Emerald Insight

Kybernetes

System dynamics to turnaround an Indian microfinance institution
Ritika Singh Chandan Bhar

Article information:

Users who downloaded this article also downloaded:

For Authors

If you would like to write for this, or any other Emerald publication, then please use our Emerald for Authors service information about how to choose which publication to write for and submission guidelines are available for all. Please visit www.emeraldinsight.com/authors for more information.

About Emerald www.emeraldinsight.com

System dynamics to turnaround an Indian microfinance institution

Ritika Singh and Chandan Bhar

Department of Management Studies, Indian School of Mines, Dhanbad, India

Abstract

Purpose – The purpose of this paper is to present a policy comparison tool for Indian Microfinance Institutions (MFIs) so that they can choose the best policy for implementation. It provides for turnaround of a troubled MFI by analyzing the performance of different policies.

Design/methodology/approach – The paper has done a web survey to identify the need of a strategic tool for MFI. It has built a Decision Support System (DSS) using system dynamics. A corporate model of MFI has been constructed using iThink 10.0.2 software. A quantitative validity test has been done to find the robustness of the model. Finally four policies are tested and the performance indicators have been used to suggest the best policy. Apart from this DSS is used to test the implementation range of a policy.

Findings – "Integration of Microfinance with country's mainstream financial system along with provisioning 1 percent of outstanding loans" is recommended for the MFI as this will increase the financial performance.

Research limitations/implications – In its present form the corporate model developed for MFI is not applicable for judging social performance. Therefore MFIs might be sceptic toward it. However, incorporation of certain performance indicators such as financial-self-sufficiency ratio might help in overcoming this reluctance.

Practical implications – "Integration of Microfinance with country's mainstream financial system along with restricting provision" will generate better performance for the MFI. Therefore this policy should be implemented by the MFI. There are other considerations which need to be taken into account while implementing this policy. The integration may require outsourcing of certain operations to banks, utilization of bank branches to disseminate knowledge related to the conduct of transactions, usage of customized bank software to handle the day-to-day business, development of new softwares for mobile messaging to help poor customers avail of schemes run by the banks, fill loan application forms online, send reminders for loan recovery; provide incentives such as upgradation of poor customers to become regular customers of banks.

Social implications – By improving the health of the MFI a bigger goal to reach the poor will be achieved in the long run. The MFI has around five million clients at present and if the company becomes insolvent then the future of these clients is going to be impacted. The organization has interacted closely with these clients and therefore knows how to upgrade their financial state.

Originality/value – The tool is first of its kind in the microfinance industry. So far the microfinance technology providers have dealt with Management Information System and Information and Communication Technology. The tool has been built to present a quantitative model for overall operations of the MFI. The simulation of this model helps in predicting future scenarios.

Keywords Microfinance, System dynamics

Paper type Research paper

1. Introduction

Microfinance industry was defined by Morduch (1999) as "All the institutions which share a commitment to serving clients with low-incomes that have been excluded from the formal banking sector are part of the microfinance industry". The industry is in existence for more than a decade now. In the past five years microfinance sector witnessed tremendous growth and most Microfinance Institutions (MFIs) transformed

from NGO to for profit companies. (www.centre-for-microfinance.org/wp-content/uploads/attachments/csy/1602/IIM%20Regulation%20V11.pdf). At present the Indian microfinance industry is witnessing lot of hot debates, roundtable retreats about future microfinance policies. The MFIs (Development and Regulation) Bill, 2012 was staged in the Lok Sabha in 2012 (www.sa-dhan.net/Resources/MFI%20Bill%202012%20as%20introduced%20in%20Loksabha.pdf). A Report of the Sub-Committee of the Central Board of Directors of Reserve Bank of India to Study Issues and Concerns in MFI Sector was submitted in 2011 by Y.H. Malegam which raised many policy issues (www.rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage = &ID = 608).

There are various platforms of policy advocates such as MicrofinanceIndia (www.microfinanceindia.org/).

However, "Of the 76 Indian MFIs in the database 12 had return on equity less than 5 percent. Only three MFIs had return on equity in excess of 100 percent. In all, 21 institutions had return on equity in excess of 25 percent. Very low return on equity in a sector with high-profit potential – with not too much difference in loan pricing – does not speak well of organizational and managerial abilities" (Microfinance India: State Of The Sector Report, 2010). There are no quantitative testing tools to understand the long-term consequences of the policies. The implications are derived intuitively leading to less efficiency.

The role of technology in enhancing the capabilities of managerial or strategic decisions is limited in the industry. To support this argument a survey of 130 microfinance technology providers was conducted regarding the kind of technology used. The website of these providers was visited to get a description of the technologies provided by them (Table AI). It can be concluded from this that most of the technologies are Management Information Systems (MIS), Information and Communication Technology. MIS revolves around loan origination, tracking, accounting and payroll system. This finding supports the literary definition of MIS "an integrated, user machine system providing the necessary information to support core functions of the firm such as operations, management, and decision making" (Trivellas and Santouridis, 2013). Only one attempt to create Decision Support System (DSS) has been found so far. Two researchers from General Electronics have identified the potential use of DSS in MFI loan recommendation based on fuzzy arithmetic (Bhaskar and Subramanian, 2011). This DSS is for semi-structured problem. Initially, the decision of loan disbursement was based on incomplete input data. Using fuzzy logic this input data was made more objective thus making loan disbursement more effective. This DSS is for operational decision making in MFI. Thus the understanding of information system infrastructure at MFIs reveals that there are no tools of strategic importance.

The objective of this paper is to develop a System Dynamics (SD) model to improve performance of Indian MFIs. The paper allows for comparison of performance under different policies for a loss making Indian MFI. The paper is structured in following eight sections. The next section uses literature review to critiques the research done in financial services sector. The third section suggests the approach for SD modeling and also shows the causal loop diagram built for MFI. The fourth section details out the service sector iThink equations and the rationale behind it. The Validation section calculates the root mean square error for key variables of the model. The sixth section shows the model behavior in normal conditions. The seventh section suggests different policies to test the performance of MFI. Finally, discussion and conclusion section compares MFI financial performance under different policies and suggests one policy that will turnaround a for profit MFI and also suggests future research work.

2. Literature review

Finance sector is closely related to the microfinance sector as cash is the stock which is traded in both these sectors. Finkenwirth and Doll (1988) presented a SD paper which is for the management of a commercial bank. It shows causal loop diagrams for the lifecycle of different products in the bank. The maturity of the product and pricing of the product are endogenous parameters decided based on volume of the product. With the help of feedback loops it tries to balance the asset and loan sectors. However, this approach is not suited for the MFI as there is no savings facility. Hence need for Asset Liability management is minimized. On further review of literature it was found that www.academia.edu/5135875/Simulating_a_Banking_Crisis_Using_ a_System_Dynamics_Model captures a banking crisis using SD modeling but it includes the saving service of bank in the model. MacDonald and Dowling (1993) presented a stock and flow diagram of saving and loan industry for analyzing the default risk. Since microfinance is a sector where repayment is around 95 percent therefore taking up this kind of analysis is not appropriate. Quaddus and Intrapairot (2001) used SD to analyzes the diffusion of technology in a large bank. This approach uses an advanced technology for diffusion. Microfinance is still lagging far behind in the use of technology. Most of the firms are NGOs and only recently converted to for profit organizations. www.stlouisfed.org/~/media/Files/PDFs/Community% 20Development/WashU-Social-Sciences-Design-Lab-Report-1-21-11.pdf presents a causal loop diagram to analyze the impact of banks on banked and under banked population. The diagram uses lots of soft variables which are difficult to capture and also the bank performance is ignored. Pruyt and Hamarat (2010) built a stock and flow diagram for failure of DSB bank. They use liquidity failure to analyze the concerted run on the bank before the start of crisis. The framework is not useful for analyzing the failure of a MFI as its operations are different. Anderson *et al.* (2011) use SD to capture the loan and asset segment but here the model has been quantified using regression equations. As the loan type varies from real estate and construction, household sector, equity loan and others. However, microfinance repayment uses single type of loan with fixed repayment period and interest therefore it can avoid using regression which does not give exact result for calculation of repayment.

The above review of literature points out to different problem areas of a financial services sector which mostly analyze risk. Few papers have modeled the operations of a bank but the technique used for quantification follows weak methodology and there is no validation for the models. Another big gap which exists in literature is that none of the above models use financial system of the institutions for analysis. Very recently the balance sheet and other financial statements have become input for the analysis using SD model. Roy and Koul (2009) use financial system of a steel plant to measure the performance. Nair and Rodrigues (2013) used SD to capture the health of a company using financial parameters.

3. Methodology

SD can resolve a problem from an integral and system point, seeking the internal relations and factors, at the same time, focussing on the dynamics and causal relations between factors; it is a better choice for simulations under different conditions (Hu *et al.*, 2007). It not just provides the result for long-term analysis but also helps in understanding the underlying linkages and relationships among different factors. The SD process has two main stages: qualitative analysis and quantitative analysis (Liao *et al.*, 2015). The qualitative analysis uses causal loop

diagrams for representation. The decisions being made in the MFI are intuitive leading the company to a loss making state. However, SD can provide counterintuitive solution to the company and also help in convincing the top management. Financial parameters would help in making the arguments stronger. Recently agent based modeling (ABM) has been used for policy testing (Lattila *et al.*, 2010). Since it does not use qualitative techniques for modeling ABM is not preferred. Causal loop diagram (influence diagram) can be understood by non technical staff and therefore it becomes easier for branch managers to approve the mental model.

Researchers must identify important variables and relationships among them in the MFI. Following the above approach causal loop diagrams were prepared for four sectors of the MFI separately which were finally integrated. The service sector has a systemic feedback loop which entails flow of fund in the organization. Figure 1 shows the flow of fund in MFI. Since the model is built for measuring financial performance therefore customers are kept outside the boundary of the system. They should be included only if social performance is to be computed. The other sectors are supporting sectors and help in analyzing the performance of the firm. Following is an adopted structural overview of MFI (http://chiapasinternational.org/about-us/about-microfinance/).

3.1 Service sector
The influence diagram of the service sector is presented in Figure 2. The availability of fund and demand for loan by customers decides the loan disbursement rate. Loan outstanding and EMI decide the principal paid and further decide the Loan repayment rate. A positive feedback loop is indicated here Fund-Loan Outstanding-Loan Repayment.
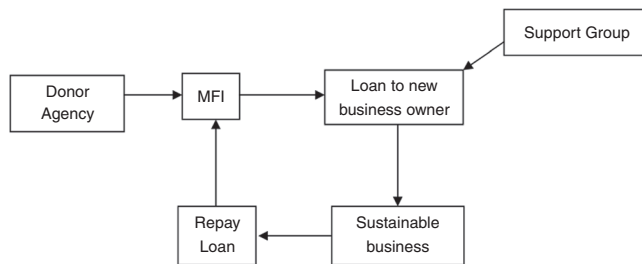

Figure 1.
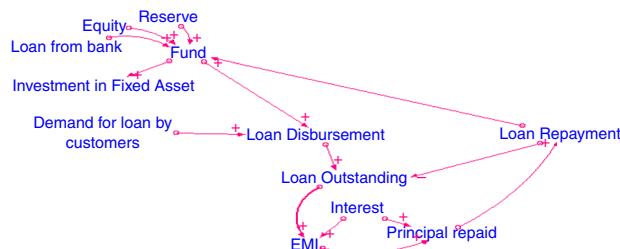Cash flow in the operations of MFI

Figure 2.
Causal loop diagram for service sector

3.2 Finance sector

The influence diagram of the finance sector is presented in Figure 3. Total revenue is decided based on interest from the loan outstanding and the revenue from assigned loans. Total expenses are the sum of admin and operating expenses, personnel expenses and provision. Gross profit is the difference between total revenue and total expenses. Financial expenses are decided based on loan from bank and interest on it.

3.3 Financial ratios sector

The influence diagram of the financial ratios sector is presented in Figure 4. The diagram uses financial formulas for representation of the ratios. The different ratios are debt-equity ratio, net worth equity ratio, Return on Equity (ROE), ROA, ROCE, profit per employee, operating ratio and financial-self-sufficiency ratio.

3.4 Asset and loan sector

The influence diagram of the asset and loan sector is presented in Figure 5. The loan from bank is decided based on discrepancy between available fund and demand of loan from customers. Value of asset and life of asset decide the depreciation. Capital employed is sum of fixed asset and loan outstanding. Since Capital employed formula is difference between total assets and current liabilities. Here in the diagram total asset is sum of capital employed and current liabilities.
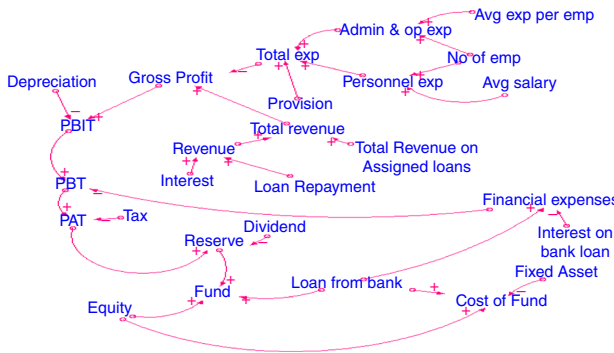

Figure 3.
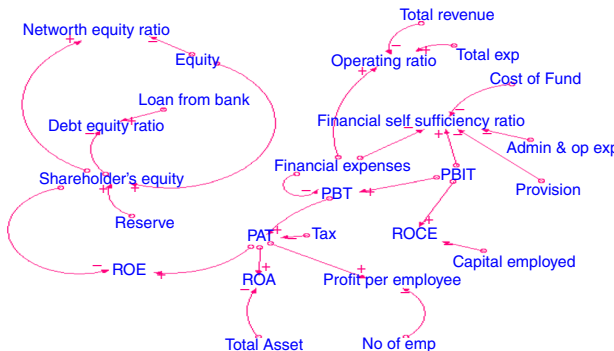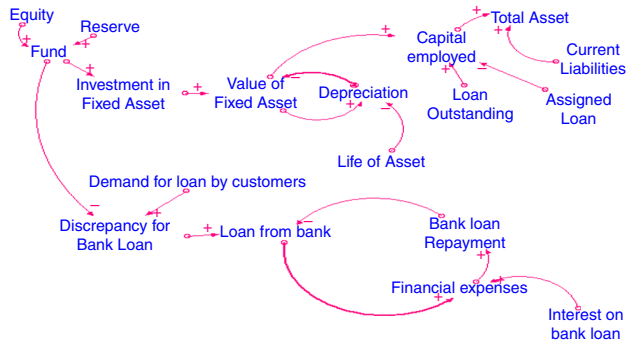Causal loop diagram
for finance sector

Figure 4.
Causal loop
diagram for financial
ratios sector

4. The model

The paper has chosen a known Indian MFI to build the model. This MFI has more than 1,200 branches all over the country. It has more than five million clients. The company converted from a non-profit NGO to profit Non-Banking Financial Company (NBFC) in 2005. The loan is only for female. The MFI follows Joint Liability Group model as part of lending model. It is up to the group how cash is invested. The MFI only ensures that the cash is used for productive purpose. Mostly the occupations involve tailoring, hotel service, hawkers, candle making, bamboo items making, poultry, sheltering items making, brick manufacturing and cobblers. It distributes loan in small amounts of Rs 2,000-12,000. The MFI gives loan at 24.55 percent annual effective interest rate. Term of loan is around 50 weeks.

The SD model for MFI has been developed using iThink 10.0.2. The SD model developed is calibrated with the help of historical data for the period from Quarter 1 of Financial Year 2010 to Quarter 2 of Financial Year 2012 collected from the microfinance company's Quarterly reports. The model consists of one exogenous variable, two time varying variables, nine-level variables and four delays. The model consists of 84 iThink equations. These equations form part of five sectors. Here only MFI service sector is discussed.

Formal description for repayment of loans is given below.

Loan is repaid in almost four quarters. Say in the first quarter loan disbursed was A. This will be repaid in parts A_1, A_2, A_3, A_4 in second, third, fourth and fifth quarter, respectively:

$$A = \sum_{i=1}^{4} A_i$$

In the second quarter loan repaid will be A_1. Say in the second quarter loan disbursed is B. This will be repaid in parts B_1, B_2, B_3, B_4 in third, fourth, fifth and sixth quarter, respectively:

$$B = \sum_{i=1}^{4} B_i$$

In the third quarter $B_1 + A_2$ will be repaid. Say, if C is disbursed in the third quarter then it will be repaid in parts C_1, C_2, C_3, C_4 in fourth, fifth, sixth and seventh quarter, respectively:

$$C = \sum_{i=1}^{4} C_i$$

In the fourth quarter $C_1 + B_2 + A_3$ will be repaid. Say, if D is disbursed in the fourth quarter then it will be repaid in parts D_1, D_2, D_3, D_4 in fifth, sixth, seventh and eighth quarter, respectively:

$$D = \sum_{i=1}^{4} D_i$$

In the fifth quarter $D_1 + C_2 + B_3 + A_4$ will be repaid. A is completely repaid in the fifth quarter. Hence A, B, C, D cycle is complete. Say newA is disbursed in the fifth quarter. Now B, C, D, newA will form a cycle. In sixth quarter, new $A_1 + D_2 + C_3 + B_4$ will be repaid.

This section provides the equation stock loan disbursement. The inflow rate is denoted by LoanDisbOR. The outflow rate is Loan Repayment:

$$LoanDisb(t) = LoanDisb(t-dt) + (LoanDisbOR - LoanRe) \times dt$$
$$LoanDisbOR = MIN(Fund, DLoan[1])/1$$
$$LoanRe = (Total\_Repayment + Provision)/1$$

DLoanInt is a graph function which uses MFIs past quarterly data of loan disbursement for ten quarters:

$$DLoanInt = GRAPH(TIME)$$
$$(1.00, 1263), (2.00, 1969), (3.00, 2050), (4.00, 2336), (5.00, 2283), (6.00, 3171),$$
$$(7.00, 1590), (8.00, 786), (9.00, 900), (10.0, 721)$$

In order to implement the logic we need to store A, B, C, D. Till A is repaid we need to store its value from first through fourth quarter. This is needed to compute the part repayments (A_1, A_2, A_3, A_4). DLoan[i = 0] stores DLoanInt value in an array. Say, in the first quarter DLoan[i] is A. In the second quarter DLoan[i+1] is A due to 1 delay and DLoan[i] is B. In the third quarter DLoan[i+2] is A due to 2 delay, DLoan[i+1] is B due to 1 delay, DLoan[i] is C. In the fourth quarter DLoan[i+3] is A due to 3 delay, DLoan[i+2] is B due to 2 delay, DLoan[i+1] is C due to 1 delay and DLoan[i] is D. Therefore value of A is available in all the four qaurters.

Model uses four EMI variables for each of the A, B, C and D loan. Here computation for 1 EMI variable is shown. It is a nested if then loop which tests time for if condition and accordingly computes value. Loan is to be repaid within 50 weeks, i.e. 3.85 quarters:

EMI1 = if(time = 1) then (EMIInt1) else (if(time = 2) then (EMIInt2) else (if(time = 3)

then (EMIInt3) else (if(time = 4) then (EMIInt4) else (if((timemod4) = 1)

then (EMIInt1) else (if((timemod4) = 2) then (EMIInt2) else (if((timemod4) = 3)

then (EMIInt3) else (EMIInt4)))))))

$$\text{Interest} = 0.2455/4$$
$$\text{EMIInt1} = -\text{pmt}(\text{Interest}, 3.85, \text{DLoan}[i], 0)$$
$$\text{EMIInt2} = -\text{pmt}(\text{Interest}, 3.85, \text{DLoan}[i+1], 0)$$
$$\text{EMIInt3} = -\text{pmt}(\text{Interest}, 3.85, \text{DLoan}[i+2], 0)$$
$$\text{EMIInt4} = -\text{pmt}(\text{Interest}, 3.85, \text{DLoan}[i+3], 0)$$

Total_Principal1 is the stock variable where the principal repaid every quarter gets accumulated. To calculate current principal part one needs to keep an account of the sum of principal part repaid in previous quarters. Say $A_1 + A_2$ has already been repaid then Total_Principal1 = $A_1 + A_2$. Also the remaining principal is $A - (A_1 + A_2)$ which is equal to $A_3 + A_4$. We can get A from DLoan. Interest on the principal $A_3 + A_4$ is subtracted from the EMI to get principal component to be repaid this quarter which is A_3. 4 variables are used for computing principal part for each of A, B, C, and D loan. Here only 1 variable is shown:

ppmt1 = if(time = 1)thenTemp1 else(if(time = 2)thenTemp2 else(if(time = 3)then

Temp3 else(if(time = 4)thenTemp4 else(if((time mod4) = 1)thenTemp1 else(if((time

mod4) = 2)thenTemp2 else(if((time mod4) = 3)thenTemp3 else Temp4))))))

$$\text{Temp1} = \text{EMII1} - (\text{DLoan}[i] - \text{Total\_principal1}) \times \text{Interest}$$
$$\text{Temp2} = \text{EMI1} - (\text{DLoan}[i+1] - \text{Total\_principal1}) \times \text{Interest}$$
$$\text{Temp3} = \text{EMI1} - (\text{DLoan}[i+2] - \text{Total\_principal1}) \times \text{Interest}$$
$$\text{Temp4} = \text{DLoan}[i+3] - \text{Total\_principal1}$$

Total_Principal is a stock. The inlow is ppmt_inflow and outflow is principalInt. Outflow is designed because the stock should be initialized to 0 after 50 weeks once total principal, i.e. A is repaid. So that newA can be stored in it. This is done by stating the value of outflow such that when a particular criterion is met the outflow equals the stock variable. There are 4 stocks for A, B, C and D but here equation for only 1 is given. Below are these equations:

$$\text{Total\_principal1}(t) = \text{Total\_principal1}(t - dt) + (\text{ppmt\_inflow1} - \text{principalInt1}) \times dt$$
$$\text{ppmt\_inflow1} = \text{ppmt1}$$
$$\text{principalInt1} = \text{if}(\text{Total\_principal1} + \text{ppmt1} = \text{DLoan}[4])\text{then}(\text{DLoan}[4])\text{else}(0)$$

Sum of repayments is the final repayment collected by the MFI:

$$\text{delayedRep} = \text{delay}(\text{ppmt1} + \text{ppmt2} + \text{ppmt3} + \text{ppmt4}, 1)$$

Since the calculation of the repayment starts from the quarter Q1FY10 the information for the repayment in the initial quarters based on loan disbursed prior to this quarter is not available therefore some adjustments have been made to it in

Total_Repayment:

$$\text{Total\_Repayment} = \text{if}(\text{time} = 1)\text{then}(0)\text{else} \ (\text{if}(\text{time} = 2)$$
$$\text{then} \ (\text{delayedRep} + 990.26)\text{else}(\text{if}(\text{time} = 3)\text{then} \ (\text{delayedRep} + 683.95)$$
$$\text{else}(\text{if}(\text{time} = 4)\text{then}(\text{delayedRep} + 449.45)\text{else}(\text{if}(\text{time} = 5)$$
$$\text{then} \ (\text{delayedRep} + 107.57)\text{else} \ (\text{if}(\text{time} = 6)\text{then}$$
$$(\text{delayedRep} + 140.29)\text{else}(\text{delayedRep})))))))$$

TotalFund is sum of fund from different sources. Total_Repayment is one of the sources:

$$\text{TotalFund} = \text{Loan} + \text{Total\_reserve} + \text{Equity} + \text{Total\_Repayment}$$

Fund is a stock variable which has TotalFund as inflow and Loan disbursement as outflow:

$$\text{Fund}(t) = \text{Fund}(t - dt) + (\text{FundIR} - \text{LoanDisbOR}) \times dt$$

$$\text{FundIR} = \text{TotalFund}$$

$$\text{LoanDisbOR} = \text{MIN}(\text{Fund}, \text{DLoan}[1])/1$$

5. Validation
In order to increase the confidence on the model, a quantitative test has also been conducted to validate the model. Sterman (1984) proposed statistical techniques for assessing the quality of fit between a SD model and historical data. Sterman *et al.* (1988) have estimated mean squared error between the model generated values and the actual values of the key variables of the model for validating the model. Sterman (2000) mentions root mean square error test to validate SD model. Following the same approach the root mean square percentage error between the model generated values and actual values of the important variables have been computed. The model is simulated for four quarters, i.e. from Quarter 3 of Financial Year 2012 to Quarter 2 of Financial Year 2013 by using iTHINK 10.0.2 software and the results are then compared with the actual data collected for the same period for the purpose of validation. The root mean square percentage error has been calculated by the following relationship. Root mean square percentage error:

$$= 100 \times \left(\sum \left((\text{Model generated value} - \text{actual value})/\text{actual value} \right)^2 / \right.$$
$$\left. \text{Number of observations} \right)^{1/2}$$

The percentage root mean square error between the model generated values and the actual values of the important variables are presented in Table I. It can be seen from Table I that for variables of the model the root mean square percentage error is between 9 and 56 percent. The two parameters for which the error is above 50 percent are assigned loans and ROE. The MFI is engaged in certain bilateral B2B marketing through securitization (assigned loans). The knowledge about such dealings in the MFI sector is limited. Therefore there was difficulty in collecting data. Second, the high error in ROE is because the basic parameters needed for calculating the ratio have error.

Sl. no.	Variables	Root mean square error (%)
1	Demand for loan	0.00
2	Financial expenses	43.51
3	Personnel expenses	18.09
4	Operating and other expenses	34.97
5	Depreciation and amortization	11.51
6	Provision	41.13
7	Loan	21.33
8	Equity	16.99
9	Fixed assets	25.80
10	Assigned loan	0.00
11	TR on assigned loans	28.30
12	ROE	50.00
13	Debt-equity ratio	23.13

Table I.
Root mean square
percentage error of
key variables

6. Model behavior (the standard run)
The SD model of the MFI has been simulated for ten quarters, i.e. from Quarter 3
Financial Year 2013 to Quarter 4 Financial Year 2015.

It can be concluded based on Figure 6 that PAT is highly negative. Figure 7 shows
that ROE is negative as the company is incurring loss. Similarly Figure 8 shows that
debt-equity ratio is much higher than ideal 1. MFIs health is poor and is continuously
deteriorating.

Figure 6.
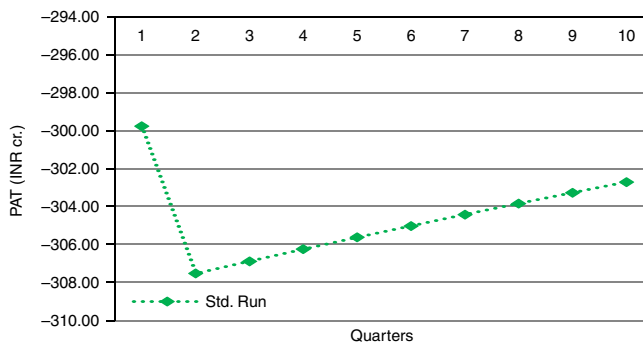Graph for
debt-equity ratio in
the standard run

Figure 7.
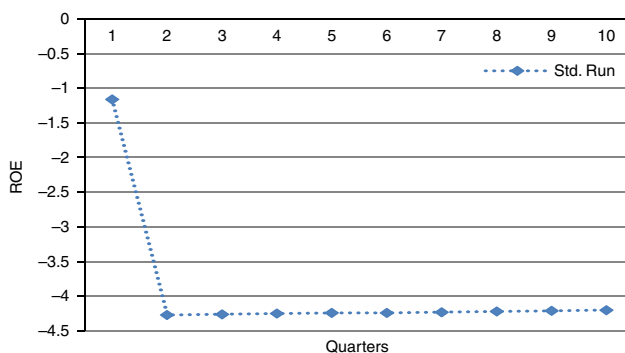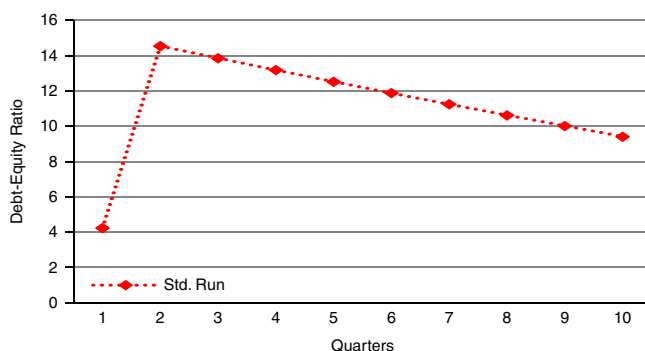Graph for ROE in
the standard run

Figure 8.
Graph for
debt-equity ratio in
the standard run

7. Policy testing

Forrester (1973) suggests that the fundamental causes of a problem should be identified first and then the revised policies should be formulated for alleviating the problem. The problem initiates the debate and the debate leads to clarification of the problem. The conventional policy making is the interplay between the knowledge base and the debate that produces a consensus for action (Morecroft, 1988).

Expert interviews were conducted and following policies for the future, which will have profound impact on the growth of the MFI were identified. These experts were branch managers and zonal officers. Ten of them were interviewed for the purpose.

7.1 Policy 1: implementing Business Correspondence (BC) model

This model can be taken up by the MFIs to increase the outreach. In this kind of model all the revenue must be collected by the MFIs through BCs and then the institution pays commission to the BCs for transacting with the customers. Thus payment of commission will increase the labor cost. According to experts to implement this model new customer service points will have to be established which will increase the operational cost. Also since BCs are not allowed to charge service fees from the clients therefore the interest rate should be increased. Therefore experts and practitioners suggested following changes in the parameters:

- −Increase in operational cost by 5 percent−Increase in demand by 20 percent

- −Increase in labor cost by 10 percent−Increase in interest rate by 3 percent

The assumptions made in respect of this policy in the MFI have been incorporated in the SD model and the model has been simulated for the period Quarter 3 Financial Year 2013 to Quarter 4 Financial Year 2015. The result and discussion are presented in Section 8.

7.2 Policy 2: integration of Microfinance with country's mainstream financial system

MFIs can partner with other stakeholders such as commercial banks to create broad-based approach to the provision of financial services to the poor. According to expert opinion commercial style competition for resources could be a disadvantage for smaller MFIs which are working in remote locations. Therefore they need to increase their scale using the banks infrastructure. Similarly they can use delivery channels of the banks to reach the clients while reducing the operational cost. Also MFIs can bring about

smooth technology upgradation. Therefore experts and practitioners suggested following changes in the parameters:

–Reduction in operational cost through innovation by 25 percent

–Increase in demand by 5 percent

–Increase in investment in capacity building to realize economies
 of scale by 5 percent

–Increase in investment for software by 7 percent

The assumptions made in respect of this policy in the MFI have been incorporated in the SD model and the model has been simulated for the period Quarter 3 Financial Year 2013 to Quarter 4 Financial Year 2015. The result and discussion are presented in Section 8.

7.3 Policy 3: restricting provisioning for loans
For the larger MFIs, the provision for loan losses as a percentage of the mean outstanding loan portfolio as at March 31, 2009 and March 31, 2010 ranged between 0.09 and 7.23 percent with an average of 1.85 percent. For the smaller MFIs it was 1.07 percent. Based on this finding Malegam Committee Report 2011 has suggested/ given the small size of individual loans, their large number, their short tenure, the frequency of repayment and the lack of collateral, it is clear that the existing prudential norms for the provision for loan losses are inadequate and must be replaced by simpler norms which apply to the universe of loans and not to individual loans. Therefore experts and practitioners suggested following changes in the parameters:

–Restricting Provisioning for Loans to 1 percent of the outstanding loans

The assumptions made in respect of this policy in the MFI have been incorporated in the SD model and the model has been simulated for the period Quarter 3 Financial Year 2013 to Quarter 4 Financial Year 2015. The result and discussion are presented in Section 8.

7.4 Policy 4: integration of Microfinance with country's mainstream financial system and restricting provisioning
The parameter values for this policy are presented below:

–Reduction in operational cost through innovation by 25 percent

–Increase in demand by 5 percent

–Increase in investment in capacity building to realize economies
 of scale by 5 percent

–Increase in investment for software by 7 percent

–Restricting Provisioning for Loans to 1 percent of the outstanding loans

The assumptions made in respect of this policy in the MFI have been incorporated in the SD model and the model has been simulated for the period Quarter 3 Financial Year 2013 to Quarter 4 Financial Year 2015. The result and discussion are presented in Section 8.

8. Result and discussion

Figures 9-11 present comparison of performance under different policies and the standard run. X-axis denotes quarterly time horizon and Y-axis denotes the value of variable. Red line indicates value of variable in standard run. Blue line indicates the value in policy run.

Based on Profit After Tax (PAT) in Figure 9 it can be concluded that Policy 3 and Policy 4 will drastically improve the health of the organization. The red line indicates policy at standard run which is highly negative starting from −300. The blue line indicates policy run which is again highly negative for Policy 1 and Policy 2. However, when Policy 3 and Policy 4 are compared the results show that PAT is much higher. Policy 4 is even better than Policy 3.

Figure 10 shows that red line which indicates standard run is dropping from around −1 to −4. This indicates that the profit generated is very less as compared to the investments even though the company has grown old. The policy run in blue line indicates that for Policy 1 and Policy 2 the results are almost same to the standard run. However, Policy 3 and Policy 4 bring ROE out of negative value making investments comparable to the profit.

Figure 11 shows that red line which is standard run has taken debt-equity ratio to more than 14 which questions the sustainability of the organization. The blue line which indicates policy run has shown that for Policy 1 and Policy 2 the changes in debt-equity ratio are not good. However, Policy 3 and Policy 4 make debt-equity ratio almost 1 which indicates good health for the organization.
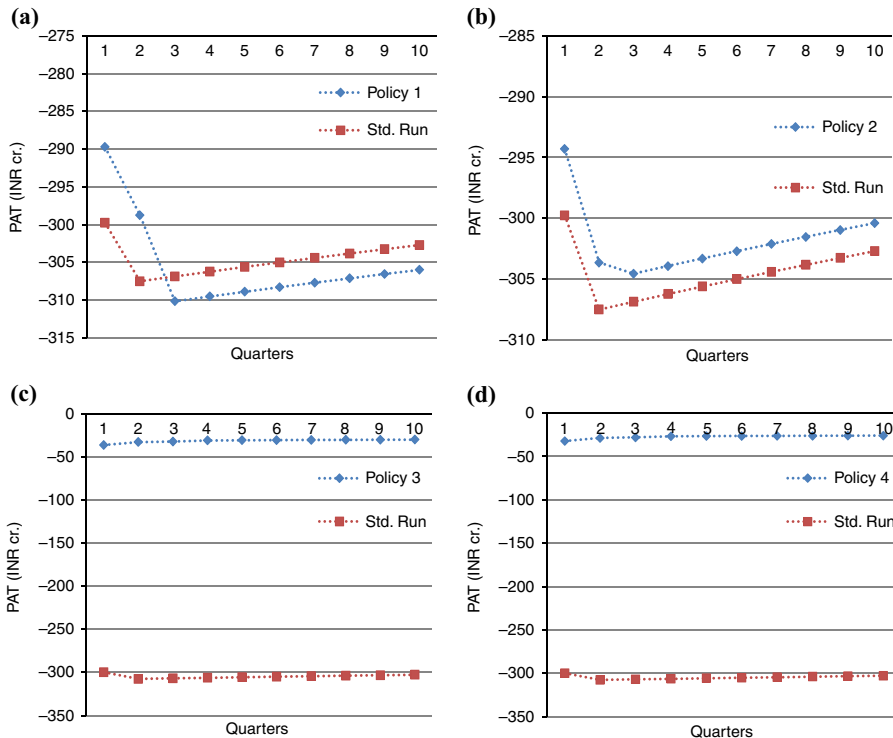

Figure 9.
Comparison of graphs for PAT for all the four policies with the standard run
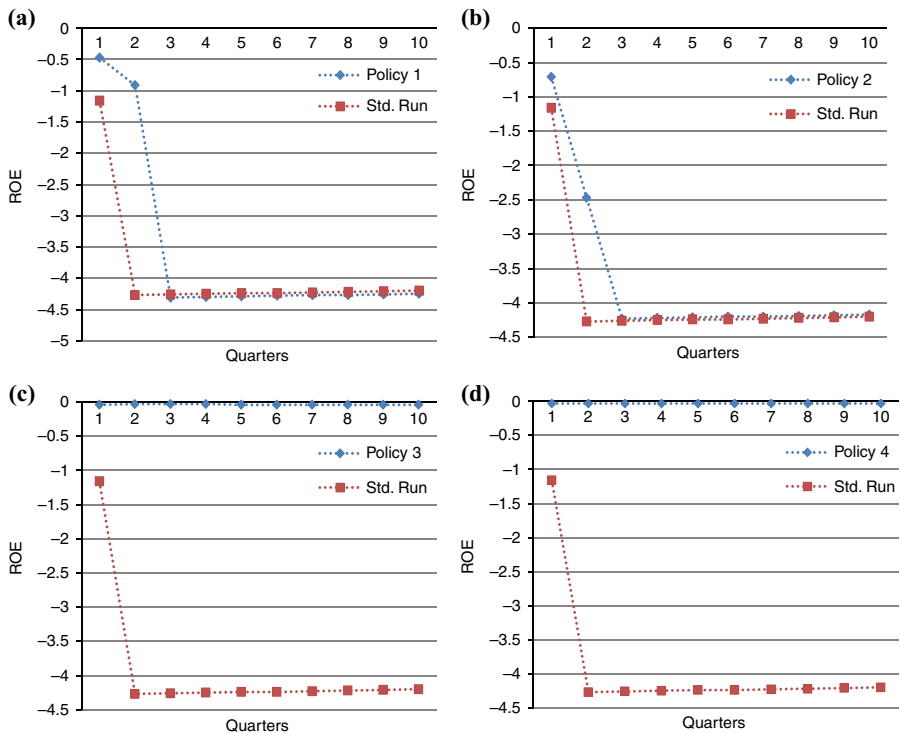
Figure 10.
Comparison of
graphs for ROE
for all the four
policies with the
standard run

On analysis of result it is found that the policy which will help MFI the most is restricting the provisioning to 1 percent of loan outstanding. The write-off on loan which was given by the company did not generate revenue leading to negative PAT. However, it contributed to decrease in loan outstanding which further reduced the revenue. Since write-off on loan was one time disturbance the model comes to a new equilibrium state. The reason behind this is that positive feedback loop of service sector in the model lead to unstable equilibrium. This can be deducted based on the understanding from paper of Georgiadis *et al.* (2005).

The reason why health of the company has deteriorated so much is because the company had to write-off huge amount of loan in the Andhra Pradesh region. After AP Act the Government had put restrictions on recovery. In case of zero recovery the losses were huge so the company decided to write-off loans to avail tax benefits. However, implementing only Policy 3 would not give the desired result of profit. Therefore Policy 4 should be taken up by the company so that it uses banks infrastructure for recovery along with restricting the provisioning of loans. Thus it can be concluded that the fourth policy which is "Integration of Microfinance with country's mainstream financial system along with restricting provision" will generate better performance for the MFI. Therefore this policy should be implemented by the MFI.

As far as future research work is considered the limitation of this paper can act as input to the new research. There was limited data for forecasting. Abnormality in data crept in due to AP Act. Social performance has not been tested. There may be some additional variables which may influence the design of future policies.
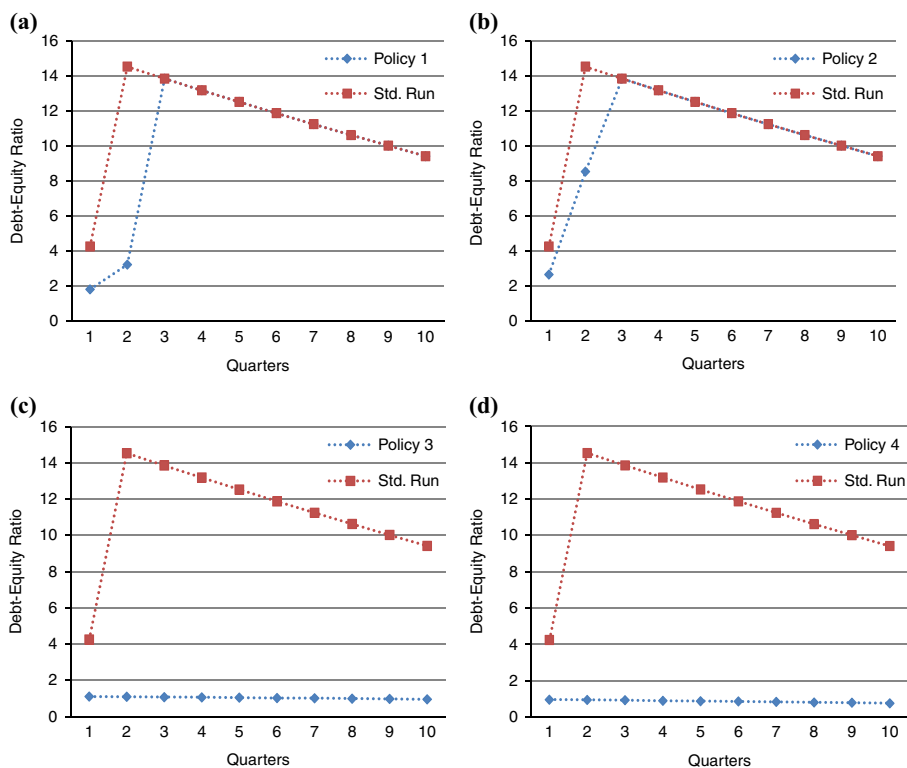
Figure 11.
Comparison of
graphs for
debt-equity ratio
for all the four
policies with the
standard run

References

Anderson, S., Long, C., Chip, J., Affeldt, F., Rust, J.W. and Seas, B. (2011), Dynamically stress testing financial systems", available at: www.systemdynamics.org/conferences/2011/proceed/papers/P1378.pdf (accessed July 12, 2015).

Bhaskar, T. and Subramanian, G. (2011), "Loan recommender system for microfinance loans: increasing efficiency to assist growth", *Journal of Financial Services Marketing*, Vol. 15 No. 4, pp. 334-345.

Finkenwirth, A. and Doll, G. (1988), "System dynamics simulations for management of a commercial bank", available at: www.systemdynamics.org/conferences/1988/proceed/finke065.pdf (accessed July 10, 2015).

Forrester, J.W. (1973), "Churches at the transition between growth and world equilibrium", in Meadows, D.L. and Meadows, D.H. (Eds), *Towards Global Equilibrium*, Wright Allen Press Inc., Cambridge, MA, pp. 337-353.

Georgiadis, P., Vlachos, D. and Iakovou, E. (2005), "A system dynamics modeling framework for the strategic supply chain management of food chains", *Journal of Food Engineering*, Vol. 70 No. 3, pp. 351-364.

Hu, B., Zhang, D., Ma, C., Jiang, Y., Hu, X.Y. and Zhang, J.L. (2007), "Modeling and simulation of corporate lifecycle using system dynamics", *Simulation Modelling Practice and Theory*, Vol. 15 No. 10, pp. 1259-1267.

Lattila, L., Hilletofth, P. and Lin, B. (2010), "Hybrid simulation models – when, why, how?", *Expert Systems with Applications*, Vol. 37 No. 12, pp. 7969-7975.

Liao, Y.-W., Wang, Y.-M., Wang, Y.-S. and Tu, Y.-M. (2015), "Understanding the dynamics between organizational IT investment strategy and market performance: a system dynamics approach", *Computers in Industry*, Vol. 71 No. 1, pp. 46-57.

MacDonald, R.H. and Dowling, A.M. (1993), "The savings and loan crisis: a system dynamics perspective", available at: www.systemdynamics.org/conferences/1993/proceed/macdo278.pdf (accessed July 11, 2015).

Microfinance India: State Of The Sector Report (2010), available at: http://books.google.co.in/books?id=9ZeHAwAAQBAJ&pg=PA33&lpg=PA33&dq=loss +making +Indian +MFIs&source =bl&ots=OWry7Esz23 &sig=nLeSzb3h62cDUac08Erd2oUWsvE&hl=en&sa=X&ei=e_e GU6O7FMuuASs7oLABg &ved=0CEgQ6AEwBA #v=onepage&q=loss% 20making% 20 Indian%2 0MFIs&f=true (accessed May 25, 2014).

Morduch, J. (1999), "The microfinance promise", *Journal of Economic Literature*, Vol. XXXVII No. 4, pp. 1569-1614.

Morecroft, J.D.W. (1988), "System dynamics and microworlds for policy makers", *European Journal of Operations Research*, Vol. 35 No. 3, pp. 301-320.

Nair, G.K. and Rodrigues, L.R. (2013), "Dynamics of financial system: a system dynamics approach", *International Journal of Economics and Financial Issues*, Vol. 3 No. 1, pp. 14-26.

Pruyt, E. and Hamarat, C. (2010), "The concerted run on the DSB bank: an exploratory system dynamics approach", available at: www.systemdynamics.org/conferences/2010/proceed/papers/P1027.pdf (accessed July 11, 2015).

Quaddus, M. and Intrapairot, A. (2001), "Management policies and the diffusion of data warehouse: a case study using system dynamics-based decision support system", *Decision Support Systems*, Vol. 31 No. 2, pp. 223-240.

Roy, K.R.D. and Koul, S. (2009), "Financial performance appraisal of a steel plant: a SD model", available at: www.systemdynamics.org/conferences/2009/proceed/papers/P1147.pdf (accessed July 10, 2015).

Sterman, J.D. (1984), "Appropriate summary statistics for evaluating the historical fit of system dynamics models", available at: www.systemdynamics.org/dynamica/articles/102/4.pdf (accessed July 11, 2015).

Sterman, J.D. (2000), *Business Dynamics – System Thinking and Modeling for a Complex World*, Irwin McGraw-Hill, Boston, MA.

Sterman, J.D., Richardson, G.P. and Davidsen, P. (1988), "Modelling and estimation of petroleum resources in the United States", *Technological Forecasting and Social Change*, Vol. 33 No. 3, pp. 219-249.

Trivellas, P. and Santouridis, I. (2013), "Antecedents of task innovation: the role of management information systems", *Procedia – Social and Behavioral Sciences*, Vol. 73 No. 1, pp. 683-691.

Web references

www.centre-for-microfinance.org/wpcontent/uploads/attachments/csy/1602/IIM%20Regulation %20V11.pdf (accessed January 30, 2014).

www.sadhan.net/Resources/MFI%20Bill%202012%20as%20introduced%20in%20Loksabha.pdf (accessed January 15, 2014).

www.rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=608 (accessed January 12, 2014).

www.academia.edu/5135875/Simulating_a_Banking_Crisis_Using_a_System_Dynamics_Model (accessed July 10, 2015).

www.stlouisfed.org/~/media/Files/PDFs/Community%20Development/WashU-Social-Sciences-Design-Lab-Report-1-21-11.pdf (accessed July 10, 2015).

www.microfinanceindia.org/ (accessed January 12, 2014).

www.mixmarket.org/service-providers (accessed January 30, 2014).

Appendix

Service provider	Website	Country	Description	Type
Afrosoft Corporation	www.afrosoft.co.zw	Zimbabwe	504 Gate-way time out	na
Better Planning Ltd	www.betterplanning.netÂ	Cameroon	Application for management of bank assets	MIS
Cabinet Microfin-A2i	www.microfina2i.com	Cote d'Ivoire (Ivory Coast)	Website is not available	na
CAGECFI	www.cagecfi.com	Togo	Software for rigorous credit management (requests outstanding, repayment schedule, nonperforming loans)	MIS
Chaka Computer	www.groupechaka.comÂ	Senegal	Website is not updated	na
Craft Silicon	www.craftsilicon.com	Kenya	Application to manage minute customer records and portfolios, and also help MFIs manage their profits and analyze the risk factors	MIS
Crystal Clear Software, Ltd	www.loanperformer.comÂ	Uganda	Provides MIS	MIS
E-Soft Solutions Ltd	www.esoftng.netÂ	Nigeria	Software for complete automation of microfinance banking operations	Automation
Esave	www.esave-ng.com	Nigeria	Website is not available	na
eShango	www.eshango.com	Senegal	Reporting software to generate financial statements and prudential ratios	Automation
Future Link Technologies (FLT)	www.savingsplus.info	Uganda	Software to handle microfinance transactions, (loans, deposits, withdrawals)	MIS
ICCSOFT SA	www.iccsoft.bizÂ	Cameroon	Application to manage accounts, budget and payment to staff	MIS
IPI	www.ipi.co.zaÂ	South Africa	Loan portfolio management system (MIS)	MIS
K&P Group	www.kpgroup99.com	Togo	Website language is in Polish	na
Kopo Kopo	www.kopokopo.com	Kenya	Application to handle transactions	MIS
Maxim-Pro Nigeria Limited	na	Nigeria	na	na
MEDIASOFT	www.mediasofthome.netÂ	Togo	Management software (MIS)	MIS
MICROMZ	www.micromz.org	Mozambique	Website language is in Portuguese	na
Octagon Data Systems Limited	www.octagon.co.keÂ	Kenya	Website is not updated	na
Orchid Systems	www.orchid.mgÂ	Madagascar	Website is not available	na
Perfect Touch Consulting Limited	www.ptconsultingltd.comÂ	Nigeria	Application for credit risk management, treasury management, branch operations, reporting	MIS

(*continued*)

Table AI.
Technologies
provided to
microfinance sector

Service provider	Website	Country	Description	Type
Pharaon	www.pharaon-technologies.com	Benin	Website is not available	na
Prisma Systems	www.prismasystems.comÂ	Kenya	Application for front office customer service, accounting	MIS
Regional Computers Limited	na	Kenya	na	na
Sensoft Sarl	www.sensft.snÂ	Senegal	Application for centralized management activities (MIS)	MIS
ShebaSoft Systems Plc.	na	Ethiopia	na	na
Sigma Data & Computers	www.sigmadc.comÂ	Uganda	Application for loan portfolio management, deposit management, reporting	MIS
Simple MFI	www.simplemfi.org	Kenya	Website is not available	na
Smart Info Systems	http://smartmicrofinance	Ghana	Website is under construction	na
Solid	www.solid.sn	Senegal	Mobile banking solution	ICT
Xpertek	www.xpertek.co.zaÂ	South Africa	Provides loan administration solution	MIS or DSS
CEN Systems and Technologies (CENTECH) Corp.	www.commoncents101.comÂ	Philippines	Software highly integrates the Loan Tracking System, the Savings System, and the General Ledger System	MIS
FAO-GTZ MicroBanking System	www.mbwin.netÂ	Thailand	Provides MIS	MIS
Micro Banker Phils. (MBPhils). Inc.	www.mbphil.com/about.html	Philippines	Application having Loan module, handling ledger	MIS
PT TEKNOVASI MITRADANA	na	Indonesia	na	na
RUMA	www.ruma.co.id/	Indonesia	Application for transaction management	MIS
Vaia	www.vaia.co.id	Indonesia	Loan Origination System, Mobile Branchless banking software	MIS and ICT
Windonesia Telematika	www.windonesia.comÂ	Indonesia	Requires username and password	na
Achid Finance Group	www.achid.orgÂ	Mongolia	Account has been suspended	na
ASPEKT	www.aspekt.com.mk	Macedonia	Application having loan module, credit scoring, social performance, general ledger modules	MIS
Dolphin Software	www.loankeeper.ge	Georgia	Loan portfolio tracking software	MIS
eFinance	www.establ.ru	Kazakhstan	Software for automated accounting lending activities	Automation
FinA	www.fina2.net	Georgia	Provides MIS	MIS
MifCloud	www.mifcloud.com	Poland	Microfinance software that can run in any cloud environment	Platform upgradation
Open CBS	www.opencbs.com	Kyrgyzstan	Open source client tracking software for microfinance	MIS

Table AI.

Service provider	Website	Country	Description	Type
Software Group BG Ltd	www.softwaregroup-bg.com	Bulgaria	Mobile banking solution	ICT
SolDevelo Sp. z o. o.	www.soldevelo.com	Poland	Provides MIS	MIS
AVMEI CIA. LTDA	www1.avmeiecuador.comÂ	Ecuador	Website language is in Spanish	na
Bantotal	www.bantotal.com	Uruguay	Application for operational processing	MIS
BYTE	www.bytesw.com	Guatemala	Application for accounting system	MIS
DAComp SC	www.dacompsc.comÂ	Mexico	Application to manage microfinance programs in an integrated manner	MIS
ETHOS Software	www.ethosweb.comÂ	Colombia	Website language is in Spanish	na
FUNDAMICRO	www.fundamicro.net	El Salvador	Website under maintenance	na
GREENSOFT CIA. LTDA.	www.greensoft.com.ec	Ecuador	Application for customer profile maintenance, savings, deposits, accounting	MIS
InformÃ¡tica Donet EIRL	www.informaticadonet.comÂ	Peru	Malware ahead	na
IT Team SAC	www.mis.aqp.com.peÂ	Peru	Website is not available	na
MFSI	na	Guatemala	na	na
Micro Software Designs, Ltd.	www.msd-tt.com/	Trinidad and Tobago	Application for financial management, HR, mobile banking, internet banking	MIS
Soft Corporacion S.A.	www.sifco.orgÂ	Guatemala	Application to manage active and passive operations	MIS
SYSDE	www.sysde.comÂ	Mexico	Application for automation of all daily activities	Automation
Top Systems	www.topsystems.com.uyÂ	Uruguay	Website language is in Spanish	na
Yotta Software	na	Bolivia	na	na
Agile Financial Technologies	www.agile-ft.com	United Arab Emirates	Application includes group/ individual customer information management, shares and savings management, loans and deposits, transaction processing and financial accounting	MIS
Bisan Systems	www.bisan.com	Palestine	Application for managing the loan workflow as well as multiple loan calculations options	MIS or DSS
Delta Informatics	www.deltainf.com	Jordan	Loan tracking and incentive module	MIS
EQI	www.eqi.com.eg	Egypt	Provides MIS	MIS
LoanTracker	www.aba-sme.com	Egypt	Loan tracking system	MIS
PAP – Egypt	na	Egypt	na	na
AccuCred	www.accucred.com	USA	Loan portfolio management system	MIS
CommonGoals Software	www.commongoals.com	Canada	Robust and intuitive microfinance software solution that will simplify the management of all your client	MIS

Table AI.

Service provider	Website	Country	Description	Type
			data including loans, grants, investors, donors and much more. You can easily capture historical demographics, socio-economic data and performance indicators to create management reports to your stakeholders	
DownHome Solutions	www.downhomesolutions. com	USA	Loan tracking system	MIS
FrontlineSMS:Credit	credit.frontlinesms.com	USA	Mobile banking solution	ICT
Kredits	www.kredits.com	USA	Application has reporting system for loan, saving, insurance, equity	MIS
Margill	www.margill.com	Canada	Interest calculation and loan management software	MIS
MFIcroscope	www.mficroscope.com	USA	Applications for loan analysis and currency analytics; Benchmarking tool; Financial planning which estimates balance, income, and cash flow projections with online tools	MIS or DSS
MicroBanx Systems, LLC	www.microbanx.com	USA	Website is not available	na
MicroPlanet	www.microplanettech.org	USA	Network support, Front-end technology integration, System hosting	ICT
Mifos	www.mifos.org	USA	Open source software Mifos X gives a platform in which MFI can deploy various applications and modules to support whatever model it uses to deliver financial services to the poor	Platform upgradation
RedCloud	redcloudmoney.com	USA	The site requested does not exist on this server	na
SystAlliance	www.technicost.comÂ	Canada	Application for auto decision making of loan disbursement	DSS
Temenos	www.temenos.comÂ	USA	Cloud-based software-as-a-service (SaaS) solution, T24 for Microfinance enables smaller financial institutions to deploy the award-winning capabilities of T24 core banking at lower cost. T24 for Microfinance features the high-performance functionality needed to run the mass retail services that comprise microfinance and community banking	MIS

Table AI.

Service provider	Website	Country	Description	Type
Village Software Inc.	www.villagesoft.com	USA	Spreadsheet-based solutions ranging from automated forms to planning and reporting	MIS
Zeptoo	zeptoo.com	USA	Branchless banking solution	ICT
Apparent Infotech Private Limited	www.apparent.co.inÂ	India	Has built MIS	MIS
Artoo	http://artoo.in/	India	Empowers social enterprises to capture, analyze and process information remotely through smartphones/tablets	ICT
Audech	www.audech.com	India	Only contact details are provided	na
DataSoft Systems Bangladesh Limited	www.datasoft-bd.comÂ	Bangladesh	Has developed Microfin360 software which automates the workflow	Automation
Datavision Software solution Pvt. Ltd	www.datavsn.com Â	India	Has developed MICROMATE a mobile-based application tailored for field personnel	ICT
Directing IT	www.directingit.com	India	Guides MFI to choose technologies	na
Ekgaon	www.ekgaon.com	India	Has proposed ICT solutions	ICT
Elitser IT solutions India Pvt Ltd	www.elitser.comÂ	India	Has developed MicroFinancerTM 2.0 software deals with maintaining of information with regard to all members and their various account transactions with the MFI along with other attributes	MIS
FINO	www.fino.co.in	India	Has worked on linking the back-end data with the front-end for smart cards	MIS and ICT
Glodyne Technoserve	www.glodynetechnoserve.in	India	Deals in smart card technology	ICT
Gradatim	gradatim.co.in	India	Provides MIS	MIS
InfrasoftTech	www.infrasofttech.com	India	Has developed OMNIEnterprise™ Microfinance Solution which is a robust & scalable platform that automates core business processes of your organization on a single technology backbone, thereby assisting to achieve business growth at lower investments	Automation
KTwo	www.ktwo.co.in	India	Solution for healthcare and microfinance in rural areas	na
MFIFlex	www.mfiflex.com	India	It has a cloud-based banking solution designed for MicroFinance Institutions	Platform upgradation
MOSTFIT	www.mostfit.org	India	Provides MIS	MIS
Natural Technologies Pvt. Ltd.	www.bancmate.com	India	Website is under maintenance	na

Table AI.

Service provider	Website	Country	Description	Type
OTCO International Limited	www.otcointernational.com	India	Website is not available	na
Paripoorna	www.paripoorna.in	India	Provides MIS	MIS
Processware Systems (P) Ltd.	www.processwaresystems.com	India	Provides solution for complete branch automation	Automation
Sathguru	www.sathguru.com	India	Has developed enterprise resource solution	MIS
Sharada Computer Services	sharadacomputers.com	India	Website is not available	na
Snowwood Infocom Technologies Pvt Ltd.	www.snowwood.comÂ	India	Provides mobile-based services to MFIs	ICT
Softwatch InfoSys (Pvt.) Limited	www.softwatch-infosys.org	Sri Lanka	Provides Total Banking Solution Professional Edition, our flagship product, is revolutionizing the rural sector microfinance banking industry, moving it from conventional hand-written ledgers to a 21st Century, fully integrated, web-based system with a capability of remote connectivity throughout Sri Lanka	MIS
Southtech Limited	www.southtechlimited.comÂ	Bangladesh	Application can be deployed in centralized or decentralized mode. It is highly parameterized. Provides loan application processing and administration, multi currency accounting, cash and cheque management, treasury operation	MIS
Theme Technologies	www.themetechnologies.com	India	Website is not available	na
Trinity Signal Technology	www.trinitysignaltechnology.com	India	Website is not available	n/a
Trust Systems & Software (I) Pvt. Ltd.	www.softtrust.comÂ	India	Provides banking automation solutions	Automation
Venture Infotek Global Private Limited	www.ventureinfotek.comÂ/ in.worldline.com	India	Provides e-payment and m-payment solutions	ICT
Aquadev	www.aquadev.org	Belgium	Website is not available	na
AUXFAM	www.auxfin.com	The Netherlands	Provides ICT solutions to MFIs	ICT
CREOVA	www.creova.com	France	Provides mobile-based services to MFIs	ICT
Delta	www.delta-bank.com	France	Provides tools supporting loan application and origination; securitization; contract recording; loan collection; arrears management	MIS

Table AI.

(*continued*)

Service provider	Website	Country	Description	Type
Fern Software	www.fernsoftware.com	UK	For banks to set interest for MFIs and manage MFI partners	MIS
Kastell Software	www.KastellSoft.com	Germany	Loan tracking, management information and accounting software	MIS
MAMBU	www.mambu.com	Germany	Software with controlled workflow and product rules; reporting on financial and social performance	MIS or DSS
MyAzimia	www.myazimia.org	UK	Provides MIS	MIS
Neptune Software	www.neptunesoftwareplc.com	UK	Provides integrated CRM, integrated workflow, delivery channels, data warehousing and multi currency functionality	MIS
Nucleus Software	www.nucleussoftware.comÂ	UK	Provides Islamic banking software	MIS
Octopus Microfinance	www.octopusnetwork.org	France	Provides MIS	MIS
Probanx Information System Ltd	www.probanx.com	Cyprus	Provides MIS	MIS
Small Bank Software, UK	www.smallbankmanager.comÂ	UK	Website is not available	na
SOPRA Group	www.sopragroup.comÂ	France	Website is not updated	na
VIVEO	www.viveo.com/www.temenos.com/	France	Website changed	na
NATHAN Associates Inc.	www.nathaninc.com/resources/microfinance-decision-support-system		DSS for MFIs strategic decisions based on the socio-economic attributes of the customers using statistical tools. Thus used for assessing potential	DSS

Table AI.

Corresponding author
Ritika Singh can be contacted at: ritikasingh.ism@gmail.com