Prayana: A Journey Towards Financial Inclusion

Apurv Mehra
Microsoft Research
Bangalore, India
t-apmehr@microsoft.com

Sambhav Satija
Microsoft Research
Bangalore, India
t-sasati@microsoft.com

Jacki O'Neill
Microsoft Research
Bangalore, India
jacki.oneill@microsoft.com

ABSTRACT

In this paper we present a solution built to improve loan management for auto-rickshaw drivers in Bangalore. As part of a bid to increase financial inclusion, a social enterprise (TWU) supports drivers in taking loans from mainstream banks to purchase their auto-rickshaws. Findings from an ethnographic study show that whilst providing a vital service, TWU managed its processes through an ad hoc mixture of paper and technology. Their processes enable the flexibility crucial for supporting a financially-vulnerable community, but unfortunately important information was often not to-hand, leading to sub-optimal decisions being made about loan allocation. We developed and deployed an integrated technical solution to support TWU's work. In this paper, we describe the back-office solution and how it has assisted the organization in streamlining its operations, supporting more informed decision making and providing the opportunity to scale-up their operations.

CCS CONCEPTS

•Human-centered computing → Interactive systems and tools;

KEYWORDS

Financial Inclusion, HCI, System, India

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1 INTRODUCTION

Achieving financial inclusion involves making financial services *accessible* and *affordable*, and addressing the barriers restricting people from participating in the financial sector [15]. Approaches aimed toward solving this problem include 1) Zero balance accounts (such as the Jan-Dhan account [3]); 2) branch-less banking and mobile money [5] 3) financial education [1]. However, the barriers to accessing financial services are many, and go way beyond being able to open a bank account [9]. Thus active take up of financial services by low income populations has remained poor. For this reason, there is a thriving micro-finance industry providing small scale savings and loans to the poorest populations [10]. However, a gap remains between the small loans provided by micro-finance and those readily able to access mainstream financial services, such as larger loans. Intermediaries, such as NGOs and social enterprises, can plug this gap [9] [6], by enabling access to mainstream financial services.

Auto-rickshaw drivers (or auto-drivers) are a prime example of a community which could benefit from access to mainstream financial services, but are currently largely excluded. An auto-rickshaw costs around 1.5 lakh rupees ($2300) and auto-drivers face many barriers to securing and managing a loan. Banks are unwilling to lend to drivers because they lack credit ratings and have high default rates. Furthermore, auto-drivers, who have a range of education levels, often do not have an active bank account, may not have easy access to all the documentation, enough collateral or the ability to raise an adequate deposit. Even when drivers do secure a loan, their low, unpredictable daily cash income makes the monthly payment schedule hard to meet. Auto-drivers are financially vulnerable, and few are able to save [14] [12]. They are vulnerable to shocks, from illness to auto breakdown, thus making long-term, consistent loan adherence difficult. Three Wheels United (TWU) is a social enterprise which acts as an intermediary, helping auto-rickshaw drivers to secure loans from mainstream banks to purchase their auto-rickshaws. TWU helps to address the barriers they face; standing guarantor for the loan, and managing the entire process on behalf of the drivers, from paper work, to collections.

In this paper, we describe a technology intervention designed to improve loan management by addressing various needs identified in an ethnographic study [14]. We have built an integrated solution consisting of a web app, an assisted allocations system, and a mobile app to be used by the loan collectors with the drivers in the field. In this paper, we focus on the parts of the system - the web app and assisted allocations - which support the back office work, making it more streamlined, efficient, scalable and improving accuracy. We believe the solution presented here is generalizable to other organizations managing loans for low income communities. In the following sections, we describe how TWU was operating before our intervention, introduce the related work and describe our intervention in detail.

2 BACKGROUND

2.1 TWU and Namma Auto

The first version of TWU's *Namma Auto* (Our Auto) scheme was launched in October 2010 [11]. A typical auto loan has two components; the main loan and a down payment (see Table 1). Currently, the main loan is sourced from a mainstream bank. Drivers provide part of the down payment, whilst the rest is sourced from micro-finance organizations, like MicroGraam. TWU charges a fixed monthly fee of 390 rupees per driver for managing the loans.

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Table 1: Different schemes for auto drivers in INR

Bank	Loan	SD Loan	TWU Fees(p.m.)	Monthly
Corporation	1,08,000	22,500	390	5200
Canara	1,28,000	13,500	390	5200
Kanaka Durga	1,30,000	13,770	390	5460

Each payment received must be allocated between these three accounts (or buckets), such that the loans do not go into default, but that TWU also has enough income to cover its outgoings.

Once issued, loan collections are managed by 1) *collectors*, who manage a set of drivers: chasing them up, collecting payments, and depositing the money in the bank; 2) *community organizers* who run various community development activities, but also take loan payments when they meet the drivers; 3) the *finance officer* who allocates the money received from each driver on a weekly basis between the three accounts. Drivers have various payment schedules including daily, weekly or no fixed schedule; furthermore drivers payments are rather erratic and most drivers are behind in their loan [14]. The main loans are sourced for 60 months, but TWU fixes the monthly amount so drivers should repay in 40 months. This essentially provides a buffer for the missed payments which are almost inevitable in a long-term loan to such a financially vulnerable community.

2.2 Ethnographic study

We conducted an ethnographic study of loan collection and repayment practices in 2015 [14]. The intervention described here was motivated by the following findings; 1) A core part of TWU's work is to enable flexibility in loan repayments, given drivers' precarious circumstances. 2) TWU managed its processes and practices through an ad hoc mixture of paper and digital systems. Out in the field, loan management processes were largely paper-based, supporting flexibility, but limiting the amount of information available to collectors and drivers to support loan management. In the back office, TWU used Cyclos, an open source banking system, chosen because TWU has limited resources for software development. However, because Cyclos is designed for traditional banking processes, once deployed it became apparent that it lacked the flexibility to support TWUs processes. To circumvent this, data was stored across many Excel sheets. 3) The relationship between collectors and drivers is crucial to payment, collectors do not just collect cash from the drivers, they persuade, counsel and otherwise chase up payments. 4) The ideal payment program would be daily collections, but this is costly and difficult to manage. TWU tried mobile payments but inadequate mobile money infrastructure meant drivers could not easily change cash to digital money on a daily basis [14]. 5) Drivers frequently underpay so the finance officer has to manually allocate the money between the three buckets. Since the loan information is distributed across hundreds of Excel sheets, in practice he did not have the information to hand to make informed choices.

Understanding these problems and orientations led us to design an intervention addressing the pain points in the back office and field work. Our aim is to better inform the decision making of all the actors (finance officer, collectors and auto-drivers) whilst enabling the flexibility required for effective loan management. In this paper, we focus on back office systems.

2.3 Technical Infrastructure of TWU

In this section we describe the technical infrastructure that was in place before the intervention.

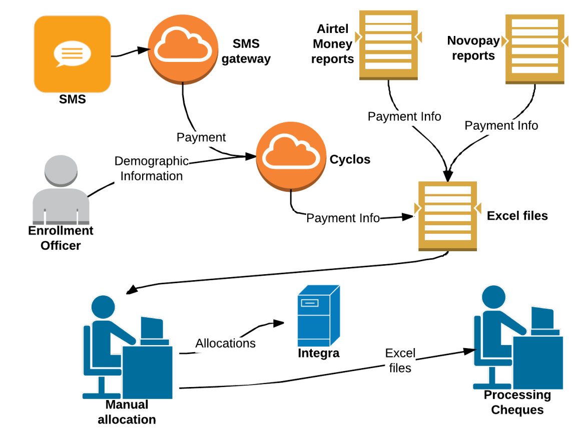

Figure 1: Workflow with previous infrastructure.

Cyclos and Cloud Infrastructure: The core cloud infrastructure of TWU was a Cyclos instance (https://www.cyclos.org), which contained driver demographics and loan information, such as loan start date, total amount for each loan, EMI, etc. As a traditional online banking application, Cyclos had a number of limitations for this setting. It could not record cash transactions happening in the field, did not allow allocations to multiple accounts, and restricted drivers to a single broker.

SMS Server: To track collections in the field, TWU deployed an SMS Server. Collectors send an SMS when they collect a payment, this updates Cyclos and sends the driver a digital receipt. For various reasons, collectors usually sent batch SMS at the end of the day (or week!) and drivers primarily relied on their TWU passbooks for record-keeping and receipting (see [14]). The service suffered from the typical problems of delayed, lost and duplicate messages.

Integra: TWU had a custom application for allocating payments and tracking allocations, Integra, which was designed to pull payment information from Cyclos and perform allocations for each driver. However, it failed for two reasons 1) it did not account for payments collected from other sources, e.g. mobile money; 2) it could only process monthly allocations. However, the loan due date is determined by the loan start date, so drivers had different due dates. It was not possible for the finance officer to manually track when each driver's loan was due, making weekly allocations necessary. These issues resulted in the software not being used operationally.

Excel Sheets: Instead of Integra, Excel sheets were used for allocations, becoming the primary source of loan information. The finance officer exported the payment report from Cyclos, collated it with information collected from mobile money and made allocations on the Excel sheets. This was used to prepare a report for the accounts officer who issued the cheques to the banks. TWU had accumulated hundreds of Excel sheets, which collectively contained a detailed history for each driver, but given the constraints of manually allocating the loans of hundreds of drivers on a weekly basis, this information was unusable in practice.

As is evident from Figure 1, lots of information about a driver's loan is captured but is stored in silos, which essentially makes it unusable. The lack of interoperability between systems and improper digitization resulted in poor allocation decisions, including sending money to drivers' deposit loan when it was already paid off, and prioritizing the wrong bucket resulting in late fees for the driver. Furthermore, manual allocations were a major bottleneck for TWU. In the field, both drivers and collectors lacked accurate information on the state of the loan, meaning collectors did not always prioritize drivers who were falling behind; drivers sometimes claimed to have already paid (e.g. through mobile money); and drivers had little understanding about the extent and consequences of their chronic underpayment on the length and cost of the loan.

3 RELATED WORK

For financial services designed for inclusion to have any measurable long term impact, it's imperative they have a sustainable business model. Cross country studies suggest that wider penetration of ICT technologies such as mobile phones can help financial inclusion [8] [16]. Mobile money has proved a valuable addition for promoting and supporting financial inclusion in Kenya [4]. ICT-based financial services built on M-PESA to increase financial inclusion include Kilimo Salama (safe agriculture), an agro-insurance product [17], and M-KESHO, which integrates M-PESA with formal bank accounts [2] [17]. In 2010, the Reserve Bank of India issued a policy which allowed agents to act as Business Correspondents (BC) for banks, hence providing a range of banking services to the people locally [13]. A recent study conducted in Karnataka, India suggests that the doorstep delivery of financial services, which would not be possible without mobile technologies, combined with the fact that local agents encourage people to save more, has resulted in increased savings for rural households [7]. Our system contributes to the space of designing sustainable ICT solutions to improve financial inclusion by addressing some common challenges faced by intermediaries.

4 SYSTEM DESIGN

Figure 2 gives a high-level overview of our system, which integrates with the legacy applications wherever possible to avoid any loss or mismatch of data. The design process was bottom-up and iterative. To build the mobile app, information on payments, allocations and so on needed to be digitised. We took this as an opportunity to help TWU with their manual time-consuming allocation process. As well as observing manual allocations, We held multiple design sessions with TWU management and the loan officer, as system design progressed. Once in operation, we also added new features where appropriate. Below we describe the system in more detail.

4.1 Web Service

Our intervention acts as an integrator of information from disparate sources. The web service acts as a wrapper on top of Cyclos

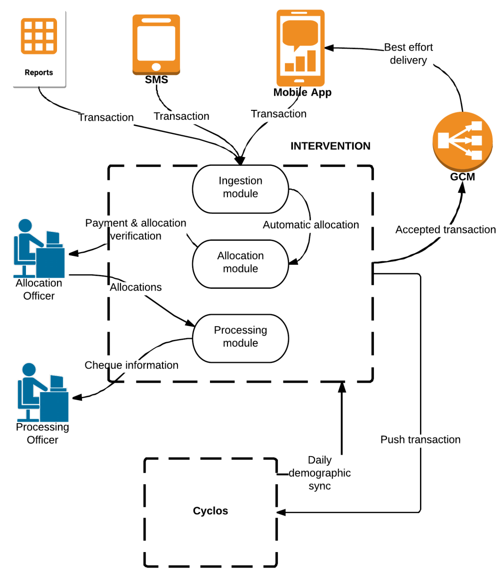

Figure 2: High-Level architecture and workflow .

to provide the additional features necessary for supporting cash collections, allocations and disbursement of money. The web service can be broken down into the following broad modules:

Ingestion Module: This module collates the data from disparate reports. TWU supports multiple payment mechanisms and it is imperative to have complete and accurate information on collected payments before allocating them. The ingestion module currently takes reports from mobile money, SMS, Cyclos, as well as REST APIs to add new payments, providing the finance officer with an accurate representation of all the various collections.

Allocation Module: This is the core module of the system, which helps maintain data in a consistent manner, enforces checks to avoid miscalculations and makes intelligent allocation suggestions (discussed in the next section) according to insights drawn from a driver's past payments and current loan status. The allocation system displays the current status of each bucket, next to the suggested allocation for this month, and clicking on a driver brings up their allocation history. The finance officer can choose to accept the systems suggestions or edit the fields. Whichever choice he makes, he now has more information to hand. Furthermore, by default *each drivers* allocations are now done on a monthly, not weekly, basis, determined by their loan due date. This mean they they take into account all the money that has been collected that month, enabling better informed choices given the often erratic payments made. Finally, drivers are given a risk status (of 0-10), with those about to go into default categorized between 8-10. Such drivers appear on the allocations every week, regardless of loan due date, and are highlighted, so the finance officer can choose to funnel payments to their accounts immediately.

Processing Module: Each week, an accounting officer prepares the outgoing payments to the banks. The incoming payments and verified allocations are stored and are searchable. Each driver's profile contains the payment and allocation history. The complete flow of a payment (collection, allocation, processing and outgoing to bank) is captured in the system, and is easily filterable and downloadable as Excel reports.

Security and Auditing: The service has multiple checks in place for preventing loss and modification of data, either malicious or accidental. We use a Role Based Authentication and Control system, with each role following the principle of least privilege. Roles include Administrator, Finance Officer, Accounting Officer, and Collector. At the application layer, we protect historic data by disallowing modifications to any payment that has been allocated. All historic allocations are saved in a different table where updates and deletes are disabled. All modifications to the database are saved in audit logs using database triggers.

4.2 Algorithm for Allocation

In the deployed system, allocations are computed according to comprehensive heuristics defined with TWU. However, this limits the extensibility of the system. Introducing new loans with different amounts, payback periods and loan sourcing agreements means re-writing the algorithms. Therefore, to allow flexibility in the loan allocation system, we have designed a generic solution to allocating amounts in an arbitrary number of buckets according to the priorities and fines assigned to them.

4.2.1 Making the generic allocation algorithm. A generic loan in a similar setting from n sources can be mathematically defined as follows:

Definition 4.1. For a loan with sources $S_1, S_2, ...S_n$:
Current paid off balance: $B = \{b_1, b_2, b_3, ...b_i, ...b_n\}$
Priorities(weighted): $P = \{p_1, p_2, p_3, ...p_i, ...p_n\}$
Buffer amount before fine is levied: $L = \{l_1, l_2, l_3, ...l_i, ...l_n\}$
Fine for amount less than buffer $F = \{f_1, f_2, f_3, ...f_i, ...f_n\}$
Payment expected this month $Q = \{q_1, q_2, q_3, ...q_i, ...q_n\}$
Total amount paid (to be allocated) = T
Let the amount allocated towards S_i be x_i, then we know:

$$\sum x_i = T; x_i \geq 0;$$

We define an auxiliary variable σ_i by the equation $b_i + x_i = l_i - \sigma_i$, using which, the cost y_i for each bucket is defined by

$$y_i = \begin{cases} max(0, \sigma_i) f_i p_i & \text{if } b_i + x_i \leq l_i \\ 0 & \text{otherwise} \end{cases}$$

To prevent overallocation into any specific source, we define the following constraints on an auxiliary variable z by

$$\forall i \begin{cases} z \geq 0 & \text{always;} \\ \dfrac{x_i - (l_i - b_i)}{p_i q_i} \leq z & \text{if } l_i > b_i \\ \dfrac{x_i}{p_i q_i} \leq z & \text{if } l_i \leq b_i \end{cases}$$

Our linear objective function is the sum of the cost incurred $\sum_{i=1}^{n} y_i$ and the allocation distribution factor z. Given b_i, p_i, l_i, f_i and q_i $\forall$ i, solving the system of linear equations for

$$\min \sum_{i=1}^{n} y_i + z$$

gives us the values of each corresponding x_i, the amount of allocation per bucket.

4.2.2 Comparing results with historic allocations. Since the deployment of the system, the heuristic-based assisted allocation has helped (191 suggestions were taken as-is, and modifications were made in 283 cases) in 474 allocations combining 588 payments. To test our generic algorithm, we created a dataset using the historic loan information used at the time of each allocation. The priority and fine per bucket were provided by TWU (ref table 2).

Table 2: Parameters required for making allocations

Bucket	Priority	Fine	Flexibility Range
Loan	3	100	3 months
SDL	1	100	1 month
TWU	2	100	1 month

We define the evaluation metric to be the total fines levied from the driver for an allocation. Using the historic 588 payments and 474 allocations, we created a baseline dataset with the most optimal allocations to reduce fines. We then compared how the new generalizable algorithm performed on this dataset to how the finance officer performed using the assisted allocation system. The results for our initial tests are summarized in Table 3 which shows that the automatic system resulted in less fines.

Table 3: Comparison with baseline allocation.

Total Fine	Automatic	Assisted
Extra Fine	6	27
No Change	468	447

Allocations can only be improved where the payment lies on the borderline for fine, so many cases necessarily fall in the *no change* category. Nonetheless, it is encouraging to see that the new algorithm performs better than the finance officer using the assisted system because it suggests that it captures the nuances of varying allocations to each bucket based on different payments. Since our initial dataset has limited data points and one use case (three buckets, fixed fines for all buckets etc.), we still need to rigorously test our algorithm for more generic use cases, but these initial results are hopeful.

5 FUTURE WORK AND CONCLUSION

The web service and assisted allocations were deployed in January 2017 and have become an integral part of TWU's operations. It has streamlined their processes, removing the bottleneck of manual allocations. Allocations are now faster, made on a rolling monthly basis according to due date and with more information to hand. This supports the flexibility required for effectively managing loans for a population whose circumstances mean payment frequencies are erratic and underpayment common. Furthermore, the web app is the one-stop port of call for drivers payment and allocation histories, whilst maintaining the legacy systems. We will deploy the generalizable allocations algorithm soon, to support more varied loan types, and are finalizing the mobile app to be deployed in the field.

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