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Mobile Training in Micro Business: Design Science Research for Frugal Innovation

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Abstract—The loan relationship between micro finance institutions (MFI) and micro businesses (MB) is crucial for the growth of small and micro businesses in Tanzania. Increase of smartphone ownership has opened possibilities to support small businesses with technology innovation. Our previous research has shown that the training services offered by MFIs to MBs face a number of challenges, for example poor attendance due to time and travel constraints. In this design science research (DSR) study, we engaged a team of a total of 50 MB and MFI owners, together with local software specialists and researchers, and designed a simple mobile application for delivery of learning materials, contextualised for the needs of MFIs and MBs. This paper describes the progress of this project, the developed prototypes, observations gained in each phase of the project, and recommendations for future research.

Keywords—mobile training, micro business, microfinance institutions, design science research, frugal innovation.

I. INTRODUCTION

The mobile revolution in Africa has opened up opportunities for solving local challenges by technology solutions. A number of players, ranging from big telecommunications companies to small grassroots-level initiatives are constantly working on new technology innovations. Common examples of innovation domains include mobile money, agriculture information systems, healthcare, education, and many others (e.g. [1], [2]).

Technology initiatives are often associated with high hopes. Educational technology, for example, has been portrayed as a cure for educational problems in developing countries [3]. But the reality has been different. While a number of initiatives have succeeded, many have failed, often due to poor understanding about the context of implementation [3]. Important big questions for all technology initiatives include: *Why some technology projects succeed, while some fail? What distinguishes between success and failure of technology initiatives?*

It has become obvious that technology projects need to be geared with solid research methods in order to understand what needs to be implemented, what are the best ways to implement, and to evaluate impact. For this purpose, design science research (DSR) [4], [5] provides a useful framework.

A. Background: Micro Finance and Micro Business

Microfinance institutions (MFI) have become an important part of the economy of small businesses in developing countries [6]. For example, micro businesses (MB) typically do

not have access to formal banking, but are often eligible for financial services offered by MFIs. In Tanzania, micro businesses (MB) form a substantial part of the economic system, underlining the importance to understand the relationship between MFIs and MBs.

The most important services offered by MFIs are credit loans, and training on credit management. Our previous research has identified a number of challenges in the credit relationship between Tanzanian MFIs and MBs, and suggested a number of technology-based ideas as potential solutions for improving the business prospects of MFIs and MBs [6].

B. Research Approach

This study directly addresses the challenges in the MFI's *training services* by introducing mobile technology as a platform to deliver learning materials. This is estimated to ease the micro business owners' burden of physical attendance in training sessions, often requiring long hours of travel in traffic.

This research falls under the framework of frugal innovation [7]. Frugal innovation is a durable product or a good-enough service that does not consume a lot of resources in its production and contains only the bare minimum features to function effectively [7]. Mobile banking solutions in Africa, Nokia's 1100 cellphone and solar light bulbs are example of products that are considered to be frugal innovations. In essence, frugal engineering refers in developing more with less resources.

The team for implementing this project included one undergraduate computer engineering student from Dar es Salaam Institute of Technology (DIT), one primary researcher who is a lecturer at College of Business Education (CBE), Tanzania and a PhD student at the University of Eastern Finland's (UEF) School of Computing, 20 MFI officers, and 30 MB owners as informants and participators in co-design activities.

The main research question of this study is:

- *How can a team of researchers and technologists with small resources build a solution for mobile-based delivery of learning materials between Tanzanian MFIs and MBs by following the principles of DSR?*

II. RELATED STUDIES

A number of initiatives are working on technology innovation for African countries. The mainstream domains for

Theme	Main issues found
General	
Significance	Many MBs depend on MFI loans MBs are a very significant customer for MFIs
Loan types	Individual: salary-based loans preferred Group loans attract less defaulting
Loan Defaulting	
Default rate	20% default rate
Causes for default	1) Inadequate skills and strategies: business management, credit management 2) Intentional frauds and misuse of money: giving misinformation, using loans for personal purposes, disappearing 3) Non-intentional family emergencies
Default Prevention	1) Identification: psychological profiling, fraud detection, asset inspection, officer consultation 2) training on business skills and credit management strategies
Training	
General	Attending is precondition for loan Pre-loan and post-loan training Typical duration 2-5 days
Domains	Entrepreneurship, credit management Business management, application process Repayment practices
Profiling	Psychological profiling, observation of applicant behaviors
Challenges	Weak continuity, time constraints, Pedagogy and curriculum, Learning materials
Other services	
Insurance, Micro savings	Currently less used than loans and training, Services of the future

Fig. 1: Identified challenges in the MFI-MB relationship from our previous research [6]. The blue rectangle highlights findings that are relevant for this study.

technology development include mobile money, technology for agriculture, eHealth, eGovernment, educational technology, among many others [1], [2]. Perhaps not so well known are initiatives that target the informal workforce, such as street vendors, with technology innovation. Informal workers form a major part of workforce in many developing countries, and are thus a significant user group for future technologies [8].

Related grassroots-level projects include online shopping [9], [10], mobile procurement [11], [12], mAgriculture [13], business education [14], financial literacy applications [15], and educational applications [14]. One project used DSR to design mobile bookkeeping for Tanzanian street vendors [16].

An important recommendation shared by many projects is the need for close interaction between designers, researchers, and project participants (e.g. [16]). This is a common guideline in inclusive innovation and participatory design. The ownership of technology projects should be local: local African technology solutions are designed for local African problems.

III. RESEARCH DESIGN

A. Design Science Research

Design science research (DSR) is a systematic study of developing solutions to practical problems emerging from real-life settings and situations [5], [4], [17]. A practical problem is an undesirable state of affairs, or a gap between the current state and a desirable state [4]. The practical problem can be a

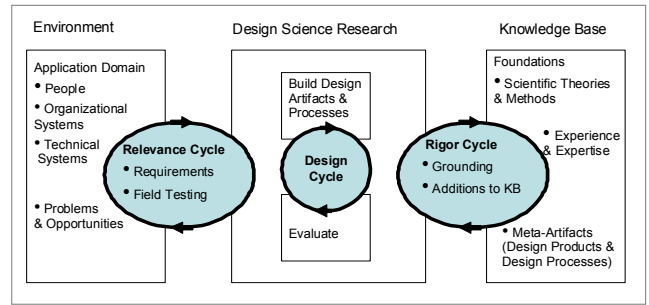


Fig. 2: Design Science Research Cycles [5].

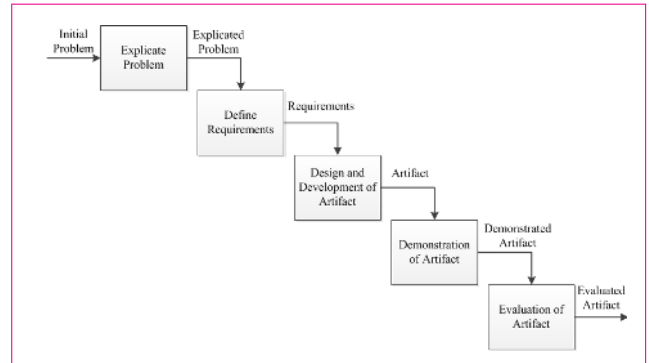


Fig. 3: The method framework for design science research [4, page 77].

puzzling question, or an unexpected circumstance, or an identified need for a change or improvement. DSR is fundamentally a problem-oriented approach in order to improve the world [18]. DSR is also used to connect theory to practice in order to study scientific questions in the real world rather than in the laboratory [19], [20].

DSR produces two types of research outputs. First, a novel solution (intervention, application, product) is created to solve the identified problem [4]. Second, the process of creating the novel solution expands the current knowledge-base related to the problem domain, design process or even the design science research approach itself [5]. Education-oriented design research is design research that is targeted to educational problems [21], [22].

DSR can be conceptualised by three interconnected cycles: *the relevance cycle*, *the design cycle*, and *the rigour cycle* (see Figure 2). The relevance cycle contributes to the identification of the research problem, requirements, and acceptance criteria for a solution's utility. The design cycle supports the design, development and evaluation of the solution. The rigour cycle connects the solution and the DSR process to the existing knowledge base to expand the scientific, academic and technical knowledge. Each cycle in a DSR project has a strong research component, where both qualitative and quantitative methods can be used to form a deeper understanding about the ongoing process.

Our previous qualitative research identified a number of opportunities for technology innovation in relation to the

TABLE I: Research Design per DSR stages

DSR Stage	Activity	Outcomes	Section
<i>Problem explication</i>	<i>Covered by our prev. research [6]</i>		IV-A
<i>Requirement definition</i>	Workshops	Requirement list Prototypes Observations	IV-B
<i>Design & Development</i>	Prototype Video production Preparing instructions	Prototype I Videos Instructions for video production	IV-C
<i>Demo & Evaluation</i>	Usability tests	Evaluation data Improvement list	IV-D

relationship between MFIs and MBs [6]. Figure 1 shows an overview of those results, and highlights results that are relevant for this study.

B. Approach

DSR projects typically start by providing requirements for research (e.g. what is the problem to be addressed with technology), and then proceeds to design, construct, and evaluate suitable technological solutions [5]. A guiding framework for a DSR project (Figure 3) defines the DSR stages as: *problem explication, requirement definition, design & development, demonstration, and evaluation* [4, page 77].

Participatory design and agile development approaches with quick development cycles are applied to transform requirements into specifications, prototypes and to fully functional products. In the demonstration and evaluation activity, the developed solution will be tested and evaluated in real-life settings. Mixed methods approaches can be used to integrate scientific principles of knowledge creation (controlled experiments and quantitative analysis) with approaches to understand and analyse human experience (qualitative methods) [23].

Table I summarizes the activities, outcomes, and collected data of our DSR study about mobile training in micro business. Each of these phases are covered in detail in the respective forthcoming sections, listed in the *Section*-column of Table I.

IV. RESULTS

This section presents the results of this DSR study.

A. Problem Explication

Our previous qualitative research [6] identified several challenges in the training relationship. These challenges includes weak continuity, time constraints, pedagogy and curriculum, and learning material preparation and delivery. The following outlines the basic characteristics of the training relationship and services offered by MFIs to MBs.

The training services are an important part of the loan relationship. The training takes place after MBs apply for a loan, and after loan disbursement. The pre-loan training is conducted in the MFIs premises, where loan officers orient the customers who are taking loans on how to make repayments and fulfill other procedures. Loan officers are the ones who

are preparing the learning materials, providing the training venue, registering the trainees, setting the training timetables, and designing the model of the training. The specific learning objectives in the training are:

- 1) To orient MBs to loan service and payment schedule
- 2) To separate business resources and personal resources
- 3) To estimate customers' loan payment ability
- 4) To equip customers on business skills (e.g. time management, financial management, determination of profit after loan repayment)

The typical duration of a training is two full business days. The teachers in the courses are the loan officers. A major challenge in the training courses is the long travel times and necessity for physical attendance. In this regard, mobile-based learning, if implemented well, would potentially be a big improvement for the training services.

B. Requirements Definition

The requirement definition phase included *participatory design meetings* which included executives of MFIs, MB owners, and the project implementation team. Two meetings in total were held. The main themes for the meetings were to reach a common understanding about the main challenges related to training activities. During the meetings, the preliminary concept for the application was presented to all participants, and the idea was discussed. Also, the project participants shared their experience, attitudes, opinions and specific wishes for the application.

The phase resulted in the following specific requirements for the first prototype.

- 1) The main format for learning materials should be videos. Other supported formats should include audio and slides
- 2) The files should be lightweight for easy transfer
- 3) Minimal UI (as simple as possible)
- 4) There should be a discussion forum
- 5) All functionalities should work in Kiswahili

C. Design & Development

In this phase the requirements and expectations were analysed, and a first prototype of the application was designed. A research on available services was performed. After comparison, YouTube¹ was selected for video delivery, Archive.org² was selected for audio delivery, and Google Drive³ was selected for slide-delivery.

The team decided that a menu for the application would be programmed as an Android application by using Android Studio⁴. In line with frugal innovation, programming was kept to a bare minimum. The application menu was programmed to include three buttons, one for each respective service (video, audio, slides). The ruling guideline for the project was to keep the project as simple as possible, and to avoid "reinventing the wheel".

¹<http://www.youtube.com>

²<https://archive.org>

³<http://drive.google.com>

⁴<https://developer.android.com/studio/>

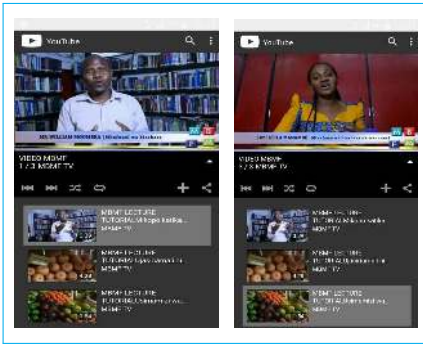


Fig. 4: Screenshots of Demo-video lectures shown via YouTube-app. The videos are stored into a specific channel MBMF in YouTube. These video lectures were prepared by one lecturer from College of Business Education (CBE), Dar es Salaam Campus, Tanzania, and one business expert from Blado Trader Co. Limited, Dar es Salaam, Tanzania.



Fig. 5: The main interface of the application. Three buttons for learning materials: *Video materials*, *Audio materials*, and *Slides*.

It was decided that the first prototype of the application would include the following functionalities: a main menu, video-delivery, audio-delivery, and slide-delivery. The main menu of the implemented application is shown in Figure 5. In main menu, pressing the first button activates YouTube with the MFMI channel. Pressing the second button activates a specific area on Archive.org. Pressing the third button activates a dedicated area for slides in Google Drive.

In the design and development phase, several video lectures were prepared as example materials to the system. The videos are training videos, which were filmed at the College of Business Education (CBE) campus. These short lectures are given by lecturers of CBE.

This phase resulted in:

- A prototype of the application, using YouTube as the video engine, using Archive.org as the audio engine, and using Google Drive as the slides-engine
- Three video lectures prepared for the testing phase
- Instructions on how to prepare and upload materials to the system
- For discussion and commentary, it was decided that youtube's comment-section would be used

D. Demo & Evaluation

1) *Workshop*: The evaluation phase started with a participatory design meeting. The agenda for the meeting was to reach a common understanding about the activities to be conducted during the evaluation period. The meeting took place in the MFI's premises, and was split to two days, one for each of the two participating MFI organizations. Basic usage of the application was explained, and instructions for video, audio, and document preparation were given. The idea was that the participants were then free to experiment with the idea material

production and usage as a part of the training activities. The participants were given four weeks for free experimentation with the preference given to video lectures.

After the application was presented to the participants, MFIs and MBs were given four weeks time to use the application in their natural working environment. During the evaluation period, research team were making supervision to see how the process took place. After the testing period, focus groups of MFIs and MBs participants convened in the MFIs premises to discuss about their experience and give feedback to researcher-developers.

2) *Observations*: After the evaluation period, a meeting was held to discuss the experiences that the participants had. Several issues were raised during the meeting. First, video preparation was found to be more challenging than thought. From the MFI side, only one video-based learning material was successfully developed, and this was done with the help of an external video production company. The MFIs officers commented that the process of video production could be outsourced, or a technical specialist should be employed to take care of learning material development in the future. Thus, in the future, ways to ease the process of video preparation needs to be included in the project.

Second, as video production was found to be challenging, the participants noted that text documents and slides would be a preferable and easy-to-prepare medium that the application should support in the future. These findings show that the support for easy preparation of learning materials is of utmost priority in the next phase of the project.

Third, from the MBs side, the evaluation period was restricted to consuming the video materials already available in the system. The participants noted that streaming thru Internet is expensive, and thus local storage of video files is of utmost priority in the future. One possibility for this would be a bluetooth-based interface, where videos could be downloaded for free from the MFI premises at the time when the MBs visit there.

Fourth, the MB officers noted several challenges to effective learning material consumption. These included Internet connectivity and cost, the small size of the mobile screen especially in some particular models, and power consumption and low battery life of smartphones, especially with some particular models.

V. DISCUSSION

The research question of this research asked “*How can a team of researchers and technologists with small resources build a solution for mobile-based delivery of learning materials between Tanzanian MFIs and MBs by following the principles of participatory design and DSR?*” In order to provide answers, a small team consisting of one computer engineering undergraduate student from Dar es Salaam Institute of Technology (DIT), and a lecturer from College of Business Education (CBE), Tanzania formed a team together with MFI and MB owners, and conducted DSR activities contributing



(a) Meeting with MB owners



(b) Meeting with MFI owners

Fig. 6: Participatory design meetings

to one DSR cycle. In regards of each of the DSR stages, the following was found.

First, in regards of the *requirement definition* stage, meetings were successfully conducted between MB and MFI personnel. The ideas were discussed and common ground was reached as to what would be implemented. A number of ideas and a list of requirements for the first application was reached. In addition to the technical requirements, this stage built trust and empowerment between the project team. This is a cornerstone of co-creation.

Second, in the *design & development* phase, co-creation activities were continued. Android Studio was used to program a simple main menu. After evaluation of different possibilities, Youtube was selected for video delivery, Archive.org for audio delivery, and Google Drive for slide delivery. Three example videos were produced, and uploaded to a Youtube-channel for testing. Instructions on video, audio and slide preparation and upload were prepared.

Third, in the *demo & evaluation* stage, the participants used the prototype-system for four weeks. The phase started with participatory meetings that lasted for two consecutive days. During the meetings, the application use was introduced and rehearsed. The idea was that the participants would prepare learning materials to the system, and take it into use for their training activities. However, it was found that *video production* posed a big challenge for the participants, thus only one video was produced. Thus, a valuable set of observations were collected for future development of the project.

To answer the research question, this study has shown that a project team can be easily set up, a DSR project can be implemented with limited resources and programming skills, and by using existing applications, a platform for training material delivery can be implemented. Important challenges were identified, the most important challenge being learning

material development. Empowerment and trust for co-creation was built between senior managers, consultants, and MFI and MB staff members. Although this project is still in its prototype stage, the results show that frugal innovation is possible, and has huge potential for the near future, if implemented well.

A. Limitations

Evaluating a DSR project should answer the questions “How well does the artefact solve the explicated problem and fulfil the defined requirements?” [4, page 146]. In this project, the evaluation remains somewhere in between evaluating an artefact in real practice, and evaluating in an artificial setting [4, page 147]. In the future, the application must be introduced as part of the actual training activities, and evaluate it’s impact as compared to training without the app. In this regard, education-oriented design research [21], [22] provides many useful recommendations.

This project resulted in a first prototype of the application, and a number of improvement ideas that need to be taken into account for future development of the project. The developed system requires more prototyping and reliable evaluation research. This means controlled pretest-posttest setups, where the application is evaluated as a part of the real training. Also, for wider applicability it has to be noted that many MBs still do not have smartphones. However, the smartphone ownership is estimated to increase. Thus, when frugal innovation projects as the one described in this paper matures to the level of well-evaluated positive impacts, scaling up will become necessary.

The project should be evaluated against the fact that the current innovation ecosystem in Tanzania is not yet fully accustomed to DSR activities. Higher education institutions focus on qualitative and quantitative research, while DSR is not yet widely taught. There is little software business industry. Also, mobile application usage is still very limited and slow, the connectivity is poor, prices are unreachable for the majority of the poor, and most people do not own smartphones.

Future research should identify the barriers that restrict wider expansion of frugal innovation projects. When means to overcome the barriers become available, this can have a big positive impact to economic and human development. Understanding how to tackle contextual barriers will also contribute to “design knowledge” of the academic DSR literature.

VI. FUTURE DIRECTIONS

We propose wider expansion of frugal innovation to the Tanzanian context. DSR projects can be initiated by universities, companies, technology-hubs, and self-educated technologists. Many opportunities for future technology projects exist. Many of the opportunities do not necessarily require programming skills, but big impact can be reached by using existing tools and software packages. In the future, projects like this can expand to mobile massive open online course (MOOC)-platforms, where masses of informal workers can receive education that is contextualised for their needs. Research needs to identify and tackle the barriers for frugal innovation, and

the impact of different software solutions needs to be carefully studied in controlled research setups.

In regards of this project:

- Material production skills need to be improved
- Research instruments need to be designed that can identify barriers for frugal innovation and ways to tackle them
- Offline viewing of learning materials
- Evaluation as a part of the actual training

VII. CONCLUSIONS

Many developing countries have experienced remarkable progress in the past decades. Various indicators show, for example, increase of percentage of children in schools, increased foreign investment, decreased child mortality, increased GDP, declined violence, declined absolute poverty, and increased life span expectancy. Technology innovation, and the mobile revolution, in particular, play an important role in facilitating positive progress. Mobile banking, for example, has improved the lives of millions who live without access to banking.

Innovations are being created for education, elections, healthcare, agriculture, street business, and many other domains. However, while the number of technology innovation activities is increasing in developing countries, their impact on economy and society is still below expectations, as many obstacles and challenges complicate technology innovation.

Many projects fail due to poor understanding of the context of implementation. Top-down led mega-projects have failed, due to false assumptions of the innovation ecosystem. Educational programs are too often replicated directly from developed world, which has been shown to result in poor educational outcomes. Technology transfer from developed world has been shown to be complex.

On the other hand, many successful technology initiatives are emerging from the grassroots. Informal technology hubs, led by self-educated technology enthusiasts, are a new part of the developing countries' innovation ecosystem. In various initiatives, technologists and researchers have grouped with poor illiterate workers and successfully co-created life-improving technologies. Grassroots-level innovation activities, inclusive innovation, and co-creation in intercultural and inter-skilled teams hold big potential for the near future — and bring with them lessons that deserve being grasped also by first world researchers and developers.

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