Automated Forms Processing and Paper User Interfaces for Data Collection from Village Microfinance Groups

Tapan Parikh
Dept. of Computer Science
University of Washington
Seattle, WA 98195 USA
tapan@cs.washington.edu

Vijay Pratap Singh Aditya
ekgaon Technologies Pvt. Ltd.
Kennet Cross Road
Madurai, Tamil Nadu, India
vijay@ekgaon.com

Muthu Velayutham
Covenant Centre for Development
Kennet Cross Road
Madurai, Tamil Nadu, India
muthu@ekgaon.com

ABSTRACT

Microfinance is defined as the provision of financial services to poor, disadvantaged and under-privileged members of society, particularly in developing countries. Since the success of the Grameen Bank in the late 1970s, microfinance has emerged as a sustainable and effective method of poverty alleviation and local financial development. Recent years have witnessed an unprecedented growth in the scale and reach of microfinance services around the world.

For that trend to continue, there is a need for increased data collection and management capacity within microfinance institutions (MFIs). Accurate documentation of local transactions is required for MFIs to track the performance of their clients and to be in a position to make sound financial decisions. We have conceptualized a scalable, flexible and accessible way for MFIs to collect data from village locations using automated forms processing and paper user interfaces. In this paper we describe the technologies required in the proposed system and an operational protocol for deploying it in the field.

Figure 1: Working with microfinance group members to elicit system needs and evaluate design alternatives.

1. BACKGROUND

Microfinance is defined as the provision of financial services, including credit, loans, savings and insurance, to poor, disadvantaged and otherwise under-privileged members of society, particularly in developing countries, who would otherwise not have access to such services. Over the last twenty-five years, since the pioneering work of Muhammad Yunus and the Grameen Bank in Bangladesh [3], microfinance has emerged as one of the most effective methods of financial development and poverty alleviation in these communities.

In recent years microfinance activities have grown dramatically and extended their reach across the globe. Although no definitive statistics exist, it is widely believed that microfinance institutions (MFIs) cumulatively process hundreds of millions of dollars each year. Rates of return on microfinance loans have in some cases equaled or surpassed those in the mainstream financial sector. This has led banks and formal financial institutions to begin lending to these groups, opening up previously inaccessible sources of capital for local use.

To continue this rapid development in scale and performance, further formalization and accountability is required within microfinance institutions. Documenting each client's transaction and repayment history is important in order to track the financial performance of individual members and groups. This allows institutions to better manage their funds, lending to individuals and groups for purposes that will maximize repayment and overall benefit to the community. This kind of detailed reporting is also required when accessing capital from the formal financial sector.

This task proves to often be a large burden for several reasons. Most microfinance transactions typically occur in far-flung rural areas, making interaction with the field cumbersome, costly and potentially error-prone. Also, the raw number of small transactions that occur in a typical operation is so high that data collection, distribution and management become a serious issue. This is one of the major overhead costs involved with conducting microfinance activities and a major reason for its perceived un-sustainability.

All of these factors lead to the conclusion that having an integrated top-to-bottom management information system (MIS) for managing grassroots operations is an attractive possibility, both from an operational and financial viewpoint. If there was some way to capture local transactions

and have this data transparently and efficiently integrated into the institution's central accounting system, it would make data collection more accurate, less cumbersome, and potentially cheaper as well. This would allow the entire institution to become more efficient and allow the end users to obtain more useful information and services.

This problem has been the subject of several recent attempts to introduce digital devices into village microfinance groups to record transactions [6]. However, these efforts have largely met with mixed results due to lack of scalability and poor integration with the central institution's systems. Another issue is the user demographic. Many members of microfinance groups, especially in agrarian societies, are uneducated agricultural workers or laborers. The low literacy and educational levels of these users, as well as their unfamiliarity with technology, makes the design of an accessible client interface a challenging task and a crucial factor to the system's success. No one has yet addressed this issue in a systematic way.

We see this as a challenging system design problem, to find a way in which modern digital technology can be used to provide these community-based financial organizations the tools they need to make better decisions and improve their financial performance.

2. PROJECT OBJECTIVE

After six months of contextual study, systems analysis and participatory design experiments, we have developed an understanding of these village end users' work processes, abilities and interaction preferences. Please review our previous work for the discussion of this work [7, 1]. One consistent result is the importance of physical models and tangible artifacts. Having had years of experience recording data in ledgers and notebooks, on top of a day-to-day life filled with numerous physically-oriented tasks, these users are much more comfortable with artifacts that they can handle and touch, and have some correlation with the notebook-based data entry mechanisms they have become used to. Moreover, these users' current social work practices are built around the idea of shared physical ledger information - which can be communally viewed, exchanged and audited among members of the group.

Even semi-literate group members have learned to interpret data from paper forms. Through repeated use they have been able to memorize the tabular formats, so that they can identify personally relevant transactions. If they are numerically literate (able to read and write numbers), they will also understand the values of their transactions. These are important characteristics to maintain. It is important that any system put in place does not dis-empower the end users, as that would defeat the whole purpose of the activity.

These studies have convinced us that paper cannot be abandoned as one of the primary data entry mechanisms. 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.

However, paper as an information medium also has its drawbacks [8]. It cannot easily be searched, indexed or archived. It is difficult to perform calculations and create reports from paper data. This is an important limitation, as timely and accurate reporting is a must for the effective functioning and accountability of a microfinance institution. Given this, and the large volume of transaction and account data generated, digitization of information at some level is required for the effective management of any middle to large-sized microfinance institution. At the very least, most of the critical data at the central office should be stored digitally [10].

3. AUTOMATED FORMS PROCESSING AND PAPER USER INTERFACES

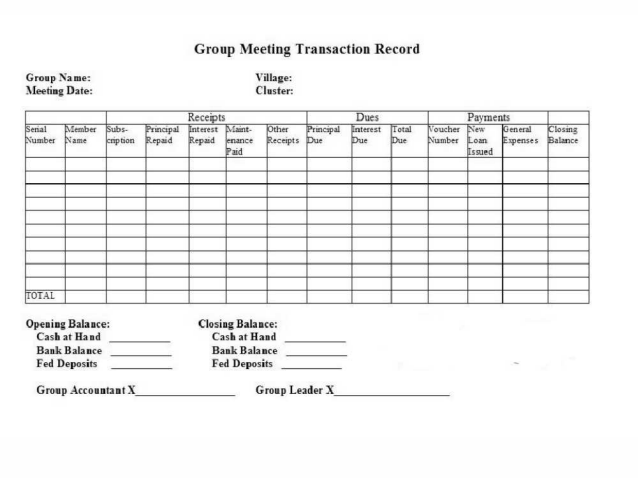
We have recently conceptualized a data collection system that suits these needs. We envision a system where data is entered, stored, and updated manually on paper in the villages. This data is then accurately and efficiently integrated into the digital data store at the institution's central office. We plan to do this using two tightly liked technologies, paper user interfaces [5] and automated forms processing [2, 9].

Automated forms processing is a new technique being used by large organizations such as governments, insurance companies, census bureaus and tax offices that have significant data processing requirements. In such a system filled-in paper forms are automatically processed by a scanning and document recognition system, which can deduce the identity of the form and extract relevant data semi-automatically. This process relies heavily on technologies such as image processing and optical character recognition. Recently this solution has been implemented by companies like IBM to automate processes such as census collection and tax form submission [4].

In our proposed system, we imagine that village end users will fill out transaction and account data in a format very similar to that which they use now (see Figure 2). This form will have been designed to be recognizable by an automated forms processing system, so that data from the form can easily be extracted. This paper form (or a digital scan of it) can be transported back to the main office, processed, and integrated into the institution's central data store.

However, automated forms processing is not an error-free process. A large potential for incorrect data extraction exists, particularly due to erroneous optical character recognition. Even now some of the best OCR systems operate only at about 80-90% accuracy. Therefore there must be a simple and effective way for end users to review the processed data, ensure its accuracy and correct any mistakes. For this we envision a role for paper user interfaces.

Paper user interfaces are paper forms with interface elements within them, such as checkboxes, buttons and entry fields. When the form is scanned, the system can parse what has been entered into these fields and take some action based on the results. Originally paper user interfaces (or PUIs) were prototyped at Xerox PARC as an interface to a document services system, where a user could print, fax or email a document to a selected list of recipients based on entries on a paper cover letter, which served as a paper user interface.



Group Meeting Transaction Record

Group Name: **Village:**
Meeting Date: **Cluster:**

		Receipts					Dues			Payments			
Serial Number	Member Name	Subs-cription	Principal Repaid	Interest Repaid	Maint-enance Paid	Other Receipts	Principal Due	Interest Due	Total Due	Voucher Number	New Loan Issued	General Expenses	Closing Balance
TOTAL													

Opening Balance:
Cash at Hand _____
Bank Balance _____
Fed Deposits _____

Closing Balance:
Cash at Hand _____
Bank Balance _____
Fed Deposits _____

Group Accountant X_____ **Group Leader X**_____

Figure 2: A sample spreadsheet format used for data collection from village groups.

Paper user interfaces would be used in our proposed system to allow users to correct errors in the automated form processing and character recognition phases. After a form has been processed and the data extracted, a report can be generated listing what data has been captured. On this report each data field would be accompanied by a check box, where a user can mark off whether or not it is correct, by comparing the value to the local physical record. In those cases where it is not accurate, the user would enter a replacement value.

After each form (or set of forms) has been automatically processed, a report can be generated and sent back to the village for corrections. The users would mark up the form and send it back to the central office for processing. Once the data has been updated, another report can be generated and sent back to the village for verification of the corrected figures. If the data still is not correct the process can iterate until no errors remain.

This is a possible protocol using automated forms processing and paper user interfaces:

1. Villagers fill out transaction entry form.
2. This form is collected by a field representative at the end of the month and transported to the central office.
3. The form is processed by an automated forms processing system, and data integrated into the central database.
4. A report is sent back to the village at the next field visit, with check boxes to indicate errors and places to enter corrections.
5. Local users compare the report to their records, check boxes with errors and enter corrected values.
6. This report is collected by a field representative at the next collection time.
7. Iterate until no errors are left in the report.

4. PROJECT BENEFITS

This paper-to-digital data collection system has many potential benefits in this application domain. The system is flexible, scalable, accessible and self-sufficient, which are all requirements for success in this setting.

Scalable Since many microfinance institutions operate on a very large, distributed scale - with many small transactions occurring regularly over a widely spread geographic area - efficient, cost-effective scalability is a requirement for any data collection system. Moreover, since the money amounts of transactions are so small, it is imperative that the incremental, per-transaction costs be kept as low as possible to maintain profitable operating margins.

Paper is a ubiquitous, easily available and familiar technology. Paper forms can be cheaply created, duplicated, distributed and transported. It is a *sustainable* solution for the institution, as the costs and overheads of paper can easily be borne by institutions in most circumstances.

Accessible As described earlier, paper is a familiar medium for the end users. After years of working with notebooks and ledgers, even semi-literate users are able to use and interpret data on paper forms. Paper also has social benefits as a communally viewable and accessible medium, which is important for establishing mutual trust and cross-verification capabilities.

Self-sufficient It is important that technology not become a limitation and source of dependence. End users need to maintain ownership of the local processes. This is important in order to maintain Mahatma Gandhi's vision of *gram swarajaya*, or village independence. Since paper is such a familiar and inexpensive medium, users can maintain their current levels of experience and ownership of the system, and be able to reason effectively about it's condition and performance. Moreover, if for some reason the technology becomes temporarily unavailable, either due to power outages, technical glitches, budget limitations, etc., a paper-based system can continue to operate without a significant interruption in protocol.

Flexible The system leaves the specific operational protocol for data collection relatively open to local control. Even though an example protocol is described above, there is much room for variation. One can imagine taking a digital camera or small scanner to the villages, and collecting digital images directly from the field. This could be advantageous if the field worker will be out for an extended period of time, and does not want to transport a lot of physical documents. Also, this saves the local users from duplicating data from their local records.

In some conditions the institution may opt to transcribe data manually from some groups. This may be for cases of remote groups with infrequent communication, or poor handwriting. The paper user interface for data correction could still be deployed as before, because even in manual data entry there can be frequent errors.

Some mixture of methods can be used based on the location of each client, the scale of the operation, the technology and infrastructure available, etc. Since microfinance institutions operate in diverse contexts and operating conditions, this type of flexibility is invaluable in allowing an institution to function effectively in different situations and to serve diverse clients.

5. RELATED WORK

Several microfinance institutions have experimented with technology-based solutions to their data collection requirements. PRODEM has successfully deployed ATM-based access points for their clients in Bolivia, including support for illiterate users through features such as a natural language interface and digital fingerprint recognition. However, this was only possible in areas with dependable electricity and communication lines, and with a huge investment in technology infrastructure that was supported by grants and government support.

Other organizations have experimented with technologies such as Palm Pilots, hand-held computers and smart card devices[6]. Unfortunately most of these efforts have met with limited success, primarily because the overhead costs of deploying technology in rural locations could not be sustained by the local economies. Our approach seeks to avoid this pitfall by judiciously deploying technology only at a central location, so that thereafter it can be supported by increasing economies of scale.

There are other forms of data collection from rural areas that have been used by the development community in their monitoring and evaluation activities. These include social science methods such as ethnography, participatory need assessment, case studies, contextual inquiry, qualitative and quantitative surveys, etc., supported by audio and video recordings. However, these largely qualitative methods are generally not appropriate for the well-defined and well-ordered data collection requirements in microfinance institutions.

6. CURRENT STATUS

The project is currently only in the conceptual stage. There has been little work thus far in actually implementing or deploying the system. One problem with the system as described in this paper is that it allows for a lot of temporary data inaccuracies between the central and remote locations. This may not be an acceptable circumstance for many organizations, so we are looking at ways to reduce the level of possible inconsistency.

Right now we are investigating options for the design or use of a suitable automated forms processing software suite. This is typically a large, complicated software system, with state-of-the art character recognition and image processing components. It would not be a simple solution to implement from scratch, so we are seeking to leverage open source tools and partnerships with existing automated forms processing service providers to expedite the implementation process.

A large concern is that the hardware and software overheads to be incurred could only be made sustainable through huge economies of scale, even with the proposed centralization of technology and hardware. One option is through the initial donation of hardware, software and technology by civil society actors such as donor agencies and national and regional governments. These types of infrastructure inputs could do a lot for the long-term sustainability and efficiency of microfinance service providers. We are currently exploring such funding options for the development of open source software and purchase of hardware, both in this and other projects.

Another concern is in the long-term service and maintenance of the hardware and software required for such a system. We are hoping that socially-oriented technology service companies, along with support from volunteers, students, universities and private companies, have a role to play in such situations.

In the meantime, we are making progress in designing and testing appropriate form layouts for use in the field. We have commenced a project to design a complete *Paper-based MIS* for those organizations that do not have the resources or capacity for any kind of computerization. This project will include the development of paper forms accessible to semi-literate users, as well as a complete data collection, management and analysis system based only on paper data formats and well-documented operational protocols. This project can show that computers are as much of a design tool as an implementation tool in the development of new technologies for rural, under-served users.

In this way, we are conceptualizing several approaches that differently leverage the paper / digital interface, and are estimating the trade-offs in terms of overhead, efficiency and infrastructure for each solution. We hope that this will give valuable insights about sustainable, appropriate information and communication technologies (ICTs) for serving these areas.

7. CONCLUSION

This project could be a compelling example of how to introduce digital technology into rural villages in a graceful, sustainable manner, without disturbing local life or making people overly dependent on unforeseen externalities. It remains true to Mahatma Gandhi's vision of *gram swarajaya*, a locally self-sufficient, independent and empowered village, by relying on locally available technologies and resources (i.e. paper) wherever possible. We hope that by using this system microfinance institutions can more effectively collect, process and store data, allowing communities to make more informed financial decisions and better manage their community capital.

In the future we hope to add other features and capabilities to the system. Paper need not only be used as a mechanism for data collection, it can be used as a way to transfer data into villages as well. We plan to experiment with novel reporting and data visualization techniques that allow semi-literate users to more effectively understand their financial positions and performance. Eventually this kind of expertise can be leveraged for local business management as well. That is another application domain we hope to tackle in the near future.

This project is just a small part of the overall vision of using scalable, flexible digital technologies for the empowerment

of local people and communities. While there are still a lot of questions yet to be answered, in the long term we foresee many applications of Information and Communications Technologies - implemented in locally appropriate ways - to make a difference in the lives of poor, disadvantaged peoples around the world.

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