The Persistence of Paper: A Case Study in Microfinance from Ghana

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ABSTRACT

Paper as a medium persists as the de facto standard for information collection, storage, and transfer in many low-resource developing contexts. Of these contexts, the microfinance industry continues to be fascinating in the ongoing ICTD conversation due, in part, to its elimination of paper by digitizing money transfers using mobile banking. This success invites scholars, designers, and industry practitioners to design technology solutions to eliminate the perceived inefficiencies of paper in microfinance and other industries. In this work, we take a step back to assess the role and value of paper in order to give designers pause when considering a blanket digitization of existing processes, norms, and transactions. Specifically, we study a microfinance ecosystem in the city of Tema in Ghana and find that paper passbooks are able to deliver valuable context-specific information to its owners that derive from the specific affordances of paper itself. Our findings encourage a more nuanced view of paper's place in microfinance, and consequently, in similar low-resource settings.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

General Terms

Human Factors, Design

Keywords

ICTD, Paper, Microfinance

1. INTRODUCTION

Paper is ubiquitous. Despite ambitious proclamations in the 90s that organizations and work-spaces would eventually achieve a "paperless" state, paper persists. Paper is light, low-cost, familiar; it is easy to use, manipulate, fold, share, and distribute, all properties that render paper as immensely usable and accessible. Sellen and Harper's comprehensive account of the "Myth of the Paperless Office" is one of the pioneering works that chronicle the indispensability of paper in work spaces [30]. The authors point to the historical legacy of paper and its co-evolution with present work practices, paper's many unique affordances, and the deficient design(s) of technology alternatives to paper that contribute to its continuing resilience in professional and personal spaces.

Existing literature reveals and underscores paper's many properties that render it as an effective medium for information including: its ease of use, low cost, light weight, portability, tangibility, and consequent ubiquity in our society [15]. These properties ensure that paper allows for easy annotation and manipulation [31, 21], for quick spatial maneuverability and adjustment that enables a more complete "at-a-glance" visibility [31, 29], and for effective recording and recapturing of historical logs or activity [20].

Paper has endured in low-resource settings across the developing world as well. The extensive use of paper documents across state bureaucracies in the developing world has inspired ethnographic accounts that reveal their intended use for exerting control over the public [14] while simultaneously offering the public a site for enhanced participation [8]. Other work has demonstrated the explicit intent by the state to digitize existing paper documents to reduce corruption [36]. Still other literature has focused extensively on the augmentation of paper documents with technology in low-resource settings to better capture, store and process data [26, 3, 12][1]. These interventions generally preserve existing workflows and replace paper or augment the processes with Information Communication Technologies (ICTs). The domain of ICTs and Development (ICTD) often exemplifies this drive for digitization in low-resource settings across the developing world, and the shift from physical platforms such as paper. However, despite this push for digitization, paper continues to play an important role in information ecologies in the developing world.

In microfinance, paper is embedded in local information practices of community groups [10, 26]. Paper is the time-honored platform for recording and storing microfinance data, both at the customer as well as at the provider. Paper is used to generate and sustain trust between transacting parties, and is in general well-understood, which makes it easy to "own and trust", thereby providing a greater sense of security than other information resources that might have to be provisionally owned, shared, or borrowed [23]. Researchers have made specific note of the enduring assurance that paper receipts bring to low-income, low-literate customers in wholly digitized systems, such as mobile banking, despite the delivery of SMS receipts confirming these very same transactions [9, 22].

Given paper's embeddedness and value, interventions proposing digitization require careful deliberation. More specifically, under what conditions is digitization recommended and to what extent? Are there attributes of paper that should be preserved and what

[1] Most recently, Dell et al [6] study paper-digital workflows in development organizations and outline design opportunities around this.

ICTD'15, May 15–18, 2015, Singapore, Singapore.
Copyright 2015 ACM 978-1-4503-3163-0/15/05$15.00
http://dx.doi.org/10.1145/2737856.2738029

technologies can provide those properties? This work seeks to address these questions in the context of a microfinance institution in Ghana. More specifically, we assess paper's use in the daily operations of Q-Star, a microfinance company in Ghana, based on ethnographic data collected in a three week study in July 2014. The contributions of this work include:

- A description of the intended and actual use of the paper passbook of Q-Star, a microfinance institution in Ghana, through an ethnographic lens (Section 4).
- An analysis of specific paper affordances that show the value of the paper passbook for low-income, low-literate users (Section 5.1).
- An analysis of the costs and benefits of using paper versus technology in order to best leverage their inherent properties and address other design considerations (Section 5.2).
- A brief exploration of the paper-technology spectrum to present existing intermediate solutions that may not require a blanket digitization of paper-based platforms. (Section 5.3).

2. BACKGROUND

The shift from paper toward digital solutions has been particularly apparent in the microfinance industry over the past few years. The microfinance industry is an umbrella term for different self-organizing as well as intermediary-driven units that drive savings and credit services amongst low-income populations. Currently, many processes at microfinance institutions (MFIs) are recorded on paper tools, such as passbooks, receipts, or paper ledgers and logs, but there is a strong drive to digitize these records. Examples include Digital Slate [28], which accepts handwritten input on ordinary paper forms and provides immediate electronic feedback, and CAM, which uses a camera phone to capture form information [23]. Aside from digitizing paper-based processes, there has also been a push towards digitizing financial transactions to enable branchless banking [18].

There are many benefits to digitizing record-keeping and monetary transactions in the microfinance industry; it saves on precious real estate, it is more efficient, and, sometimes, it is cost-effective (automating financial transactions as opposed to maintaining brick-and-mortar bank branches). However, rural and other low-resource settings pose many challenges for the deployment of these digital tools. Power shortage, intermittent connectivity, and inadequate storage facilities pose infrastructural challenges for deploying computing technologies. Limited education, lack of immediate perceived benefit, and deficiency of other human resources present user challenges to the adoption and uptake of these technologies [24]. Inertia against adopting a new, alien, technological solution may be high, especially when awareness of the tool is limited. Parikh and his collaborators point out this tension when discussing the reception to CAM, their digitized data entry tool [26]; the users did not entirely trust or understand the new technology, and felt the need to preserve their existing paper-based ledgers to be referenced independently of the new digital tool.

Parikh et al [27] underscore one consistent insight from their work with microfinance groups in India, that of the importance of *physical models* and *tangible artifacts.* The act of touching and handling paper records (Parikh discusses the ledger in particular) is significant in that it is recognizable, owing to the years of experience with notebook-based data entry mechanisms across various applications, and the daily ritual of physically-oriented tasks. When discussing their work, Parikh et al [27] note that:

> *"Paper is cheap, ubiquitous, flexible and comfortable for the end users. The infrastructure required to support paper based data-entry is readily available in villages, and it requires little additional investment in terms of technology, training or support. Paper is a flexible, accessible, and sustainable technology appropriate for use in local villages."*

The authors use these broad insights to inform and introduce specific digital solutions in the microfinance context, but they do not go into detail about the nuanced ways in which users are using existing paper based information resources. We believe these details are needed to highlight *why* paper remains persistent in microfinance. This, in turn, will shed light on specific affordances of paper that low-income, low-literate users in the developing world may especially find beneficial. Such insights can inform subsequent digital solutions that seek to replace and/or augment existing paper based information platforms.

Institutional and Interpersonal Trust

The microfinance industry is both formally regulated and informally driven in the developing world. Sriram observes in [32] that the microfinance industry uses "trust as an effective mechanism to address one of the issues of imperfect information in financial transactions." A more formal system that is governed by institutional trust will move towards standardized procedures that can help manage diversity and achieve scalability and reliability; whereas a more informally driven system will rely on interpersonal trust, frequently between homogenous populations, to sustain ongoing transactions and processes.

In practice, MFIs will often foster and depend on both institutional and interpersonal trust, as we observe with Q-star, despite it falling under the purview of formal regulation in Ghana. This implicates a highly complex ecosystem where in spite of standardized information activities (recording, storing, retrieval, and transactional), customers, particularly those with low literacy levels, may be vulnerable to information deficiencies. Therefore, interpersonal trust, even within a formal ecosystem, becomes critical. We elaborate on this in the next section.

2.1 Q-Star

Q-star is a microfinance institution based out of Tema in Ghana. Q-star operates a *susu* (savings) operation that targets low-income clients from surrounding settlements and townships. Mobile bankers (susu collectors) are sent out to collect the susu deposit amount from each of their clients on a daily basis. In this way, the susu collectors bring banking services to their customers right at their doorsteps. The savings process is straightforward: a customer saves a standard deposit amount every day for 31 days, of which 30 days worth of deposit is his accumulated sum, whereas one day's deposit becomes the MFI's commission. To ensure seamless operations and to minimize instances of fraud, data from three separate sources are reconciled on a regular basis: i) a formal paper passbook that has date, deposit amount, and receipt number information in it and is kept with the customer, ii) paper receipts that are handed to the clients once the susu collector has received their deposit amount, and iii) the (paper + electronic) databases in the Q-star office where daily records are updated.

In theory, the susu customer is expected to be updated about his balance at all times. The susu collector updates the customer's passbook when a deposit is made, as well as hands him a paper receipt confirming this transaction. When a withdrawal is made, the teller updates the passbook. However, customers are almost never involved in the filling in of their passbooks, and therefore are seldom aware of their balance. This may be partly explained by the notion of *secondary users* conducting *intermediated information tasks* in the developing world as conceptualized by Parikh and Ghosh [25].

Parikh and Ghosh differentiate between primary and secondary users based on their distance from the actual information resource. While primary users have direct access to such a resource, a secondary user will typically acquire this access, if at all, through a "proxy" primary user. This proxy primary user demonstrates the skills to navigate this information resource as well as manage the secondary user's information-seeking experience. Their use then becomes "intermediated" wherein the secondary user does not directly use the information resource but can observe the proxy. Parikh and Ghosh are referring to digital information resources when discussing intermediated access, but the secondary users of paper passbooks are subject to similar educational and instructional constraints that limit their understanding of the passbook, and therefore render the need for intermediated use as essential. Still, it is important to mention here that it was common for susu clients to be engaged in different forms of trade in the local markets, which encourages basic arithmetic competence.

As we spent more time in the field, it became clear that two types of trust played a huge role in Q-star's continued patronage. First, *institutional trust* played a large role in the acquisition of new customers as well as in the retention of old customers. Q-star has a physical office that clients often go and check out before agreeing to become a customer. The owners of Q-star have been running a forex bureau in the vicinity for the past decade, further amplifying the customers' general trust in the institution as a whole. Second, customers demonstrate great *interpersonal trust* in the mobile bankers. This is the trust relationship that mobile bankers are able to develop with their clients, both prospective and existing. Measures to perpetuate this trust include general amiability in demeanor, provision of the bankers' personal mobile phone numbers and home addresses (in some cases, new clients would go and check out the homes of the mobile bankers as a security measure), and an undertaking of personal liability on behalf of the bank even though this bears no real legitimacy. Furthermore, as we will see later in this paper, Q-star customers also build trust through the physical medium of their paper passbooks. This paper artifact and associated processes serve as indications of consistency, transparency, and reliability.

3. METHODOLOGY

We spent 3 weeks in the month of July 2014 in Tema, a city on the outskirts of Accra, Ghana. During this time we closely studied the practices of Q-star and its customers using a mixed-method approach.

3.1 Qualitative Field Study

We used a combination of formal/informal interviews, as well as observations, to closely study Q-star's susu operations in the field. To begin with, we conducted in-depth, semi-structured interviews with 4 Q-star administration members to better understand their processes, logistics, infrastructure, and constraints of the susu operations. Following this, we accompanied the mobile bankers on their trips to the customers' homes and work places. We spent the first week observing the mobile bankers and the customers, while engaging in informal conversations with both to better understand the susu process. In total, we undertook day trips with 5 different mobile bankers who serviced, on average, 15 customers each. We spent the next two weeks conducting semi-structured interviews primarily with the customers. During this time, the mobile banker would take us to the home or work space of the customer and leave us there for 30-60 minutes during which time they went about completing their own work. Customers were chosen to represent as broad a demographic spectrum, in terms of gender, work practices, and literacy levels, as was available to us. In total, we conducted semi-structured interviews with 27 customers.

Interviews with Q-star's administration and employees were conducted in English. Interviews with the customers were conducted in the local languages, either Ga or Twi, with the help of an interpreter. All field notes from the interviews were then subjected to a thematic coding process, a process that began in the field itself and continued into our analysis phase.

3.2 Usability Study

We conducted a usability test of the paper passbook to better ascertain its utility to the customers. We used a convenience sample of participants by trailing two different mobile bankers and choosing to conduct the usability test with a small set of customers, but still attempted to include a diverse set of participants. If the customer granted us consent, we then proceeded to ask them to complete three tasks using a passbook with dummy data. In total, we completed the usability study with 14 participants. The usability tasks were timed, and any irregular task completion strategy was then followed up on in an unstructured interview. The tasks in detail were as follows:

Task I: Calculate Balance

The dummy data showed the balance in the passbook to be 88 cedis[2], which is 2 cedis per day saved over 44 days. In the passbook, this was split up into 62 cedis (saved over one cycle) and 26 cedis (partially saved over the next cycle). We handed over the passbook to the participants and asked them to tell us the balance that has been accumulated by saving over 44 days using the passbook.

Task II: Calculate Commission

Participants were asked to tell us the commission they would have to pay for withdrawing 88 cedis. The correct answer would be 4 cedis, that is, 2 cedis per cycle started.

Task III: Calculate Updated Balance

Participants were asked to calculate the updated balance, after a partial withdrawal had been made. To orchestrate this task, we used another passbook with dummy data where after a partial withdrawal had been made, the red strikes made, and the rest of the deposits completed for that cycle, the "teller" had now updated the balance in the appropriate fields. More specifically, we asked the customers what the updated balance was after someone had made a partial withdrawal of 12 cedis from an accumulated sum of 88 cedis.

We present the demographic profiles of our respondents from the qualitative field study as well as the usability study in Table 1.

[2] 1 cedi is around 0.3 USD at the time of writing.

4. THE PAPER PASSBOOK: INTENDED DESIGN VS ACTUAL USE

Here, we describe the findings from our qualitative and usability study. Our daily observations showed that the mobile bankers were the primary users of the paper passbooks while mediating and

Table 1: Profiles of the Interviews/Usability Test Respondents

Characteristics		Interview	Usability
Gender	Male	13	6
	Female	14	8
Age	18-25	6	4
	26-35	9	3
	36-45	7	1
	46-55	4	4
	55+	1	2
Mobile Phone Owner?	Yes (Feature Phone)	11	4
	Yes (Smartphone)	13	10
	No	3	0
Highest Education Level	None	5	5
	J.H.S.	16	5
	S.H.S	5	2
	University	1	2
Total Respondents		27	14

managing its access for their clients, that is the secondary users. Despite this, the clients demonstrated their own exceptional use of the passbook that indicated its perceived value within the community, as well as its role as a medium of information that beyond sum and balance. The paper passbook, as we will see, often contained or conveyed information that reinforced the secondary users' trust in Q-star's susu service.

4.1 Deposit & Withdrawal

The paper passbook (Figure 1) is a detailed log with date, deposit, and accumulated sum information. In addition, there is a column for receipt number and a signature column where the mobile banker signs his name to indicate the formal completion of a unique transaction. Below the table, there are three fields that record the 'total contribution', the 'commission', and the 'total balance' information at the end of each cycle.

Each 31-day cycle of the susu deposit is represented across two sheets of the passbook. The first sheet records up to 18 discrete deposits, whereas the second sheet records up to 13 discrete deposits, totaling 31 deposits. Therefore, every two sheets in the passbook represents one 'cycle', or what the MFI terms as one 'month' to facilitate ease of instruction and understanding.

4.1.1 Deposits

Deposits are straightforward. The mobile banker goes to their client's home or work space to collect the deposit. Thereafter, the mobile banker updates all the columns in the client's passbook, and signs it to conclude the transaction. We observed many occasions when clients were unable to deposit the required amount due to ongoing financial struggles or extra expenses. This was not a cause for penalty; the only impact on the proceedings was that one cycle did not perfectly coincide with one calendar month.[3]

Clients also handed over *extra* money to the mobile banker. Clients explained that depositing any extra money on hand could make up for a (possible) deficit at a future time, thereby ensuring that their susu deposits were consistent over time. This was articulated in the passbook. For instance, if a client deposited 15 cedis instead of his daily deposit of 5 cedis, then the mobile banker would record this into the deposit column as three separate deposits of 5 cedis each on the same date. As one mobile banker explained to us, this mimics the original premise of the daily susu deposit system, even though in reality people were almost never depositing the same amount regularly on a daily basis. Clients echoed this sentiment, and told us that they could clearly see all the deposits ever made and their gradual accumulation over time.

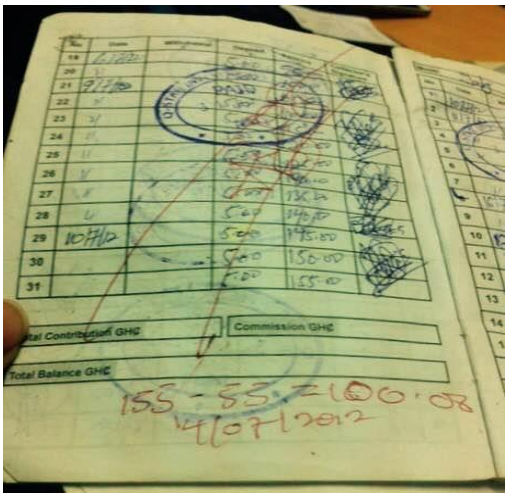

Figure 1: Paper Passbook

4.1.2 Withdrawals

In theory, a customer can withdraw their 31 day accumulated sum (less the commission) at the end of the cycle. However, this is seldom the case. Customers usually continue saving up until the point that they needed to access a lump sum. Typically, at this point customers withdraw all the money they have accumulated. The passbook, in and of itself, has no specially designated space for withdrawal information. Instead, when a withdrawal occurs, the teller will strike out the page with a red pen, up until the point accumulated amount that the customer has chosen to withdraw. If the ongoing cycle is incomplete at this point, then the mobile banker will wait until the 31st deposit is made, and then update the balance in the balance field. For instance, as shown in Figure 1, the teller has indicated at the end of the cycle that the customer now has a balance of 100 cedis in his account after he withdrew 55 cedis during the cycle.

This was a makeshift solution to indicate a withdrawal in a passbook that was not designed to explicitly record this

[3] This was not a real concern in practice. To simplify the message of the susu operations, Q-star told their customers that they accumulated a pre-defined amount based on their daily susu deposit at the end of every month. However, in practice, clients were accumulating this amount after every 31 discrete deposits (minus commission).

information. It provides a powerful visual marker while retaining the historical record of previously accumulated sums. As we spent more time with customers, we found that they appreciated this feature of the passbook as it was able to retain their historical deposit information in a way that was visible through the red strikeouts. At the same time, these red strikes, rather intuitively and unmistakably, indicated that this money had been withdrawn and could not be used anymore. In this way, the red strikes simultaneously preserved old data and conveyed new information.

One customer compared Q-star's passbook with a competitor's passbook where old records were torn and discarded once a withdrawal had been completed. She said that this made her distrust the competitor instantly, immediately likening this deliberate exclusion of past records to a lack of transparency. She said, *"Why would they throw away those pages? Do they want to cheat us?"* Indeed, it was common for customers to retain their old passbooks long after all the pages had been struck out. The actual utility of these historical logs was unclear, given that they were almost never referenced afterwards. Still, their perceived utility was articulated time and again; customers believed that all transactional information that was physically recorded (even if by someone else) would protect them in any contingency.

4.2 Access & Storage

The passbook is, at least in theory, expected to be the customer's *personal* log for easy tally and recall, even though it is filled in completely by the mobile banker. We found that customers do not supervise the mobile banker filling in the passbook to verify its accuracy, nor do they actually even keep it with them in many cases. As one market woman told us,

> *"I sell produce here in the open market where it may rain and water will drip onto my stock. I can still cover my stock and cover myself, but I do not want to risk the paper getting wet. All my susu information is in it. That's why I keep it with my mobile banker"*

This respondent was extremely articulate, although illiterate by her own admission. When we asked her if she trusted the mobile banker with her passbook, she said that he was merely "guarding" the passbook for her. The passbook belonged to her ever since the first day when it was handed to her with all her personal identifying information in it. She told us that she had watched the mobile bankers fill in empty passbooks with the specific details of customers, affix their photographs, and then hand them over to them. Once it became her passbook, it was her prerogative to decide whether she intended to keep the passbook with herself or with the mobile banker. She had chosen the latter.

The market woman was unable to tell us her exact balance when we requested her for the information, *even after she checked her passbook.* Yet she believed that the passbook held all the information that was necessary to navigate her own position within the susu deposit ecosystem. "*It is all in there*", she said, holding up the passbook in her hand and immediately implicating its physical value. She believed that her mobile banker was better equipped to fill in her passbook without any mistakes. Moreover, she observed that the rigid information fields in the passbook prevented the mobile banker from entering any erroneous information, deliberately or mistakenly. This is inaccurate, but it illustrates that the formal look-and-feel and visual transparency of the paper passbook serves as an indicator of trust[4].

The formal looking passbook reassured her (*"It has Q-star's name and logo on it!")*, and she believed that in the event of any discrepancy, the passbook would be enough for her to get relief. She said that if she ever realized that her account did not have as much money as she thought she had saved, she could walk into Q-star's office at any time with her passbook in her hand and that in itself would be enough to navigate the situation in her favor.

In contrast, several customers that we spoke with stored their paper passbooks away in a tied-up polythene bag as soon as the mobile banker completed writing in the details of a transaction. Therefore, customers, whether they kept their passbooks with the mobile bankers or with themselves, almost never checked their passbooks in between transactions. What is common, as we repeatedly observed with customers, is that they kept a running total of their susu deposits in their heads at all times. This is usually the case amongst the customers who deposit a standard amount consistently, thereby making the regular addition more manageable. In contrast, we also encountered clients who did not want to know their balance at any point in time, unless they wished to make a withdrawal. These customers voiced a need to make the barrier between them and their savings more significant in order to avoid any unnecessary expenditure.

4.3 Parsing & Calculation

We conducted a usability study of the passbook to assess its ability in terms of helping users calculate sum, commission, and balance. The results of the three tasks are shown in Table 2. The times are averages of the N respondents using one of the four calculation methods on a task.

These results reinforce our initial observations in the field; the passbook was seldom used on its own, and when it was, respondents almost always answered incorrectly for sum information (4 respondents as opposed to 1 respondent who answered correctly). Determining the sum across multiple cycles, especially if one was partially completed, was tedious. This was particularly awkward when most customers ended up saving across multiple cycles before they decided to make a withdrawal. Therefore, using one's own arithmetic skills to calculate one's balance, using a calculator in conjunction with the passbook, or devising approximation cues were various ways in which customers were able keep themselves updated about their susu deposit information. As described previously, the passbook had no commission information, and provided updated balance information only after a cycle completed.

From Table 2, the most salient feature is the preference for mental math in calculating answers over all other methods 24/34 (70.6%) and the high error rate associated with mental math across the tasks 16/24 (66%). Customers almost always preferred to calculate the balance mentally, *even though all the information was contained within the dummy passbook that was handed to them*.[5]

[4] Interestingly, these formal markers and the trust that low-income, low-literate populations derive from it can foster an environment that makes it easier for fraudsters to dupe vulnerable clients by capitalizing on these seemingly institutionalized formats [16].

[5] We ensured that respondents were asked specifically to look at the passbook to find the answers to the questions that we were asking them.

In contrast, when respondents used the calculator they always arrived at the right answer.

Approximations

The other interesting result from Table 2 is the approximation method itself. The approximation cues hack was especially interesting given that low-literate clients were using this tactic the most. These customers understood that two sheets of the susu passbook represented one cycle's worth of accumulated sum.

Table 2: Usability Test Results for Task Completion, Correctness, & Calculation Method

Task	Correct	N	Calculation Method							
			Passbook		Mental Math		Approx		Calculator	
			N	Time (s)	N	Time (s)	N	Time (s)	N	Time (s)
Sum	Yes	7	4	74	2	47	-	-	1	10
	No	7	1	49	4	43	2	52.5	-	-
Commission	Yes	3	-	-	3	31	-	-	-	-
	No	7	-	-	6	20	1	35	-	-
Updated Balance	Yes	4	-	-	3	38	-	-	1	14
	No	6	-	-	6	44	-	-	-	-

Accordingly they deduced that each sheet must be worth *half* this amount. In reality, the first sheet had 18 discrete rows and therefore represented 18 deposits worth of accumulated money. The second sheet represented 13 discrete deposits worth of accumulated money to bring the total up to 31 days of deposits.

During this evaluation we asked a fruit seller who had never attended school what the balance in the dummy passbook was. Her response was 75 cedis. She then explained to us that she arrived at this answer by adding across two and a half sheets. Since the susu deposit amount was 2 cedis in the case of dummy passbook, she assumed each page was worth 30 cedis. The third sheet, which was actually filled in until the 12^{th} deposit (and was therefore a little more than half that sheet), was worth about half that. She then mentally added 30+30+15 to arrive at the total of 75 cedis. This was incorrect, but was within a margin of error and would rectify itself as soon as one cycle was completed.

4.4 Storage and Sharing

Low-literacy certainly plays a part in disengaging the users from the heavily-textual information in the passbook that is potentially valuable to them. However, it was clear that as the daily schedule of the susu deposits became more routine, people grow habituated to the process. Their role in the entire proceedings is eventually relegated to the mobile banker with customers making withdrawals when desired. The passbook stays with the mobile bankers at all times or passes from their hands into the ubiquitous black polythene bag, tied up securely and stored away out of reach. Both these storage strategies demonstrate the perceived value of the passbook to the clients, indicating a need to keep the passbook safe, secure, and almost quarantined.

There were many instances where clients left their susu deposit *money* as well as their passbooks with an assistant, friend, or family member. This proxy would typically be a member of Q-star's susu deposit service as well. The process was straightforward: hand over both of your passbooks to the mobile banker with the appropriate susu amount neatly stacked within the respective passbooks, which the mobile banker will then retrieve and update the passbooks accordingly. The proxy will keep the passbook until the end of the day which is when the rightful owner will retrieve it. Sharing of passbooks was especially common amongst people with certain types of jobs. For instance, shop owners who had assistants to manage the shop while they were out, would commonly leave their money and passbooks behind. Busy grocery store owners, who dealt with a constant churn of customers, or car mechanics, who worked in a garage and were afraid of soiling their passbooks, also left their money and passbooks with proxies.

These customers had little choice but to leave their passbooks with a trusted aide. In theory, there is some scope for fraud if the customer checks up on his passbook later in the day. However, in practice, this was not the case. Just as customers did not check their own passbooks after the mobile banker had completed the transaction, unsupervised and uninterrupted, they did not check their passbooks after they retrieved it from their proxy. This process of sharing passbooks was governed by the same general trust in the susu deposit system that was driven by institutional and interpersonal trust, as well as the familiarity of routine and a lack of any untoward incidents. As a Q-star representative put it, *"They do not worry until something goes wrong."*

4.5 Errors and Corrections

As expected, sometimes mistakes are made. We found one such instance during our time in the field where sharing led to an error. The subsequent response of the mobile banker in rectifying this error is an interesting example of the flexibility of paper interfaces while reinforcing the customer's faith in Q-star's services.

There was a Q-star member who owned and managed a store that sold some basic groceries and hardware tools. His store was right next to a garage where a bunch of mechanics had also signed up for Q-star's susu services. These mechanics had struck up a friendship with the storeowner and routinely left their passbooks with him. Therefore, at any given point in time during the day the store owner had with him between 2-4 passbooks, including his own, depending on who had been able to furnish the susu deposit for that day.

At this particular incident, this member had one mechanic's passbook which he gave to the mobile banker along with his own passbook. He also handed over 15 cedis to the mobile banker without indicating that he wanted 5 cedis deposited into his account and 10 cedis deposited into the mechanic's account. The mobile banker deposited the entire amount into the store owner's passbook by dividing up 15 cedis into three deposits of 5 cedis each (this was the susu deposit amount for the store owner as well as the mechanic). The storeowner noticed that the mobile banker had not opened the mechanic's passbook and immediately informed her. On realizing the error, the mobile banker made two small crosses against two of the 5 cedi deposits in the storeowner's passbook to indicate this discrepancy.

This simple repair step was visible even weeks later, which is when we conducted the interview (Figure 2, rows 10 and 11). The storeowner told us that when he next made the two deposits of 5 cedis, the mobile banker did not need to update the passbook. The fact that the storeowner could still see those small marks against

those deposits reassured him greatly. He said, while showing us the very page that still showed this repair procedure:

> *"Can you see these marks here? I can still see them. The mobile banker made these marks when she realized the mistake. But she immediately corrected it and made the changes. It makes me happy whenever I see it. It means she will listen to me if she has made a mistake. She is a good mobile banker."*

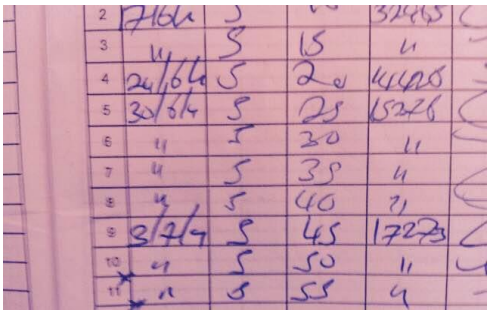

Figure 2: Error Repair in the Paper Passbook

5. DISCUSSION

We unpack three related discussion points based on our findings. First, we reaffirm the properties of the paper interface within the context of our microfinance setting. We then compare these properties with those of a notional electronic passbook to highlight the properties that are naturally absent from a digital information medium. Recovering or preserving these affordances in a digital solution requires additional consideration to design and implement.

Second, it is important to consider the digital alternatives, especially when positioning this evidence within the ongoing ICTD conversation. Mobile phones, especially, constitute a realistic alternative, keeping in mind its widespread reach in the developing world, and its popularity in the microfinance context. In general, both paper and ICTs as mediums of information come with their own material constraints, but the tradeoffs should be made clear and carefully considered.

Third, we present the paper-technology spectrum that spans a range of hybrid paper-ICT tools, between the extremities of paper and ICT tools themselves. These options embody the qualities of each platform to varying degrees. The spectrum presents a range of possible solutions to address imminent information problems before resorting to a dedicated ICT solution.

5.1 Properties of the Paper Interface

Paper has several specific properties that make it useful in the microfinance context beyond general descriptions about its tangibility or flexibility. Here we discuss the themes from our investigations.

5.1.1 Natural Inscriptions and Transparency

Paper is conducive to being marked and inscribed with a physical trace that can provide intuitive and persistent visual feedback to users. In the example where the mobile banker made a marking in the passbook to indicate an error, she was able to immediately alter the paper record in a way that was not necessarily within its prescribed usage, but which demonstrates the vast space of visual marking that paper can sustain. This marking to draw attention to the error was visible to the user, and remained so long after it was rectified. As the user observed, this persistent visual feedback helped reinforce his trust in the mobile banker. An electronic passbook, on the other hand, can rather effortlessly support the complete erasure of any errors; a design decision that fulfills the goal of accuracy and clarity, but foregoes the power of a constant visual cue. Activating and maintaining a persistent, visible error log in a digital solution requires an explicit design decision and implementation effort.

This physical trace was also seen in the deposit and withdrawal information within the passbook. The use of the red strikes to cross out money withdrawn seemed like a natural action on the part of the teller, even though this action was pre-determined, and communicated an instinctual meaning to the user, that the deposits that have been crossed out can no longer be used. Moreover, the use of the red strikes was able to preserve the historical deposit information as users could still see this information through the singular red strikes. Therefore, these red strikes were simultaneously imparting new meaning to this deposit information, that it had in fact been withdrawn. This was a necessary visual signal for the clients because the teller did not actually update the balance fields until the ongoing monthly cycle had completed.

The paper passbook also transparently exposed the mechanics of computation to its users. The passbook clearly conveyed the cumulative sum over time, where a client is able to see his savings increase arithmetically. Even if a user, with a 5 cedi daily deposit, gave 15 cedis on a particular day, the mobile banker broke this up into three separate deposits of 5 cedis each. This not only provided complete transparency to the user, it also mirrored the intended premise of the daily susu deposit proceedings, both extremely crucial factors in simplifying the message and the process for the susu clients. In contrast, an electronic solution can provide a more parsimonious design, one that maintains only the updated balance information and collapses the deposit column entirely. There may be merits to both solutions, but when dealing with low-literate populations, complete visual transparency, even at the cost of physical real estate, can be particularly beneficial.

An electronic solution affords the possibility of rearranging, streamlining, and presenting its data in infinite ways, which makes every design decision around a particular solution, an explicit one. This is unlike paper that characteristically preserves its data in its original form (of course, one may erase or alter original data on paper but this is neither effortless nor immediate). As a medium, paper achieves the traits of constant visibility and transparency without additional exertion. Therefore, when activated alongside a specific design decision for increased transparency, such as breaking down a lump sum susu deposit into its discrete units, paper is able to cater to low-literate populations in a natural and particularly salient manner.

5.1.2 Physicality and Perceived Value

It became clear during our time in the field that even without dispensing any actual or consistent utility to the customers, they still considered the paper passbook an important part of the susu proceedings. These customers believed that having an *actual, physical* artifact, something they could refer to in times of doubt, something that *physically recorded* their daily deposits even though this was not immediately explicit or visible to the them,

something that they knew preserved this deposit information over time, is what constituted the optimal recourse device in the event of any inconsistencies or emergencies. Moreover, the passbook's "formal" appearance also contributed to its perceived value.

Of course, a digital solution can easily offer this property of "physicality" as well. Here, there is something to be said about the exclusivity of purpose of the paper passbook. Assuming, for instance, that a mobile application is designed to record customers' susu deposit and withdrawal information. The mobile phone in this case could very easily replicate the "physicality" of the paper passbook. Still, the fact that the mobile phone at any point in time is fulfilling multiple user tasks (making and receiving calls, sending and receiving text, mobile money transfers, etc.) certainly diminishes some of its perceived value as a passbook. As we observed, customers immediately put away their passbooks once a transaction was completed, very frequently tied up in a waterproof polythene bag and stored away. This *storing* and *securing* of the passbook both perpetuates and indicates its perceived value, and implicates its dedicated function.

At the same time, there were many customers who gave their passbooks to their mobile bankers for safekeeping. In addition, we also observed multiple instances where customers, especially those with mobile jobs, left their susu deposit money as well as their passbooks with an assistant, friend, or family member, who would then give the money along with the respective passbooks to the susu collector to update. These customers seemed to have no problem parting with their passbooks. This suggests a curious harmony between the perceived value of the passbook and keeping it isolated, and its ability to transcend this state and be shared.

Is paper then an optimum way of achieving this balance over technology artifacts? For instance, can mobile phones be shared in this manner? The fact that a mobile phone is a multi-purpose tool is certainly a deterrent. Moreover, while mobile phone sharing remains persistent in the developing world, these are usually temporary redistributions for provisional access, given that mobile phones themselves are purchased at some meaningful cost to the owner. In contrast, we have seen that the paper passbook has little inherent monetary value, but can be personalized and made to look and feel "formal" if inscribed with an official logo and standardized formats.

5.1.3 Control and Ownership

Low literacy levels and sometimes a general lack of understanding can render populations vulnerable to deceit and manipulation. How do low-income, low-literate customers maintain a sense of control, in terms of access, ownership, and transparency, in Q-star's susu ecosystem if all actions are constantly arbitrated by the mobile bankers?

As we have seen, customers actually *prefer* this intermediated use by a skilled moderator. Microfinance operations themselves rely on multiple points of service which brings with it some inherent risks. For instance, Q-star works out of a main bank branch, but its team of mobile bankers takes their banking services to hundreds of homes and work spaces everyday. Protocols are in place to ensure that money and information transfers seamlessly between the multiple points of service. Despite this, loopholes do exist and these can be exploited. Vulnerable populations are frequently aware of this and, as we have seen, will seek out markers (and sometimes, proxies) for trust to safeguard their transactions. At other times, they will devise hacks to navigate their way through systems that are heavily textual or esoteric to them.

The approximation hack is evidence for how low-literate customers negotiate an information overload to arrive at the information that is most salient to them. By attaching a numerical value to each physical page, low-literate customers are able to arrive at a reasonable approximation of their current balance, with a decreasing margin of error as the ongoing cycle nears completion. When considering a digital solution, designers must evaluate the needs of low-literate users. If information (especially textual information) overload is inevitable, then the designers should consider opportunities where low-literate users can engage meaningfully with the given information medium to derive benefits such as control and trust in the solution.

The paper passbook confers transparency and control to customers in the daily susu operations. The customers who choose to keep their passbooks with them understand that they can inspect the passbook for any clarifications before any third party can access it. In contrast, it is hard to imagine the degree of control a low-literate customer, who keeps his passbook with his mobile banker, is able to exert within the susu ecosystem. Here, some degree of perceived control is derived from the ritualistic, physical transfer of a "formal looking" passbook[6]. In general, the paper passbook immediately establishes the client's presence within the Q-star ecosystem by stating his identifying details, including a photograph, in a document that very clearly belongs to Q-star; these personal identifying details also help in establishing "ownership". Therefore, even when the passbook is permanently with the mobile bankers, customers are able to consider this as merely an ancillary act of safeguarding.

An electronic passbook would provide the same degree of access and use that the tied-up polythene bag in one's home or shop would. However, the ritualistic transfer of "ownership" may be hard to achieve on a mobile phone application, given that the mobile phone would already belong to the customers themselves. Given the high degree of intermediated use and the relegation of already vulnerable populations, designers need to consider the implications of removing this ritualistic entry from the susu ecosystem that serves as a marker of trust for these customers.

5.2 Paper vs ICTs

The discussion so far reveals the embeddedness of paper and its relative strengths in the microfinance context. However, there are benefits to introducing a digital passbook. The cost of reproducing paper passbooks may be expensive when compared to the operational costs of a digital passbook solution. As one Q-star representative observed, if customers' unique mobile phone numbers could be linked to their digital passbooks, auditors could verify balance information from the customers through a simple call or text message, instead of physically going to their homes and work spaces. However, as one Q-star representative pointed out, the one-time costs of designing and implementing a digital passbook would require substantial capital that Q-star does not have. So, how does one then determine whether a paper or technology platform might be the best medium for a given context?

[6] Sellen & Harper [30] note the significance of such ritualistic transfers in the work practices of a chocolate-manufacturing company as well. More specifically, they find that *physically* handing over a file to a buyer is a means of both, explicitly delegating responsibility, as well as communicating this visually to others in the department.

5.2.1 Cost vs Benefit

Resource cost is of course the single-most critical factor, especially in low-resource settings. Even if the financial cost of adding additional users on to a digital application is only marginal, the one-time financial cost to build, test, and implement the system is typically substantial. Moreover, migrating existing customers onto a new, possibly unfamiliar platform, is expensive in terms of instruction and training costs. This may be an especially relevant factor to consider when working in low-resource settings with low-income, low-literate populations. As far as the microfinance industry is concerned, customers frequently rely on interpersonal relationships and traditional information processes to maintain their trust in the system. Therefore, they might be sensitive to sudden, unfamiliar overhauls.

Of course, there are the additional costs to truly understanding which properties are most important in a given context. For example, perhaps the physical sharing of tools is less important in a healthcare facility context, but historical records remain especially crucial. A tool or application built for this context would have to be sensitive to these prioritizations. Moreover, there are costs to designing technological solutions to engage these properties. Maintaining a visible error log, for instance, may be a nontrivial feature when designing and implementing a technological application where errors can be completely and efficiently eliminated. However, as shown in the previous section, this property is activated in paper at no cost. Therefore, these "no cost" benefits of paper should be considered when performing a cost-benefit analysis for interventions or digital migrations.

5.2.2 Paper vs ICT Baseline

When considering the paper versus technology baseline and its associated costs, it is important to mention Heeks' idea of deep-vs-shallow-inscribed applications[7] and its relevance to this conversation [13]. Heeks suggests that "design-imposing" applications that point to ICT tools, either foster or force a limiting set of "processes, values, competences, systems". In general, when introducing a technological application in a setting that has limited or no technology reach, one must contend with the "design-actuality" gap [13]; that is the disparity that may exist between the actual context, and the local users and infrastructure that populates it, and the intended future design.

One can, of course, design around this gap. However, this implies financial, instructional, and acclimatization costs, especially in the developing world context. Designing for a context-specific condition will entail a careful assessment of the situation at hand. In contrast, introducing a paper intervention, or augmenting an existing paper information medium within a given setting will impose fewer systemic conditions and enable an "actuality-supporting" condition. This is because paper is most likely already embedded within an existing setting as a baseline medium of information. Therefore, the paper baseline, as opposed to the technology baseline, is in fact associated with a smaller initial design-actuality gap and reduced costs.

5.3 Exploring the Paper-Technology Spectrum

Information solutions do not have to be either paper or ICT-based. There exists a range of solutions on the paper-technology spectrum that could address the same needs. With standalone paper and ICT tools making up the extremities, the spectrum comprises of a range of hybrid paper-ICT tools that leverage the qualities of each platform to varying degrees.

In Figure 3, we place ICTs along a spectrum that determines how close each technology is to 'computers' or to 'paper'. The far-left computer end of this spectrum consists of technologies that rely solely on computer devices such as smartphone applications. They provide the most computational power but provide none of the properties of paper that we have discussed thus far. As we move to the right end of the spectrum, we start encountering hybrid solutions that trade to varying degrees computational power for paper's features. These include i) paper-like devices, essentially digital tools mimicking the look and feel of paper [11, 33, 35] whose high monetary costs unfortunately make them unsuitable for low-resource settings; ii) paper computing tools that use paper to control technological environments [15]; iii) paper prototypes that utilize paper's easy access and its ability to be quickly manipulated to simulate and test the usability of software designs in a "wizard of oz" experimental structure [2], and iv) paper composites that augment paper-based tools with computational power, but still exist to simulate computers using computer devices and electronic materials embedded in paper's fabric [4].

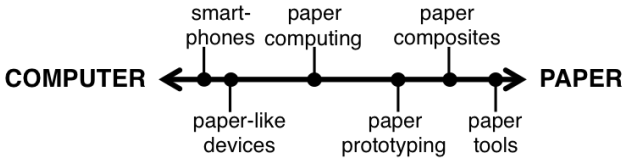

Figure 3: The Paper-Technology Spectrum

We would also like to refer our readers to a relatively unexplored design space on the paper-technology spectrum; paper tools that support computation, such as math, information lookup, and decision-making. Examples include nomographs that use scales to represent a three-variable equation that can be paired with a pen to, for example, determine ideal body mass [34]. Partographs can provide predictive feedback to midwives and they are cheap, effective, and popular in low-resource settings [7]. Tools such as these may be particularly useful in low-resource settings where organizations continue to struggle with the high development, deployment, and operational costs of digital tools.

We believe that a redirection of focus in future work may result in augmented baseline paper artifacts. For instance, Prakash et al developed an origami-based paper microscope [5] and a robust microfluidic platform based on punch card programming [17]. The authors of this paper are also invested in similar efforts to develop a system that allows a publisher to rapidly generate and print paper tools for simple computation and visualization tasks [19]. We invite researchers interested in low-resource solutions to consider working with paper as a primary medium for information.

6. CONCLUSION

In this work, we examined the role of paper in a microfinance context in Ghana. We find that paper passbooks are able to deliver valuable information to its owners that derive from the specific affordances of paper itself. Our findings encourage a more nuanced view of paper's place in microfinance and, more generally, a consideration of paper in other low-resource domains.

[7] As Heeks points out, this is based on Akrich's ideas of *obduracy* and *plasticity* of artifacts [1].

Further, it is intended to give pause to designers when considering a blanket digitization of existing paper-based tasks and procedures.

7. ACKNOWLEDGMENTS

We thank Q-star for their generous help and our participants for their time and valuable feedback.

8. REFERENCES

[1] Akrich, M. 1992. *The description of technical objects*. Shaping technology/building society, 205-224.

[2] Chandler, C. D., Lo, G., & Sinha, A. K. 2002. *Multimodal theater: Extending low fidelity paper prototyping to multimodal applications*. In CHI'02 Extended Abstracts on Human Factors in Computing Systems (pp. 874-875).

[3] Chen, K., Kannan, A., Yano, Y., Hellerstein, J. M., and Parikh, T. S. 2012. *Shreddr: pipelined paper digitization for low-resource organizations.* In Proceedings of the 2nd ACM Symposium on Computing for Development (p. 3).

[4] Coelho, M., Hall, L., Berzowska, J., and Maes, P. 2009. *Pulp-based computing: a framework for building computers out of paper.* In CHI'09 Extended Abstracts on Human Factors in Computing Systems (pp. 3527-3528).

[5] Cybulski, J. S., Clements, J., & Prakash, M. 2014. *Foldscope*: *Origami-based paper microscope.* PloS one, 9(6), e98781.

[6] Dell, N., Perrier, T., Kumar, N., Lee, M., Powers, R., & Borriello, G. 2015. *Paper-Digital Workflows in Global Development Organizations*. In ACM 2015 Conference on Computer Supported Cooperative Work and Social Computing.

[7] Fawole, A. O., Hunyinbo, K. I., & Adekanle, D. A. 2009. *Knowledge and Utilization of the Partograph among obstetric care givers in South West Nigeria*. African journal of reproductive health, 12(1), 22-29.

[8] Finn, M., Srinivasan, J., and Veeraraghavan, R. 2014. *Seeing with Paper: Government Documents and Material Participation.* In System Sciences (HICSS), 2014 47th Hawaii International Conference on (pp. 1515-1524).

[9] Ghosh, I. 2013. *The agent in a transformational m-banking ecosystem: interface or intermediary?* In Proceedings of the Sixth International Conference on Information and Communications Technologies and Development: Notes-Volume 2 (pp. 33-36).

[10] Ghosh, K., Parikh, T. S., and Chavan, A. L. 2003. *Design considerations for a financial management system for rural, semi-literate users.* In CHI'03 Extended Abstracts on Human Factors in Computing Systems (pp. 824-825).

[11] Gomes, A., Nesbitt, A., & Vertegaal, R. 2013. *MorePhone: a study of actuated shape deformations for flexible thin-film smartphone notifications.* In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.

[12] Hartung, C., Lerer, A., Anokwa, Y., Tseng, C., Brunette, W., & Borriello, G. 2010. *Open data kit: Tools to build information services for developing regions*. In Proceedings of the 4th ACM/IEEE International Conference on Information and Communication Technologies and Development (p. 18). ACM.

[13] Heeks, R. 2002. *Information systems and developing countries: Failure, success, and local improvisations.* The information society, 18(2), 101-112.

[14] Hull, M. S. 2012. *Government of paper: The materiality of bureaucracy in urban Pakistan*. Univ of California Press.

[15] Kaplan, F., & Jermann, P. 2010. *Papercomp 2010: first international workshop on paper computing*. In Proceedings of the 12th ACM international conference adjunct papers on Ubiquitous computing-Adjunct (pp. 507-510).

[16] Koker, L., and McKee, K. 2012. *Financial Crime: Risks for New Formal Finance Customers.* Available at CGAP: http://www.cgap.org/blog/financial-crime-risks-new-formal-finance-customers

[17] Korir, G., & Prakash, M. 2014. *Punch Card Programmable Microfluidics.* arXiv preprint arXiv:1408.4874.

[18] Mas, I. 2009. *The economics of branchless banking*. Innovations, 4(2), 57-75.

[19] Ming, J., Ghosh, I., Chen, J., & Abouzied, A. 2014. *Printing Paper Technology for Development*. In Proceedings of the Fifth ACM Symposium on Computing for Development (pp. 117-118). ACM.

[20] Nomura, S., Hutchins, E., and Holder, B. E. 2006. *The uses of paper in commercial airline flight operations.* In Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work (pp. 249-258).

[21] O'Hara, K., and Sellen, A. 1997. *A comparison of reading paper and on-line documents.* In Proceedings of the ACM SIGCHI Conference on Human factors in computing systems.

[22] Panjwani, S., Ghosh, M., Kumaraguru, P., and Singh, S. V. 2013. *The paper slip should be there!: Perceptions of transaction receipts in branchless banking*. In Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services (pp. 328-331).

[23] Parikh, T. S. 2005. *Using mobile phones for secure, distributed document processing in the developing world*. Pervasive Computing, IEEE, 4(2), 74-81.

[24] Parikh, T. S., & Lazowska, E. D. 2006. *Designing an architecture for delivering mobile information services to the rural developing world*. In Proceedings of the 15th international conference on World Wide Web (pp. 791-800).

[25] Parikh, T. S., and Ghosh, K. 2006. *Understanding and designing for intermediated information tasks in India*. Pervasive Computing, IEEE, 5(2), 32-39.

[26] Parikh, T. S., Javid, P., Ghosh, K., & Toyama, K. 2006. *Mobile phones and paper documents: evaluating a new approach for capturing microfinance data in rural India*. In Proceedings of the SIGCHI conference on Human Factors in computing systems (pp. 551-560).

[27] Parikh, T., Aditya, V. P. S., and Vellayutham, M. 2003. *Automated Forms Processing and Paper User Interfaces for Data Collection from Village Microfinance Groups*. Unpublished draft, http://people. ischool. berkeley. edu/~ parikh/papers/itira2003.

[28] Ratan, A. L., Toyama, K., Chakraborty, S., Ooi, K. S., Koenig, M., Chitnis, P. V., and Phiong, M. 2010. *Managing microfinance with paper, pen and digital slate*. In Proceedings of the 4th ACM/IEEE International Conference on Information and Communication Technologies and Development (p. 37). ACM.

[29] Schilit, B. N., Golovchinsky, G., and Price, M. N. 1998. *Beyond paper: supporting active reading with free form digital ink annotations*. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 249-256).

[30] Sellen, A. J., and Harper, R. H. 2002. *The myth of the paperless office*. MIT press.

[31] Sellen, A.,and Harper, R. 1997. *Paper as an analytic resource for the design of new technologies*. In Proceedings of the

ACM SIGCHI Conference on Human factors in computing systems.
[32] Sriram, M. S. 2005. *Information asymmetry and trust: a framework for studying microfinance in India*. Vikalpa, 30(4), 77.
[33] Tarun, A., Wang, P., Strohmeier, P., Girouard, A., Reilly, D., and Vertegaal, R. 2013. *PaperTab: tablets as thin and flexible as paper.* In CHI'13 Extended Abstracts on Human Factors in Computing Systems (pp. 2881-2882).
[34] Thomas, A. E., McKay, D. A., & Cutlip, M. B. 1976. *A nomograph method for assessing body weight*. The American journal of clinical nutrition, 29(3), 302-304.
[35] Underwood, H. 2012. *PartoPen: enhancing the partograph with digital pen technology*. In CHI'12 Extended Abstracts on Human Factors in Computing Systems (pp. 1393-1398). ACM.
[36] Veeraraghavan, R. 2013. *Dealing with the digital panopticon: the use and subversion of ICT in an Indian bureaucracy.* In Proceedings of the Sixth International Conference on Information and Communication Technologies and Development: Full Papers-Volume 1 (pp. 248-255).