issues or payment issues. They preferred cash-based transactions and perceived them as faster, less riskier, and independent on external factors such as availability of network.

All merchants were adept in dealing with cash transactions and managing change. Most of them had neatly organized cash register and had different sections for different denominations of banknotes and coins. Several merchants kept change in a sack near the cash register. They often encouraged customers to bring exact change or round off the transaction amount to the nearest ten by selling them something else (e.g., candies). To process transactions quickly, we observed that merchants often engaged several customers at the same time, using change given by one customer to complete transaction with another customer. A merchant expressed how accepting mobile payments to avoid managing change is not a strong motivator:

> *"We are expert in handling multiple customers at the same time. If one customer is taking time to get cash out of the wallet, I switch to another customer who is ready to pay. Why should I increase my hassle by offering mobile payments?"* — 34yr, Male, Peri-urban

Some merchants who supported mobile payments found it easier to distinguish between customers who paid and who had not when the transactions were cash-based instead of mobile-based: *"tracking faces is easier than phone numbers."*

Lack of need. While a few enterprising merchants supported mobile payments *"to look progressive"* or *"to attract young adults who use mobile payments,"* many merchants felt it was unnecessary to support mobile payments. While merchants in rural and peri-urban areas believed *"no customer uses mobile payments here,"* merchants in urban areas acknowledged that customers do use mobile payments, but they still did not feel they had to accept mobile payments because *"cash transactions were working just fine."*

The merchants who accepted mobile payments expressed frustration with the process of withdrawing cash from wallet-based systems. To withdraw money, they had to transfer the money first to their bank accounts, a process that takes time and usually involves a fee. This delay and cost was unacceptable to some merchants who also expressed concerns about the balance limit on the wallet-based systems. A jeweler stated:

> *"I stopped using Paytm because the basic account has a wallet limit of just ₹20,000. After KYC, it is ₹100,000 which is still less."* — 64yr, Male, Urban

Advertising mobile payments. A majority of our merchant participants did not advertise that they accept mobile payments: out of ten merchant participants who supported mobile payments, only four reported advertising them. As a result, whether a store supports mobile payments was not evident to customers unless they explicitly asked; when not advertised, customers assumed that the merchant does not accept mobile payments.

Some merchants said they chose not to advertise because they do not prefer mobile payments. But a few merchants felt overwhelmed by all the different mobile payment options and were confused about how many to support and how many to advertise. A merchant noted:

> *"There are so many mobile money services. If I use one of them, some customers will expect me to use another services as well."* — 37yr, Male, Urban

Indeed, the mobile payments landscape is fragmented in India with many competing public (e.g., BHIM, NUUP) and private mobile payment services (e.g., Paytm, Tez). Merchants could benefit with some cross-platform integration that makes it easy for them to support multiple mobile payment services.

5.5 Security and Privacy Perceptions

We now highlight the security and privacy perceptions about mobile payments that emerged from our interviews with merchants and customers.

Safety and reliability. Customers saw cash as a safe and reliable mode of payment for small in-person transactions. They noted that cash transactions (usually) involve only the two relevant parties—customer and merchant—and the transaction can be verified by both parties immediately.

> *"Mobile payment has to go through technology and it involves many parties and hops. Cash, I just give it to someone, and I know for sure that the transaction has happened."* — 27yr, Male, Urban

Both merchants and customers believed online banking to be the safest mode of payment. This belief reflects their trust in the traditional banking institutions than the new and less familiar mobile payment systems. Customers in urban areas also found online payment via credit cards risky and feared that the payment information

could be stolen from the online merchant by an online adversary. Merchants and customers in rural, peri-urban, and urban areas had mixed opinions about the security of mobile payment systems: four participants thought mobile payments were as safe as online banking, seven considered mobile payments as insecure, and the rest of the participants were largely unsure.

> *"I mean people are using mobile payment services and the government is allowing it. Maybe they are secure. I don't know."* — 33yr, Female, Urban, Merchant

Perceptions on transaction history. While some customers emphasized how in-situ verification of the cash transaction makes it more trustworthy, others noted that cash transactions can be difficult to dispute in the future because there is no transaction history. This lack of transaction history with cash was seen as a privacy feature by some customers in urban areas, and a few participants reported leveraging this advantage for transactions they did not want to be logged. For example, one participant reduced the use of mobile payment services, and reported using cash to buy movie tickets, after his transaction history was accessed by his conservative parents.

> *"I was dating a girl without the knowledge of my parents. They looked at Paytm's history and figured that I have a girlfriend since I was regularly buying tickets for two people."* — 24yr, Male, Urban, Customer

Two merchants also expressed privacy concerns that mobile payments *"track users' transactions and maintain an everlasting record of their spending habits."* They felt there was little they can do to prevent such tracking. One of them stated:

> *"Tracking is a risk, but what can you do about it? It [digitization] is happening one way or the other."* — 34yr, Male, Urban, Merchant

Most customers were not concerned about leaving digital transaction records about their spending. In fact, many participants appreciated the transaction log feature since it helped them analyze their expenses and manage their finances. On the other hand, many merchants expressed concerns about how an adversary, the government or a hacker, could learn about their earnings via the transaction history.

A few merchants and customers expressed doubt in the government's ability to safeguard their private data, and also questioned government's motives in pushing for digital payments. We heard comments like *"all our biometric data is out in the open. It is probably in a thumb drive, and other countries already have it"* from three participants when discussing digital payments and government's digital inclusion efforts. One of them believed that the whole *'Digital India'* campaign was lobbied by private corporations seeking data for profit.

> *"Don't buy into this digital India propaganda. It is all driven by private companies who want your data. Government will profit of course and use it to suppress minority and people who oppose... I had to get Aadhaar – it's compulsory – but I have opted for biometric lock for me and my family so companies cannot easily access our biometric data."* — 34yr, Male, Urban

Participants who shared these views acknowledged having a mobile payments account because it was *"convenient at times,"* but noted that it was not their preferred payment option.

Threats models and adversaries. Some customers identified merchants as potential adversaries when transacting with cash (e.g., when merchants short change customers), but not when paying with cards or mobile phones; card payments and mobile payments are relatively new in India, and perhaps because of that only a few customers were familiar with the sophisticated credit and debit card skimming attacks.

Participants' threat models around mobile payments were largely shaped by rumors, hearsay, and nationalist sentiments. Some merchants believed that hacking mobile payment systems was easier than hacking online banking accounts. These participants had the *"Hackers are Burglar"* mental model [60], i.e., they believed that hackers are criminals that are motivated by financial gain and they would *"break into"* computers to look for information much like a burglar will break into houses to look for valuables. They saw online hackers as a threat, and felt that mobile wallets should not be used because hackers *"can easily steal money and transaction information."* Another advice we got from merchants was to avoid Chinese phones for accepting mobile payments because *"Chinese phones are hackable."* As one participant expressed, this belief was likely formed while trying to justify the low cost of Chinese phones.

> *"There are too many Chinese phones flooding the Indian market. These phones are of low quality and can be hacked. People should not do any financial transactions on these phones. "* — 26yr, Male, Rural, Mechant

Such beliefs and hearsay contributed to participants' mistrust about using mobile phones for digital payments.

Mobile payments on shared devices. Since phone sharing among family and friends is a common phenomena in developing regions [14, 18, 48, 56], a key question is how users of mobile payment systems protect their financial information. All participants were aware that when a mobile payment service is set up on a shared phone, someone with access to the phone can easily check on the phone owner's finances, past transactions, or even do transactions. Some participants took light measures, such as being around the phone when someone else is using the phone, using PIN to unlock phone, or enabling application level locks on the mobile payment application, to mitigate potential security and privacy risks. But overall, participants were not worried about someone misusing their mobile payment accounts, and said their use of mobile payments does not affect their phone sharing behavior in any significant way. We also asked participants what would happen to their mobile wallets if they lost their phone. All participants felt their phone PIN would protect their mobile payment accounts if their phone gets lost or stolen.

6 DISCUSSION

We now take a step back from our findings and discuss the barriers to using mobile payments that surfaced in our findings. We also provide recommendations to designers, policy makers, and entrepreneurs to mitigate barriers for customers and merchants who want to use mobile payments.

6.1 From a Cash-heavy to a Cash-less Society

India is a cash-heavy economy [6], and the move to mobile payments is at odds with India's consumer culture that greatly values the tangibility of cash and receipts in everyday transactions [28, 45]. Adopting mobile payments for everyday customer-merchant transactions requires overcoming technological barriers, but also a psychological shift in how individuals and society view and use digital money. Making this shift is difficult and can take years.

Need for a strong use case. A strong use case for mobile payments can force people to overcome some technical, social, and psychological barriers. For example, M-Pesa was readily adopted in Kenya because it provided a significantly better solution to the remittance problem faced by millions. However, none of our participants found current mobile payment services compelling enough to readily adopt for a particular use case. Although demonetization jump-started the digital payments movement in India by forcing people to signup for mobile payment services due to scarcity of cash, the use of mobile payments dropped significantly once the new banknotes became available [41] since people had no compelling reason to continue using mobile payments.

Need to emphasize that mobile payments will co-exist (not replace) cash. One recurring observation in our interviews was how participants saw using mobile payments as synonymous to *"not using cash at all"*. Since it is impractical to stop using cash completely in a cash-heavy economy like India, participants with this misconception were unlikely to even try mobile payments. We believe this misconception stems from how people think of technology adoption: new technology replaces old technology [51]. This misconception is re-enforced by the *'go cashless'* campaign by the Government of India, making people view mobile payments with an overly critical eye where they expect mobile payments to work for all their payment needs. In interviews, participants pointed out cases where mobile payments may not work (e.g., no phone battery or phone network) as their reasons for not using these systems. However, mobile payment systems do not have to replace cash. They can co-exist with cash as another payment modality that a user carries (along with cash) and can use it where it is supported [35]. This view is inline with the *'less-cash society'* goal, which is in fact what the Government of India means when they say *'cashless society'* [2], but many participants interpreted the campaign for its literal meaning.

6.2 Hesitant Customers

Many of our participants had incorrect mental models about mobile payments and were hesitant to try mobile payments on their own, even if they wanted to use them. The hesitation stems from the fear of making a mistake (and losing money) or fear of embarrassing themselves if they fail when using mobile payments in public. Although several mobile payment services have created online video tutorials to train novice users, our study participants favored in-person demonstrations on how to use mobile payments instead of just relying on these video tutorials or ad campaigns. Since several mobile payment services in India already provide a range of offers and rewards to recruit new customers and retain existing ones, people's own social network could be incentivized to leverage these instructional videos for informing non-users about the available functionality, connectivity requirements, safety features, and general know-how of mobile payments.

Explicit transaction confirmation. Some of the concerns raised around mobile payments (e.g., fear of making a mistake, lack of familiarity) can be mitigated by re-designing ICT solutions to add explicit confirmation that reduce error probability. For example, in merchant payment transactions that involve manual entry, a confirmation step can be added that shows the merchant's name and photo (if available); current mobile payment services do show this information but only if the recipient is in the sender's contact list. Alternatively, a confirmation step could involve sending a one-time password to the customer, who then manually shares it with the merchant to complete the transaction. Although this two-step low-tech process makes the payment process slow, customers may feel more confident that the payment is going to the intended recipient. This process is usable in practice, for example, Ola Cabs uses this approach to correctly match customers with drivers.

A more forgiving system. Another approach to alleviate the fear of making a mistake is by allowing customers to retract a transaction with a certain time limit. Such transactions would appear as *pending* in recipients' view until the undo time expires or the sender manually confirms the transaction. This approach could allow users to get comfortable with a new technology without any fear of getting penalized for their actions. For example, when online shopping was a new phenomenon in India, online merchants (e.g., Amazon India and Flipkart) allowed customers to order with cash-on-delivery payment option and even reject the merchandise on delivery without paying if the customer no longer wanted the merchandise. This pushed curious yet anxious people to shop online [24, 54].

6.3 Unmotivated Merchants

Merchants can play a central role in the adoption of mobile payments by actively advertising and promoting them, but they do not have any strong incentive to support these services.

Need strong business incentive for merchants. If mobile payments can bring business value to merchants, they are likely to readily adopt and promote them. Incentives such as discounts or tax breaks on processing digital payments could encourage merchants to overcome the friction of supporting these services. Customer-merchant payments is one component of merchants' business; the other components being inventory management, preparing invoice, and tracking sales, among other things. Adopting digital payments is relatively easier for merchants who already use digital tools to manage one or more aspects of their business, compared to merchants who do it all manually. Thus, value added digital services (e.g., inventory management, invoices, sales reporting and analytics) that help merchants manage and grow their business could be one way to incentivize merchants to adopt digital tools and subsequently digital payments. Digital payments and digital inventory management systems can be bundled with other financial services such as loans; for example, KopoKopo [9] provides loans to business who in turn use their digital payments platform.

Need to protect merchant interests. Customers feel that merchants should just adopt mobile payments, particularly the ones who do not have perverse reasons (e.g., skim taxes); this sentiment

resonates with the nationalist message associated with the government's *'Digital India'* campaign. But merchants in our study raised valid concerns to adopting mobile payments. For example, many merchants found it difficult to integrate mobile payments in their existing workflows that have been heavily optimized for cash [28]. In addition, some merchants were concerned about the use of transaction data by local corrupt officials for excessive policing and possible harassment. As a result, we found, merchants support mobile payments to maintain status quo, but actively discourage its use by not appropriately advertising or sometimes claiming that the machine is broken when it is not. There is a need for appropriate regulations to protect merchants from excess oversight and surveillance, but there is also a design opportunity to develop mobile payment systems that seamlessly integrate with merchants' workflows and offer them transactional privacy with the necessary tax accountability.

6.4 Rural vs. Urban Perspectives

Customers in rural and urban areas had similar perceptions about barriers to using mobile payments, but some of these barriers were perceived more strongly in rural areas than in urban areas. For example, rural participants were more afraid of making a mistake than urban participants, and rural participants were also more concerned about the lack of connectivity. Compared to urban participants, more rural participants reported that local merchants do not support mobile payments and rural customers (who had considered online shopping) were wary of discounts in online shopping and incentives on using mobile payments. Rural customers, however, regularly used mobile payments when it saved them a trip to the nearby city (e.g., purchasing a train ticket in advance, for which they would normally have to travel afar). Thus, for certain types of services, rural customers found greater utility in using mobile payments. We also found intermediated use of mobile payments was more in rural areas.

Merchants in the rural areas felt an even greater lack of need for mobile payments because they thought none of their customers use mobile payments. In rural areas, mobile payments could potentially help alleviate some of the problems associated with the lack of infrastructure, for example, less accessible ATMs and banks. However, poor infrastructure impacts the use of mobile payments both positively and negatively. For example, customers may prefer paying with their mobile phones to save themselves a visit to the ATM, but merchants may want to accept cash to keep cash float since many people they transact with do not accept mobile payments. Thus, like most two-actor systems, the challenge for mobile payment systems is how to reach a critical mass of users to minimize the friction to use the system.

6.5 Policies and Regulations

While digital payments may be part of a government or development agenda, cash transactions fit well in processes and workflows of merchants, and suit the needs of customers as well. Appropriate policies can provide the right incentives to merchants and customers, while protecting their interests. The government of India, in its bid for a *cashless society*, has passed several policies and initiatives to nudge and push people to adopt digital payments. For example, some initiatives (e.g., demonetization, the *'go cashless'* campaign, a policy proposal to provide tax break to small business when they use digital payments [32], and Rupay debit and credit cards that have low surcharges [12]) have created momentum towards reducing cash. However, the implementation of other initiatives (e.g., Goods and Services Tax [7], KYC [8]) have been counterproductive and some incidents (e.g., breaches in Aadhaar [53]) have made people question the government's ability to keep citizens' data secure. There are clear benefits to the government and to organizations that can (or intend to) use customer's transaction data, but so far, there is no evidence of a compelling benefit of mobile merchant payments to either customers or merchants. This raises an important question: if people start using mobile merchant payments, what are the guarantees that their data would be safe and secure? None of the government's recent policies and initiatives focus on protecting customer rights or providing assurances in case of dispute when using mobile payments. Currently, liability lie with the customers, and they do not have any good recourse if something goes wrong. A policy that provides strong customer protection regulations and encourages mobile payment service providers to offer effective recourse for customers could be instrumental in building customers' trust in mobile payments.

7 CONCLUSION

In India, the government and industry forces are pushing for mass adoption of mobile payments. But it is unclear how the masses (in particular, customers and merchants) perceive mobile payments for merchant transactions; for example, whether they want it, how the early adopters are using it, what barriers do people face in adopting and using such services, and how they perceive associated utility and risks. To answer these questions, we conducted interviews and observations with 19 customers and 15 merchants in rural, per-urban, and urban areas in India. We found that, for example, rural customers identified high utility of mobile payments but much of the adoption was in urban areas; customers who wanted to use mobile payments were hesitant due to the unfamiliarity with the technology and no good recourse for transactional errors; and merchants found mobile payments inefficient and limiting with their current business workflow and practices. We provided design and policy recommendations to address the barriers surfaced in the study and to enable those who want to use mobile merchant payments.

ACKNOWLEDGMENTS

We are grateful to people who participated in our study. We thank the anonymous reviewers for their constructive feedback. The work was supported in part by a grant from the Financial Services for the Poor program at the Bill and Melinda Gates Foundation.

REFERENCES

[1] 2015. *2015 Internet Trends.* Technical Report. KPCB. http://www.kpcb.com/blog/2015-internet-trends.
[2] 2016. Cashless means less cash, not no cash: Arun Jaitley. https://timesofindia.indiatimes.com/india/cashless-means-less-cash-not-no-cash-arun-jaitley/articleshow/56168975.cms.
[3] 2017. 2016 Indian banknote demonetisation. https://en.wikipedia.org/w/index.php?title=2016_Indian_banknote_demonetisation&oldid=765801391.
[4] 2017. Digi-Dhan Vyapar Yojana. https://digidhanlucky.mygov.in/.

[5] 2017. The Power of Smartphone Interfaces for Mobile Money. http://www.cgap.org/blog/series/power-smartphone-interfaces-mobile-money.

[6] 2018. Digital payments to grow to $1 trillion by 2023: Credit Suisse - The Financial Express. https://www.financialexpress.com/industry/technology/digital-payments-to-grow-to-1-trillion-by-2023-credit-suisse/1055252/.

[7] 2018. GST - Goods and Services Tax. http://www.cbec.gov.in/htdocs-cbec/gst/index

[8] 2018. Hard times: RBI's KYC norms burn a hole in mobile wallets. [Online; accessed 15. Jul. 2018].

[9] 2018. Home - Kopokopo. https://kopokopo.co.ke/

[10] 2018. Internet Shutdowns in India. https://internetshutdowns.in.

[11] 2018. Paytm KYC Process. https://blog.paytm.com/few-important-changes-in-paytm-from-1st-march-95b31549d6eb.

[12] 2018. RuPay – A New Domestic Card Payment Scheme. https://www.rupay.co.in/

[13] 2018. Tez - Money made Simple. https://tez.google.com/.

[14] Syed Ishtiaque Ahmed, Md. Romael Haque, Jay Chen, and Nicola Dell. 2017. Digital Privacy Challenges with Shared Mobile Phone Use in Bangladesh. In *Proceedings of the ACM: Human Computer Interaction (PACM)*. https://doi.org/10.1145/3134652

[15] Jenny C. Aker and Isaac M. Mbiti. 2010. Mobile Phones and Economic Development in Africa. *Journal of Economic Perspectives* 24, 3 (Sept. 2010), 207–232. https://doi.org/10.1257/jep.24.3.207

[16] Asli Demirguc-Kunt, Leora Klapper, Dorothe Singer, Saniya Ansar, and Jake Hess. 2017. *The Global Findex Database 2017*. Technical Report. The World Bank. https://globalfindex.worldbank.org/

[17] Virginia Braun and Victoria Clarke. 2006. Using Thematic Analysis in Psychology. *Qualitative research in psychology* 3 (Jan. 2006), 77–101. https://doi.org/10.1191/1478088706qp063oa

[18] Pankaj Doke and Anirudha Joshi. 2015. Mobile Phone Usage by Low Literate Users. ACM, 10–18. https://doi.org/10.1145/2835966.2835968

[19] Paul Dunphy, Andrew Monk, John Vines, Mark Blythe, and Patrick Olivier. 2014. Designing for Spontaneous and Secure Delegation in Digital Payments. *Interacting with Computers* 26, 5 (Sept. 2014), 417–432. https://doi.org/10.1093/iwc/iwt038

[20] Ishita Ghosh. 2012. The Mobile Phone As a Link to Formal Financial Services: Findings from Uganda. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development (ICTD '12)*. ACM, 140–148. https://doi.org/10.1145/2160673.2160693

[21] Andrew Harris, Seymour Goodman, and Patrick Traynor. 2013. Privacy and Security Concerns Associated with Mobile Money Applications in Africa. *Washington Journal of Law* 8, 3 (Feb. 2013). https://digital.lib.washington.edu:443/dspace-law/handle/1773.1/1198

[22] Nick Hughes and Susie Lonie. 2007. M-PESA: Mobile Money for the "Unbanked" Turning Cellphones into 24-Hour Tellers in Kenya. *Innovations: Technology, Governance, Globalization* 2, 1-2 (April 2007), 63–81. https://doi.org/10.1162/itgg.2007.2.1-2.63

[23] Samia Ibtasam, Hamid Mehmood, Lubna Razaq, Jennifer Webster, Sarah Yu, and Richard Anderson. 2017. An Exploration of Smartphone Based Mobile Money Applications in Pakistan. In *Proceedings of the Ninth International Conference on Information and Communication Technologies and Development (ICTD '17)*. ACM, 1:1–1:11. https://doi.org/10.1145/3136560.3136571

[24] Business Insider Intelligence. [n. d.]. Cash on delivery remains the preferred method of payment in India. http://www.businessinsider.com/cash-on-delivery-remains-the-preferred-method-of-payment-in-india-2016-6

[25] William Jack and Tavneet Suri. 2011. *Mobile Money: The Economics of M-PESA*. Working Paper 16721. National Bureau of Economic Research. https://doi.org/10.3386/w16721

[26] Joseph Jofish Kaye, Mary McCuistion, Rebecca Gulotta, and David A. Shamma. 2014. Money Talks: Tracking Personal Finances. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM, 521–530. https://doi.org/10.1145/2556288.2556975

[27] Deepa Krishnan and Stephan Siegel. 2017. *Effects of Demonetization: Evidence from 28 Slum Neighborhoods in Mumbai*. SSRN Scholarly Paper ID 2896026. Social Science Research Network. https://papers.ssrn.com/abstract=2896026

[28] Deepti Kumar, David Martin, and Jacki O'Neill. 2011. The Times They Are A-changin': Mobile Payments in India. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*. ACM, 1413–1422. https://doi.org/10.1145/1978942.1979150

[29] Neha Kumar and Richard J. Anderson. 2015. Mobile Phones for Maternal Health in Rural India. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, 427–436. https://doi.org/10.1145/2702123.2702258

[30] Neha Kumar and Nimmi Rangaswamy. 2013. The Mobile Media Actor-network in Urban India. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*. ACM, 1989–1998. https://doi.org/10.1145/2470654.2466263

[31] Rama Lakshmi. 2017. India's 'cashless billionaire': Currency crisis spawns an unlikely magnate. *Washington Post* (Feb. 2017). https://www.washingtonpost.com/world/asia_pacific/indias-cashless-billionaire-currency-crisis-spawns-an-unlikely-magnate/2017/02/09/b891836a-ee19-11e6-a100-fdaaf400369a_story.html.

[32] less-tax-on-small-traders 2016. Less tax for small traders on digital transactions: Government. The Economic Times. https://economictimes.indiatimes.com/articleshow/56065649.cms

[33] Scott D. Mainwaring, Ken Anderson, and Michele F. Chang. 2005. What's in Your Wallet?: Implications for Global e-Wallet Design. In *CHI '05 Extended Abstracts on Human Factors in Computing Systems (CHI EA '05)*. ACM, 1613–1616. https://doi.org/10.1145/1056808.1056979

[34] Ignacio Mas and Olga Morawczynski. 2009. Designing Mobile Money Services Lessons from M-PESA. *Innovations: Technology, Governance, Globalization* 4, 2 (April 2009), 77–91. https://doi.org/10.1162/itgg.2009.4.2.77

[35] Bill Maurer. 2015. *How Would You Like to Pay?: How Technology Is Changing the Future of Money*. Duke University Press. Google-Books-ID: pRWKCgAAQBAJ.

[36] Indrani Medhi, Aishwarya Ratan, and Kentaro Toyama. 2009. Mobile-Banking Adoption and Usage by Low-Literate, Low-Income Users in the Developing World. In *Internationalization, Design and Global Development (Lecture Notes in Computer Science)*. Springer, Berlin, Heidelberg, 485–494. https://doi.org/10.1007/978-3-642-02767-3_54

[37] Olga Morawczynski, David Hutchful, Edward Cutrell, and Nimmi Rangaswamy. 2010. The Bank Account is Not Enough: Examining Strategies for Financial Inclusion in India. In *Proceedings of the 4th ACM/IEEE International Conference on Information and Communication Technologies and Development (ICTD '10)*. ACM, 24:1–24:11. https://doi.org/10.1145/2369220.2369242

[38] Jacki O'Neill, Kentaro Toyama, Jay Chen, Berthel Tate, and Aysha Siddique. 2016. The Increasing Sophistication of Mobile Media Sharing in Lower-Middle-Class Bangalore. In *Proceedings of the Eighth International Conference on Information and Communication Technologies and Development (ICTD '16)*. ACM, 17:1–17:11. https://doi.org/10.1145/2909609.2909656

[39] Shem Alfred Ouma, Teresa Maureen Odongo, and Maureen Were. 2017. Mobile financial services and financial inclusion: Is it a boon for savings mobilization? *Review of Development Finance* 7, 1 (June 2017), 29–35. https://doi.org/10.1016/j.rdf.2017.01.001

[40] Michael Paik. 2010. Stragglers of the Herd Get Eaten: Security Concerns for GSM Mobile Banking Applications. In *Proceedings of the Eleventh Workshop on Mobile Computing Systems & Applications (HotMobile '10)*. ACM, 54–59. https://doi.org/10.1145/1734583.1734597

[41] Joyojeet Pal, Priyank Chandra, Vaishnav Kameswaran, Aakanksha Parameshwar, Sneha Joshi, and Aditya Johri. 2018. Digital payment and its discontents: Street shops and the Indian government's push for cashless transactions Interactions. In *2018 CHI Conference on Human Factors in Computing Systems*. ACM.

[42] Saurabh Panjwani. 2011. Towards End-to-end Security in Branchless Banking. In *Proceedings of the 12th Workshop on Mobile Computing Systems and Applications (HotMobile '11)*. ACM, 28–33. https://doi.org/10.1145/2184489.2184496

[43] Saurabh Panjwani. 2013. Practical Receipt Authentication for Branchless Banking. In *Proceedings of the 3rd ACM Symposium on Computing for Development (ACM DEV '13)*. ACM, 3:1–3:10. https://doi.org/10.1145/2442882.2442886

[44] Saurabh Panjwani and Edward Cutrell. 2010. Usably Secure, Low-cost Authentication for Mobile Banking. In *Proceedings of the Sixth Symposium on Usable Privacy and Security (SOUPS '10)*. ACM, 4:1–4:12. https://doi.org/10.1145/1837110.1837116

[45] Saurabh Panjwani, Mohona Ghosh, Ponnurangam Kumaraguru, and Soumya Vardhan Singh. 2013. The Paper Slip Should Be There!: Perceptions of Transaction Receipts in Branchless Banking. In *Proceedings of the International Conference on Human-computer Interaction with Mobile Devices and Services (MobileHCI '13)*. ACM, 328–331. https://doi.org/10.1145/2493190.2493236

[46] PTI. 2018. Digital payments in India to reach $1 trillion by 2023: Credit Suisse. *The Economic Times* (Feb. 2018). https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/digital-payments-in-india-to-reach-1-trillion-by-2023-credit-suisse/articleshow/62935890.cms.

[47] Arundhati Ramanathan and Shashidhar KJ. 2018. The UPI musical chairs. https://the-ken.com/story/upi-payments-apps/

[48] Nimmi Rangaswamy and Nithya Sambasivan. 2011. Cutting Chai, Jugaad, and Here Pheri: Towards UbiComp for a Global Community. *Personal and Ubiquitous Computing* 15, 6 (April 2011), 553–564. https://doi.org/10.1007/s00779-010-0349-x

[49] Bradley Reaves, Nolen Scaife, Adam Bates, Patrick Traynor, and Kevin R.B. Butler. 2015. Mo(bile) Money, Mo(bile) Problems: Analysis of Branchless Banking Applications in the Developing World. In *24th USENIX Security Symposium (USENIX Security 15)*. USENIX Association, Washington, D.C., 17–32. https://www.usenix.org/conference/usenixsecurity15/technical-sessions/presentation/reaves

[50] Jeanette Rodrigues. 2018. UPI-based upstarts giving Mastercard, Visa a run for their money. https://www.livemint.com/Industry/ul91LQhxlVlQCwlM8FvyUI/UPI-gains-in-Indias-hot-payments-space-beats-Visa-Masterc.html

[51] Everett M. Rogers. 2003. *Diffusion of Innovations, 5th Edition* (5th edition ed.). Free Press, New York.
[52] Emma Runnemark, Jonas Hedman, and Xiao Xiao. 2015. Do consumers pay more using debit cards than cash? *Electronic Commerce Research and Applications* 14, 5 (2015). https://doi.org/10.1016/j.elerap.2015.03.002
[53] Michael Safi. 2018. Personal data of a billion Indians sold online for £6, report claims. *The Guardian* (Jan. 2018). http://www.theguardian.com/world/2018/jan/04/india-national-id-database-data-leak-bought-online-aadhaar
[54] Obi Pritam says. 2017. How Cash on Delivery Fuelled E-Commerce Growth in India. https://onlinesales.ai/blog/cash-on-delivery-ecommerce-growth-india/
[55] Tavneet Suri and William Jack. 2016. The long-run poverty and gender impacts of mobile money. *Science* 354, 6317 (Dec. 2016), 1288–1292. https://doi.org/10.1126/science.aah5309
[56] Aditya Vashistha, Richard Anderson, and Shrirang Mare. 2018. Examining Security and Privacy Research in Developing Regions. In *Proceedings of the 1st ACM SIGCAS Conference on Computing and Sustainable Societies (COMPASS '18)*. ACM, 25:1–25:14. https://doi.org/10.1145/3209811.3209818
[57] Aditya Vashistha, Neha Kumar, Anil Mishra, and Richard Anderson. 2016. Mobile Video Dissemination for Community Health. In *Proceedings of the Eighth International Conference on Information and Communication Technologies and Development (ICTD '16)*. ACM, 20:1–20:11. https://doi.org/10.1145/2909609.2909655
[58] John Vines, Mark Blythe, Paul Dunphy, and Andrew Monk. 2011. Eighty Something: Banking for the Older Old. In *Proceedings of the 25th BCS Conference on Human-Computer Interaction (BCS-HCI '11)*. British Computer Society, 64–73. http://dl.acm.org/citation.cfm?id=2305316.2305330
[59] John Vines, Paul Dunphy, and Andrew Monk. 2014. Pay or Delay: The Role of Technology when Managing a Low Income. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM, 501–510. https://doi.org/10.1145/2556288.2556961
[60] Rick Wash. 2010. Folk Models of Home Computer Security. In *Proceedings of the Symposium on Usable Privacy and Security (SOUPS)*. ACM, 11:1–11:16. https://doi.org/10.1145/1837110.1837125