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Design and Evaluation of a Mobilebased Cultivation Planning Application for empowering Sri Lankan Farmers

Tamara Ginige
Department of Computing, Faculty of Science,
Macquarie University, Australia and
Faculty of Business,
Australian Catholic University, Australia
Email: tamara.ginige@acu.edu.au

Deborah Richards
Department of Computing, Faculty of Science,
Macquarie University, Australia
Email: deborah.richards@mq.edu.au

Abstract

We have field tested a profit calculator for Sri Lankan farmers as a part of our investigation to develop mobile-based tools for empowerment. Lack of access to information to support livelihood activities is creating economic hardships for the farmers. Though the majority of the farmers use mobile phones there aren't many useful mobile applications for them. In the field test we captured farmers' experiences of using the profit calculator and a revised set of requirements. When reflecting on these observations we realised that instead of developing ICT applications just to provide information or perform tasks, we need to develop applications based on user goal-oriented empowerment processes. Based on this insight, we reviewed our original design of the profit calculator and designed a new Cultivation Planning Application.

Keywords

User Empowerment, Mobile Computing, IS Design

INTRODUCTION

This paper explores the ways to develop mobile based applications to empower users. User empowerment has been identified as a major contributing factor for the rapid growth of Web 2.0 applications. As a part of this investigation we have developed a profit calculator for the farmers in Sri Lanka and trialled it with a group of farmers. The findings from this trial gave us very valuable insights into how we can develop Information Systems incorporating user empowerment aspects. This is a very important finding when considering the ways to reshape the society through information systems.

Empowerment is multi-dimensional, social and a process that occurs within sociological, psychological, economic and other dimensions (Page 1999). It is of intrinsic value and can be applied at the individual and collective levels. It is studied across many areas such as psychology, community development, education, social studies, and organisations among others (Perkins and Zimmerman 1995; Rappaport 1987; Zimmerman 1988; Zimmerman 2000, p44). It is a concept that is linked to power and requires that power can change. Many researchers have described empowerment as an iterative process of gaining power (Masterson and Owen 2006; Speer and Hughey 1995; Wallis et al. 2008). Empowerment has different meanings in different sociocultural and political contexts, typically involving the use of terms such as self-efficacy, control, self-power, self-reliance, independence, making one's own decisions, and being free to define it (Narayan 2002). It has been defined as the "ability to get what one wants, and the ability to influence others to feel, act, and/or behave in ways that further one's own interests" (Dodd and Gutierrez 1990, p. 64) and "the capacity to exert control and influence over decisions that affects one's life space for one's own benefit" (Zimmerman 2000, p44). Empowerment includes beliefs that goals can be achieved, awareness about available resources and factors that hinders or enhance one's efforts to achieve those goals and efforts to fulfil those goals (Alsop and Heinsohn 2005; Zimmerman 1995). In its broadest sense, empowerment is the expansion of freedom of choice and action. Access to timely information can greatly increase these choices and assist people to take actions to gain better control over their lives.

In developing countries, Information and Communication Technology (ICT) solutions have been used to improve efficiency, competitiveness, productivity and income in many areas, including agriculture. For example, numerous projects have been launched to support the farmers in developing countries including: MFarm platform in Kenya that links farmers and buyers with up-to-date market information and agriculture trends (mFarms 2013), Farmforce mobile-based software solution to manage and improve smallholder marketing ability (Farmforce

2013), e-Choupal project in India that delivers farming information to farmers' mobile phones (Radhakrishna 2011), 8villages business project in Indonesia that delivers information to farmer's mobiles using the social network concept (Vaswani 2012), Harvest Choice project in Africa that uses Global Positioning Systems (GPS) and mobile technology to enhance the productivity of smallholder farming systems (Choice 2004) and Esoko project that provides mobile based market information to farmers (ESOKO 2009). These projects have brought many benefits in their own context but none explicitly addressed empowerment or how to motivate the targeted users to utilise the technology to its full potential. Access to information itself is not enough. Technology should be used to design processes to identify the needs of the users in the environment in which the users operate and empower them to use these processes to achieve their goals.

Social Life Networks (SLN) for the Middle of the Pyramid (www.sln4mop.org) is an International Collaborative research project aiming to develop Mobile Based Information Systems (MBIS) to support livelihood activities of people in developing countries. A specific project is to develop a MBIS for farmers in Sri Lanka to address a frequently occuring over-production problem. As a part of this project we are investigating whether the provision of relevant and timely information using a MBIS to farmers in Sri Lanka leads to an increased sense of empowerment (Ginige and Richards 2012). MBIS needs to provide information on rapidly changing dynamic situations such as fluctuations in market prices, prevailing supply and demand situations for their produce as well as more stable information such as information on seeds, pests, weather patterns and soil types. Other groups in the collaborative research team are investigating ways to obtain and deliver this information to farmers using MBIS (De Silva et al. 2013; De Silva et al. 2012; Ginige et al. 2012; Ginige and Richards 2012; Giovanni et al. 2012a; Giovanni et al. 2012b; Walisadeera et al. 2013).

In this paper we present our investigation into developing a Cultivation Planning Application within an MBIS that has been designed with empowerment as the central focus. The paper is organized as follows. The next section presents background information relevant to the current situations of farmers, followed by an introduction to empowerment theory and related work involving empowerment studies. We then present the design science research approach that we have used to arrive at the Cultivation Planning Application, including description of the stages: design of a profit calculator, the field trial, and analysis of the field trial data, design of the new empowerment model and high-level design of the Cultivation Planning Application. The last section contains next steps and conclusions.

BACKGROUND

Currently, mobile-cellular penetration stands at 96% globally, 128% in developed countries and 89% in developing countries (ITU 2013). Due to the popularity of web 2.0 applications, users today have become not only information users but also information producers. This can be seen as an empowerment of previously passive information consumers (Cormode and Krishnamurthy 2008). However, Jain et al. (2011) show that there are about 3.5 billion people who have mobile phones but are not part of the modern Internet due to lack of useful applications and suggest that the SLN concept can be used to minimise that gap.

In the Sri Lankan economy, agriculture is one of the important sectors and approximately 33% of the total labour force is engaged in agriculture (Agriculture 2006). Currently there are not many mobile-based agricultural applications that have been developed to address the local needs of the farmers. Depending on the crop cycle there will be different information needs. There are six stages of a crop cycle: *crop selection* stage where farmers decide what to grow, *pre-sowing* stage where farmers either purchase or prepare seeds, *growing* stage where farmers plant, apply fertiliser, pesticides and water, *harvesting stage, post-harvesting stage* where farmers take their produce to the market and *selling stage* where they sell their produce (Walisadeera et al. 2013). Farmers often make poor decisions due to the lack of access to current and relevant information. Most farmers depend on their self-knowledge, friends, family and sometimes a village middle-person or agriculture extension officer for advice and information that may not be accurate, up-to-date or complete (Lokanathan and Kapugama 2012). Often the middle-person takes advantage of these situations as farmers do not have enough information to carry out successful negotiations. This leaves farmers feeling powerless, helpless and desperate, and they do not see their livelihood is improving. Some farmers have stopped farming and started to look for other jobs.

The main objective of the proposed MBIS is to address some of these issues by providing relevant, timely information that they need. Further it will have empowerment activities that would help them to get involved in their own environment, learn new skills, become independent, and achieve their goals.

EMPOWERMENT THEORY

Empowerment has many definitions. Mechanic (1991) has defined it as "an intentional, ongoing process centred in the local community, involving mutual respect, critical reflection, caring and group participation, through which people lacking in equal share of valued resources gain greater access to and control over those resources". Group (1989) has defined empowerment as "a process where individuals learn to see a closer correspondence

between their goals and sense of how to achieve them, and a relationship between their efforts and life outcomes". Both of the above definitions define empowerment as a process which has outcomes.

Empowerment theory provides a framework that helps to organise the knowledge needed to create strategies to support the development of empowerment. The theory suggests that actions, activities or structures may be empowering, and the outcome of each process results in a level of being empowered (Zimmerman 1988). A thorough development of empowerment theory requires exploration and description at multiple levels of analysis such as individual, organisational and community. In empowerment theory, empowering processes and their outcomes are clearly defined. Empowering processes for individuals might include learning decision-making skills, managing resources and working with others. Empowering processes for communities might include being able to access government agencies, media and other community resources. Possible outcomes of individuals feeling "empowered" would be situation specific perceived control, critical awareness, skills and proactive behaviours. For communities, empowerment outcomes might include the evidence of pluralism, the existence of organisational coalition and accessible community resources.

In their model of empowerment Stacki and Monkman (2003) demonstrate the obstacles and facilitators that exist as people participate in a variety of contexts as they move from the private sphere to the public sphere (personal, family, work, community, institutional, national, global) and how they interact with these forces. Processes can be introduced to promote awareness and education that can result in three forms of responses or actions: accommodation, resistance or change. When people accommodate and resist, change does not happen. Empowerment can occur when people proactively seek change (Stacki and Monkman 2003).

Cattaneo and Chapman (2010) provide researchers with an empowerment process model that is intended to understand and promote this change. One of the important components of this model is defining personally meaningful, power-oriented goals. Studies have shown that understanding the nature of such goals and how they differ across people and contexts is critical to facilitating the process of empowerment (Kieffer 1984; Kroeker 1995). When describing empowerment, researchers often identify an individual's beliefs about his or her abilities, their sense of value or self-worth and self-efficacy as core elements of the empowerment process (Cattaneo and Chapman 2010; Kroeker 1995; Riger 1993). Many studies have revealed consistent evidence linking self-efficacy to motivation and performance across situations and cultures, at both the individual and community levels (Bandura 2002).

After identifying a goal and feeling that one can accomplish it, one must identify a course of action. In this model, Cattaneo and Chapman (2010) define knowledge as an understanding of the relevant social context, including the power dynamics at play, the possible routes to goal attainment, the resources needed, and ways to obtain them. Learning skills to accomplish a task will increase self-efficacy and promote action, and experience with taking action will refine skills, further influencing self-efficacy and action (Kieffer 1984; Zimmerman 1995). The impact component of this model is considered as the assessment of what happened after an action is taken. The reflection on impact will help to understand the obstacles to success such as discrimination, lack of resources, revealing related knowledge and leading to refinement of goals. This is the component of the model in which the role of social context is most explicit (Cattaneo and Chapman 2010).

In the context of domestic violence, Li et al. (2012) have done a feasibility study to examine the use of intelligent, online advisory tools to address the informational needs of domestic violence victims. The study explores how an online advisory system based on empowerment theory can help a domestic violence victim to make well-informed decisions. Their proposed empowerment model supports processes to provide personalised information to the victims. Providing facts and alternatives to a victim assists him/her to make an informed decision to take an action. Circumstances of every victim is different, therefore understanding their individual situations and providing them with personalised information may help them to become more knowledgeable about their situation, that may help them to feel confident to take an action in their lives.

RESEARCH APPROACH

As our aim is to design a set of artefacts, we have adopted a Design Science Research (DSR) approach (Hevner and Chatterjee 2010). These aretfacts are an empowerment model, empowerment processes derived from the model and tools to be embedded within MBIS for farmers to enact the process. DSR consists of three cycles of activities: relevance cycle, rigor cycle and design cycle. The relevance cycle initiates the DSR process. It identifies the design requirements of the research question, the environment in which the artefact can be introduced, how the artefact is to be used in the environment, how it is to be field tested and what metrics are used to demonstrate the successful use of the artefact in that environment. The Rigor Cycle ensures that the design is based on scientific theories and methods to produce a new knowledge base of artefacts that will be useful to the environment. The new knowledge base may contain extensions to the original theories and methods, new artefacts and all experience gained from performing the iterative design cycles and field testing the artefact in the application environment (Hevner and Chatterjee 2010; March and Smith 1995).

The approach we have used involves many iterations of these three cycles. In the first iteration we have used a scenario-based approach to design an empowerment model (Ginige and Richards 2012). We have used the goals that we have identified in scenario-based analysis to design and implement a prototype of the profit calculator to support empowerment activities of the farmers. The next step was for us to introduce and field test our prototype in the environment it will be used. We have designed two questionnaires to capture field test data. The first questionnaire had closed-ended questions with multiple answers to capture the demographic information of farmers, including gender, educational level, employment details, ownership of land, involvement in the community, decision making process, how they access information, and their mobile phone and internet usage. Capturing this information was important for us to create a profile of a farmer. The second questionnaire had both closed-ended questions with multiple responses as answers as well as open-ended questions. We had several objectives of using the second questionnaire: (a) to find out whether the farmers carry out an expense analysis and how, at the beginning of the crop cycle (b) to capture their response on using the profit calculator (c) to understand whether our prototype can successfully be used in the farming environment (d) to understand the issues farmers may have experienced using it (e) to know whether it would help farmers to make important decisions and improve their knowledge and skills.

With closed-ended questions, we counted how many farmers provided the same answer and computed the total or the % value where appropriate. To analyse the responses to open-ended questions we have used quantitative/quasi-statistical method (Saldana 2009). In this method of qualitative data analysis, data is first interpreted by coding to create an impression in a structured and quantitative form. As the responses were in the native language, first we had to translate it into English language for analysis. We read the responses captured in native language and each text segment that was meaningful to the domain of analysis was labelled with a code, usually a word or a short phrase in English. Sometimes, farmers used few different terms in their native language to describe the same concept. During translation one English word or a short phrase was used in place of these different native language terms combining coding with translation. For example, farmers used the words “wathura” and “jalaya” in Sinhala language to represent the word “water” in English language. When coding was completed, we grouped similar codes together to create possible structured impressions to determine whether there were common themes or relationships among data. We used NVivo Software: Computer Assisted Qualitative Data Analysis package to generate tag clouds to visually observe commonly occurring themes in the qualitative feedback provided by farmers. We then calculated word frequencies of these themes to quantify the importance of these themes from a farmer perspective. From the insights that we gained through this data analysis process, we have entered the second iteration of the design cycle of DSR to re-evaluate original empowerment model and re-design the profit calculator. As a result we made some modifications to the original empowerment model and designed a new Cultivation Planning Application (CPA) within the MBIS which has tools to support empowerment activities.

DESIGN OF PROFIT CALCULATOR

One of the empowerment goals for the farmers was for them to have financial security. The causal analysis carried out by the Sri Lankan research team has identified that farmers make important decisions at key phases of a crop cycle such as crop choosing, growing and selling with the revenue in mind (De Silva et al. 2012). Further, in recent ICT application development to support farmers in developing countries, calculators have been included as part of the application. For example, Farmbook is a basic business planning tool and profitability calculator that enables farmer registration to the application, build business plans and evaluate the profitability of specific products in their business plans (Ferris 2011). The details of Farmbook application were not available therefore it was not possible to comment whether or not it was a suitable application for the farmers in Sri Lanka.

For the farmers in developed countries, a profit calculator can be seen as a very basic and simple tool to use. This is not the case for Sri Lankan farmers. The majority of these farmers use basic mobile phones, not smart phones. They haven’t seen or used a tool like a profit calculator for decision making before. There are two supporting factors for us to build this application. The first factor is the rapid mobile growth in Sri Lanka: currently 92% of the total population in the country are mobile phone subscribers hence proving the fact that the mobile phone has become a part of their daily lives (Telecommunications 2012). The second factor is the motivation of farmers which is revenue driven to carry on farming despite the constant hardships they face. Therefore we have decided to implement a profit calculator as a tool that is specially developed to calculate farming expenses, expected income and profit/loss. Our aim is that this tool would assist the farmers to make decisions at crucial stages of the crop cycle.

The main functionality of the profit calculator is to calculate profit or loss by providing a systematic approach for farmers to enter the expenses and expected income for a whole crop cycle in a season. There are several stages in a crop cycle and for each stage there is a different set of expenses (De Silva 2010). We have identified fertilizer cost, pesticide cost, labor cost and machine hire cost as main expenses for our design based on the recommended crop growing procedure (Agriculture 2006). At different stages of a crop cycle a farmer may apply different

types of fertilizer and pesticide for their crops and may need to hire people or machines to support various activities (Agriculture 2006; Lokanathan and Kapugama 2012). Our design allows a farmer to choose an expense category, choose an expense item in that category and enter necessary information to compute expenses (Figure 1). This expense is used to update the total expenses for the fertiliser category and total expenses for the whole crop cycle. To calculate the expected income, the farmer can enter the data for expected harvest and unit selling price. With the values of total expenses and expected income, the profit calculator computes and displays the profit or the loss. Figure 2 shows the main screen of the profit calculator application in English language.

FIELD STUDY

We field tested our Profit Calculator at two locations in Sri Lanka: Dambulla and Galewela over two days. Dambulla is situated in the central province of Sri Lanka, 148km north-west of Colombo, the capital of Sri Lanka. Dambulla has the largest wholesale vegetable market in Sri Lanka. Galewela is 20 Km away from Dambulla. Altogether there were 32 farmers involved in our study: 18 at Dambulla and 14 at Galewela. The research group at University of Colombo, Sri Lanka organized the farmers to attend the study via the agricultural officers at Dambulla and Galewela. We met the farmers at the agricultural offices at these two places. Five researchers from the Australian and Sri Lankan research groups were involved in this study which was conducted in the farmers' native language: Sinhala.

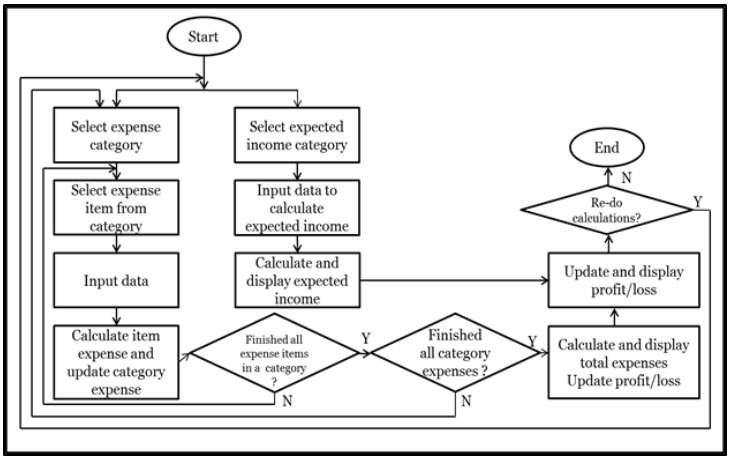


Figure 1: Profit Calculator

Figure 2: Main Menu of Profit Calculator

After collecting the demographic details of the farmers (approximately one hour) farmers used the prototype to calculate the expenses and profit for the current season. They used the Sinhala (native language) version of the profit calculator for this. On average each farmer took a little over an hour to complete the second part of the study. The last part of the field study involved an open ended questionnaire to understand whether they normally carry out a profit/loss calculation prior to their farming activities, how the farmers keep a track of their expenses, their experiences of using the profit calculator prototype, usability issues, additional information and new features that they would like in the application.

Part 1 Results: Participant Demographics

All 32 farmers were male and married. Education up to year 10 level had been completed by 69% of them, 16% of them up to year 12, 9% of them were university graduates and 6% did not have any formal education. Around 75% of the farmers owned the land they used for farming, 16% of them rented it and the rest of the farmers did not make any comment. There were about 53% of the farmers who were self-employed and 44% of them were employed on permanent contract at the time. Nearly 84% of them had borrowed money to support their farming expenses at various stages of their farming career. At the time of the study, 38% of the farmers were in debt.

Regarding technology use, 84% of the farmers had at least one mobile phone and out of which 7% had smart phones. Around 16% of the farmers did not have a mobile phone and they were all over the age of 40. Around 25% of the farmers had two mobile phones or more. Nearly 94% of farmers' households had at least one mobile phone and 69% of the households had two mobile phones or more. 84% of the farmers did not use the Internet using a computer as they did not have one at home. The main reason for this was the high purchase cost, inability to use technology related to operating a computer and ongoing maintenance cost. With regards to activities they carried out on the mobile phone, 80% of the farmers used it to receive and make calls, nearly 30% used it to play games, send SMS, take photos and listen to radio and music files (Figure 3). About their awareness of the

Internet activities, 10% of the farmers used their mobile phones to browse the Internet, access the Facebook and check their bills and 30% of farmers were aware of the livelihood related Internet services available (Figure 4).

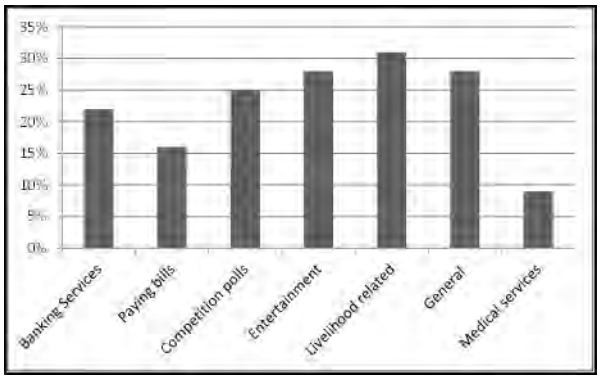


Figure 3: Mobile phone activities of farmers

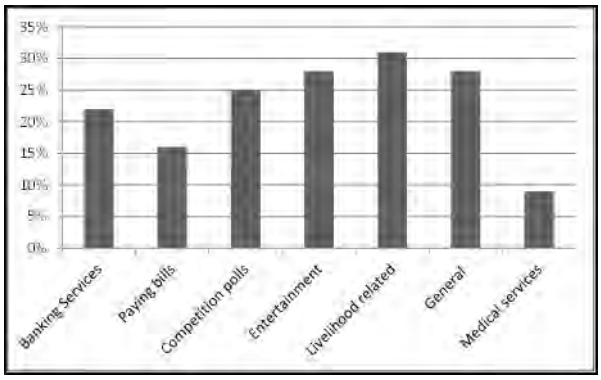


Figure 4: Internet service awareness of farmers

Part 2 Results: Testing the Prototype

When field testing the profit calculator, we first demonstrated how they can use it. They needed to enter data for four categories of expenses: fertilizer, pesticide, labor and machine hire. Each expense category had a drop down menu with four expense items to choose from. For fertiliser and pesticide expense calculations, once the expense item was selected, farmers had to input the quantity required and the unit price. For labor and machine hire expenses, farmers had to enter hiring cost of a machine or a person per day and number of days that service was required. Farmers also needed to enter data to calculate the expected income. Using this data, profit calculator computed the total expenses and displayed the profit/loss.

Though farmers took a while to get used to using a smart phone, at the end of the session, 97% of them said they understood the functions of the profit calculator, 81% found it easier to navigate through various screens, 91% agreed that it was easier to understand the instructions and 88% of them agreed that it was easier to carry out a profit/loss analysis using an application on a mobile phone.

Part 3 Results: Follow-Up Questions

The main objective of the third part of the study was to find out how the farmers kept a record of farming expenses and their experience of using the prototype. About 12% of the farmers did not keep any records of their expenses. Another 23% of the farmers did a mental calculation of their expenses and 4% of them used a calculator but did not keep a record. 42% of the farmers did expense calculations manually and recorded them on books. 19% of the farmers used a calculator to compute their calculations and recorded the expenses on books.

Despite the fact whether or not there was a profit/loss analysis at the beginning of the crop cycle and the farmers kept records of their expenses, all the farmers had an approximate idea about what their net revenue might be. Nearly 72% of the farmers said their predicted profit was very different to what they received at the end of the crop cycle, 25% of them said it was different only sometimes and 3% of them said there was no difference. The reasons they gave for this difference in predicted and actual revenues were: fluctuating selling price in the market (66%), unpredictable weather conditions (31%), damaged crops due to pests and diseases (34%) and unexpected costs (25%). Nearly 67% of the farmers who did not carry out an expense analysis reported unexpected expenses as one of the reasons for this difference. Around 81% of the farmers agreed that it is beneficial to carry out some analysis on their expenses during the crop cycle.

Activity	Pre-Sowing Stage	Growing Stage	Harvesting Stage	Post Harvesting Stage
Labour cost calculation	√	√	√	√
Chemical cost calculation	√	√		
Fertiliser cost calculation	√	√		
Machine cost calculation	√			
Packaging cost calculation				√
Pesticide calculation	√	√		
Seed cost calculation	√			
Transport cost calculation				√
Water cost calculation	√	√		
Applying for micro finance	√	√	√	√
Online Ordering	√	√		√
Discussion forum	√	√	√	√

Figure 5: Various activities in crop cycle stages

In order to gather user requirements for our future designs, we asked farmers what they wanted. They mentioned that having a better understanding of their expenses in the various stages of the crop cycle and an awareness of different suppliers may help them to better manage their expenses. On average, each farmer has listed at least four expense items that have an effect on their total expenses. In addition they proposed more functional requirements for the future design of the profit calculator: detailed expenses for each stage of the crop cycle and whole cycle, correct units of fertiliser and pesticide as they come in powder, liquid and granular form, history of expenses for future comparison and analysis, profit as a % of expenses, space for farmers to enter new costs and information, and a facility to obtain loans via banks during financial hardships.

NEW EMPOWERMENT MODEL: CULTIVATION PLANNING APPLICATION

The next step in our investigation was to review and revise our current design of the profit calculator. In addition to identifying new requirements, our systematic analysis sought to discover much deeper needs of farmers and to come up with a new design to help farmers to achieve their goals and become motivated as a result. Qualitative analysis revealed that the farmers need customized information for them to make their own decisions. Farmers had an idea about their expected income but were reluctant to discuss it. It is a cultural belief that they should not talk about good outcomes that are yet to happen in the future.

One of the requirements was to have details of expenses for different stages of the crop cycle and for the whole crop cycle. When the prototype of the profit calculator was first developed, its main function was to calculate the total expenses for the whole crop cycle and not for the stages. Therefore in our new design, we have decided to incorporate this requirement of the farmers. To design this requirement we first analysed the different stages of a crop cycle, and various activities, related expenses and information requirements of these stages. The expenses that are related to various activities in these four stages are listed in Figure 5.

The proposed new design of our empowerment model is shown in Figure 6. In an earlier study (Ginige and Richards 2012), we used scenario-based analysis to identify possible empowerment processes that may assist farmers to achieve their goals: decision making, planning and managing resources, learning and disaster recovery. To design and measure the empowerment processes we must consider the empowerment outcomes. Applying empowerment theory and previous studies to our scenario-based analysis we identified four empowerment outcomes: *sense of control*, *increased self-efficacy*, *increased knowledge* and *competence*. (Bandura 1997) suggests that an individual's *self-efficacy* beliefs influence the choices made and the actions pursued. They should be able to see the resources that would assist them and the path to take to access these resources (Cattaneo and Chapman 2010). Access to personalised information and learning tools will increase their knowledge and competency and allow them a greater sense of control and self-efficacy. By focusing on these empowerment outcomes, we have designed the new Cultivation Planning Application (CPA) with a number of tools to support empowerment activities (Figure 6). As the farmers are more interested in expenses than profits, we have renamed the profit calculator as an expense calculator. The proposed expense calculator computes all the expenses that are related to pre-sowing, growing, harvesting and post harvesting stages and has the following tools and data sources to support the empowerment outcomes.

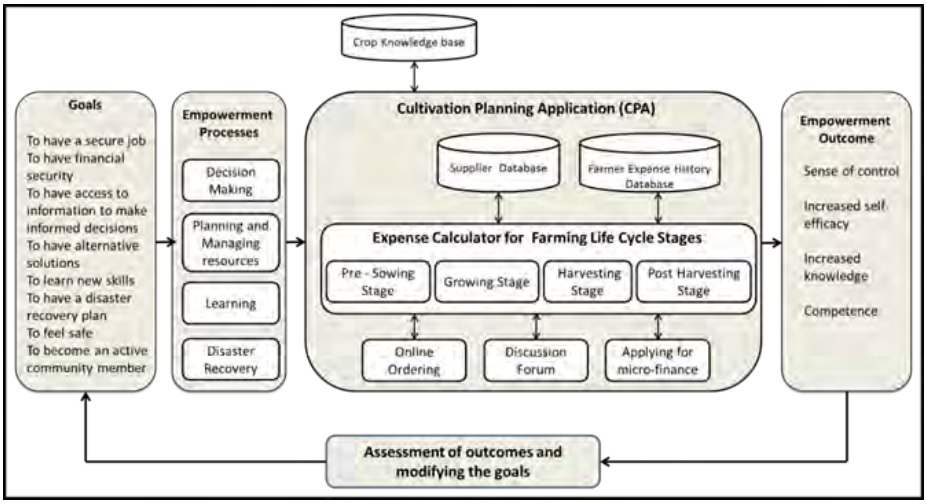


Figure 6: Re-designed Empowerment Model with Cultivation Planning Application

- *Supplier Database* has the details of the suppliers who provide seeds, fertiliser, pesticide, chemicals, packaging, machines, transport and any other expense details. This will provide a farmer an opportunity to make decisions hence improving the empowerment outcomes of sense of control (Bandura 2002).
- O*nline ordering* tool will help the farmers to learn the business transactions and banking activities involved in online ordering. This will improve farmers' decision making skills, business skills and will support the empowerment outcomes of sense of control and self-efficacy (Bandura 2002; Cattaneo and Chapman 2010; Kroeker 1995; Riger 1993).
- *Farmer Expense History Database* will be used to store the past expenses that each farmer has created using Expense Calculator for different products and different stages. This will help farmers to study and compare the history of expenses for different crops in different seasons enhancing their decision making process (Bandura 2002; Kieffer 1984; Zimmerman 1995).

- *Applying for Micro Finance* will help farmers to apply for a loan through state/private owned bank to receive financial support immediately.
- *Discussion Forums* will help farmers to discuss their issues with the other farmers and exchange ideas, become aware of new ideas and alternative solutions. This would help them to become an active member of their community and potentially achieve all four empowerment outcomes.

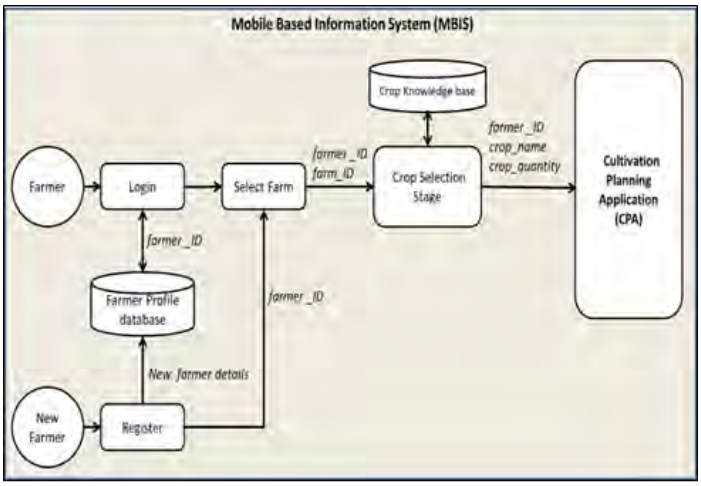
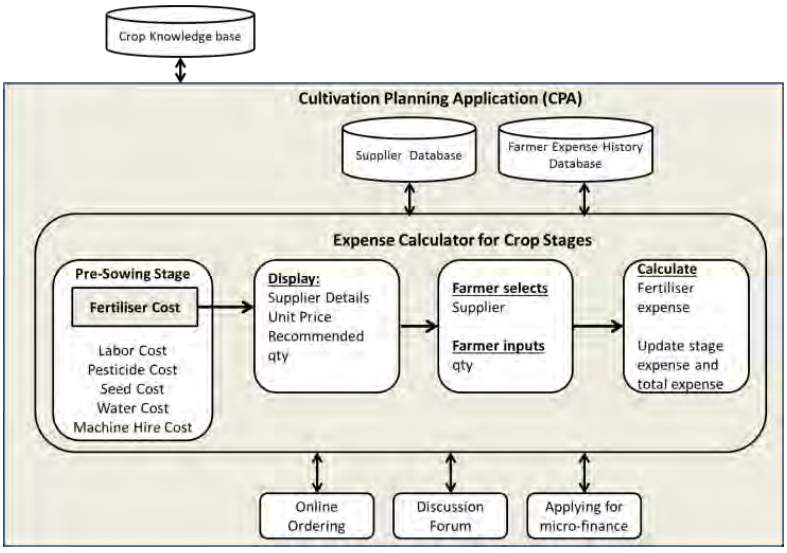


Figure 7: High Level Architecture of the Overall System

Within the revised empowerment model, personalization is central to achieving the empowerment outcomes. As shown in Figure 7, Cultivation Planning Application (CPA) is embedded in the MBIS. To use CPA, a new farmer must register his name and mobile number, farm name and location (may own more than one). These details are stored on a farmer profile database where farmer will be identified by a *farmer_ID*. In future visits registered farmers need to first login, and then select the appropriate farm. The Crop Knowledgebase has information on crop knowledge such as crop names, how they are grown, crops that are grown in different areas, activities that are carried out in each stage of crop cycle, common pests and diseases and how to control them (Walisadeera et al. 2013). Once the farmer selects a farm, Crop Knowledgebase provides a selection of crops that can be grown in the location where farmer's farm is. Farmer can select which crop to grow and the quantity which is decided at the first stage of the farming life cycle: Crop Selection Stage. In addition to *farmer_ID*, now farmer has data for *crop_name* and *crop_quantity*. Each step that was described earlier identifies the farmer and farmer's needs hence providing personalization to farmer's requirements. Through this deign we have achieved an important component of empowerment which is to understand and define personally meaningful goals and providing an environment and opportunity to achieve these goals. Once the farmer has selected the crop, the farmer enters the Crop Planning Application to understand various expenses in other stages of the crop cycle as shown Figure 8. For example, in Pre-Sowing stage, a farmer may be interested in fertilizer expense. The supplier database has the details of suppliers and the products that they sell.



The results returned will be specific to the farmer. A farmer can choose the suitable fertilizer and also the quantity to order if the farmer does not agree with the recommended quantity. Using this information, the expense calculator can compute the fertilizer expense, update expenses in the crop life cycle stages and the total expense. These details will be stored in the Farmer Expense History Database. The farmer can use this history of expenses in future sessions for expense comparisons that would help the farmer in decision making processes.

Figure 8: Operation of Cultivation Planning Application

NEXT STEPS AND CONCLUSION

Empowerment is a process to assist users to achieve their goals. Our field trials with the profit calculator, have allowed us to map out a process for Sri Lankan farmers, and possibly others, to plan their cultivation and design a

Cultivation Planning Application to assist the farmers to enact the empowerment process. At various stages our new design will provide information about available choices in terms of suppliers and associated costs to the farmers to make informed decisions and actions. As we found their goal is to minimise the cost we designed the new application to show the cost at various levels of granularity; total cost, stage cost and individual item cost. In the coming months, we will be implementing this new design and developing it as a part of the Mobile Based Information System for the farmers in Sri Lanka.

In this paper we have demonstrated an approach to develop Information Systems grounded on empowerment theory by identifying the deeper requirements and motivations of the users. Through discovery of requirements that meet essential aspects of empowerment: *sense of control*, *increased self-efficacy*, *increased knowledge* and *competence* we can develop more meaningful applications. This research has shown us that to reshape the society through information systems; empowerment has to be built in to motivate the end-user to fully utilize what these new and diverse information systems can provide.

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