Market and price decision enhancement services for farmers in Uganda

Aregu, Raphael

Market and Price Decision Enhancement Services for Farmers in Uganda

Raphael Aregu

Publisher: University of Groningen, Groningen, The Netherlands

Printer: Ipskamp Drukkers B.V.

ISBN: 978-90-367-7194-8

eISBN: 978-90-367-7193-1

Raphael Aregu

Market and Price Decision Enhancement Services for Farmers in Uganda
Doctoral Dissertation, University of Groningen, The Netherlands

Keywords: decision enhancement, decision making, farmers, farming, decision, agricultural market, design science, information systems

rijksuniversiteit
groningen

Market and Price Decision Enhancement Services for Farmers in Uganda

Proefschrift

ter verkrijging van de graad van doctor aan de
Rijksuniversiteit Groningen
op gezag van de
rector magnificus prof. dr. E. Sterken
en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op

donderdag 25 september 2014 om 16.15 uur

door

Raphael Aregu

geboren op 22 november 1970

te Soroti, Uganda

Promotor

Prof.dr. H.G. Sol

Beoordelingscommissie

Prof.dr. E.W. Berghout

Prof.ir. A.J.M. Beulens

Prof.dr.ir. J. Nerbonne

Dedicated to:

Agnes, Arnold Alfred, Aaron Ronald, Ashley Franklin, Antonia Jasmin, Christine, Joyce and William

Table of Contents

List of Figures

Preface and Acknowledgement

Though several efforts have been directed towards issues relating to farmers' market participation in many developing countries, there are still gaps on farmers' market and price decision making challenges. The main driving force has been to achieve economic development, poverty reduction and commercialization of agriculture. However, during the inception of this study, it was evident that much recent research efforts focus on market access strategies and market access challenges. Particularly, research on farmers' decision making has focused on factors that influenced those decisions. These studies have identified a number of factors that influence effective farmers' market participation, ranging from infrastructure, dominant subsistence systems, information access and asymmetry, including inadequate institutional support among others.

This study specifically focused on farmers' market and price decision enhancement services for facilitating agile market access among farmers in Uganda. Our motivation was that, among others, the agricultural market environment is continuously changing, complex and uncertain. This, therefore, requires more attention to be directed on the interaction of individual market participants, technological opportunities and shifting attention of government's priorities. On the part of farmers' market and price decisions, challenges arose due to external and internal entities such as market liberalization, infrastructural development, including dynamism in consumer environments (Bijman and Wollni, 2008). These shifts present challenges to farmers' decision making processes, including decision outcomes, and therefore requiring agility in the way they market their products. In this study, the decision enhancement services' perspective provided the lens to leverage farmers' market participation by focusing on their market "decisions that matter" (Keen and Sol, 2008). The study particularly addresses issues relating to market identification and price determination among farmers, traders and other market participants.

While conducting this study, a number of people contributed to its completion in various ways and it is difficult to name all. I am greatly thankful to all of them. In particular, I pay great gratitude to my promotor Prof. dr. Henk G. Sol for his tireless encouragement, patience and motivating guidance among others. In him, I greatly gained an in-depth methodological and problem domain knowledge that helped me focus the study until completion. He equally kept mobilizing the needed resources that were required for the various levels of facilitation during the study. In particular, I have learnt several research philosophies and methods, with emphasis on design science, inductive reasoning and 'ways of' framework, all of which have expanded my jurisdiction of expertise. Through Prof. Sol, I am greatly

thankful to all the staff of the University of Groningen as a whole, and in particular, those from the Faculty of Economics and Business for providing me a working space, facilities and resources. In the same note, I extend my sincere gratitude to both Prof. ir. Adrie Beulens and Prof. dr. Egon Berghout, including Prof. dr.ir. John Nerbonne for accepting to be in the promotion committee of this thesis. I greatly appreciate in particular Prof. dr.ir. John Nerbonne's initial guidance that helped me focus the research problem during my first visit to the University of Groningen.

Thanks to the team under Eric J. Haarbrink at the International office and Irene Ravenhorst for their administrative roles and support during my time at Groningen University. It is in this similar note that I wish to acknowledge the financial support I obtained from the NUFFIC sponsorship programme, including staff from the Netherlands Embassy in Kampala.

On the same note, I would like to convey my sincere gratitude through the Vice Chancellor (VC) to all Gulu University staff. The support I obtained from Gulu University was immense and it is difficult to enumerate. Similarly, I thank the respective Farmers' Associations of Gulu and Soroti, as they provided their commitment, knowledge and resources that were vital for the completion of this study. Through their programme officers, I kindly extend my appreciation to all of them. In addition, I thank Makerere University administration and staff for providing me the initial opportunity to carry out this study. I particularly thank Prof.dr. V. Baryamureeba's generosity and inspirations. Similarly, I extend my appreciation to Mr. Aaron Kuloba for accepting to participate as a team member in the studio interface development, testing and implementation.

Finally yet importantly, I thank my family members who in one way or another missed my valuable support during my absence from home. It is in this light that I dedicate this work to them in their own names: they include Agnes, Arnold Alfred, Aaron Ronald, Ashley Franklin, Antonia Jasmine, Christine, Joyce and William. Both Jasmine and William were born during the course of the study. I thank all of them for their support, guidance, patients and forgiveness. I thank God for his blessings and keeping me healthy until the end of this study.

Raphael Aregu

Groningen, The Netherlands, August 2014

1 The Problem Landscape

One of the ways in which farmers' market capability can be addressed is through designing services that improve their competitiveness. While there is no easy way to achieving this, a thoughtful examination of the needs of farmers, other market stakeholders and prevailing conditions can reveal opportunities for proposing decision enhancement services for improving farmers' market and price decisions. The target of this study is on designing services that facilitate enhanced links between farmers and individual traders (who may be individuals, groups or institutions). Therefore, under this chapter, we specifically set out the research scene starting with a brief introduction (1.1). In section 1.2, we provide brief relevant details about Uganda with a focus on agricultural market environment. Section 1.3 addresses the loci of the study, which encompasses background discussions on decision enhancement services. The chapter continues by specifying the research objective, scope and questions in section 1.4.

A research approach is presented in section 1.5 and covers the research philosophy, strategy, instruments and an overview on interviews and observations. In section 1.6, we discuss the research relevance and rigor, and finally end the chapter by presenting the thesis structure in section 1.7.

1.1 Introduction

The discourse around the nature of markets dominates discussions on farmers' market and price decisions in many developing countries. The mainstream view considers a free market that fosters competition to promote the best interests of consumers and producers alike. Often combined with this belief is the view that efficient markets are formal, modern and accountable. Farmers are seen as operating mostly in informal arrangements which vastly reduce their ability to make market and price decisions in congruence with market demands; this reduces returns for their effort and hence their wellbeing. To this end, several efforts have been directed towards issues relating to farmers' market participation in many developing countries of the world. The main driving force has been to achieve economic development, poverty reduction, and commercialization of agriculture and overall well-being of the affected farmers. However, much recent efforts have tended to focus on market access strategies (Shepherd, 2005; FAO, 2006; Fischer and Quim, 2012; Chamberlin and Jayne, 2013); market access challenges (e.g. Markelova *et al*., 2009; Bijman and Wollni, 2008; Ali and Kumar, 2010; Tong *et al.*, 2012).

Particularly, research on decision making has focused on factors that influenced farmers' decisions, including influence of farmers' decisions on technology adoption (Edwards-Jones, 2006; Mathijs, 2003; Solano *et al*., 2003). For example, Fountas *et al.* (2006) describe a high-level abstract system for precision agriculture focusing on farm managers. These studies identify a number of factors that influence effective farmers' market participation, ranging from infrastructure, dominant subsistence systems, information access and asymmetry, inadequate institutional support and so on. On the other hand, little research attention has been directed toward farmers' market decisions.

Similarly, our motivation was that, among others, the agricultural market environment is continuously changing and requires more attention on the interaction of individual market participants, technological opportunities including uncertain government's priorities. In particular, with the agricultural market domain, a paradigm shift has been caused by external and internal entities such as market liberalization, infrastructural development, including dynamism in consumer environments (Bijman and Wollni, 2008). These continuous changes present challenges to farmers' marked competitiveness including their decision outcomes. In this study, the decision enhancement services perspective was used as a lens to leverage farmers' market participation by identifying and focusing on their market "decisions that matter" (Keen and Sol, 2008).

Since agriculture is the main global economic activity especially in Sub-Saharan Africa, Asia and the Latin Americas, enhancing farmers' market decisions would contribute immensely to the national development of these countries. Agriculture in developing countries is characterized by small subsistence systems with low levels of mechanization (Alonge, 2004), an issue, which influences the decision making process of agricultural market stakeholders. In an attempt to change the status quo, governments including other stakeholders have recommended policy interventions for addressing challenges that hinder farmers' market participation (United Nations, 2010; World Bank, 2005). The United Nations (United Nations, 2010) in particular adds that, in order to achieve these policy directions, other deliberate efforts to motivate farmers need to be identified since a majority of them depend on agriculture for their livelihoods.

In addition to the above, the increasing need to transform agricultural systems from mainly subsistence to commercial and profit enterprises in developing countries presents a daunting challenge to farmers and other key stakeholders (such as traders, consumers and policy makers). Subsequently, agro-market actors are increasingly participating in dynamic local and global markets that involve complex and flexible market decisions (Verdouw *et al*., 2007). Within this complex and uncertain agricultural

product markets, individual farmers need to realize profits by easily accessing markets and breaking through market barriers. Farmers seek to maintain and increase their family incomes, ensure food security and be able to meet their livelihood demands. This puts pressure on the decision making process of farmers as well as the other market players.

Hence, implementing decision enhancement services among market participants is one of the critical areas of opportunity, growth and improved performance, and an environment to facilitate this is inevitably desirable. Such an environment is postulated to among others bring information within the hands of the farmers, leading to farmers' empowerment through control of their resources and decision making (ECA, 2007; Maningas *et al*., 2000). As our contribution, this study proposes to design, prototype and implement farmers' market and price decision enhancement services for farmers in Uganda. Therefore, in the next section, we give a brief background on the Ugandan agricultural market environment so as to delineate the problem scope.

1.2 Overview of Agricultural Market Environment in Uganda

Generally, Uganda is a landlocked country whose economy is predominantly agrarian with 6,810,000 hectares of land under agricultural activities, providing 85% of employment, contributing 38% of export earnings and 44% of Gross Domestic Product (GDP) (World Bank, 2008). However, despite this potential, half of Uganda's poor households are those engaged directly in agricultural cultivation; and the average income in Uganda for non-farm based households is 70% higher than the farm based households (World Bank, 2005). The strategic direction for market development and access in Uganda is provided within the Plan for Modernization of Agriculture (PMA) (MAAIF and MFPED, 1999).

PMA's main goal is to attempt and eradicate poverty in Uganda as outlined in the Poverty Eradication Action Plan (PEAP) of 1997 as revised in 2004 (MFPED, 2008). In order to achieve the overall government's strategy on poverty eradication, PMA was set up with a mission of "transforming subsistence agriculture to commercial agriculture". This continued transformation of the Ugandan agricultural landscape has far-reaching effects on the agricultural market communities. Farmers in particular need to access cost effective, reliable and useful market and price information, reach at agile and dependable market and price decisions as a means of surviving current market demands.

It has been reported that in Uganda farmers are unable to make the right decisions due to information access issues, often making farmers unfavorably compete in the market (Katungi, 2006; Katungi and Smale, 2006; Nalukenge *et al*., 2009; Robbins and Ferris, 2000). Poor access to market information is

not limited to the Uganda environment alone but rather applies to most developing countries. For instance, Mukotjo and Kalusopa (2010) indicate the same situation in Lesotho; Mackrell (2006) for Australian cotton farmers; and Adomi *et al.* (2003) report the same problem among Nigerian farmers.

Similarly, attempts to establish similar services (such as of a formal market information service) in Uganda started in the 1990s under the United Nation's Food and Agricultural Organization's (FAO) support. The service, which was mainly set up with funding from the United States Agency for International Development (USAID), aimed at collecting retail prices of agricultural products for use by policy makers, researchers and farmers (Ferris and Robbins, 2004). These services did not last long and stopped operation in 1999 due to a number of reasons (see for instance Francis and James, 2003). While on his conclusion, Nair (2006) states that, "access to information may improve a farmer's productivity, enhance awareness about innovative farm practices and market trends, and this in turn will contribute immensely to national development". We found Nair's arguments very inspirational to this study.

It is equally important to note that, the current policy interventions in Uganda encourage private sector partnership in service delivery (MFPED, 2008) as a key driver of the PMA strategic direction. It was in this direction that the National Agricultural Advisory Services (NAADS) was set up to spearhead the revitalized extension services in Uganda. However, from the time of its establishment, NAADS registered satisfactory service delivery to farmers (Benin *et al*., 2007), which services have since kept declining due to a number of factors (Benin *et al*., 2007; Alonge, 2004) leading to its continued criticism and lose of trust from stakeholders. As a result, several attempts have been taken overtime to re-think the whole NAADS philosophy.

Moreover, (though a positive strategy), the private sector involvement has its own positive and negative impact. For instance, lack of effective control and coordination, including liberalized regulatory framework has led to the establishment of many un-coordinated services that do not reflect the needs and capacities of local communities (Benin *et al*., 2007). While some initiatives (such as FOODNet) (Ferris and Robbins, 2004)) depend on donor funding and have since closed down as the donor funds are completed. There are many examples of such agencies such as WOUGNET (2006), Ferris and

Robbins (2004), MTN (2009) [1] among others. For instance, Shepherd (2005); Tollens (2006); Khatiwada (2005) and World Bank (2009) have since highlighted the weaknesses of most of these initiatives, among which is their inability to provide an interactive and collaborative platform for decision making among farmers and other market participants.

Generally, an effective and sustainable farmers' market and price support solution must be underpinned by approaches that are integrated and responsive to the settings in which they operate. Particularly, an overview of the Ugandan farmers' market environment shows that a majority of them practice small-scale farming, i.e. farmers typically cultivate areas of up to 5 ha; the farms are labour intensive and are characterized by: 1) a high degree of fragmentation, 2) a low resource base and 3) mixed cropping (Beckford, 2002). This raises the need for a multidisciplinary approach that underpins acceptability, confidence and sustainability on the side of the farmers' decision enhancement services. The challenge remains to how to develop such support services, which are both adaptive and relevant to local conditions, while generating lessons that are more generic.

1.3 Decision Enhancement Services (DES)

Decision making or decision analysis can be considered a scientific field, which offers options and procedures, approaches and methods aimed at facilitating human problem solving. Decision Enhancement (DE) introduced by Keen and Sol (2008) forms part of these procedures and methods that was used in this study. Figure 1 below represents Decision Enhancement (DE), which has been described as a management lens for looking out at the dynamic and volatile landscape of complex private and public sector decision making arenas. Through the DE lens, private sector and public sector decision making interdependencies and potential collaborations are discerned. DE has been grounded from a sound theory and proven practice that is underpinned by the application of principles and tools for implementing Decision Support Systems (DSS). However, the divergence of DE is reflected on its focus at providing "a process instead of a system" (Keen and Sol, 2008).

Decision enhancement is a lens that focuses on stakeholders in decision arenas and their decisions that matter; and it employs the combination of people, process and technology in decision making. The

[1]Together with the Grameen Foundation, MTN launched its mobile technology work in Uganda as Community Knowledge Worker initiative, which combines mobile technology and human networks to give smallholder farmers access to accurate, timely information that helps them protect their crops and animals, improve their yields and get better market prices. (Source: http://www.grameenfoundation.org/where-we-work/sub-saharan-africa/uganda).

studio environment introduced in the decision enhancement services' notion of Keen and Sol (2008) facilitates actor decision making processes by providing a collaborative and interactive workspace using suites (i.e. integrated sets of technology) and a set of guidelines.

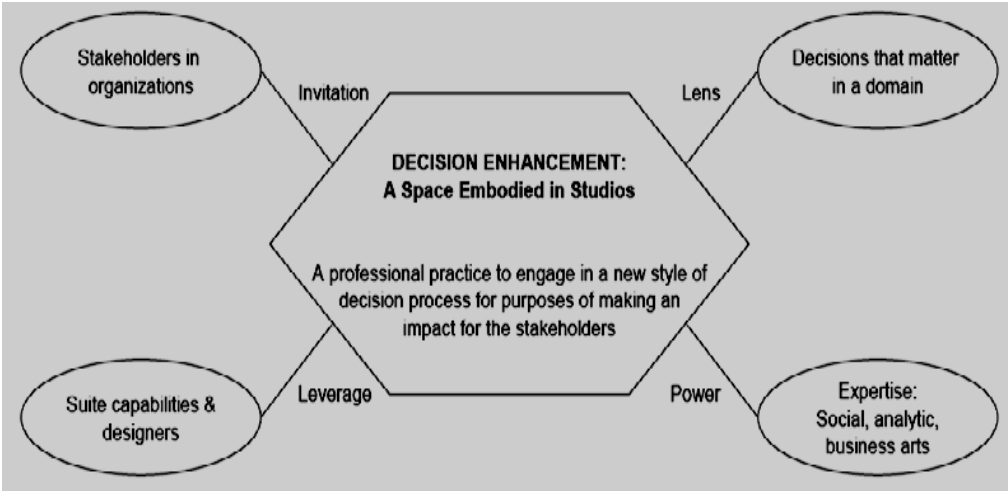


Figure 1: Decision Enhancement as a Field of Practice (Keen and Sol, 2008)

Within the DE's lens, three types of studios have been identified (Keen and Sol, 2008) namely: learning studios, inquiry studios and participatory studios. Learning studios can help decision makers to build a new understanding that leads to a new source of decision options and processes. Inquiry studios are prescriptive and involve critical inquiry, challenging assumptions while seeking optimal directions for the decision process. On the other hand, participatory studios involve more invitation and aim at encouraging participants' involvement in the decision making process that is most likely to lead to consensus, agreement and commitment. In particular, participatory design represents a collection of principles and practices aimed at making technologies, tools, environments, processes and requirements more responsive to human needs (Simonsen and Hertzum, 2008).

Developing a decision enhancement studio involves landscaping, orientation and initiation, recipes, suites and process. Landscaping refers to the assessment of stakeholders' business goals, time framing and capabilities. Landscaping seeks to define as to what are the decisions that really matter. Orientation and initiation provides for a team with skills, credibility and domain expertise to attract, innovate, coordinate and help the studio participants move to a decision commitment. An effective decision

enhancement studio employs recipes, which are repeatable, adaptive and codified procedures that can be transferred across organizations. Recipes are build on practice and experience (Keen and Sol, 2008). On the other hand, suites represent integrated sets of tools focused on enhancing the process and the people contributing to decision making. Decision processes, (if well structured) influence the likelihood of participants making effective decisions. Processes, on the other hand, specifically describe the steps that the participants have to make together in order to support them reaching a decision.

Based on the work of Keen and Sol (2008), Knol (2013) identifies flexibility and visual thinking as the two major components of decision enhancement studios. The flexibility component seeks to ensure that the studio easily adapts to the changing and volatile decision making environments. While quoting Conboy (2009), Knol (2013) relates flexibility to agility that is concerned with "continued readiness […] to rapidly or inherently create change, proactively or reactively embrace change, and learn from change." Consequently, flexibility, adaptability and suitability seek to ensure the decision enhancement studio's usability. On visual thinking, Keen and Sol (2008) recommend its application on a decision enhancement studio via appropriate images, and without losing focus on content. As an example, Knol (2013) finds visual thinking to be useful in enhancing sourcing and sharing in the Dutch government.

Various researches to address several decision making challenges in various specific domains have used the decision enhancement lens. Some of these previous works include logistics brokering in developing countries (Muniafu, 2007); enhancing mining enterprise start-up decisions (Ejiri, 2012); a studio for business process agility (Amiyo, 2012); and sourcing and sharing in the Dutch government (Knol, 2013). Generally, decision enhancement focuses on decisions that matter; visual thinking, facilitative services, and technology suites that draw on software, telecommunications, data resources, and analytic methods , and thereby, provide a new method of increasing decision process agility (Keen and Sol, 2008; Amiyo, 2012). This study, therefore, proposes to build a farmers' market and price decision enhancement studio with emphasis on Ugandan context. The studio seeks to facilitate market and price decision making agility among farmers by employing sets of technological opportunities, a responsive and facilitative environment among others.

1.4 Research Objective, Scope and Questions

The Research Objective and Scope

If the farmers had the ability to close the market and price decision gaps for their produce, the decision alternative that will best solve their products' selling problem could easily be selected. Hypothetically,

enhancing farmers' market and price decisions may contribute to improved productivity among farmers, including corresponding changes in their farming styles. However, in order to scope the study objective, we note that, the complete agricultural production cycle involves many activities, but this research was limited to the post-harvest or market stage as outlined by Fafchamps and Hill (2005): "an activity where the farmer is pre-occupied with making decisions relating to his/her products' market and price choices". Hence, the main aim of the study was:

- to develop, implement and evaluate a farmers' market and price decision enhancement studio for farmers in Uganda.

The specific objectives include:

- to identify market decision enhancement requirements among farmers,
- to come up with an approach to design farmers' market decision enhancement studio, and
- to develop and test a farmers' market decision enhancement studio.

In respect to the research scope, the research involved members of the farmers' associations from Soroti and Gulu districts shown in the map of Uganda in Appendix 2. This was mainly due to proximity, logistics, and availability of key and willing informants (farmers). Similarly, the focus of the study is on farmers' market and price decision making. Formerly known as Teso district during independence (i.e. in 1962), Soroti has since been divided to the present day Soroti, Kumi, Kaberamaido, Amuria, Katakwi, Ngora and Serere districts. The district has among others one Agricultural Research Institute and one Agricultural Training College. The main economic activity is agriculture with emphasis on food crops for both household consumption and for sale. The district has 2,662.5 square kilometers of land of which 2256 square kilometers is potential farmland. Women provide most of the labour for farming activities in Soroti district[2]. According to Samuel Ejouk (the coordinator), though Soroti District Farmers' Association (SODFA) has many members, only about 250 of them are active.

On the other hand, Gulu district is one of the seven districts that constitute the Acholi sub-region, the historical homeland of the Acholi ethnic group, also known as Acholiland. The district is located at longitudes 30 to 32 degrees east and latitude 02 to 04 degrees north. It has a total land area of 3,449.08 sq kilometers, which is 1.44% of the national land area (Gulu District, 2007). By 2002, Gulu district had a population of 298,500 (Gulu District, 2007), which has since increased to over 300,000; 72.3% of the population live in rural areas and the main economic activity is agriculture (Gulu District, 2007).

[2]Soroti District Administration (2002).Three year development plan, 2003-2005, Vol. I.

Gulu District Farmers Association (GDFA) was formed in l992 with the objective of mobilizing the farming community to have one voice under one independent umbrella organization. GDFA is also a registered member of the Uganda National Farmers Federation, the umbrella body for all farmer organizations in Uganda. The association operates in the whole of Gulu district. Currently, the total membership stands at over 8000, of which 500 are active members (according to the association's programme officer).

Research Questions

Determining the research question(s) was an extremely important step in this study because these questions helped us narrow the research objective and research purpose. Consequently, in this section, we outline the key research question as:

"How can market and product price decisions of farmers in Uganda be enhanced?"

Using this main research question, we were able to investigate and gain a deeper understanding of the problem domain using the following specific questions:

- What are the market channels available to farmers?
- What are the farmers' market and product price decision making requirements?
- What factors influence farmers' market and price decisions?
- What strategies and resources are needed for designing, prototyping and testing decision enhancement services for farmers?

1.5 Research Approach

The research approach outlines the philosophy, strategy and methods used in gaining in-depth understanding of the problem domain, approach to design, prototyping, testing and evaluating the farmers' market and price decision enhancement services in Uganda. An approach to achieve these targets is sought and described in this section. Generally, since the target of science is to develop knowledge of the natural world and the universal laws that govern it (Taper and Lele, 2004), it therefore provides fundamental options to the domain research endeavors. The scientific method consists of a collection of research **approaches** (i.e. philosophies of knowledge generation) that differ in the type of information produced and the robustness of conclusions drawn from a particular research project. Galliers (1992), for instance, refers to these research approaches as a way of going about one's research.

Research approaches may embody a particular style and employ different methods or techniques depending on the research domain.

In this research, our task was to choose an approach that would enable us address our research objective and questions outlined in section 1.4 above. First, we had to recognize the lack of a clear theory or critique regarding an agreed view of decisions, decision making and farmers' decision making processes in particular. A number of the existing theory frameworks on farmers' issues focus on services at an economic level (Gurbaxani *et al*., 2000; Konana *et al*., 2000) or theory-informed business engineering framework (Xiao and Greer, 2007) among others.

Design Science Research Philosophy

A research philosophy underpins key vital assumptions on how to perceive knowledge and acquire it, a concept mainly referred to by researchers of specific disciplines as "paradigm' (Trochim, 2006; Arunthari, 2005). Ballsum-Stanton (2010) uses the term "philosophy" to describe three perspectives of data. In this study, the research philosophy refers to the humanities discipline that searches for fundamental truth and a comprehensive view of reality, covering the ontological and epistemological orientations (Kroeze, 2011). Design science is a research philosophy in which questions relevant to human problems are addressed by creating innovative artefacts (Hevner and Chatterjee, 2010; Hevner *et al*., 2004). The *science* in design science represents the process of knowledge creation and understanding during a design problem whose solution is acquired by building and applying an artefact (Hevner and Chatterjee, 2010; Knol, 2013). The learning process is specifically achieved during the process of building an artefact (Kuechler and Vaishnavi, 2008).

On a philosophical perspective of design research, information systems' researchers have considered positivism and post-positivism (Gonzalez and Sol, 2012; Crossan, 2003; Proctor, 1998; March and Smith, 1995) philosophies including "the critical theory" (Avgerou, 2005; Mingers, 2001). Others have recommended interpretivism and pragmatism (Knol, 2013; Goldkuhl, 2012; Gonzalez and Sol, 2012; Kroeze, 2011; Marshall *et al*., 2005) as well as critical approaches based on interpretive methods (Avgerou, 2005). Cilliers (2005) argues for an alternative scientific methodology that can address complex problem environments where the researchers' understanding of the problem area is limited. This is partly because information systems research investigates socially constructed issues, which require the use of complimentary research orientations (Weber, 2004; Avgerou, 2005; Walsham, 2006).

The positivists assume the world as consisting of natural phenomena that are measureable and therefore can be quantified, knowledge is considered to be absolute and objective (Gonzalez and Sol, 2012; De

Villiers, 2005). As a result, the positivism paradigm as presented by Smith (1998) mainly uses quantitative methods in addressing a research problem. On the other hand, the post-positivism paradigm mainly employs qualitative methods (Trochim, 2006; Crossan, 2003). March and Smith (1995) note that research in IT can be either of a positivist or of post-positivist nature depending on the discipline handling the problem. This is due to the interdisciplinary nature of IT, meaning, "it is either science or non-science" March and Smith (1995). Natural science methods that emphasize theory and truth (March and Smith, 1995) are useful for performing rigorous studies in information technology since information technology falls within the discipline of information systems.

Critical research is regarded as a process that aims to make sense of the research problem, a radical procedure for engaging the researcher's capabilities, tacit knowledge and moral values (Avgerou, 2005; Hevner *et al*., 2004). In particular, research is seen as the art of putting together research questions with critical content, multiple theories and epistemological awareness to develop claims of truth (Mingers, 2004).

Similarly, interpretivism is a philosophical system that focuses on reality as a human construction that can only be understood subjectively (Kroeze, 2011), and has since provided epistemological insights to a number of information systems' design researches (e.g. De Villiers, 2005; Lee and Nickerson, 2010; Knol, 2013). Inquiries are value-related and are directed on people at their natural social settings while findings are subjective (Knol, 2013; Oates, 2006). The inquiries, in addition, focus on the uniqueness of each problem situation (Kroeze, 2011; De Villiers, 2005). The aim of interpretivism is to aid an understanding of the pluralistic worldview based on the principle that people assign meanings and values to their unique contexts. Instead of targeting at generalization of the natural worldview as in positivism, interpretivism aims at gaining an in-depth understanding of the problem situation (Chen and Hirschheim, 2004).

Interpretivism provides useful epistemological insights to researching into farmers' market and price decision making processes. The core aim of interpretivism is to work with the subjects' meanings that exist in the social world. Researchers acknowledge these meanings, understand them, reconstruct them as well as avoid distorting them, while using them as building blocks in theorizing. Hence, interactive knowledge creation underpins interpretivism-based information systems' research strategies (Gregg *et al.,* 2001).

On the other hand, pragmatism deals with situations, actions and their consequences as opposed to antecedent states i.e. there is a focus on effective application of findings to human problems (Cresswell,

2003; Knol, 2013). It (pragmatism) is concerned with action and change, and the interplay between knowledge and action (Goldkuhl, 2012; Mingers, 2004). Hence, pragmatism forms an important basis for intervention research into the world of human problems. The intervention may be an organizational change (as in action research) or building of artefacts (as in design research) (Knol, 2013; Goldkuhl, 2012; Hevner *at al*., 2004). Due to pragmatic orientations, there is a growing interest in action and design research among information systems researchers (e.g. Hevner *et al*., 2004; Jarvinen, 2005; Iivari and Venable, 2009; Kroeze, 2011). The essence of a pragmatic ontology for instance is on action and change i.e. humans acting in a world, which is in a constant state of becoming (Goldkuhl, 2012).

On a specific note, this research was meant to develop decision enhancement services for farmers that would among others facilitate the collection, packaging and delivery of quality market and price information, and equally providing a collaborative decision making environment for farmers and other market participants. Consequently, we see the need for an approach that guides knowledge creation and understanding of the farmers' decision making processes. This approach had to employ complimentary schools of thought ranging from the positivists, critical, interpretivism to pragmatism. Hence, we use the design science paradigm of information systems research (Carlsson *et al.*, 2011; Hevner, 2007; Arnott, 2006; Hevner *et al.*, 2004; March and Smith, 1995). Secondly, other researchers have used design science in addressing similar humanistic problems (e.g. Carlsson and Walden, 2010; Mackrell, 2006; Wijnhoven and Kraaijenbrink, 2008; Amiyo, 2012; Knol, 2013). Design science fitted this study since the product of this research covered three main activities of: 1) elicitation of farmers' market and price decision requirements, 2) an approach to design a studio, and 3) developing and testing the proposed decision enhancement services.

Figure 2 below represents the design science three-cycle research framework for information systems (Hevner *et al.,* 2004) from which methods and techniques for this problem domain were constructed. The design science approach, through its three-cycle based research framework enabled rigorous analysis and development of farmers' decision enhancement service based on DE lens of Keen and Sol (2008). Designing in the problem domain was concerned with the design and management of an artefact using a decision enhancement studio (Keen and Sol, 2008; Forwell, 2002) and providing collaboration opportunities (Briggs *et al*., 2003) to farmers and other market participants. The overarching focus of the study was on market and price information as a means of enhancing farmers' market collaborative decision making processes. The choice of market and price was seen essential since they represent a crucial phase in the agricultural product cycle (Mittal *et al*, 2010). Particularly, in order to improve their

overall wellbeing from their agricultural activities, farmers need to obtain equitable access to markets, and be able to determine prices for their own products.

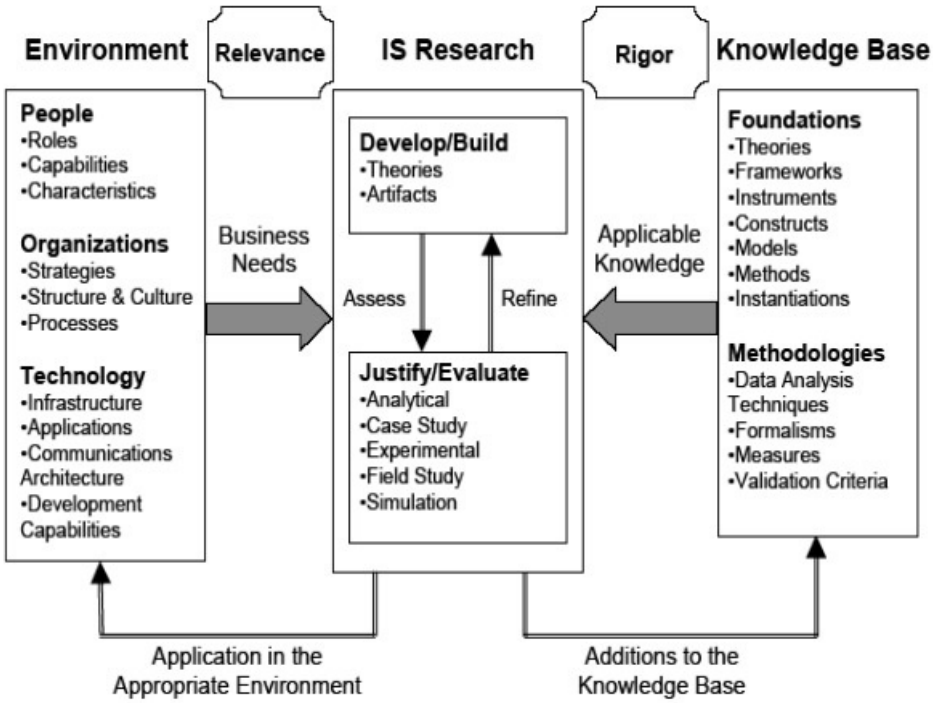


Figure 2: Design Science Framework: (Hevner et al., 2004)

Research Strategy

Within information systems domain, a research approach follows a given "strategy" that is grounded in a particular philosophy (Davis *et al.*, 1994). In particular, the term "strategy" refers to an abstract methodology that represents an overall strategy of conceptualizing and conducting an inquiry as well as constructing scientific knowledge (Gonzalez, 2010). Referring to research methods and techniques, Gonzalez (2010) outlines "… strategy..." to equally refer to the epistemological assumptions of methods and how they are linked to a particular theory.

After selecting our research approach and philosophy, the next task was concerned with identifying appropriate research strategies that would fit the problem domain. We note that farmers' market and price decision environment is full of uncertainties, unstructured, and requirements may be hard to

delineate. Therefore, the strategy chosen should address these concerns. Sol (1982) argues that, a research strategy consists of sets of steps used for addressing a research problem. From the design science perspective, these steps vary according to individual researchers and the problem domain (Hevner, 2007; Hevner *et al.*, 2004; Walls *et al.*, 2004; Nunamaker *et al.*, 1991). As noted above, selecting a strategy for this research was not obvious given that farmers' market activities rely on unstructured decision environments mainly due to their lack of organized structures and decision processes (Shepherd, 2005; Ferris and Robbins, 2004).

However, from the design science paradigm (March and Smith, 1995: 252, Hevner *et al.*, 2004; Vaishnavi and Kuechler, 2004; Hevner, 2007), a number of strategy alternatives are available to leverage this bottleneck. Particularly, the inductive-hypothetical strategy provides a flexible strategy for research regarding ill-defined and unstructured investigations (Sol, 1982). The inductive-hypothetical research cycle (Sol, 1982) can be considered as an early instantiation of design science, where the problem-solving process is utilized as a means for research. Our inductive-hypothetical strategy for the problem domain follows Sol's (1982) innovative foundations and is presented in Figure 3 below.

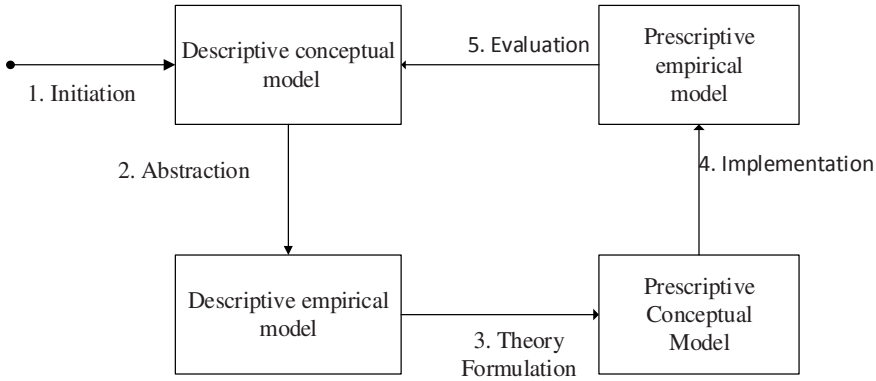


Figure 3: Inductive-hypothetical Research Strategy (Sol, 1982)

The rationale for choosing the inductive-hypothetical strategy was because it emphasizes the specification and testing of premises in an inductive way; enables the generation of various alternatives for the solutions of the problem; opens up possibilities for an interdisciplinary approach; and permits feedback and learning (Sol, 1982; De Vreede, 1995). The inductive process provides an opportunity for explaining what is going on in the problem domain. The inductive-hypothetic research strategy is tailored for ill-defined problems and it enables: 1) inductive reasoning moving from exploration and understanding to design, 2) an interdisciplinary approach, 3) generation of alternatives for problem

solving in an iterative design process and 4) interdependent analysis and synthesis of activities (Sol, 1982; Gonzalez and Sol, 2012; Knol, 2013).

As shown in Figure 3, the inductive-hypothetical five stages include research problem initiation, which was concerned with the scoping of farmers' decision making pitfalls regarding their market participation (or problem definition) leading to a descriptive empirical model. The second stage deals with abstraction where research issues were identified and resulting with a descriptive conceptual model or sets of requirements. The second stage in particular involved literature analysis and exploration directed towards proposing a design. The third stage deals with theory formulation whose output is a prescriptive conception. On the other hand, the fourth stage involved prototyping and implementation whose main outcome is an empirical prescription, which is evaluated or tested at the fifth stage. For purposes of clarity, these stages are briefly described below.

Initiation Stage

For clarity purposes, this study was concerned with investigating and addressing issues relating to market and price decisions of famers in developing countries. Consequently, it had to do with services and an environment that had to be identified and designed. Gu and Lago (2011) define service identification as a significant initial task aiming at determining services that are appropriate for use by the intended users. Consequently, our focus in this research is on what is needed to be able to present relevant product(s) (or artefact) -"market decision enhancement solution" as perceived by farmers. The initiation stage, therefore, involved preliminary interviews and literature reviews. The initiation stage was vital for achieving set development and implementation goals. Secondly, the initiation stage helps in identifying the research relevance, contribution and its scope (the relevance cycle, Hevner *et al*., 2004; Hevner, 2007) including organizational set ups, domain challenges and opportunities.

Abstraction Stage

After defining the empirical description, the next stage involved abstraction where an analysis of proposed solution design is explored to obtain in-depth understanding. The abstraction process of the inductive-hypothetical methodology presented us with an opportunity of analyzing several existing concepts, approaches and strategies of the problem domain. Specifically, the abstraction and representation stage refer to the appropriate means, ends and laws, which are crucial to design science research (Hevner *et al*., 2004). It is at this stage where we gain insights into the set of actions and resources available to construct the farmers' decision enhancement service. Similarly, goals and

constraints, including uncontrollable environmental forces are acknowledged. This was achieved through interviews, observations and literature review and presented in Chapters 1, 2 and 3.

Theory Formulation

During theory formulation, the identified requirements and perceived solutions were combined into a general theory for solving the problem. Van de Kar (2004) notes, "the term theory in this sense constitutes the proposed solution"- the farmers' decision enhancement service in this case. Specifically, the result of the theory formulation process is a conceptual prescription for the problem domain. Here we particularly define the service values that the studio may deliver to farmers, relevant activities to be performed, identify resources that are required, including a preliminary implementation scope whose details are presented in Chapter 4. Theory formulation represents a change in orientation from problem identification (or definition) towards problem solving, that is from descriptive towards prescriptive models. The target of theory formulation being to find appropriate solution for the conceptualized problem (Janssen, 2001).

It is therefore, at the theory formulation stage that we introduce an approach to design the Farmers' Decision Enhancement Studio (FDES), which started with preliminary information gathering up to the actual elicitation of farmers' market decision needs through exploratory studies. At this stage, further consultation with experts was conducted to refine the problem scope and verify the proposed theory. For instance, Goldstien *et al.* (2002) present four additional service concepts, which are necessary for an on-going service system development. These concepts include 1) service operation, 2) service experience, 3) service outcome, and 4) service value. Verdouw (2010) in particular describes agricultural markets as being demand-driven and calls for the implementation of agile support solutions that focus on responsiveness and customization. In this research, all these concerns had to be taken into consideration.

Prototyping, Implementation and Evaluation

At the implementation stage, the research is presumed to have gained a sufficient knowledge base to enable an independent way of thinking to evolve. Using knowledge from the conceptual prescription, the design process continues through the analysis of requirements to document specifications as perceived by users. In this study, the implementation outcome is an empirical prescription consisting of design requirements and the proposed solution. In theory, an empirical prescription implies putting the conceptual prescription into practice (Van de Kar, 2004), which in this research was achieved by

deploying and evaluating a Farmers' Decision Enhancement Studio (FDES) packed in technology suites, recipes and services.

Generally, the nature of the research problem needed a solution that would handle unstructured information, provide an interactive and collaborative information sharing, and accommodate continuous changes prone to agricultural markets, technology and user preferences. This was achieved by employing evolutionary and collaborative ways of thinking, grounded on information systems perspectives. Further, developing and implementing this kind of solution consists of two components including the service system and the service process. The service system involves identifying resources and structures required to develop a quality service offering (Edvardsson and Olsson, 1996), which in turn consists of various sub-components, including service staff, the target users, physical/technical environment, organization and control. On the other hand, the service process is the chain(s) of parallel or sequential activities, which must function if the intended solution is to be produced, i.e. the decision enhancement studio in this study.

The evaluation stage involved testing the usefulness, usability and validity of the empirical prescription. In principle, this was done by comparing empirical and conceptual prescriptions (Van de Kar, 2004) in order to establish the effectiveness of the proposed theory. Groups of farmers from Soroti and Gulu districts were used for evaluation purposes, and the details presented in Chapter 6. In the next sections, the instruments used in this study are briefly discussed.

Research Instruments

While discussing the inductive-hypothetical research process in his popular research knowledge base publication, Trochim (2006) presents detailed discussions on several types of research instruments including their use. Such discussions were not part of our study, but only provided us with the required knowledge base. For this research, we used three sets of data collection techniques consisting of literature review, unstructured interviews, and observations. These techniques enabled us achieve our aim of gaining an increased understanding of the research problem. Secondly, the instruments chosen helped in effectively addressing our research questions by facilitating exploration and exploitation within the confines of the problem domain.

We particularly used the knowledge base for gaining knowledge on traditional market information services, agricultural market information, clarify and focus the research problem and broaden our knowledge on farmers' market decision arena. In addition, we learnt more on designing as documented

by similar or related studies especially those in information systems (Chapter 2). In the next sub-section, we briefly focus our discussions to the interview instruments' construction.

Interviews and Observations

From existing literature, interviews may be structured or unstructured (semi-structured) depending on the problem domain (Dawey and Cope, 2008; Trochim, 2006). Information on farmers' market decision making requirements including details of existing selected agencies were collected using unstructured interviews. The choice of interview method was based on lessons learnt from the knowledge base, particularly Myers and Newman (2007); Mason (2002); Reyman (2001) and Mishler (1986). Briefly, we note that despite a few shortfalls with the interview method, interviews:

- enabled an in-depth understanding of relevant variables, gaining insights on farmers' experiences, and helped us approach research questions from different dimensions,
- facilitated access to a wider variety of informants to achieve a greater breadth of coverage and
- through the interview guide, it was possible to carefully decide how best to use the limited time available, interview a number of different farmers more systematically and comprehensively by delimiting the issues to explore in advance.

In particular, we choose to use unstructured interviews and observations due to the following additional conditions that are associated with the problem domain:

- there were no accurate records for determining the actual population of farmers in the study areas;
- relatively, a bigger part of the study population are of low literacy level, therefore, use of local language and interpretation was necessary during data collection;
- There was need to learn more and gain added knowledge on existing related services in Uganda by allowing free and open dialogue with respondents.

In addition to the above, Collis and Hussey (2003) state that unstructured interview is likely to use open-ended probes to explore participants responses in more depth. Consequently, there is an assured richness in communication (Gillham, 2000) since respondents express themselves freely with little interference from the researcher.

However, interviews have some limitations as well (Fontana and Frey, 2000; Yin, 1994) such as the issues of bias by the researcher or interviewees, and the difficulty in constructing words with intended

meanings. In this research, insights from Myers and Newman (2007) helped us address these limitations as we used unstructured interviews, sought informants consent and commitment in advance, and provided feedback in time. Secondly, knowledge from related studies was used to moderate validity and reliability of the results. For instance, the interview construction was guided by the work of Kang (2006) who administered unstructured interviews to a group of users in order to establish the hierarchical structure of service quality of mobile phone providers in Seoul, Korea.

Conclusively, observations were used due to a number of factors, some of which have been advanced in theory by Nandhakumar and Jones (2002). For the problem domain, observations helped in verifying data collected from interviews and gaining practical insight into the operations of agricultural products' markets in Uganda in particular. Observations further enabled physical verification of relevant tools and devices currently in use; unearth possible non-disclosures during the interview process; gaining insight into local meanings and their effects; and weeding out deliberate misleading disclosures obtained during the interview process as in Nandhakumar and Jones (2002).

1.6 Research Relevance and Rigor

Hevner and Chatterjee (2010) have identified three design science research cycles in any design research project. These include the relevance cycle that bridges the environment context and the design processes of the design science research project. The rigor cycle connects the design processes of the design science research project with the knowledge base of scientific foundations, experience, and expertise that informs the research project. The design cycle iterates between the core processes of building and evaluating the design artefacts. These three cycles must be present and clearly identifiable in a design science research activity. As depicted in Figure 2, the relevance cycle is concerned with the problem environment and comprises of issues on people, organizations and technology. Rigor on the other hand refers to the knowledge base i.e. foundation and methodologies.

Research Relevance

Hevner *et al.* (2004) describe research problem relevance as the second guideline in design science research whose primary objective is to develop artefacts to address important and relevant human problems. Consequently, in this study, we proposed a farmers' decision enhancement service to address farmers' market and products' pricing decisions. The services are developed following an innovative strategy of a decision enhancement studio advanced by Keen and Sol (2008), and which is packed in technology suites, recipes and services for collaborative market-decision making among farmers and

other market actors. In particular, the studio offers two broad services of Market Identification and Price Determination as presented in detail in chapter 4 and 5.

Generally, the results of this study are not only important to farmers and traders, but to a larger community of policy makers and the research community. From problem initiation to epilogue, we seek to add knowledge to the existing knowledge base as commanded by the design science philosophy (Hevner *et al*., 2004). We expect the outcome of this study to influence the way farmer-centered services are designed and deployed not only in Uganda, but also in the entire farming communities of the world. In addition, we expect the way farmers' interact with traders in the agricultural market place to be enhanced.

Research Rigor

Explicated as the fourth guideline in design science research (Hevner, 2007; Hevner *et al.*, 2004), research rigor is achieved by appropriately using foundations and research approaches from the existing knowledge base in designing and implementing artefacts. Basing on design science research, this research used inductive-hypothetical strategy of Sol (1982) to propose, prototype and test a Farmers' Decision Enhancement Studio comprising of Market Identification, Price Determination and Communication Services. We used knowledge from various domains such as adaptive, evolutionary, collaborative engineering and service orientation as outlined in Chapter 2. In addition, extensive literature review was conducted to gain an in-depth understanding of the problem domain. Similarly, exploration involving field interviews and observations was conducted among farmers using unstructured interviews and observations.

Finally, evaluation was carried out based on the 3Us (including usefulness, usability and usage) as proposed by Keen and Sol (2008) in their decision enhancement paradigm. The evaluation of the studio was conducted using case studies of selected farmers from key study areas. The evaluation exercise involved a number of activities such as selecting and identifying participants, defining participants' roles, scoping decision tasks to guide the evaluation exercise, carrying out the evaluation exercise, analyzing evaluation results, and interpreting the results. Hence, both the process of evaluation and the evaluation results supplemented our efforts to ensure that the research process was rigorously performed.

1.7 Thesis Structure

The thesis is presented in seven Chapters in line with our research strategy, practice and interests. A brief summary of the chapters covering the five inductive-hypothetical stages of initiation, abstraction, theory formulation, prototyping and testing and evaluation is given below.

As an initiation to the study, the research scene is set out in Chapter 1 that outlines an initiation process by introducing the research background, motivation, research approach and relevance and rigor of the study. Chapter 1 also presents the research objective, scope and research question. It is in chapter one where we provide an outline of our research philosophy, strategy and instruments. After the initiation stage, abstraction is conducted involving existing literature and expert consultations and presented in Chapter 2. Chapter 2 in particular describes the theoretical and practical perspectives of the problem domain as based on the existing knowledge base. Subsequently, a deeper understanding of information and farmers' decision enhancement is discussed in this chapter. It is in chapter 2 where we describe farmers' decision making processes and requirements based on relevant theories such as heuristics, service science etc. We in addition report on the investigation of relevant design approaches using the "four ways" framework. Chapter 2 closes with an overview on ICT and farmers' market and price decision making.

Similarly, Chapter 3 presents discussions on an exploratory field study that contributed to our conceptual prescription. This mainly involves the process of gaining a deeper understanding of the problem domain, including eliciting requirements for designing the farmers' decision enhancement service. Similarly, Chapter 4 describes our research contribution consisting of a design of a farmers' decision enhancement studio. It comprises of the way of thinking, way of working and modeling and the way of governance. It is in Chapter 4 where the design of FDES suites, services and recipes are prescribed based among others on insights from collaborative engineering strategies, systems perspectives evolutionary development, and service oriented architecture.

In Chapter 5, we discuss prototyping and implementation with emphasis on synthesizing requirements, studio architecture and development tools and strategies. The implementation is described using purposively sampled studio services and participants. Chapter 6 provides discussions on the evaluation process comprising of the procedures, evaluation results and key studio adoption considerations. We finally present the summary and overall recommendations of the study in Chapter 7. In particular, chapter 7 presents a brief overview of the problem domain and enables us reflect on research questions,

theory formulation, instantiation and the evaluation exercise. Chapter 7 equally summarizes our research agenda.

As concluding remarks, we have in this chapter described the problem landscape starting first with an introductory perspective and the background to the research problem. Within the background to the research problem, we have discussed an overview of Ugandan agricultural market place, with a focus on farmers' market challenges. Secondly, we have highlighted the decision enhancement theory, objective and research questions and our research approach. Within the research approach, we have presented discussions on design science research philosophy, the inductive-hypothetical research strategy that comprises of five stages namely: the initiation stage, abstraction stage, theory formulation stage, implementation stage and the evaluation stage. A discussion on the research instruments is provided in this chapter. Finally, it is in this chapter where we provide an outline on the research problem relevance, rigor and scientific contributions.

2 Decision Analysis of Farmers' Market Environment

In this chapter, we report on our literature review encompassing a number of issues around farmers' market and price decision enhancement. The chapter starts by describing information as a decision enhancement requirement followed by a discussion of farmers' decision making practices. We continue the chapter with a review of relevant design approaches and explore insight on how to design, prototype and evaluate the farmers' market and price decision enhancement services. The chapter highlights factors that influence farmers' market and price decisions, including resources and facilities that have been in use.

2.1 Information and Farmers' Decision Enhancement

In this section, we note from Keen and Sol (2008) that an organizational decision is the execution of a choice made in terms of objectives from among a set of alternatives on the basis of available **information** (p.81). Thornsbury *et al*., (2003) specifically add that agricultural decision makers rely on information provided by public and private entities. Information is therefore, a key decision enhancement requirement, which is briefly presented under this section covering agricultural information in general; markets, market and price information.

Agricultural information

Agricultural information has largely been defined basing on the agricultural production activities and processes such as planting information, soil management information, input acquisition information, harvesting and marketing information (Fafchamps and Hill, 2005; Haneveld and Stegeman, 2005). Ali and Kumar (2010) point out that agricultural information and knowledge are important factors in accelerating agricultural development through facilitating appropriate production planning, adoption of improved cultivation practices; including promotion of effective post-harvest management, market and price decisions. Agricultural information refers to meaningful data for decision making and it is a resource that is acquired and used (Samuel, 2001).

Mittal *et al.* (2010) have come up with an agricultural chain model indicating all the stages where different types of agricultural information are required to aid decision making by various stakeholders. In the context of this study, the cycle indicates the market stage as the final activity, though market stage ideally does not terminate the cycle of agricultural production, which is represented in Figure 4

below. Beulens *et al.* (2005) have, however, opined that, all stages of agricultural product chain are closely related and therefore cooperation is needed in order to remain competitive. This as a result may ensure the safety and quality of products to consumers.

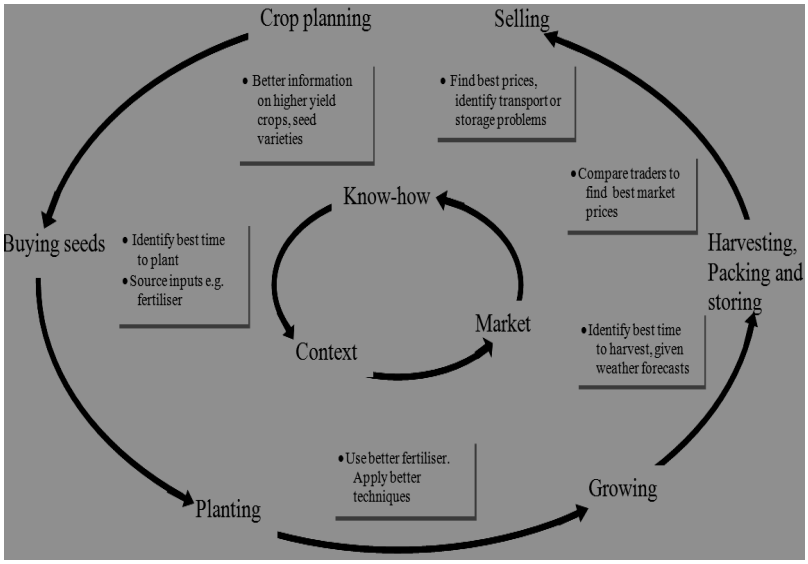


Figure 4: Agricultural Cycle and Information Needs (Mittal et al., 2010)

From Figure 4, several types of agricultural information may be identified such as land information, production-planning information, harvest and storage information, and market information (Ali and Kumar, 2010). Research indicates that the demand for agricultural information is reportedly higher during the early production, and at the later market stages of the agricultural product chain (de Silva and Ratnadiwakara, 2008), a stage where farmers are faced with making crucial decisions. Similarly, another study finds that farmers and the public constitute the highest number of agricultural information users (Nair, 2006) as compared to policy makers.

On a specific note to this study, market information is a key requirement for farmers' market and price decisions and its lack is mentioned as one of the major problems constraining market performance and supply response (Chianu *et al*., 2008). In particular, Marcucci (2001) indicates that market information is an important element in market expansion and performance. Market information is essential for farmers who wish to fully become market oriented and ensure that their products meet market demands

(Shepherd, 2011). Consequently, the scope of manipulation and unfair pricing significantly reduces when market information is available to all the market participants (Ferris *et al.*, 2006) since informational access is provided to all participants who wish to make better market and price choices for their products.

In practice, agricultural market and price information are important facilitating ingredients in agricultural market performance and decision making. It facilitates effective market decisions, regulates the competitive market processes and facilitates market mechanisms (Kohls and Uhl, 1990). It is much needed by farmers in planning production and market choices, and equally needed by other market stakeholders in arriving at optimal market decisions. Theoretically, market agents are assumed to have sufficient agricultural information to engage in optimal market and price arbitrage and this information is symmetric (Aker, 2010); in reality, however, this is not the case as information is often expensive, poorly managed, hence making it not symmetrical. Due to these factors, price dispersion across agricultural markets is a common occurrence (Brown and Goolsbee, 2002), and this is especially acute in developing countries (Jensen, 2007) including Uganda (Nkonya, 2002). Since gathering and processing of market and price information is costly and demanding. Hence, a more appropriate way would be to design and provide services within the farmers' capabilities and reach. Therefore, the need to understand the information needs of farmers is seen as the crucial starting point (Getnet *et al*., 2011) in developing effective decision enhancement services for farmers.

Generally, market participants can pursue three initiatives while dealing with the inherent complexities of the need for information (Schiefer *et al*, 2008), namely:

(a) Establishment of communication services that build on participants' loops and serving the communication needs. These services have to be build on infrastructure that allows the interaction of participants from within and outside of their own business network,

(b) A framework that ensures user trust by providing services that support the reliability of information, security and protection of data ownerships,

(c) A framework that can integrate different applications or existing systems that may provide relevant information through appropriate collection and processing techniques.

In conclusion, the proposed studio offers agricultural information services that provide farmers and other market actors the opportunity to access information related to the planning, management, and

operation of agricultural markets. Information is critical for national development and access to markets, as well as services for farmers.

Scoping Agricultural Market

Our next challenge was to build a perspective on scoping what a market is in the context of the problem domain. Dealing with farmers' decision enhancement, implies considering issues relating to agricultural markets. From the perspective of this study, agricultural markets simply refer to the characteristics of consumers' demand for agricultural products (Shepherd, 2003). Agricultural markets may also be defined as static locations where agricultural producers, traders and consumers come together for commercial purposes of supplying, selling and buying agricultural goods (FAO, 2003). Similarly, Marocchino (2009) describes agricultural markets by their typologies, locations, management and ownership. Whatever the type or characterization of agricultural markets, Lokanathan and de Silva (2010) argue that farmers need to have effective access to these markets in order to improve their incomes and access increased opportunities. This study proposes a decision enhancement service that may facilitate and leverage this access among farmers.

On the same note, Kohl and Uhl (1990) classify the functions involved in agricultural and food markets into three: exchange function (buying and selling); physical functions (storage, transportation and processing); and facilitating functions (standardization, financing, risk bearing and market intelligence). While Crawford (2006) discusses three categories of agricultural market stakeholders: the public marketing boards; producer/consumer societies or cooperatives; and individuals. However, marketing boards have since failed resulting in market setbacks for many smallholder farmers. For instance, Collett and Gales (2008) conducted four case studies in India and find that problems with market decisions forced women to sell their products on disadvantageous terms, and prevented them from reaping the full benefits of their farming efforts.

Generally, in this study, farmers' market activities have been defined to include both formal and informal business enterprises (Cater, 1998; Cater and Ram, 2002; McElwee, 2008) since in both cases they are involved in decision making. When individual market participants seek for information that enhances their decision making, they can collaboratively carry out the task in one session together, or at their current dispersed locations. The business processes that evolve are unique to individual farmers, highly volatile and vary among participants. Moreover, market participants are in addition characterized by different strategic, cultural and structural values, yet as organization, they are faced with varying interaction possibilities (Adam *et al.*, 2005). Following the liberalization of agricultural activities and

technology advances in developing countries, farmers operate in a volatile and unpredictable market environment associated with structural problems, low quality of human capital, limited access to inputs, credit and information (Pingali *et al.,* 2001).

2.2 Service-Based Theoretic Insights

Due to advances in information technology, solutions can be designed to offer relevant services aimed at enhancing farmers' market and price decisions. Hence, gaining knowledge on the service concept including service development approaches was necessary. As an initiation step, we consider "service" as outlined by Kotler (1988) to be an "act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything". In addition to this, more insights were drawn from the information systems' research domain. Within the discipline of information systems research, a "service" refers to the unit of functionality that some entity (e.g. a system, organization, or department) makes available to its environment (including service users) (Lankhorst, 2004). Some researchers use the two terms of 'service' and system interchangeably, while Mathiassen and Sorensen (2008) provide a comparative discussion between the two terms. Service interaction, in particular, comprises of three primary participants namely: 1) a service provider, 2) a service requester and 3) a service catalogue (or registry) (O'Sullivan *et al.*, 2002).

Empirically, services have fundamental differences with other public resources such as physical goods e.g. land, housing, etc. and this makes service development unique and challenging. Other researchers (Palmer, 1994; Van de Kar and Verbraeck, 2007) outline five key distinctive features of "services" as opposed to other resources (physical goods) and these are presented in Table 1.

Table 1: Distinctive features of a "service" (Palmer, 1994; Van de Kar and Verbraeck, 2007)

Service formular	**Underlying theory**	**Implications for service users**
Intangibility	An abstraction which cannot be directly examined	Difficulties in evaluating competing services; perceiving high levels of risks; placing emphasis on personal information sources, and using cost as a basis for assessing service quality.
Inseparability	Consumption of a service is not separable from its production. Producer and consumer interact during the service development process.	Being co-producers; being co-consumers; seldom traveling to the point of production.
Variability	Because users are involved in the production, it is hard to carry out an effective evaluation and monitoring of the services developed.	Setting service standards is often a challenge; hence, the need to use machines to produce services other than personnel. Many organizations use ICTs for this purpose.
Perish-ability	Cannot be stored nor reserved for future sell.	Greater emphasis on demand management, pricing models and promotion.
Ownership	No physical ownership transferred from the seller to the buyer.	Mainly related to service intangibility and perish-ability, hence users only get rights to a service

In the marketing domain, Gronroos (1990) abounds with definitions on traditional services and indicates a set of generally accepted characteristics of services leading to the SHIP acronym. Hence, services are: 1) **Simultaneously** produced and consumed- the user and producer are assumed to be present during a transaction (they co-produce the service); 2) **Heterogeneous**, every service produced through interaction is unique to a certain degree; 3) **Intangible**, services are intangible but at the same time are coupled to products. This is particularly true with farmers' decision enhancement services because they

imply intermediation by ICT- applications, for example one needs a mobile phone in order to receive an SMS; 4) **Perishable**, the "services" value is gone with the act of consumption. It is therefore hard to quantify the value of the service, hard to price on an evolved feeling or an experience derived from the service.

Therefore, from a service perspective, farmers' decision enhancement services refer to services that offer capabilities for identifying, acquiring, storing, transforming, processing, retrieving, utilizing, or making available information via appropriate media (Hovorka and Germonprez, 2009). The media here refers to the technology, medium or software applications that facilitate these capabilities (Federal Communications Commission, 2008). The proposed solution attempts to make multiple heterogeneous information resources discoverable and accessible by breaking through traditional barriers of location, structure, and context. Hence, it can be considered a service system, where a system has been defined as a whole of objects one would like to recognize in a certain problem area under study, during a certain period of time (Sol, 1982). Consequently, a farmers' decision enhancement service is considered a system that facilitate farmers' market decisions via information collection, packaging and aggregation for easier dissemination to stakeholders (Lokanathan and De Silva, 2010). The service system proposed in this study implies elements of intangibility, inseparability, variability, co-creation and a need for a strong evidence of ownership, including involvement of target users.

2.3 Decision Making Practices of Farmers

Farmers' decision making practices reflect their particular aims and constraints, and an understanding of *whys* and *wheres* of these practices forms a necessary step for designing overall agronomic decision support systems (Poppenborg and Koellner, 2013; Parker, 2001; Aubry *et al*., 1998; Gibbon, 1994). In this section, we explore farmers' decision making practices by reviewing relevant literature. We particularly inform our discussions with insights from decision enhancement services of Keen and Sol (2008).

In light of the above, we continue our discussions by noting that, there is no common acceptable definition for "decision" or "decision making process" (Keen and Sol, 2008), which is the same even in the agricultural domain (Gray *et al.*, 2009). For the purposes of this study, a decision refers to a specific commitment of an individual to taking an action. The sets of actions that begin with the identification of a stimulus for an action and end with a specific commitment to action, forms the decision making process (Mintzberg *et al.*, 1976). Mintzberg *et al.* (1976) define the decision process to include three stages of identification, development and selection. Decision making implies: searching for information

on the problem to be solved; to identify (design) possible solutions (alternatives); to evaluate different alternatives and to choose among them; and to control the implemented decision (Simon, 1960). Therefore, decision making is a process of making choices from a number of alternatives to achieve a desired result (Eisenfuhr, 2011).

In some cases, decision makers are not aware that problems do exist, even when they are, they do not systematically search for all possible alternative solutions. For example, time constraints, cost and in-ability to process needed information (Nair, 2006; FAO, 2006) greatly influence farmers' decision making practices. Simon (2009) coined the term '*bounded rationality'* to describe a decision maker who would like to make the best decision but instead [… due to a number of constraints] settles for less than even the optimal. To characterize decision making styles, researchers have emphasized both the rationalistic and bounded rationality models (March, 2010) to be of importance. Rational decision making implies that the decision maker operates under certainty, knows the alternatives, knows the outcomes, decision criteria and the ability to make optimum choice and implement (Simon, 1997, 2009; Towler, 2010). In reality, this is often not the case, especially among actors operating in an uncertain, volatile and dynamic environment (Towler, 2010; Keen and Sol, 2008: 49), and in agriculture markets in particular (Parker, 2001).

Further to the above, decision makers equally tend to rely on heuristic practices of decision making due to a number of factors (Marsh, 2002). Marsh (2002) defines heuristics as cognitive short cuts that enable individuals to make evaluations based on one or a few simple rules, thereby, avoiding the processing and time costs related to exploring an exhaustive set of possibilities (p.9). Heong and Escalada (1999) on their part refer to heuristics as "informal-rules-of-thumb". The decision making strategies farmers pursue do not only depend upon the actual effects of the market, but also on how they perceive and cognitively process their experiences and update their perceptions of the market. As has been widely explored in the psychology literature and more recently in the economics literature, when individuals are faced with complex and uncertain decision situations they use heuristic rules to simplify mental tasks into simpler ones. Heuristics are believed to play a role in determining decision perceptions in the context of farmers' choice for markets and product pricing (Murray-Priot and Wright, 2001).

For the purpose of this study, we base our analysis on the decision enhancement services of Keen and Sol (2008), which is grounded on Decision Support Systems (DSS) that emerged in the early 1970s to support and improve human decision making (Knol, 2013; Arnott, 2006; Parker, 2001). The decision enhancement perspective of Keen and Sol (2008) is an extension of DSS theory, where they consider

decision making as a process that emphasizes moving new generation decision making and new generation technology to new generation decision processes (p.76). Decision making comes from the design of processes not the search for the solutions, "a process that leads to a commitment to action" (Keen and Sol, 2008; Arnott, 2006). As a departure from traditional decision support systems, a decision enhancement studio exists to complement and support decision-makers rather than to replace them (Keen and Sol, 2008; Arnott, 2006; Parker, 2001).Within the decision enhancement perspective, decision making have also been described in two contexts including descriptive and prescriptive axioms, both of which are discussed by Keen and Sol (2008) in detail.

In conclusion, we have defined decision making to be a process targeted to commitment and to enable follow-on action. This is because farmers' market and price decisions require commitment and joint follow up on actions that have been agreed on. Decision enhancement services are designed to assist in helping an effective move to a commitment, which presupposes several conditions described by Keen and Sol (2008), to include:

1) stakeholders are known and are willing to engage in collaboration and sharing their information, and be open about their views and values, 2) stakeholders have an agreed position on both goals of the decision process and some measure of an effective outcome, and 3) that the results from the decision process will be actionable in that there are available resources and management support to follow-up on the decision. For the case of this study, individual support instead of management support is crucial since market and price decisions are taken at an individual level (Parker, 2001). These assumptions are key decision making requirements among farmers.

2.4 Examination of Relevant Design and Development Methodologies

In this section, a review of information systems design approaches is described. The main aim of this section was to enable us gain deeper insights on answering the research question that deals with *what* resources and requirements were needed for designing, testing and implementing decision enhancement services for farmers including *how* the design can be carried out. It was therefore, important that we explore a number of different systems-based development viewpoints, especially given that enhancing farmers' market decision making involves the use of ICTs, processes and involvement of various actors. The task at this stage of the design was concerned with identifying an approach to guide the examination.

Fortunately, information systems' design approaches can be examined from the perspective of "way of thinking, way of working, way of modeling and way of controlling" (Sol, 1988). These "ways of" framework was used to examine a number of design approaches as a learning roadmap from which useful lessons were learnt. As enrichment to our understanding, the examination focused on gaining insights on the "way of governance" (Weill and Ross, 2004), an extension of the "way of controlling" proposed by Sol (1988) and others. A number of researchers have used the "ways of" framework to structure their methodologies for new problem domains, such as De Vreede and Dickson (2000); Van de Kar (2004); Mulira (2007); Yonasi (2010) among others. In these studies, for instance Van de Kar (2007), a design approach is defined as a set of coherent activities, guidelines and techniques for structuring, guiding and improving (a complex) design process. Figure 5 represents the "ways of" framework used in our examination.

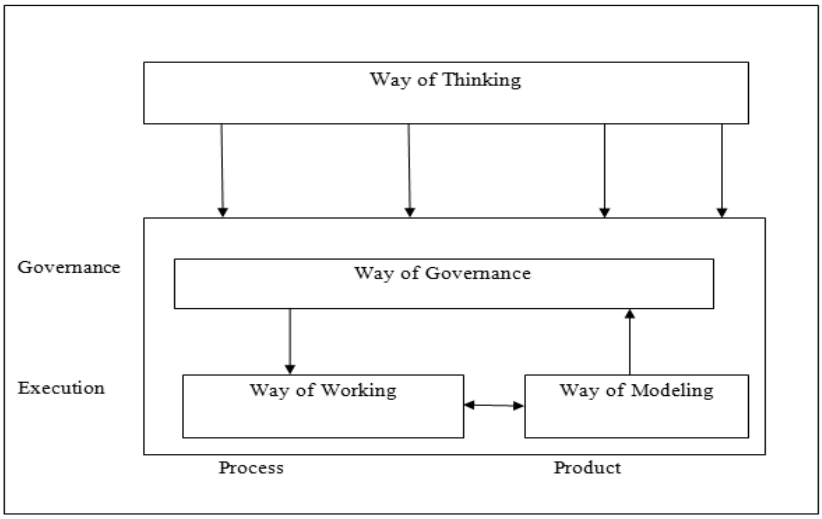


Figure 5: Framework for Examining Design Approaches (Sol, 1988; Seligmann et al., 1989)

Way of thinking

The way of thinking refers to an underlying philosophy of the problem context including its field and statements of all fundamental assumptions (Sol, 1988). In this study, the way of thinking sets out the basis for the way of governance, way of working and modeling, and it is expressed as guidelines, rules, and/or design theories.

Way of governance

The overall purpose of governance is to address the processes, systems, services, policies and controls by which organizations operate (Tarantino, 2008). It relates to the cultures, values, structures, layers of policies and measures by which organizations are directed and controlled. Defined as a governance architecture by Keen and Sol (2008), the way of governance in our context refers to the decision rights and accountability framework for encouraging desirable behaviours in the use of information technology (Weill and Ross, 2004) to enhance decision making. It (the way of governance) encompasses the full range of management activities, including the governance layer that seeks to provide assurance to users that the requisite policies, processes, structures and services are in place and are aligned to their needs and objectives. Therefore, the way of governance is a direct reflection of the rigor and relevance cycle of the design science research advanced by Hevner *et al.* (2004) and others. A clear governance structure for the design process may help to involve relevant actors in the network by looking deeper into actors and their values, language and argumentation (Van de Kar and Verbraeck, 2007).

Way of working and modeling

The way of working and modeling, represents the working method(s), and outlines all the necessary tasks and modeling activities that are carriedout in the design process. The tasks and activities are intended to guide designers and developers in their way of working to solve the problem at hand.

Using the above "ways of" framework, we examine different and relevant schools of thought below.

Systems Engineering

A systems perspective was needed mainly due to the complexity of the agricultural market environment, which in turn has greater implication on farmers' decision making processes. In systems thinking, a system to be designed is considered as a whole in time (Checkland, 1993) i.e. as it develops through its lifecycle (from conception to disposal), and space (a whole separated from its environment) (Van de Kar and Verbraeck, 2007). The systems engineering perspective is concerned with the creation of cost effective solutions to address real life complex human problems through the application of scientific knowledge (Maier and Rechtin, 2002).

The above perspective is critical for the realization of effective farmers' decision enhancement services in Uganda. Designing farmers' decision enhancement services too is complex requiring participation of all market actors (especially farmers and traders who on the one hand are not well organized), the

developers, enabling technology providers and policy makers who ensure a conducive legislative and policy environment, including decision making processes that are to be carried out. The influence of policy makers is felt during the development process mainly from actions and decisions that will have already been put in place, or may be put in place as the proposed service system design evolves. These policy actions and decisions may greatly influence the nature and adoption of the resulting artefact.

Another information systems' development paradigm of interest is the component-based development (CBD) approach described by a number of researchers including Babar *et al*. (2011); Van de Kar and Verbraeck, 2007; Brown (2000) and Clements (2000). This paradigm focuses on selection, reconfiguration, adaptation, assembling, and deployment of encapsulated, replicable, interoperable system elements with clear functionality and hidden implementation. This solves the challenges associated with building systems from scratch, facilitates solution localization and change management. CBD is one of the methodologies where applicable insights for the development of farmers' market decision enhancement services were gained, since our attention was to tailor existing applications, localize them and be able to focus on managing market changes and dynamics in relation to actor preferences. Market as one of the main activities in farming enterprises is prone to volatility and co-evolution within social, economic, political and ecological contexts (Norman *et al.*, 1994; Collisson, 2000; Dixon *et al.*, 2001). Therefore, insights relating to localization, adaptation, reconfiguration among others were of great importance to the problem domain.

Further insights are drawn from the information systems lifecycle of Avison and Fitzgerald (2003); Avgerou and Corenford (1998). In this perspective, the design is structured into a series of manageable steps with each containing a number of specific activities, which relate to each other. Work through these activities is conducted incrementally as in the waterfall model (Mulira, 2007; Vidgen *et al.*, 2002; Cadle and Yeats, 2001).

In this study, additional rigor is achieved by exploring development theories that support user participation, learning and feedback during problem definition and implementation activities. Hence, we draw inspiration from the 4Ps methodology proposed by Sol[3]. From these 4Ps perspective, the design seeks to ensure that the resulting solution is people centric, personalized, process enabled and participatory developed. People centric systems are systems that involve many human interactions and

[3] In a presentation titled "Smart Conversations for Smart Development: the Collagen Approach for Engaged Research" , which was presented at the Foundations of Government Information Leadership Workshop at Uganda Technology and Management University in Kampala, Uganda from 22-26 July 2013, Sol (2013) advances the principle of the 4Ps.

where the actors work with some degree of autonomy, and where some social aspects have to be considered (Garg, 2013). In a process-enabled system (or service), a process engine typically stores the state of the process instances during enactment (Haesen *et al*., 2009). As an alternative, process enactment entails that the process state is derived from the state of business objects, which are organized in a domain model. The business objects are referred to in pre- and post-conditions of activities, which determine when the activity is enabled and completed respectively.

While a personalized system is a complex system made of many interacting parts, from data ingestion to presenting the results to the users (Picault *et al*., 2011). However, designers have to be aware that certain levels of personalization may impose constraints to the design process, for instance, data may not be in a suitable format, and there may be some privacy and architectural constraints etc.

In participatory system design, the scope of designing and research blur and the user becomes a critical component of the process. It (participatory design) seeks to ensure that the users of the technological artefacts are involved in their design as informants and co-designers (Kensing and Blomberg, 1998; Bowen, 2010). There are new rules, which call for new tools since people want to express themselves and to participate directly and proactively in the design and development process.

It is in light of these 4Ps that we considered additional insights from user-centered development (UCD), evolutionary development, service oriented architecture and collaborative engineering.

Users Centered Development (UCD)

The UCD is characterized by placing users, user tasks and user goals as the main concerns for the design and implementation of the product (Mulira, 2007; Shekar, 2007; Van de Kar and Verbraeck, 2007; Van de Kar, 2004; Alam and Perry, 2002; Nielsen, 1993). Consequently, the UCD being a human-based product development approach presents additional knowledge for the development, prototyping and evaluation of a farmers' market decision enhancement service. The purpose of the UCD approach is not only on delivering functional and reliable products, but emphasizes the usability of the product by its target users (Nielsen, 1993), which is key for this study.

In the users centered development process, the focus is on the thing being designed (e.g., the object, communication, space, interface, service, etc.), looking for ways to ensure that it meets the needs of the user. The user centered approach puts emphasis on identifying users' characteristics, their perceived context of use and an assessment of the user and his or her context by the service designer (Van de Kar and Verbraeck, 2007); and in addition works from and/or with people's existing habits and desires

(Restrom, 2008). Consequently, the design process tends to employ the rhetoric of participation, co-creation and enablement, all of which are attributes of a service system and whose insights were found useful to the design of the farmers' market and price decision enhancement services.

Within the confluence of Users Centered Design, further domain inspirational insights were obtained from Meroni (2008) who advances the concept of Community Centered Design (CCD) as an approach that scales up the consolidated methods and tools to community size. She proposes a reference to design focusing on creative communities (Meroni, 2007) as CCD "where understanding values and behaviors and collaborating with the most active social communities in conceiving and developing solutions (Jégou and Manzini, 2008) is the distinctive work of the designer".

Evolutionary Development Approach

In problem domains where user requirements are difficult to specify, a proposed solution is not easy to formulate and operate, evolutionary approaches have been reported to be suitable (Mulira, 2007; Arnott, 2006; MacManus and Wood-Harper, 2003). An evolutionary approach involves expanding incrementally the operational product with the direction of evolution being determined by operational experience (Mulira, 2007). Hence, the strongest consequence of the evolutionary development is that the success of the developed solution requires assurance of development perpetuity. This implies that all the system's development lifecycle activities need to be perpetual if it (the system) has to sustain working overtime (Arnott, 2006; Lehman and Ramil, 2001).

Generally, evolution theory added more insights to the problem domain since it has great epistemological appeal as an interpretive framework. It is relevant for addressing macro-scale socio-cultural issues and equally provided a well-informed perspective of the whole phenomenon within which to address the ways of how [for example] market actors develop their own thinking, doing and thereby resisting to adopt "externally developed solutions" (Laszlo, 2001).

Service Oriented Architecture

The perspective of the service-oriented architecture (SOA) enables creation of systems, and their components that can be modular, accessible and interoperable (Izza and Imache, 2010; Van de Kar and Verbraeck, 2007). This is achieved by utilizing organizational existing assets and applications as services to integrate business processes and needs. SOA's approach can facilitate agility in the business by aligning support technologies with organizational business needs. Within the SOA perspective, we have further considered a "service" as an abstract resource that represents capabilities of performing

tasks, as well as representing a coherent functionality from the point of view of provider and requestor (Kim *et al.*, 2004).

Developing and implementing farmers' market decision enhancement services requires that several services be identified and put in use, and this may involve a number of different capabilities and technologies. Some services required can be common and therefore, using the SOA principle, such common services can be shared among participants. For instance, a "particular service request capability" can be used by both farmers and traders, and from different locations to meet sometimes-different decision making needs.

Collaborative Engineering

Collaborative engineering is an approach to the design of re-usable collaboration processes and technologies meant to engender predictable and transferable processes (De Vreede *et al*., 2003; De Vreede and Briggs, 2005). Collaborative work processes are accomplished by division of labour among collaborating participants, as an activity where each individual participant is responsible for a portion of "problem solving" (Briggs *et al.,* 2003; Sol, 1988). To collaborate simply implies making joint efforts toward a goal (Briggs *et al.,* 2003), and can be achieved using several techniques such as consensus voting, brainstorming, set criteria etc.

As participants continue working collaboratively, patterns emerge in the process. For instance, Den Hengst *et al.* (2006) have identified six collaboration patterns among participants namely: generate, clarify, reduce, organize, evaluating and building consensus. Collaborative business processes describe a set of interrelated processes usually performed by separate, interdependent firms in order to produce and deliver a specified range of goods or services (Mevius and Oberweis, 2005). For instance according to Batt *et al.* (2010), by engaging in collaborative decision making farmers can gain access to more alternative markets, technical information, inputs and microfinance, improved bargaining power, higher prices and low overhead costs. Research on collaborative decision processes have been conducted in a number of domains such as design in concurrent engineering (Pol *et al.*, 2007); management of supply chain, collaborative manufacturing (Wang, 2009); business process re-engineering (Den Hengst and De Vreede, 2004) among others. Collaborating participants also complete useful tasks using a number of patterns also described as collaboration approaches (Den Hengst *et al.*, 2006).

Therefore, collaboration offers additional insights to the development of farmers' decision enhancement services since it addresses activities that are complex and difficult for one individual to handle (Chen and Hsu, 2001).

2.5 ICTs and Farmers' Decision Enhancement Services

Information and Communication Technologies (ICTs) have for decades been recognized as essential in the overall agricultural sector. Examples include precision agriculture, tracking and tracing of food products along the food supply chain and identification of food characteristics through labels and logos for consumer support (Lehmann *et al.,* 2012).

For the case of farmers' market and price decision making, these have been noted to include low business operational costs, provision of timely and accurate information about markets and market conditions and speeding up the process of information creation, acquisition and use (Antonelli, 1991).The use of ICTs in agriculture in general arose due to a number of factors (Chisenga, 2006; Kapange, 2006; Lwonga *et al*., 2006). An example where ICTs have been used to improve farmers' market decision is the cost-effective framework for disseminating agricultural information to farmers in India (AgrIDS) (Reddy, 2004). AgrIDS is an IT-based system for communicating personalized agricultural information to farmers.

Similarly, the rapid growth of mobile ICTs has further enabled access to a wider part of the society. Because of the continued ubiquitous development and deployment of mainly mobile applications and devices (Donner, 2008; Farley, 2007; Islam and Gronlund, 2007) improved market information delivery opportunities for farmers are being set up. Existing literature contains several examples of mobile-based services and applications (services designed and delivered via mobile devices) (Donner, 2008; Tscherming and Damsgaard, 2008; Farley, 2007; Islam and Gronlund, 2007; Karim *et al*., 2006; Schubert and Hampe, 2006; Nysveen e*t al*., 2005; Yang and Wang, 2005; Campos *et al.,* 1999). In other domains, mobile devices and applications have been developed to enhance delivery of various services such as proactive information delivery (Lei *et al*., 2007); advertisement (Drossos and Giaglis, 2006); mobile government (Yonazi, 2010; El-Kiki and Lawrence, 2006); tracking of product locations (Giaglis *et al*., 2003); entertainment (Hampe and Schwabe, 2003); location management (Pura, 2005; Cousin and Varshney, 2001), and several others.

Others are more specific and focus on issues concerning market access by farmers (Antonelli, 1991; Aker, 2010). The critical factors identified by these studies include: consideration of local context; time

factors; cultural endowment, knowledge, skills and user assistance (including access to experts); direction of national economy; including infrastructure (power, transport and telecommunications). Similarly, the growth of internet, mobile applications and mobile device features have promoted the evolution of mobile information dissemination services suitable for agricultural communities (Bhavnani *et al*., 2008; United Nations, 2010). Mobile ICT devices are used to improve management of market information (Aker, 2010); information provision and learning among specialized agricultural activities such as organic agriculture (Karestos *et al*., 2007) among others.

Additional capabilities can be drawn from Wijnhoven (2008) who describes content aggregators and data integrators, which have been developed and implemented over the last two decades via the web. Web-based services communicate information to clients while keeping full control over content and property rights by the owner. Content Aggregators (CA) serve particular users and enable them find and compose their own information within their specific disciplines; example of CA include academic research repositories. In particular, CA enables multiple service providers to deliver services and applications to consumers on shared platforms or devices (Moyer and Kriens, 2009). Insights on the capabilities of content aggregators offer an opportunity for developing decision enhancement services targeted in this study.

Enterprise Information Portal (EIP) is another information technology opportunity for enhancing farmers' market and price decision making process. Information portals are a type of information services that enable organizations to unlock internally and externally held information, and provide users with a single location to personalized information needed to make informed decisions (Shilakes and Tylman, 1998; Nakono, 2001; Mathiassen and Sorensen, 2008). They are an amalgamation of software applications that consolidate, manage, analyze and distribute information among organizational actors (Nakono, 2001). Hence, knowledge on the design of EIPs is relevant to the problem domain. Examples of similar services that have been developed during the recent decades include for instance Drumnet (Gine, 2005), AgrIDS (Reddy, 2004) and Esoko (Davis, 2008), FoodNet (Ferris and Robbins, 2004).

Any ICT intervention that improves the decision making of farmers will likely have significant direct and indirect impacts on enhancing agricultural production, market access and other post-harvest activities – which in turn can further contribute to poverty reduction. However, despite information technologies' potential to leverage farmers' decision making, a bigger part of the communities in developing countries still lack access to ICT enabled services despite the increasing penetration rates

(Etzo and Collender, 2010). For instance, internet access and general telecommunications coverage is still low in developing countries compared to their developed counterparts (United Nations, 2010; World Bank, 2008).

For the case of Uganda, the liberalization of the telecommunications sector has equally resulted in a rapid growth and expansion of telecommunications services across the country. According to findings from a private research and markets agency[4], mobile penetration in Uganda is expected to increase from 39% in 2009 to 70.7% by 2014. Despite this significant progress, the Ugandan ICT coverage is still below national expectations (NITA-U, 2012). For instance, a survey conducted among central government employees shows that though the mobile phone penetration among government employees is 51%, only 38.5% have access to Internet; 32% of the staff has ICT skills; 52% of central government civil servants use computers; and the commitment to ICT infrastructure development stands at 0.5% of overall national budget (NITA-U, 2012)[5]. In order to improve the status quo, the government key recommendation is that, *"… government institutions to engage in developing e-government initiatives that can be implemented through mobile phone technology accessible platforms…*" (NITA-U, 2012).

The situation is not good either on the side of the farmers where high levels of poverty, illiteracy and lack of institutional structures have equally played part in influencing ICT usage (Mulira *et al*., 2010). Specifically, for the study area, mobile network coverage is 100%, because of the Ugandan Rural Communications Development Fund (RCDF), whose aim is to increase and improve ICT services in rural areas (Uganda Communications Commissions, 2010). Drawn from the Rural Communications Development Policy for Uganda, the fund seeks to address issues of communications coverage, connectivity and content. As an example, Table 2 provides a summary of the services that have been established in Soroti district through RCDF.

[4]Communications Markets in Uganda, 2011. http://www.researchandmarkets.com/reports/940948/; accessed 30th May 2013

[5]NITA-U is the National Information and Technology Agency of Uganda. NITA-U is an autonomous statutory body established under the NITA-U Act 2009, to coordinate and regulate Information Technology services in Uganda.

Table 2: RCDF Provided ICT Services in Soroti district (UCC, 2010)

Status	POS, 10Km radius, 480kbps	Internet Cafes	ICT Training Centers	Multi-Purpose Community Telecenters	Pay phones	Web Portals	Postal Projects	School ICT labs	Health ICT Projects	GSM Sites	Total Projects
Commissioned	1	1	1		36	1	1	1			42
Under Installation					17			5	2		24
Totals	1	1	1	0	53	1	1	6	2	0	66

2.6 Chapter summary

In this Chapter, we have learnt that designing and deploying farmers' decision enhancement service has to rely heavily on an interdisciplinary knowledge base. The design has to consider issues concerning market information, decision making styles of farmers, farmers' decision making requirements and available tools and technology. The design strategies have to consider user requirements and decision processes have to be clearly defined. ICTs play a greater role in the design and implementation of farmers' decision enhancement services. However, there are limited success stories, with a few examples showing a skewed trend to mainly Asia (Lokanathan and De Silva, 2010) and southern parts of Africa (Mokotjo and Kalusopa, 2010). Moreover, even these examples do not address farmers' market and price decision making arenas. Similarly, recent research seem to concentrate on Asian agriculture (Jensen, 2007; Slavova, 2007; De Silva and Ratdikawara, 2008; Labone and Chase, 2009; Lokanathan and De Silva, 2010) - hence the need for this study.

Studies conducted in Uganda by Kaddu (2007) and Katungi (2006) cover broad agricultural information systems' themes with much of it meant to benefit research-based communities in universities, research organizations and funding agencies. Little consideration is paid to the kinds of appropriate services needed by farmers and the match between research results and decision making enabling technologies among farmers is still weak.

Generally, insights from service design and development is an important element to the design of farmers' decision enhancement services in Uganda. Agricultural market chain is a highly diverse and dynamic domain. Within this diverse and dynamic environment, good decision making by all actors in terms of market and price strategies is extremely important and necessary. Moreover, within this diverse and dynamic environment it is often difficult for farmers to make correct decisions since the likely impact of market and price changes is equally hard to predict beforehand.

3 Exploratory Field Investigation

We start the chapter by a brief outline on the agricultural market and its stakeholder synopsis. The purpose of the exploration was to gain an improved understanding of the problem domain from the perspective of the users, understand their requirements, and verify existing phenomenon. The chapter describes our exploration exercise and results. The exploratory field study helped us to derive current and prospective requirements, challenges and opportunities on farmers' market and price decision making. The chapter, which describes the interview process, sample selection, results, key lessons learnt and summary, helps us further understand the current way of working in the problem domain.

3.1 Introduction

First, we note that, the agricultural market as an industry and organization has undergone significant transformations across many developing countries. This transformation is not only limited to mechanization technologies, but also in size of business, resources control and operations, business models and linkages with the market. A number of factors such as production and processing technologies, communication technologies, economic and financial conditions, human capital and value chain forces, have been identified as the catalysts of this transformation (Gray and Boehlje, 2007; McCorriston, 2010). Hence, farmers 'decision making requirements have continued to evolve and change dynamically.

Secondly, the basic concern in requirements elicitation is to achieve a set of correct, consistent and complete requirements (Mulira, 2007; Nuisebeh and Easterbrook, 2000). Though this is often difficult to achieve, especially in the problem domain, it is essential to identify success-critical stakeholders such as primary users, customers, domain experts and so on, and involve them in the elicitation and negotiation of requirements. This core essence of our exploration field studies is reported in this chapter.

3.2 Agricultural Market Stakeholders' Synopsis

This section is concerned with scoping agricultural market stakeholders to guide the field exploration exercise. Coughlan *et al.* (2003) identify stakeholder selection and gaining their participation as the main starting point in system's requirements elicitation. Different researchers have advanced a number of stakeholder definitions from several domains as outlined in Pouloudi's analysis (Pouloudi, 1999). However, a stakeholder is considered as an individual, group(s) of individuals or institutions that

directly and/or indirectly influences the functioning of the developed artefact (Den Hengst *et al*., 2004). One of the most widely cited definitions is that proposed by Freeman (1984):

"a stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization objectives" (p. 46).

Generally, agricultural market stakeholders may comprise of farmers, produce dealers (or traders), Non Governmental Organizations (NGOs), consultants, researchers, and policy makers. This is in agreement with existing literature (Mabota *et al*., 2003). However, as indicated in section 1.4, the scope of this research was limited to farmers from Soroti and Gulu districts in Uganda. Therefore, in this study, target stakeholders are selected basing on their knowledge and skills on the problem domain, status and responsibilities. Figure 6 is a simple representation of the stakeholders considered in this study.

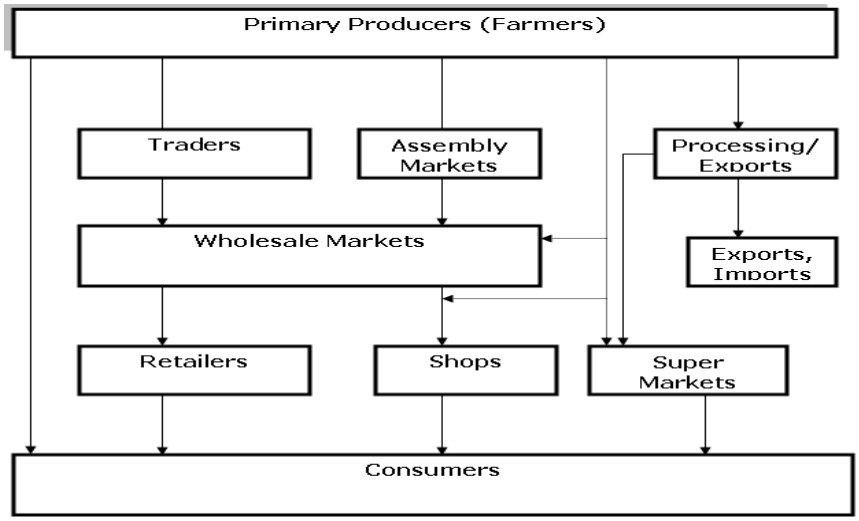


Figure 6: Agricultural Market Chain Stakeholders (FAO, 2006)

Primary Producers or Farmers

A primary producer (in this case a farmer) is an individual, partnership, trust or company carrying on a primary production business(or farming enterprise activities) within an agricultural production network. A primary producer carries plant cultivation (propagating or cultivating plants, maintaining animals), fishing and pearling (operations relating to catching or taking fish, turtles etc.) and tree planning

(planting or tendering, felling and transporting timber for sale) (FAO, 2006); De Haes and De Snoo, 1997). In farming enterprises, actors may engage in each of these activities alone or carryon more than one of them at any time. Cater (1998) defines a farmer or primary producer as an entrepreneur engaged in agricultural activities of crop cultivation and animal rearing.

Hence, in the context of a farming enterprise, Cater and Ram (2002) note that farming as a business through years have been pluri- active, serving generations while displaying characteristics of portfolio entrepreneurship. McElwee (2008) develops the idea further with a taxonomy that classifies farmers through their core activities as either professional farmer or contractor. Another body of literature useful for this study offers insights into business creation, operation and its death (McElwee and Robson, 2005; Robinson, 2008).

3.3 Exploration Technique and Sample Selection

Interview Construction

Unstructured interviews and observations were used for eliciting requirements among farmers and other stakeholders. A pilot test of the unstructured interview and observation guides was conducted among four staff from the Faculty of Economics and Business (University of Groningen, The Netherlands), three farmers from Soroti district and executive members of the respective farmers' associations from Gulu and Soroti. Additional in-depth discussions were held with the President and Treasurer of the Gulu Commercial Farmers Association respectively. The aim was to go through the interview guides and adjust the questions accordingly (see Appendix 1).

Each interview guide consisted of unstructured questions, some of which contained 'reminders' whose purpose was to act as "prompts" (Browne and Rogich, 2001) for gaining more information through an in-depth probing of interviewees.

Selection of Interviewees

Since agricultural market participants are often not homogeneous, the selection of interviewees was done through purposive sampling (Den Hengst *et al.*, 2004). Generally, purposive sampling technique, also called judgment sampling, enabled deliberate choice of informants due to the qualities the informants possess, and it was done non-randomly (Tongco, 2007). In purposive sampling, what needs to be investigated is the choice of the researcher who also sets out to identify people and instances from whom to generate information (Bernard, 2002).

Additional criterion that guided the selection of informants included:

1) having a relatively large plantation, (large scale == two acres and more); 2) interest to participate in the study following initial contact by the researcher or a fellow farmer; 3) membership to some related existing services such as NAADS' agricultural loan (or credit) facilities; and if in an association, a recommendation from the association leaders was found very useful. Fortunately, farmers from both study areas operate under umbrella bodies (the respective District Farmers' Associations).

For the case of Gulu two such agencies exist, i.e. Gulu Farmers' Association (GFA) also referred to as Acoli Commercial Farmers' Union, and Gulu Agricultural Development Company (GADC).We solicited the help of these agencies in identifying key interviewees in the Gulu district.

Similarly, in Soroti, farmers have organized themselves under the Soroti District Farmers Association (SODFA) in addition to the various Farmer Field Schools (FFS) initiated mainly for technology adoption by research organizations. However, our use of these field schools was limited because they are mainly active during planting seasons, and used for technology experiments and adoption by research institutions.

Other interviews covered staff from the National Agricultural Advisory Services (NAADS). NAADS was established in 2001 by an act of parliament to increase the efficiency and effectiveness of agricultural extension services in Uganda, and it is one of the seven core programmes under the Uganda government's wide Programme for Modernization of Agriculture (PMA). The NAADS goal is to develop demand driven, and farmer-led agricultural service delivery systems. Though the mission of NAADS is, "To increase farmers' access to information, knowledge and technology for profitable agricultural production", (NAADS, 2010), issues concerning farmers' market decision making still need consideration (Alonge, 2004; Benin *et al.,* 2007). Hence, through exploration, attempts were made to find out the extent to which NAADS activities enhance farmers' decisions.

Visits were conducted to NAADS Secretariat where the Head of the Information and Communications Department held an initial meeting with the researcher. Later on phone calls and emails were used to follow on the appointments. NAADS works in close partnership with the National Agricultural Research Organization (NARO)[6]. On its own, NARO operates an information portal called the Agricultural Research and Extension Network (ARENET). ARENET is a web portal meant to strengthen linkages between the National Agricultural Research System (NARS) and the National

[6]The National Agricultural Research Act of 2005 established NARO whose main mandate is to provide strategic direction for publicly funded agricultural research in Uganda.

Agricultural Advisory Services (NAADS) program. Findings from these interactions indicate that, both NAADS and ARENET services are:

- targeted for research and policy making communities,
- accessible via respective websites, which are equally not updated regularly and are inaccessible to farmers,
- address all general issues and hence offering little on farmers' market and price decision making challenges, and
- not well conceived among the farming communities.

Exploratory Sample Size

In conjunction with the above agencies and the respective farmers' associations, 12 farmers from Gulu and 10 from Soroti were selected for this study. The main sampling criteria targeted at involving farmers who are based in rural areas. The main constraint faced was in getting the actual number of active members in the respective district farmers' associations. GCFA membership is estimated at about 8000 spread in Acoli region; while SODFA is estimated to be having about 3000 members spread in Teso region. For both districts, records on actual numbers of members were lacking, save for GADC that had some information regarding cotton based smallholder farmers in the areas where they operate.

All together, a population of 22 farmers were initially identified from Gulu out of which 12 were sampled. Similarly, 17 farmers were identified from Soroti out of which 10 were sampled. Hence, the actual target group identified consisted of 39 farmers, out of which we were able to interview and interact with 32 interviewees, regarding their market and price decision making issues.

Prior to the actual exploratory exercise, appointments were made with key selected informants via phone calls (and emails to association leaders). Farmers' phone contacts were obtained from the District Production Departments, friends and District Farmers' Association Offices. Secondly, meetings were held with executives of the respective farmers associations from Soroti and Gulu. The main purpose of these meetings was to: 1) Establish contacts and access with individual farmers,2) Make appointments with individual farmers on interview dates, 3) Explain to the executives the aim of the research and purpose of meeting them, 4) Review the interview and observation guides and unearth some of the challenges beforehand, for instance, there was need to provide executives with facilitation in the form

of airtime, lunch and transport for going to the field. Interviews were conducted on site (i.e. at homes and markets) and in groups of three in order to save on time and transport costs.

The interviews mainly focused on background information including farming (farm) characteristics; farmers' knowledge of existing market information services (or any other information service they knew off); farmers' information needs and how they are met; challenges faced by farmers in accessing information, and how they were accessing the information; market activities that have to be performed; decisions that have to be made in relation to each of the activity, and any existing design. As part of the interviews, individual inspection of farmers' gardens were conducted in order to verify the results of the interviews. This was further supplemented by conducting guided tours in conjunction with officials from the GDAC and SODFA to selected markets. Among others, framing our interview questions from these set of themes enables:

- gaining deeper insights into the problem domain,
- an engaged fact finding and feedback process with farmers,
- discovery of the farmers' market and price decision making requirements,
- mapping the core factors that influence farmers' market and price decision making, and
- un-earthing the kind(s) of activities that farmers are involved in during their market a price decision making.

3.4 Interviews and Observation Results

Unstructured interviews and observations data were transcribed in detail including reading the transcripts repeatedly. Thematic analysis which was used in this study, is just one of the techniques of analyzing interview data and is seen as a method for identifying, analyzing and reporting patterns (themes) within data (Braun and Clarke, 2006; Roulston, 2001). There are, however, other techniques of analyzing interview data such as discourse analysis (Willing, 2003) or narrative analysis (Murray, 2003). The analysis process was recursive and followed six steps of gaining familiarization with data, creating initial codes, searching for themes, reviewing themes, defining and naming actual themes, and producing the final report (Braun and Clarke, 2006).

To ensure reliability of requirements, preliminary data analysis was conducted to gain an overview and crosscheck any anticipated errors. Feedback was edited to ensure that completed data collection instruments were done correctly – to ensure data quality, deleting and correcting data collection

problems, and repeat the data collection where necessary. In addition, preliminary analysis helped us check whether a proper procedure was used during sample selection, interviewing, and recording responses.

We have presented the interviews and observation results below covering the farmers' background information, information needs and decision making, experience drawn from the NAADS, factors influencing farmers' decisions making, and the farmers' organizational network. Results on information and decision making are presented covering the farmers' knowledge and utilization of existing services, types of information needed by farmers and their decision making, and preferred options for information presentation and delivery.

Farm and farm household characteristics and decision making

To supplement insights from the knowledge base, this part of the exploration helped us further understand the farmers' socioeconomic characteristics. These characteristics such as age, education level and wealth among others, are generally reported to influence human behaviour (Rogers, 1993). Hence, it was essential during the course of studies to gain on the field knowledge on demographic data including the location of the farming activity, size of the farm, gender and education level of the farmer, age of the farmer, financing of the farming activity, farm ownership, objective(s) of the farm, and kinds of crops grown. Simple pre-coded questions were asked and interviewees were expected to provide their responses based on the provided alternatives. Farm and farm-household characteristics can provide useful insights to farmers' market and price decision making practices (Poppenborg and Koellner, 2013; Parker, 2001; Aubry *et al*., 1998; Gibbon, 1994).

On the part of farm size, a number of studies such as (FAO, 2006; Nair, 2006; Defrancesco *et al.*, 2008) have found it (size) as an important factor that influences farmers' overall behaviours. In this study, we sought to understand the influence of farm size on farmers' market and price decision making. As outlined in chapter 1, Ugandan agriculture is mainly characterized by smallholder farmers who carry out subsistence activities. In order to understand this farming characteristic further, empirical evidence was collected during the exploration filed studies. The results indicate that, of the farmers interviewed, 13 (59.1%) own farms more than 5 but less than 10 acres big; and 9 (40.9%) own farms less than 5 acres big. The number is, however, bigger in Gulu where seven (or 58.3%) of those interviewed own between 5-10 acres of farmland, compared to 6 (or 50%) for Soroti of the same sample. We considered farmers with 5 or more acres as owning big farms. It was evident that farmers whose farms were relatively bigger (i.e. 5 and more acres) produced more products and they equally reported a greater

need for supporting their market and price decision making. For instance, one of the farmers who had produced more cotton in Gulu highlighted his difficulties is locating buyers for his cotton compared to those who had little cotton output.

In addition to farm size, age has equally been reported to influence farmers' behavior in many ways (Difrancesco *et al.*, 2008). Young farmers are reportedly more willing to take risky decisions as opposed to elderly farmers (Difrancesco *et al.*, 2008). It was therefore essential to gain insights into the age grouping of the farmers who participated in the study. The results indicate that, most of the farmers who participated in the field studies were young (90.9%) i.e. aged between 20-40 years. As a result, their commitment during the study phases was observable compared to the elderly farmers. It is the young farmers who reported having many tones of produce that they would wish to locate market for its sale. Hence, the age of the farmer shapes his/her market and price decision outcome and commitment to implementing that outcome.

Another characteristic we sought to understand involved the level of education of the farmer and its influence on market and price decision making. Dupraaz *et al*. (2002) regard education as an indicator for quality capital that generally encourages farmers' participation in activities that seek to improve their overall wellbeing. A fair number of respondents have at least attained secondary education level (59.1%). Unfortunately, of the farmers who participated in field exploration, only 18.1% were female. Interestingly, though the education levels influenced farmers' market and price decision making, to the contrary, some studies have shown that the higher the education level, the less time the farmer is likely to devote to farming activities (see for instance Solano *et al.*, 2001). For the case of this study, farmers who were able to read, write and count provided better feedback to the interview questions. They also exhibited a higher need for decision enhancement services. For instance, all the 59.1% of those with secondary education level indicated the need for decision enhancement services. Decision enhancement according to them would most likely increase the chances of them locating better buyers for their products.

Achieving secure household incomes is generally assumed to be a fundamental step for poverty alleviation and food security (Dose, 2007). This is the desire of every farmer who is involved in making market and price decisions. Dose (2007) further argues that, though each individual farmer is in position to improve their level of incomes, they need some basic capital to do so. Hence, for this study, we sought to explore on the kind of income at the disposal of farmers as this has a bearing on their ability to effectively reach at reasonable market decisions. The results indicate that, all those interviewed

depend on their own funds since only a few (13.6%) reported having got some support in kind from government and non-government agencies. These agencies mainly include NAADS, Northern Uganda Transition Initiative (NUTI), Gulu Agricultural Development Company (GADC), and SODFA among others. Farmers also receive support in kind, while some are given credit awaiting harvest. All these options have reportedly according to farmers disadvantaged them from making better market choices. Moreover, this is exuberated by the limited income opportunities available to the farmers. Hence, farmers require a service that would, among others, enable them seek and find sources of financing capital.

Exploration results also found that: 1) farmers grow similar types of crops in both Gulu and Soroti, at different times and locations; and each crop is sold at different times, and at different prices; 2) farming activities are small, mainly self-financed; and 3) market participants vary by sex and age, many of whom are women and youth. Hence, the decision enhancement services required by farmers need to be suitable across different farmer groups and networks.

Information needs and decision making

Information needs and decision making was concerned with understanding the importance of market information on farmers' decision making, how it is met, and farmers' awareness of existing information services, types of market information provided by existing information services, usefulness of information provided by existing services, reasons of using those existing services, and quality of information received from existing information services. In section 2.1, we provide an overview of information and farmers' market and price decision making enhancement.

(a) The market information status of the art and farmers' decision making

In chapter 2, the literature suggests the availability of market information as being very crucial for effective farmers' market and price decision making. In this section, we report on the exploration findings on the market information status of the art. Similarly, analysis of the current status enables service developers gain empirical insights, strategic alliance partners, uniqueness of the proposed service, and whether efforts should be directed to either improving existing service (s) or coming up with a new one (Van de Kar and Verbraeck, 2007). A number of existing market information services targeted for farmers were identified by requesting respondents to indicate any information service that they might have used, and how these improved their market and price choices. Some researchers

discuss a number of strategies that have been pioneered in developing countries to improve agricultural market competitiveness for smallholder farmers (Ostertag *et al.*, 2007; Ferris and Robbins, 2004). However, most of these studies do not address market and price decision enhancement for farmers.

The results of our analysis on existing farmer market support services indicate that:

- Only 2 respondents (16.7% of Gulu sample) indicated ever having heard of FOODNet, a service pioneered and implemented by the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARCA) (see Ferris and Robbins, 2004 for a detailed discussion on FOODNet). However, they did not understand what it meant and they never used it. Some respondents from Gulu (58.3%) reportedly get information from GDAC in form of paper-based price lists (The Buyers' Price Lists). While in Soroti, a smaller number (30%) obtains information from SODFA. However, in both all cases, the information obtained was also indicated to be general agricultural information, untimely, most times irrelevant, and mainly exploitative. It was not addressing specific market and price decision making challenges.
- Secondly, farmers were asked to give their opinion on the usefulness of the information they get from existing market support services. To this end, only a third (33.3%) of those using SODFA indicated they are getting some useful information; while 42.9% of those using GADC gave a similar response. Largely, 60% of the respondents indicated that the market information provided by GADC and SODFA was not useful to their decision making needs. Useful information is one of the means of measuring the overall support service quality, as well as the information quality (Jiang *et al*., 2002) and also key to effective decision making (Keen and Sol, 2008). Hence, absence of useful information has direct implications on farmers' market and price decision making process. From these findings, farmers lack access to quality information as well as quality information services. Particularly, the immediate issues advanced by these farmers include:
- Information provided is often not relevant to their market decision needs and comes late. The late delivery of information is significant among farmers who do not own mobile phones or have no access to any information access outlet. Moreover, almost all the farmers interviewed (95.5%) indicated that they would need to access information on a daily basis (and even most frequently during early planting and after harvest). After harvesting, other than food crops, farmers need to locate profitable markets for their produce,

- Information provided by existing agencies is exploitative. Exploitation of farmers by traders has been noted to be a serious issue that if not addressed limits farmers' growth (Verdouw *et al*., 2007),
- Information provided mainly focuses on inputs and credit that the very providers offer to the farmers. The costs of inputs are later deducted when the farmer is selling his/her products.
- They are not made aware of the existing services, and as a result cannot use them. Since most respondents are not aware of any existing service, we found "awareness" as an additional requirement for the successful deployment of decision enhancement services among farmers.

b) Types of information needed and decision making

Knowledge of value net thinking (Brown, 2009) was used to scope the market information needs of farmers and the types of information they need during decision making. Interviewees were requested to name the types of market information they need and which of those was provided by existing services. Different types of agricultural information have been noted to aid farmers' decision making at different stages (Mittal *et al.*, 2010).

However, though respondents were neither aware nor using any of the existing information services, all of them indicated the need for information regarding prices; traders' or buyers' contacts; storage opportunities; transport availability; credit sources; and some legislation on the sale of their produce (such as market dues). This information according to respondents need to be precise and disseminated continuously whenever it's needed, which was the case during the time of this study. Indeed, imprecise requirements are one of the factors responsible for failure of many service deployments in organizations (Van de Kar and Verbraeck, 2010; Wijnhoven and Kraaijenbrink, 2007).

c) Information presentation and delivery and farmers' market and price decisions

Traditionally, information has been presented to farmers via print media, radio and TV broadcasts, and/or orally communicated by extension agents among others. The emergence of ICTs has dramatically transformed the manner in which information is captured, processed and delivered to the farmers (Chisenga, 2006; Lwonga *et al*, 2006; Antonelli, 1991). In this section, we explore market and price information presentation and delivery mechanisms among farmers in the districts of Gulu and Soroti.

Both interview and observation results indicate that more farmers (90.9%) prefer to receive information via a mobile phone by either calling or sending and receiving short message service (SMS). Surprisingly, equally a bigger number (72.2%) prefer using broadcast radio, while only 40.9% preferred

the print media. Interviewees were required to provide more than one response, and therefore, of those who preferred one media also preferred another alternative one. May be this picture resulted because almost all the respondents purposively selected had mobile phones. Indeed, interviewees were asked as to which media they were currently using. The number of those using radio (86.4%) was more than those using other media such as mobile phones (63.6%) and newspapers (40.9%). The newspapers used refer to only those published in the respective local languages. Actual ownership of the indicated media was asked separately, because, some respondents had access to use certain media via friends and neighbours.

Respondents were then asked to indicate whether they owned a mobile phone and for how long. Though the number of interviewees accessing information via mobile phones is high (63.6%), a smaller number do own simple mobile phones (50%); and they have only owned them for a period less than five years. The number of those planning to acquire a mobile phone soon was higher (56%). In another study conducted in Uganda in 2008, it was found that 46% of the rural respondents reported owning a mobile phone, while additional 10% owned SIM cards that they would use on borrowed phone handsets (Scott *et al*., 2008). Our findings have shown that there is a steady increase of those owning mobile phones among Ugandan rural communities.

Whether interviewees owned a mobile phone or not, they were asked to indicate, their level of willingness to pay for information services implemented using mobile phones or any other media. Of all the respondents, 45.5% indicated they are willing, 36.4 % indicated they would be very willing, while another 18.2% were not willing except if the benefits are clear. A number of factors were found to be responsible for the increased adoption of mobile phones among farmers. Among these factors were:

- Ability to send and receive information in local language,
- Information is sent and received instantly, making it easy to keep constant contact with traders, peers, wholesalers etc,
- Ability to individually manage the transaction costs relating to accessing information, especially given that buying of air time is user friendly through the pre-paid regimes,
- Mobile phones are ever becoming affordable,
- It is possible to share information with others, especially if it is via sms,

- It is not possible to send information to traders; get neither feedback instantly via radio nor any other media in rural areas. Mobile phones are portable and one can keep moving with it all the time,
- Directly benefiting from economies of scale, by using mobile phones, rural commercial farmers can gain access to wholesale traders, supermarkets and other outlets that was a monopoly of large-scale commercial farmers,
- It is possible to develop and deploy information service without having a deal with a telecommunications operator /and or handset manufacturer,
- While using SMS, end users are able to work in a true and transparent disconnected mode, and hence reduce on connection charges/costs.

During the interviews, respondents were specifically asked to give challenges they face while using their mobile phones. Respondents reported the following as influencing their effective use of mobile phones.

- Phones operate using batteries that need to be charged regularly yet there is no source of power in the rural areas,
- A majority of those who are unable to read, (mainly women and the elderly), still find it hard using the phone keyboard and SMS services,
- The phone's screen limits displays of text messages at ones,
- Available mobile phones mainly enable information access and delivery but it is still not possible for users to create, develop, own and be content providers using existing handsets. This situation may, however, change as phones with new and advanced features become affordable,
- Monetization of services is dependent on the network service provider, who in most cases acts in the middle,
- Discoverability- Unlike in other web-based service, both SMS and voice options of low-end mobile phones do not offer users the ability to search, find and use the service. However, this may become possible as the technology with advanced features becomes more accessible to farmers.

Despite the weaknesses of the mobile phone currently in use by farmers, many still prefer to use it. "A mobile phone has more advantages than weaknesses", noted one farmer from Paicho, Gulu district. In addition, better mobile devices are being deployed and will soon be affordable among farmers (Farley,

2007; Donner, 2008; Aker and Mbiti, 2010; Aker, 2011; Qiang *et al.*, 2012). In Uganda, this study has , in addition, found that the majority of the farmers used the mobile phone to call stockists, technocrats and traders.

The case of NAADS and farmers' market decision making

Further interviews were conducted to cover NAADS services and ARENET introduced earlier in this chapter. In addition to our earlier insights, exploration results show that although ARENET is contributing a lot of agricultural information, it does not meet farmers' market related decision making needs mainly because:

- ARENET focus is on disseminating scientific information among researchers, and disseminating research results to other stakeholders. There is no specific objective regarding market information for farmers,
- Information is disseminated via a web portal and print publications. Both of these media are currently not within the reach of farmers,
- From interview results, no respondent indicated having heard of ARENET,
- The language used is predominantly English, which most farmers do not use,
- Information on ARENET website is not current as updates take months to be effected. Farmers would wish to make market choices whenever an opportunity comes. Hence, they need services on a daily basis and continuously, a requirement ARENET does not meet, and
- ARENET is centrally housed at NARO secretariat based in Kampala with no linkage at the farmer level countrywide.

Similarly, during the interviews, respondents were asked to indicate reasons as to why they were not getting services they expected from NAADS. The findings of these interviews indicate that:

- Most farmers reportedly expect NAADS to provide them with money which they divert for meeting some of their social needs such as school fees, marriage money etc.,
- NAADS is a regulatory agency and offers its services by appointing and contracting third party service providers at village, sub-county and district levels. Third party providers are mainly contracted to offer advisory services, provide inputs and linkages with policy,

- There is no established system for information flow to the farmers and vice-versa. The flow of information is adhoc and farmers (80% of those interviewed) express dissatisfaction with NAADS level and quality of service. In particular, there are no reporting formats, supporting equipment and storage facilities for information services. Most of the information collected is demand driven and for use by big agencies, and
- NAADS lacks the capacity to collect and disseminate market information to farmers at village level.

The activities of the third party service providers contracted by NAADS were not investigated during this study. We recommend this for an additional study in future- since it was not within the scope of this research.

Hence, the proposed decision enhancement service should be designed to mitigate the limitation of the existing services. The strengths of the existing NAADS services should be retained, while new services should be developed as improvements. Secondly, there is need to make users gain a better understanding of the purpose of the proposed service prior to its implementation.

Challenges Encountered During Exploratory Field Studies

In conclusion, we note that researchers have long cautioned on the likelihood of encountering challenges during an interview-based investigation (Myers and Newman, 2007; Mason, 2002). Similarly, during the course of our field investigations, a number of challenges were encountered, some of which include:

- Time schedules of key informants at NAADS. The contact informant (Head of the Information and Communications Department) was often busy and kept on adjusting appointments for interviews,
- The initial field exercise coincided with election period in Uganda. Some of the key farmers, including their respective executives were participating as candidates in village elective posts. As a result, a repeat field exercise was conducted to update the requirements. On the case of NAADS this was not possible since re-organization was taking place at the NAADS Secretariat,
- In a number of instances, informants expected financial facilitation. This according to them would enable buying of airtime, lunch and transport while in the field. Transport to the field was necessary when an informant is located some distance from the farming area. This was mainly the case in Paicho sub-county in Gulu and Gweri sub-county in Soroti. For the case of Paicho sub-county, most of the farmers are just returning following the long insurgency that had displaced them. A number

of them still stay at the nearby urban centre and commute to the field in the morning. Similarly, some farmers in Gweri cultivate in borrowed land sometimes used by a group, and

- Repeat visits due to failed appointments meant committing more resources and time.

d) General findings

Some general findings emerged during the interviews, which mainly comprised the following:

- Some providers operate in isolation- thus repeating mistakes, duplicating services within the same locations,
- There is need for public support if a successful market information service covering a bigger part of the population is to be implemented,
- It is not recommendable to develop one service for all the farming communities. For sustainability purpose, different services need to be developed for each section of the community with similar needs. These independent services need to be implemented in a collaborative framework.

e) Summary of exploratory field results

As a recap, below is as abridged summary of user requirements. Specifically, respondents require capabilities to enhance:

- collecting and delivering information/content in local language,
- locating profitable markets for their products,
- easy access to key market information (such as prices, transport opportunities, traders' contacts etc,
- delivering information at the farmer's current location,
- interpretation of market information to ease understanding,
- contact and interaction among individual farmers and with buyers,
- collaborative environment for skills and experience sharing,
- collection and delivery information on a daily basis and whenever needed,
- updating (including creation and deleting) data by both the user and developer,
- transparent service pricing, billing and price management,
- automatic alerts for market and related opportunities for members (Push),

- collection, processing and delivery of information on commodity prices, traders' contacts and offerings, etc,
- sending and receiving information instantly (Pull) on request,
- selecting the type(s) of information users wish to send and receive (enabling communication of implicit ideas),
- maintaining a repository of market and price related information for current and future use.

Respondents also indicated some factors that may affect the proposed service accessibility, usability, availability and timely delivery of the required information. Some of these factors include:

- lack of required skills to develop, maintain and run the proposed service,
- Weak organizational structures of farming systems,
- ill-defined decision making practices of farmers regarding the sale of their products,
- weak support regulatory framework on farmers' market access,
- small farming activities, which are mainly self financed, and
- ignorance among farmers, coupled with low motivation to seek information for decision making,

3.5 An Overview of Factors Influencing Farmers' Decision Making

In addition to insights gained in Chapter 2, a number of market access barriers have been identified through interviews and results presented above. These were captured using a concluding open ended question that required interviewees to provide their own opinions. The barriers can be categorized as internal and external depending on the farmers' ability to influence them. External barriers represent those decision making challenges that the farmer may have limited (or no) ability to mitigate. On the hand, internal barriers reflect the farmer's behavioral sphere and hence the farmer may have limited influence to shape to their impact. Some of the external barriers include:

- location of the markets,
- inadequate skills and expertise needed to evaluate market information alternatives and reach at useful decisions,
- poor infrastructures (such as roads, telecommunications, storage,
- limited availability of physical resources (farm size, farm ownership, inputs etc.),
- instances of regulatory issues,
- lack of processing capabilities that would promote product value addition,

- inadequate extension services,
- low financial capacity coupled with lack and/or stringent credit facilities,
- weak institutional and /or organizational framework,
- poor market information services (characterized by its quality, delivery, awareness of, etc.).

Similarly, some of the internal barriers include:

- product perish-ability,
- individual personality,
- influence of family or group members,
- the perceived value of the market etc.
- cultural issues etc.

Table 3 provides brief summaries on the attributes of factors that influence farmers' market and price decision making.

Table 3: Factors Influencing Farmers' Market Decision making Process

Factor	**Attributes**
Market Attributes	Liberalization that has increased competition; Consumer preferences; location and accessibility; times of operations; volatility, many alternatives; varying Prices;
Transport Infrastructure	Access road network; availability of adequate transport means; cost of transport;
Family and/or group influence	Reaching consensus on key decision issues; Means of reaching consensus (either voting; use of expert advice, etc); Differing opinions on key decision issues; enabling and creating team spirit; succession;
Telecom infrastructure and services	Availability; accessibility; coverage; costs; enabling tools and services (such as telephone handsets); unfavorable regulatory environment;
Weather and Natural Features	Rainfall patterns; drought; flooding; pests; famine occurrences;
Financial and Other Resources	Level of income and capital; credit availability; storage facilities; labour (household or hired); land (owned, hired or rented); prevailing prices; farm

	size and hence product quantities;
Skills and experience	Level of literacy; level of education; required expertise; accessibility to learning facilities; issues with children education;
Opportunities and Risks	Opportunities (transportation; bulk purchase by relief agencies such as WFP; diversification; value addition; Risks (damage during transportation; wrong buyers; post-harvest insects; thefts);
Individual perception	Values, goals and objectives; lifestyles; public relations;
Cultural values	Gender roles; property ownership; decision making restrictions; tolerance to external influence;
Legislation and policy frameworks	Taxes and market levies; restrictions on product movements; government interventions or takeovers; product price controls;
Organizational structures	Over-reliance on the family head as the sole decision maker; lack of standard procedures; authority vested in one individual may lead to suspicion and conflicts; limited collaboration; limits access to business financing opportunities such as loan facilities from banks; except with individual families, market participants are connected by market and price and the linkages and highly of a personal view;
Information	Inadequate information on all the above factors; not timely; not accurate; unreliable; manipulative; poor feedback; access costs.

Other sets of factors that need to be considered while conceptualizing the farmers' decision enhancement services comprise of the following:

- Information should be collected, refined, processed and re-organized for easy comprehension and absorption by farmers. Therefore, ability to collect, refine and re-organize information process activities are tasks for a service system,
- The service system needs to be solution oriented, i.e. commitment to users' requirements as expressed by their past, current and expected future service requests,

- Facilitating innovation among market actors, which is one of the weaknesses with traditional market information services. Other than just delivering market information, the service system provides value added knowledge to the participants by encouraging collaboration, service requesting by actors and sharing. This demands that, the service system is deployed with an activity to understand actors' daily decision making practices, facilitate gathering and evaluating alternatives, identify opportunities, and provide market information that opens actors' vision beyond their current perspectives,
- Personalized service(s), where the design ensures a service system that focuses on actors' individual needs as this helps them solve actual and immediate problems. An activity, which for instance, is meant to understand and profile farmers, their capabilities, preferences, lifestyles (Smith, 2007) among others could form part of the design framework,
- The solution could also facilitate comprehensive integration, collaboration and sharing. Endeavoring to integrate a variety of resources (such as skills needed, information resources, technical resources etc.) so as to help leverage on the barriers and risks in the marketing environment. For instance, an open service paradigm is promoted through systems and service integration, including teamwork, to jointly coordinate and utilize information resources and provide knowledge-based services (Du Yeli *et al.,* 2005).

3.6 Farmers' Organizational Network and Decision Making

During the exploratory study reported above, one of the issues highlighted relates to the weak farmer institutional and /or organizational capacity. In chapter 1, we already indicate that our problem domain concerns with an information system, and more so a service system. Research shows that service systems often operate in inter-organizational networks, and therefore, they are jointly developed, operated and used by more than one organization, all of which may have no pre-defined formal structures and hierarchies (Mulira, 2007; Wierda, 1991). A similar argument has been advanced as a way of addressing transactional costs in agricultural value chains of developing countries (Bijman and Wollni, 2008) where producer organizations have been noted to play a greater role.

Specifically, a farmers' market network can evolve in many ways, such as:

Bottom-up activity identification

The quality of the system under development depends strongly on the quality of the user requirements elicitation process. We can only make a fitting system when we understand the needs of our customer. The outcome of an elicitation process is often an overload of needs. We need a selection process to balance what is needed with all kinds of constraints, such as cost, effort, and time. To this end, Muller (2010) recommends a bottom-up needs identification which enables actors come to realize that the things they are doing individually, if given small additions, could together achieve a new goal in an effective and efficient way. Similarly, considering the large number of the farming communities and varying market goals, it is only natural that the required information and interaction are built from existing actor values and resources. It should be noted that the concerned business processes start with the individual farmers; hence, solutions will be aligned with evolving market decision processes.

Concurrent Activities

Carrying out concurrent task and activity processing- letting actors work on activities concurrently so that they gain freedom and confidence over individual and group tasks, keep control over their resources and instead realize outcomes through collaboration. Tasks are more-or-less individually worked on, results are compared and most practical ideas are adopted through observation and learning from each other. This kind of activity based control technique has been used in similar scenarios. For instance, Collagen *et al.* (1997) recommend a mechanism for representing user tasks in computer models and these are used to create task constructs handled by the system. Using the task constructs, users can collaboratively talk about tasks and goals and reach a shared plan of action. Moreover, this facilitates capturing the social, personal and emotional aspects of participants.

Evolution of Virtual Teams

Encouraging evolution of a virtual structure among market participants, technology and the decision process has found great success level of applicability in the open source movement where participants come from various domains, with differing perspectives and cover large geographical areas (Defermos, 2005; Garcia and Steinmueller, 2003). Logically, this sounds viable given that agricultural market participants are dispersed, their preferences and decision making needs will change over time, new technologies will emerge and even new decision making patterns may begin to appear.

Facilitation

The concept of facilitation has been discussed by different domains each arriving at a particular epistemological perspective. For instance, social psychologists take facilitation to include action(s) taken to improve performance of simple tasks, and yet impair performance of complex and ill-defined tasks (Zajonc, 1965). This view has, however, been questioned over time with new perspectives being developed. Mallick and Alyott (2005) have considered facilitation to include role modeling, providing learning opportunities and building collaborative actor networks. Raelin (2005) describes facilitation as a way of improving team functioning, making tasks easy for the group, offering assistance to the group but not to control, and making it generally easy for the group to do its work. Group facilitation also refers to a process in which a person whose selection is acceptable to all the members of the group, who is substantially neutral, and who has no substantive decision making authority diagnoses and intervenes to help a group improve how it identifies and solves problems and make decisions, to increase the group's effectiveness (International Association of Facilitators, 2013)[7].

Vidal (2009) specifically focuses on stressing the importance of community facilitation, which provides useful insights for this study. In decision enhancement services, facilitation is considered as one of the items related to organizational decision making and is crucially needed for the realization of FDES.

3.7 General Lessons Learnt

Additional findings from exploratory field studies show that:

- Small and medium-scale buyers (or traders) who serve as an important function of providing farmers in isolated communities with access to markets dominate market channels. The challenge to farmers is that, these buyers are many, with each having different prices, product preferences, quantities and buying terms. This has led to lack of trust between farmers and buyers, as 76% of the farmers interviewed indicated that buyers cheat on prices and use faulty measuring scales,
- Small buyers (traders) who operate as rural agents buy and assemble products from the various small-scale farmers in mainly inaccessible areas. These rural agents use bicycles, but alert the large buyers when the product quantities are sufficient for collection. The large buyers then arrange for transport to collect the product and pay cash including rural agent commission. However, there are difficulties in alerting the large buyers due to the current level of information delivery. This leads

[7] Accessed 30th October 2013 From: www.iaf-methods.org.

the rural agents to face storage problems, delays in paying the farmers, and the risks of products being spoiled,

- Another set of buyers are the processors and millers who are either small-scale or large. The small-scale operate at rural centers and sometimes act as rural agents, or provide value addition opportunities for farmers.

From the preceding sections, other implications, namely: 1) little processing of the required information for decision making, 2) paucity of information to be considered, and 3) fast pace of decision making observed in farmers' practices, have to be considered.

1) The requirement for little processing

Exploratory results indicate that farmers' ability to make reliable decisions is influenced by a number of factors notably: sources of information, level of skills and training, cost of the information, and so on. For instance only 59.1% of the farmers interviewed attained secondary education level, moreover of these less than 40% are women. Consequently, farmers experience difficulties interpreting raw sets of information and would prefer to receive useable information instead. Consequently, given the underlined parameters relating to data, a service system that presents data would not be of use to the farmers who have limited capacity to communicate and perform information interpretation. What farmers needed is a service system that helps them to gain knowledge, to learn and to interactively make the right decisions. Therefore, a service system that reduces information processing activities on the side of farmers is relevant to their needs.

2) Paucity of information

In an ideal natural situation, all humans should be in position to have access to unlimited amount of information when and from where they need it. However, in reality this is not the case despite the amount of information potentially in circulation or still held by humans. For this study, a number of factors were found to be responsible for information paucity among farmers:

- The information system does not meet the farmers' initial problems or goals,
- The service system makes information access prohibitive in terms of cost, formats, language, need for expert skills on the side of actors and so on,
- The service system does not provide for the needed collaboration and interaction among actors and other external stakeholders,

- Actors may limit themselves from supplying the needed information for the service system to operate. For instance, farmers' deliberate refusal to avail information, or the traders won't divulge their information because of competition, the service system may not be of help. Hence, motivational areas need to be identified during the design and testing phases of the service system. This was addressed by involving the key actors in the study,
- Key actors are not regularly informed of the services and facilities offered by the service system.

3) ***Fast pace of farmers' decision making practices***

Considered as managers in their respective domains, farmers have to incorporate price, input-output and resource availability information with appropriate analysis procedure to determine most effective production, marketing and financial alternatives. This sets the requirement for different types of information from different sources. Secondly, farmers make decisions in different ways depending on the importance of the decision, information available and other external factors such as family members. Procedural decision making as advanced by many authors (e.g. Ohlmer, 2007) would ideally induce farmers to make studied or researched decisions. However, this is not the case.

In reality, farmers rely on friends, neighbours and personal experience in their decision making (see Harsh *et al.*, 1981; Ohlmer, 1998, 2007). Secondly, the farmers' decision making processes largely depend on the agricultural activity (Merot *et al.,* 2008) being undertaken, and this activities may take place simultaneously and at a faster rate as may be dictated by other factors such as labour availability, consumer preferences, weather patterns etc. Consequently, farmers may not follow the logical decision making stages, which have been advanced by many theorists. Even if they do so, they may not explicitly follow all the steps as some steps may not be needed or may be performed simultaneously depending on the decision at hand. These among others, are some of the issues that need to be considered while formulating a market and price decision enhancement service for farmers.

3.8 Summary

We have carried out an analysis and interpretation of exploratory data obtained during the interviews and observations. The exploratory study employed unstructured interviews involving farmers from the districts of Gulu and Soroti. Farmers who participated in the exploratory field studies were sampled purposively using information obtained from their respective district associations, and criteria developed following the literature review.

Generally, exploration results have shown that farmers' market decisions and decision processes are characterized by a number of issues making them to be:

Urgent

Due to a number of factors, farmers prefer simple and faster rules in decision making and hence not requiring sophisticated service systems. For instance, ones the product is ready for the market, it is likely that it has to be sold, a buyer has to be found at the very opportune time. Delays can result in other overhead costs such as storage and fumigation, or more competing products entering the market, leave alone the need to address family pressing obligations, which must be met,

Consequential

The farm output is always limited in quantity due to a number of factors such as production and weather issues. There is therefore, little room for time wastage and failed market choice, or poor price selection; implying risks have to be mitigated as much as possible, preferably at the farm-gate level,

Uncertain and volatile

Following the liberalization of agricultural activities and technology advances, particularly in developing countries, farmers operate in volatile and unpredictable market environment, hence they face structural problems such as low quality of human capital, limited access to inputs, credit and information (Pingali *et al.,* 2001). There is a constant market preference, unpredictable changes in demand**,** unpredictable weather conditions etc. This plays a greater impact on the farmers' market and price decision making process. Generally, complex or uncertain problems (also referred to as messy) are characterized by incomplete understanding of how options are linked to outcomes and by conflicts over values (Metlay and Sarewitz, 2012),

Involvement of many and dispersed stakeholders

As pointed out in Chapter 1, farming systems are mainly subsistence holdings operating individually at household level. For instance, Alonge (2004) indicates that agriculture in developing countries is characterized by small subsistence systems with low levels of mechanization,

Family, gender and group opinions

In this study, we have found that family members impose an influence on each other regarding market and price decisions. Therefore, the involvement of all family members in the decision making process is essential as indicated by similar research, such as Ram (2002). Asfaw and Admassie (2004) equally

suggest that a bargaining process among household members may influence and complicate a farm household's decision making process.

By being urgent, consequential, uncertain, volatile, and involving many and dispersed stakeholders, including the need to accommodate group opinions, farmers can be considered to be faced by wicked and ill-defined problems (Sol, 1982; Hevner *et al*, 2004). Further to this, the agricultural market environment is characterized with the involvement of several individuals across different cultures, relational and jurisdictional boundaries, resulting in price dispersion (Brown and Goolsbee, 2002). In conclusion, therefore, it can be deduced that farmers are involved in making decisions that matter (Keen and Sol, 2008). More specifically, we consider a decision process as the stages a farmer goes through in making choices about which buyer(s) and/or market(s) to sell his/her product, when to sell, and at what price. Hence, a better synopsis of the stakeholders was essential as this helps develop useful insights into their market and price decision making requirements. The exploratory study has enhanced our ability to achieve in getting to know the farmers' market and price decision making requirements, constraints and capabilities. In the next Chapter, we describe our approach in designing a decision enhancement studio for farmers.

4 Designing Farmers' Decision Enhancement Studio (FDES)

Design as an artefact demands the production of a viable artefact in the form of a construct, a model, a method or an instantiation. In this chapter, we describe our approach in designing the proposed market and price decision enhancement studio for farmers in Uganda. The chapter starts with an introductory overview and proceeds with discussions on the "way of" framework. In particular, we describe the way of thinking, way of governance and way of working and modeling. Under each of these ways, we consider three studio building blocks of people, technology and process. The chapter describes the studio's suites, recipes and ends with a brief summary.

4.1 An Approach to Design a Studio

In principle, information systems are implemented within an organization for the purpose of improving the effectiveness and efficiency of that organization (Hevner *et al*., 2004). As a recap, in this study we consider an agricultural market as an organizational system. There are sets of related objects carrying out activities geared toward a common goal (Handy, 1999), which in this case include selling and buying activities that are performed by individuals within a particular market environment (Stockbridge *et al*., 2003). As outlined in previous chapters, the use of decision support tools to enhance these activities requires adequate skills and competencies (Keen and Sol, 2008; Churi *et al*., 2013). Hence, farmers who are mainly of low education and income levels have not been able to use these tools despite their advantages (Newman *et al.*, 2000; Churi *et al.*, 2013). This is because little has been done to develop simple tools, which focus and meet the capabilities of farmers (Newman *et al*., 2000; Churi *et al*., 2013). However, the value of decision enhancement services can be realized by employing new opportunities of the web and mobile technologies linked to farmers' resource capabilities.

The object of this chapter is primarily to describe an approach to design the Farmers' Decision Enhancement Studio (FDES), whose focus is to enhance the farmers' market and price decision making processes. As outlined in the previous chapters of this thesis, farmers face a number of challenges in their pursuit to access markets and fair prices for their products. Subsequently, during the initiation of this study, FDES has been conceived as an appropriate mechanism for enhancing market and price decision making processes among farmers. Therefore, an approach to design FDES, which follows the inductive-hypothetical strategy of Sol (1982) outlined in Figure 3, is presented following the "ways of" framework consisting of: way of thinking, way of governance, way of working and way of modeling

(Sol, 1988; Selingmann *et al.*, 1989). An approach to design FDES underpins our theory formulation exercise by linking the conceptual description model and that of conceptual prescription.

4.2 Way of Thinking

Arising from the concept of decisions support systems in agriculture (Parker, 2001) FDES is an ICT-based service system, which helps users to enhance decisions that are more effective by accessing information and collaboration opportunities. Hence, FDES is considered a service system upon which we draw inspirations from various systems' development theories (section 2.4). Service systems design is a complex activity that requires knowledge from several different disciplines as outlined in Chapter 2. In particular, we draw inspirations from service system development that include (Van de Kar and Verbraeck, 2007): user needs translated into performance criteria and operational processes; information and communication technology that deliver the services, and the inter-organizational setting needed to develop and deliver the service.

The way of thinking outlines the design contexts and the theoretical underpinnings of farmers' market decision making services. A number of factors outlined in Chapter 2 and 3 have been found to influence farmers' market and price decision making process, including their market participation. In order to mitigate these factors, a Farmers' Decision Enhancement Studio (FDES) has been proposed. Keen and Sol (2008) (outlined in detail in Chapter 1 and 2) suggest the development of a decision enhancement studio for solving human decision related challenges involving complex and uncertain problems. Farmers' market decisions are characterized with varying levels of complexity and uncertainty. The way of thinking particularly deals with defining the specific tasks and activities to direct the collaborative market decisions among farmers and is further informed by the work of Kolfschoten *et al.* (2009).

Based on insights advanced by Keen and Sol (2008), FDES is considered a service system that enables or enhances the decision making ability of actors involved in collaborative market decision making processes. Consequently, from the perspective of decision enhancement services, FDES comprises of three fundamental elements including people, technology and a collaborative decision making process presented in Figure 7, and upon which our way of thinking is discussed.

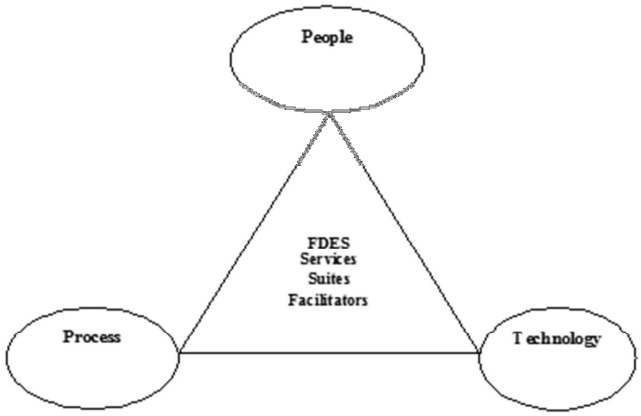


Figure 7: FDES Framework (Adopted from Keen and Sol, 2008)

The People Aspect

In design science, an environment defines the problem space in which resides the phenomena of interest. It is composed of people, organizations and their existing or planned technologies (Hevner *et al.,* 2004). In this environment are the goals, tasks, problems and the opportunities that define business needs as they are perceived by people. Subsquently, the people aspect is very important in the design of FDES as a service system, since it has been noted that service systems often operate in inter-organizational networks (Wierda, 1991). For decades, practice has shown that designing usable systems requires knowledge of the likely users, their needs, place where the systems is potentially to be used and capabilities. This kind of thinking is related to among others human-computer-interaction (HCI), service-oriented architectures and user-centered design, all of which are discussed in section 2.4.

For the case of this study, the people aspect refers to farmers and farmers' run groups involved in the market environment as outlined in Chapter 3. Farmers are involved in making market decisions very frequently, but face challenges in the process ranging from lack of skills, lack of institutional frameworks, inability to collaboratively share experiences and skills, difficulty in accessing market and price information among others. This has a direct bearing on their decisions outcomes, as Keen and Sol (2008) put it that, people skills, values, judgment and experience are very important attributes in shaping their decisions. Most of the farmers were found to be either running family farms, formal farming groupings, or informal farm groups; though informal groups were mainly common among the

women and the youth, where labour is alternatively rotated among group members i.e. from one household to another.

Specifically, the market comprises of individual traders and produce dealers, local weekly markets located in the villages, with some loose links to the super markets in towns. A few exporters, mainly for cotton, procure from rural farmers in an organized scheme with collection centers spread across the villages. Using the perspective of collaborative business process, FDES describes the inter-related market decision making processes performed by farmers carrying out separate and interdependent market activities.

The Technology Aspect

As outlined in chapter 1, the relevance in design science is underpinned through the development of technology-based solutions to important and relevant human problems (Hevner *et al*., 2004). In the case of this study, technology provides multiple types and levels of support directed to enhancing market and price decision making among collaborating market actors (Keen and Sol, 2008). Consequently, a number of enabling technologies for developing FDES may include internet, telecommunication networks, gateways, content platforms among others. Specifically, these technologies provide a facilitative and collaborative environment (in the form of tools, hardware and software) which is necessary for the enhancement of farmers' market decisions and decision making processes.

However, research has also shown that technology can only be beneficial if it is used as a tool, which can be adjusted to combine additional knowledge and experience, and adopted within a local context (Wade, 2002). It is therefore, imperative that the quality of technology for enhancing farmers' market decisions should be similar to the qualities of their goals: such as "local relevance, repeatability, sustainability and predictability" (Steinberg, 2003). The technology aspect may be realized through a novel collaborative approach of the studio and suites packed with relevant services and recipes. Consequently, our way of thinking is grounded on collaborative engineering (Amiyo, 2012; De Vreede *et al*., 2003), underpinned by deploying well-tuned recipes (Ejiri, 2012; Keen and Sol, 2008) to aid the collaboration among market participants.

We also note that, technology has enabled collaborative business processes in organizations for several decades. Some examples include workflow management, groupware and project management (Bussler, 2001; Kirsch-Pinheiro *et al.*, 2003; Dustdar and Gall, 2003); requirements negotiation (Boehm *et al*., 2001); collaborative usability testing aimed at facilitating stakeholder participation (Fruhling and De

Vreede, 2005); enabling information management and distribution among distributed work processes (Kirsch-Pinheiro *et al.*, 2003; Antunes *et al.*, 2007); knowledge-based collaboration systems (Kim *et al*., 2004); business process agility (Amiyo, 2012) and so on. And for this particular study, we consider collaboration engineering (introduced in section 2.4) as an approach whose facilitators develop transferable, repeatable and predictable collaborative processes which can easily be adopted and used by practitioners in any local contexts (Briggs *et al.*, 2003).

With novel studio strategies, technology in all its forms increases the likelihood of improved decision processes in many problem solving domains where automation is feasible (Keen and Sol, 2008). Specifically technology may lead farmers to a number of benefits, such as:

Low operational overhead costs; provision of timely, accurate/ quality market and price information; access to a variety of markets and prices may be made possible; increased interaction, including sharing of experience and skill among participants; and possibility of delivering services to market participants who could not be reached by traditional means.

The possibilities of enriching farmers' decisions is more likely given that there are still some gaps such as needs for sharing tacit knowledge, which is localized to individual groups and contexts, including addressing specific localized requirements through domain specific recipes (Keen and Sol, 2008). From chapter 3, findings indicate that current systems focus on internet-based collaboration, which are directed towards interest of more formalized organizations. Indeed, collaboration among farmers has not been well addressed. A technology-based collaborative environment is key to handling market complexity and agility, where one participant only lacks the information or skills to make what has been referred to as "effective choices" (Keen and Sol, 2008).

The Decision Process Aspect

A decision process has been explained in many ways by different disciplines. However, in the context of decision enhancement services, a decision process refers to that process that has one and only one purpose: "making real impact for stakeholders in handling decisions that really matter in their sphere of responsibility" (Keen and Sol, 2008). The decision process may also refer to creating a sequence of steps as in workflow design (Aalst *et al.*, 2003), business process change (Amiyo, 2012; Kettinger and Teng, 1997) and systems analysis and design methods. In particular, we consider "process" as an interrelated sequence of events that occur over time leading to an organizational outcome of interest

(Robey *et al*., 2000). These steps (also so called phases) have elaborately been discussed in earlier chapters of this thesis, though Ackoff (1978) views could equally add useful insights.

This study is concerned with aspects of the farmers' decision making processes i.e. decisions relating to the selling of farmers' products. As introduced in section 2.3, farmers' decisions may be seen to involve both prescriptive and empirical dimensions (Keen and Sol, 2008). Empirically, every decision made deliberately presupposes an idea of the desired objective(s). Hence, initial market and pricing objectives of farmers are crucial for the decision making process. On the other hand, prescriptive perspectives relate to the search for optimal solutions to a problem situation (Keen and Sol, 2008). In particular, the farmers' decision making process encompasses product decisions, pricing decisions, decisions methods to be used in determining product price(s), and issues relating to merchandising (where and how to deliver the product to the buyer). The studio as described in Keen and Sol (2008) and applied by other researchers (Knol, 2013; Ejiri, 2012; Amiyo, 2012), combines the prescriptive and empirical dimensions to enhance the farmers' decision making process. The focus of the studio therefore is on enhancing the processes that farmers go through while selling their products.

In conclusion, our way of thinking can be described under four dimensions of:

- Farmers' Decision Enhancement Studio (FDES) has been considered as a service system consisting of people, technology and procedures (including its environment), and which offers capabilities for discovering, processing and making available timely and quality market information to market decision makers,
- Similarly, the sets of actions and factors which begin with the identification of a stimulus for an action and end with a specific commitment to action forms the decision process,
- Decision enhancement represents effective strategies of fusing people, process and technology through services, studios and suites,
- Collaborative business processes describe a set of interrelated processes usually performed by separate, interdependent firms in order to produce and deliver a specified range of goods or services.

Therefore, from the outline above, we consider FDES as:

"a service system comprising of people, technology and processes, that provides a collaborative decision making environment for enhancing farmers' market and products' price decisions, by facilitating market information discovery, processing and making available the market information to

all market actors via services packed in a studio, recipes and suites". It is a socially constructed collection of service events in which participants exchange beneficial actions through an information-based strategy that captures values from a provider-service customer relationship.

4.3 Way of Governance

The way of governance represents the blueprint embedding the FDES studio and integrating its suites within the farmers' market decision making activities outlined in section 4.4. Keen and Sol (2008) refer to this as the governance architecture, which may include guidelines, regulations and/or shared facilities. Tan et al. (2011) describe governance in service systems to include coordination, service frameworks, trust and controls. While Spoher and Kwan (2009) urge that in ensuring value propositions of service systems, there is need for governance mechanisms that help in uncertainty reduction efforts. For the problem domain, all of the governance attributes are necessary, some may be applicable out-rightly, while others may emerge with time along the decision process, and depending on the changes of the domain landscape.

In the problem domain, the way of governance is characterized by the coordination, direction and control of market actors who are largely autonomous, i.e. they are not directly subject to the same hierarchical authority. This refers to a situation where actors relate as peers rather than linked in hierarchical authority (Marku and Jacobson, 2010). None of the parties involved in a decision making environment has the formal authority to command others (Bijman *et al*., 2006). It is, therefore, inevitable that several governance mechanisms are used in combination.

Insights from common project-based ways of control such as adaptive and process management (De Bruijn *et al.*, 2002; Ndagu and Obuobi, 2010) may provide a good starting point. As indicated in Chapter 2, the decision making process of farmers, a majority of whom are rural based, does not follow a standard pattern but tends to employ heuristics (Heong and Escalada, 1999; Marsh, 2002). Whereas a traditional project process control principle provides knowledge, the applicability to the problem domain is inadequate because it presupposes the presence of motivated leadership with precise roles to be executed (De Bruijn *et al.*, 2002; Mulira, 2007; Ndagu and Obuobi, 2010). Farmers' market structures appear at multiple levels, conducting market activities and assuming roles more specific and autonomous at each of the levels. Consequently, the way of governance must provide for tradeoffs due to the significant interdependencies among market activities being conducted across the autonomous levels, which can be subsumed into a set(s) of collaborative decision making processes.

Secondly, though De Bruijn *et al.* (2002) recommend simple coordination tactics that could enable all the actors understand and follow the storyline, the farmers market environment looks chaotic with no clear coordination among actors, though some farmers have engaged programme officers to manage the-to-day activities of their associations or groups. Creating coordinated settings among multi-actors requires that joint activities such as problem exploration, actor scanning and fixing of any rules should be taken seriously (De Bruijn *et al.*, 2002), a requirement that further underpins the principle upon which the dispersed nature of agricultural-based market actors can be appreciated. Things like service level agreements (SLAs) can be useful tools that actors can be made to enter into if they show willingness to participate, though few farmers show open willingness, belonging to a farmers' network organization (or association) is highly voluntary; while others may require tangible motivation to join a collaborative market decision process. There is need to identify facilitators from among farmers or even from outside, to provide the needed coordination, facilitation and guidance. The roles of the facilitator and other market actors are spelt out explicitly to mitigate role conflicts.

Thirdly, Ndagu and Obuobi (2010) stress that project management processes assume problems and solutions to be reasonably stable and those formal management techniques can be used during project lifecycle. Process management, on the other hand, is concerned with identifying and implementing changes via a sense of urgency, integrity, openness, protection of interests and values of all those involved, including rewards for ensuring continuation and process type arrangement that facilitate sufficient content (De Bruijn *et al.*, 2002). Moreover, decision process management helps the involved individuals focus on agreements, meetings and negotiations (De Bruijn *et al.* 2002; Amiyo, 2012). Subsequently, the way of governance focus in this research is to contribute to increasing decision process agility. By increasing decision process agility, we seek to enhance speed, flexibility, coordination, collaboration and innovation using technology (Keen and Sol, 2008; Amiyo, 2012, Knol, 2013).

The requirements for adaptive strategies provide yet another governance dimension to farmers' decision making. Requirements of the problem cannot be precisely defined, nor even understood by users, and how the proposed solution will function is difficult to determine beforehand (Sol and Crosslin, 1992; Vidgen *et al.*, 2002; MacManus and Wood-Harper, 2003). Particularly, in adaptive strategies a design process itself is an adaptive process of learning for those involved (Sol and Crosslin, 1992). In this way, the induction to the problem situation enhances participants to effectively rehearse their future (Meder and Hagmayer, 2009; Keen and Sol, 2008). Hence, the way of governance in this respect, seeks to

ensure that the studio provides a learning environment for participants, and gains its applicability depending on changes in the problem situation.

Another governance mechanism relates to the presence of an active and participative actor network, as in actor network theory (Latour, 1986 ; Woods, 1997; Harty, 2010). Based on the decision enhancement perspective of Keen and Sol (2008), FDES is designed to bring together many actors into the market and price decision process. Through its suites, the studio invites actors by offering information and display tools that ease actors' search for optimal decisions. In this way, the way of governance enhances group decision making (Keen and Sol, 2008) by outlining who is to make the decision, through what process, and under what incentives and constraints.

In conclusion, the way of governance addresses issues relating to coordination, facilitation, decision process management and control, adaptation in decision making, including an actor network that promotes group decisions and outcomes.

4.4 Way of Working and Modeling

The way of working or the working method represents an outline of the tasks that need to be carried out during FDES design and implementation (Sol, 1988). Specifically, the way of working and modeling represent the steps or stages that were carried out in FDES design, the means of coordinating those tasks and resources, as well as the description of tools that assist stakeholder learning and feedback (Sol, 1988) during implementation. As a recap, a number of development methodologies were discussed in section 2.4 and the insights gained are used to inform the alternatives for the problem domain. Specifically, knowledge from collaborative approaches provide the necessary starting points (Briggs *et al.,* 2003; Den Hengst *et al.*, 2006; Keen and Sol, 2008). In this respect, collaboration is seen as a system comprising of market participants interacting with a common purpose, and aided by technological tools and communication networks.

Secondly, our way of working and modeling is also concerned with aiding access to market and price information, as this is one of the users' key requirement for an approach to design FDES. One mechanism for improving decision making has been noted to be associated with the use of information, information presentation and visualization (Tufte, 2001; Speier and Morris, 2003; Keen and Sol, 2008). The FDES communication and other suites are aimed at aiding both collaboration and information related issues within the decision process.

Our way of working and modeling is structured in three broad steps consisting of: the people aspect, the decision process aspects and the technology aspect. The technology aspect in particular is presented as suites, packed with services and recipes as discussed in section 4.5.

The People Aspect

Collaboration processes depict the purposeful interaction between two or more market participants, defined by a sequence of activities consuming information and involving exchange of messages. Hence, the human aspects plays a greater impact in shaping the collaborative decision making arenas. Therefore, we use a mixture of business process models (Siegel, 2008) and Unified Modeling Language (UML) knowledge, to refine farmers' market activities upon which tasks are decomposed and decision areas are defined (at the same time, we refer to decision areas as deliverables). Focusing on users' requirements is paramount to an approach to design FDES because people are key in the decision process, they can execute an existing process and define new ones as and when need arises, they can also decide to withhold their involvement for various reasons (Keen and Sol, 2008).

As noted in Chapter 2 and section 4.2 above, the problem domain is concerned with a multi-actor environment characterized by dispersion, weak network linkages among actors and uncertain market conditions. It is also indicated that a service system is likely to be successful if roles of the likely stakeholders are spelt out and their participation acknowledged (Van de Kar, 2004; Mulira 2007). For the purpose of this study, actors are grouped into two categories of service providers and service customers, and are presented together with their roles in Table 4 below (see next page).

From Table 4, a service provider refers to a public agency that carries out research, extension and local administration; and a private sector actor (or agency) involved in inputs, extension, business planning, finance, storage, and most importantly market facilitation (Ostertag *et al.*, 2007). Our focus in this study was to support the roles of service customers by enhancing their decision making processes.

Table 4: FDES Actors and their roles

Actors	Roles	Example
Service Providers	Responsible for setting up and running Farmers' Market Decision Enhancement Services Ensuring smooth running of the market Decision Enhancement Services Ensure that Market Decision Enhancement Services meet the market needs of actors	District Production Department NAADS sub-county co-coordinator Extension Agents, Farmers' Association Leaders Facilitator/Expert
Service Customers	-To seek for Market and Price Information -To Use the Decision Enhancement Services -Enable market functioning by buying products through negotiations with farmers -Seeking products' and farmers' information	Farmers(also referred to as sellers or producers) Individual traders, wholesalers etc. (also referred to as buyers)

In order to fulfill their roles, service customers have to carry out two interdependent market activities of: *market identification and price determination,* implying performing a number of tasks for each activity within a specified timeframe. We use these activities as building blocks to generate tasks upon which decision process deliverables are defined. For consistency and ease of understanding, tasks are also considered sub-activities (George, 2007). The timeframe for performing market activities is often constraint by a number of factors such as weather patterns, market conditions and many others.

For ease of reference, activities have been given serialized codes, as well as their respective tasks, and presented in an activity table based on George (2007), Table 5 below. The codes do not indicate prioritization, but are meant to ease representation.

Table 5: Service Customers' Activities (Source: Exploratory Interview Results)

Activity	Tasks	Timeframe
1. Identifying Market(s)	1.1 Facilitate market activity by having products ready 1.2 Request information of potential market(s) 1.3 Evaluate information on available markets 1.4 Set product reserve prices and conditions 1.5 To obtain family member or group acceptance 1.6 Identify means of reaching the market 1.7 Prepare the product for onward delivery to the market	Post-Harvest activity, and takes place throughout the year
2. Determining suitable price(s)	2.1 Make products ready in respect to quantity required 2.2 Check product quality with respect to market needs 2.3 Evaluate product existing prices 2.4 Set and examine reserve price values 2.5 Deliver the crop to the market 2.6 Sell or do not sell the product 2.7 Agree with the buyer, the mode of payment 2.8 Check if there is need to pay market dues, and pay them	Post-Harvest activity, and takes place throughout the year

Generally, the market identification activity is concerned with selecting a market choice to address *where* and *when* to sell the product and within which constraints and opportunities. A summarized discussion on factors that influence farmers' market identification decisions is presented in section 2.5, however, it is important to note that this is a very critical activity in the farmers' market and price decision process (FAO, 2006). Results from field interviews strongly show that both institutional and technical factors influence the farmer's decisions during the market identification process.

On the other hand, price determination activity is concerned with evaluating existing product prices, fixing reserve prices and agreeing with buyers the actual price. The activity can become complex since at any one point in time, there are changes in supply and demand, and subsequent price trends are difficult to predict. The price determination activity is inherent to the market process, hence making effective management of product price a major challenge. Activities relating to price decisions are even made more challenging since other factors such as yield levels, costs of production, technology adoption have greater impact on farm profitability than does price (Kastens and Nivens, 1999). In the next section, we use these activities and tasks to determine the deliverables (or intended decision outcomes).

The decision process aspect

In section 2.4, we introduced both business process management and collaborative engineering as sets of theoretical underpinnings relevant for this study. A collaborative process describes a set(s) of interrelated activities performed by different and inter-dependent market participants. From the perspective of process management and collaborative engineering principles, a process can be modeled in several ways (De Vreede and Briggs, 2005). As indicated in section 2.4, collaborative engineering describes six patterns that a collaborative decision process can take. These patterns include divergence, convergence, organizing, elaborating, abstracting, evaluating and building consensus (Briggs *et al.*, 2003; Den Hengst *et al.*, 2006; Briggs and De Vreede, 2009).

Secondly, collaborative principles are emphasized given the multi-actor and complex nature of the problem domain (De Vreede *et al.*, 2006; Keen and Sol, 2008 ; Edita and Denysiuk, 2012), which in addition creates a need to focus the decision process with user requirements (Mulira, 2007; Van de Kar and Verbraeck, 2007). In addition, a flexible and adaptive way of working and modeling is recommended as it allows the service system to evolve and change with the decision process and situation (Keen and Sol, 2008). The farmers' market environment is continuously changing as consumer demand and characteristics change.

FDES Prototype and Implementation

At this stage of the design, we start by spelling-out the services, tasks and deliverables arising from market activities identified in section 4.4. These are presented in Table 6 below. Secondly, we use activity diagrams to represent the flow sequence between these activities. Activity diagrams offer a way to present activities graphically by enabling easy representation of the relationships between those activities (Dennis *et al.*, 2012). Consequently, Table 6 provides a summary of the examples of decision outcomes during execution of a specific decision task or group of tasks, while Figure 8 gives a sequence of FDES Decision Process Activity Diagrams discussed below under process modeling.

Table 6: FDES Services and Decision Areas

Services	**Tasks**	**Decision Areas**
Market Identification Services	1.1.1 Identify Market 1.1.2 Obtain and evaluate information on alternative markets 1.1.3 Create market evaluation criteria 1.1.4 Select the desired Market 1.1.5 Proceed to pricing services or wait for the right time	1.2.1 Are the criteria acceptable to all actors 1.2.2 Is there a suitable market, if not the market search is repeated or terminate 1.2.3 Are other key stakeholders involved 1.2.4 Is it the right time to sell, if not end the decision process, otherwise proceed to Pricing Services
Price Determination Services	2.2.1 Request information on existing product prices 2.2.2 Evaluate existing prices based on set criteria 2.2.3 Set the reserve prices 2.2.4 Negotiate and reach agreement on actual price 2.2.5 Agree on mode of payment 2.2.6 Sell or buy the product 2.2.7 Check on the status of market dues Payment 2.2.8 Terminate the market process, or	2.2.1 Are criteria acceptable to all actors 2.2.2 Is there consensus from all key stakeholders 2.2.3 Is the right buyers/market the one chosen 2.2.4 Is the actual price acceptable 2.2.5 Is the mode of payment acceptable 2.2.6 Pay market dues, if status

	continue to Market Identification Services to sell/buy another product	indicates so 2.2.7 Is there need to sell/buy another product, if Yes, proceed to Market Identification Services

Process modeling techniques

As a recap, process design or process engineering has been discussed by several disciplines (see for instance De Vreede and Dickson, 2000; Kolfschoten and De Vreede, 2009). Our focus in this study is on business process, which implies envisioning of new work strategies, actual process design activity and the implementation of the change (Kolfschoten and De Vreede, 2009). Hence, collaborative process design in the context of this study consist of a structured systematic approach to design purposeful interaction using a sequence of steps that help market actors achieve their goals. Secondly, the value of the studio rests on processes since from Keen and Sol (2008) "the processes fundamentally involve people and collaboration". In our way of modeling, we consider a decision process undertaken by farmers in arriving at market and price decisions as an operational business process. This process has to be modeled and managed based on standard norms and specifications as in business process modeling (BPM) (Weske, 2007; Van der Aalst, 2004).

Similarly, the modeling should follow a simplified pattern that can be understood by a large constituency of stakeholders with a multitude of actors (De Vreede and Briggs, 2005; Barjis, 2007). For this case, the earlier notations used in engineering (Ferguson, 1993) and computer science (Wieringa, 2002) may not be suitable for this problem domain. The focus is on graphical representations such as petri-nets (Emmerich and Gruhn, 1991; Van der Aalst, 1998; Erikson, 2000; Desel, 2005). However, for the case of this study, petri-nets too could not offer the required advantage (Suit, 2011).

Subsequently, we considered insights from the Unified Modeling Language activity diagrams (Fowler and Scott, 1999), which have been recommended by among others such as De Vreede and Briggs (2005) as being suitable for modeling similar collaboration business processes. Generally, the Unified Modeling Language (UML) consists of several graphical options for systems design (Dumas and Hofstede, 2001; Eriksson and Penker, 2000; Eshuis, 2002; Wieringa, 2002); and particularly for collaborative support systems (Wieringa, 2002; De Vreede and Briggs, 2005). UML activity diagrams

support the modeling of business activities including the ordering between these activities using a combination of petri-net, flowchart and statechart notations (Dumas and Hofstede, 2001; Eshuis, 2002).

Hence, we use UML activity diagrams to model farmers' Market Identification and Price Determination processes such as "identification of a suitable buyer for a specific product(s), choice of a suitable market etc". The diagram below (Figure 8) indicates the pattern of information flows (request for service), the kind of information that is needed to aid the collaboration (consisting of inputs, product, price and market details information). Two services are represented in the activity diagram namely: Market Identification and Price Determination services. Price determination services are meant to enhance both price and product related tasks.

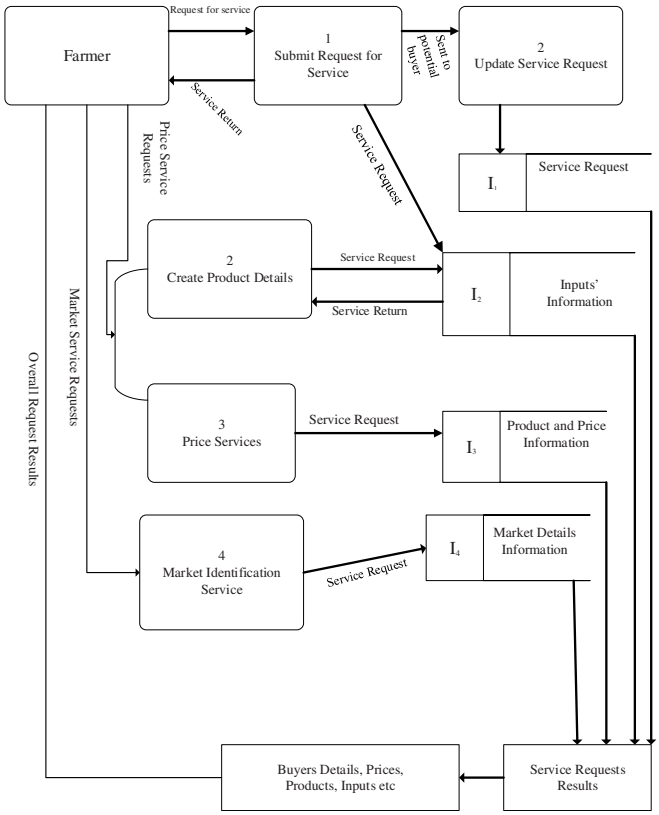


Figure 8: FDES Information Flow Diagram

Generally, FDES offers two interdependent and integrated services consisting of “Market Identification and Price Determination Services”. Two suites are derived from these services, namely the Market Identification Suite and the Price Determination Suite. Through the Market Identification Suite, actors gain access to information and collaborative environment that enables them to among others: evaluate market demand and buying conditions for existing products; evaluate market options for new products to encourage diversification-with focus to high value products; and evaluate opportunities for value addition, transport and other logistics.

On the other hand, the Price Determination Suite supports tasks concerned with price determination and discovery activities. The relationships between services, suites and tasks are further represented in Figure 9 below. It should be noted that the figure does not present a prioritization of activities but represents a sequence of activities where collaborative decisions have to be made. The circles represent emphasis, meaning more attention is needed from all actors to reach a decision, which may imply some delay in the overall process, depending on the method(s) used for gaining consensus.

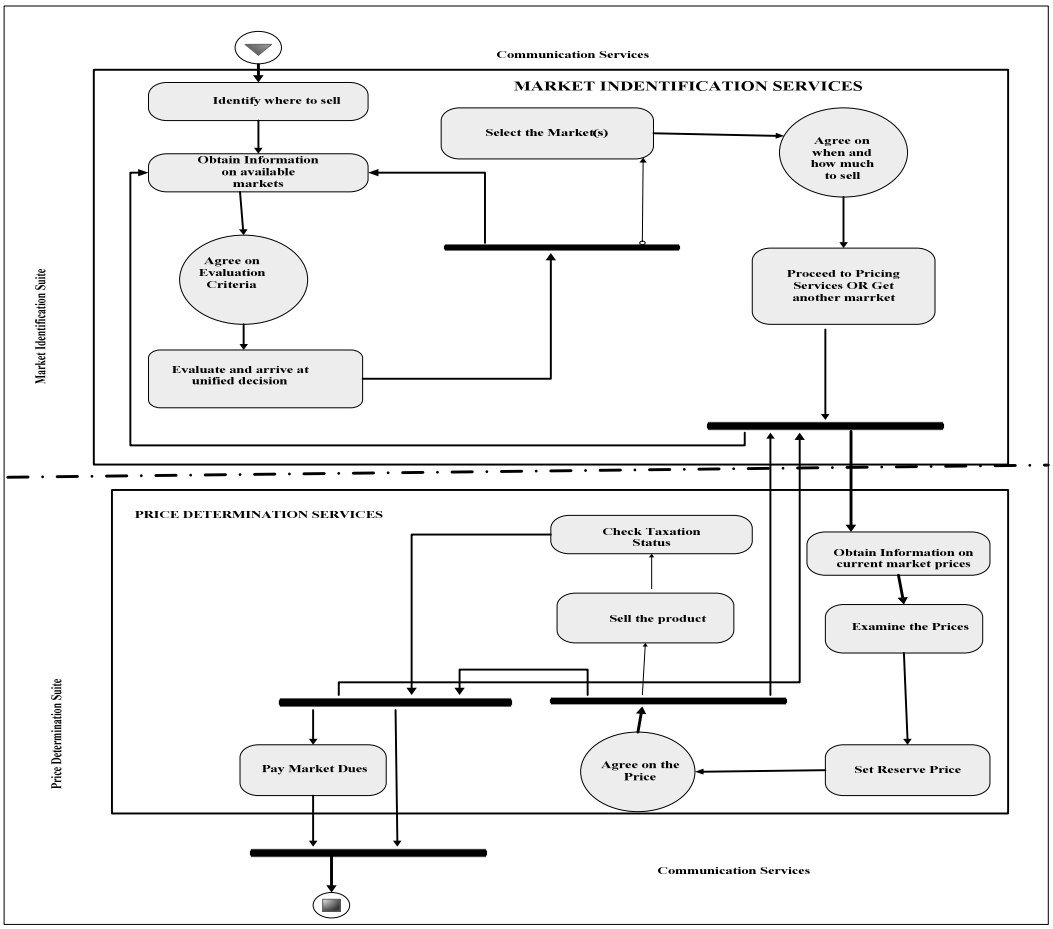


Figure 9: FDES Activity and Decision Process Diagram

The decision processes starts from Market Identification Services when a farmer(s) triggers the decision process ones there is a need to sell a particular product. At this stage, information requests are sent to generate a list of alternative markets. An evaluation is conducted based on agreed upon criteria, and if no suitable alternative is found, more information requests are sent for additional alternatives, this time with some modification in the information request. The process is "adjourned" if no suitable market can be found. Successful results from the Market Identification Services provide input to the Price

Determination Services, which may include buyers' contacts information; product information; and price information on individual products.

On the other hand**,** communication services enable link-to-link (L2L) information flows, peer-to-peer (P2P) communication and end-to-end (E2E) communication (Parikh *et al.*, 2007) during the decision making process. Communication services enhance farmers' decisions and decision processes through facilitating collaborative interpretation of market information, facilitating information requests and feedback, and enabling selective information services. Similarly, in designing the farmers' decision enhancement services, some critical perspectives had to be considered in our way of working:

- Identifying market source(s) and price(s) that best fits farmers' passion, interest, family situation and available resources. This means farmers have to deal with three critical issues in their market decision making process: 1) dealing with a series of interdependent decisions and/or actions (today's choices have to be made in coherence with those made previously), 2) dealing with constantly changing situations, and 3) attending to shifting market goals and preferences,
- The amount, quality and location of the products to be sold,
- The potential relevant information that drives the decision process needs to be extracted or even constructed for every choice task. Farmers need to get preferences and beliefs on the spot when needed, hence, in order to be able to understand differences among farmers' decision making behaviors, a service system should identify the types of information invoked, the role of that information in the decision process and the way that information is dynamically acquired. The choice process involves information sources that induce a restriction on the set of candidate solutions (for instance non-argent candidates solutions can be discarded if others are argent), and
- Due to internal market constraints and other factors, results may be modified for a particular solution to be obtained, therefore, calling for tradeoffs to be made. Uncertainties about the actual state of the market (due to observation difficulties among others) or future events (e.g. weather conditions) can affect the farmers' choice process, which as usual involves trading off between what ought to be (the goal) and what can be (the belief and reality).

4.5 FDES Studio Suites and Recipes

FDES Suites

Figure 10 below shows the sequence flow of activities and tasks within each of the FDES suites. In this section, we describe FDES suites in detail: indicating their purpose, guidelines and the collaboration pattern they support. Though a "suite" has already been explained in various sections of this thesis, we briefly consider it as sets of technology tools packed with services and recipes for enhancing farmers' market and price decisions. In these suites, participants collaborate using the various services and tools designed to facilitate communication and feedback. The suites as depicted in Figure 9 comprise of the Market Identification Suite, Price Determination Suite, and the Communication Suite. All together, these suites combine to provide the technological and facilitative environment required for realizing the farmers' decision enhancement service.

Guidelines are developed to enable users know how to use individual suites. These guidelines are central to the suites and are sets of expectations that market actors should know, be able to do, and assume responsibility for accomplishing an on-going decision task. The guidelines form the linking pins that connect all stages of the decision making process.

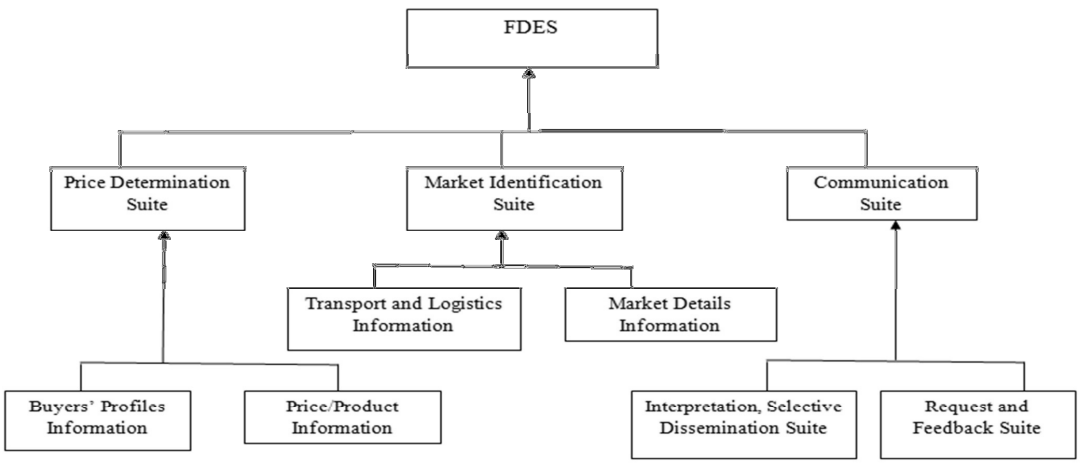


Figure 10: Hierarchical View of FDES with Suites and Services

1 Market Identification Suite

From Figure 10 above, this suite's purpose is to aid collaborative decision making relating to the identification of market choices, and facilitates the provision of the needed information. Experts have indicated that an organizational/ or group decision refers to the execution of a choice made in terms of objectives from among a set of alternatives on the basis of available **information** (Herrera *et al.*, 2005; Keen and Sol, 2008). For the problem domain, information on market conditions and transport (including any other logistic) opportunities is collected from among actors and external sources. Both the collection and utilization of this information is enabled via the suite's interface, tools and its collaborative environment. As indicated in Figure 10 above, the Market Indentification Suite comprises of two sub-suites, namely: the Price and Logistics Informartion, and the Market Details Information.

Market Identification Process guidelines

The main activity carried out under this suite concerns making choices on actual market, where to whom and when the product should be sold. The following guidelines are recommended to guide this process:

i. ***Developing evaluation criteria,*** participants committed to the decision process will discuss and agree on how the criteria should be developed, and what should be in its contents,
ii. ***Generating information on alternative markets,*** participants discuss and agree whether sufficient information has been obtained. They also jointly generate an overview on these alternatives using the criteria set already and agreed upon. Alternatives that partially fit within the criteria are discarded out-rightly on consensus, only the most relevant ones are retained,
iii. **Grouping and evaluating relevant alternatives**, group the remaining alternatives according to agreed upon attribute(s), then evaluate each of the alternatives in its own right based on the criteria of step (i) above,
iv. ***Decision making,*** make a final choice or decision based on the discussion results gained from step (iii) above. The decision outcome is the market(s) alternative(s) that have been reached at by consensus.

2 Price Determination Suite

Price Determination Suite refers to a suite, which enhances decision making and decision processes relating to product price determination and discovery. It is also concerned with market dues and

taxation issues. The suite facilitates collection, storing and enabling access to price information, farmers' and buyers' profiles, and enables collaborative price determination and discovery. The suite, therefore, relates to creating an understanding on supply determinants or factors influencing the quantity and quality of products in the market; facilitating the process of buyers and sellers arriving at a transaction price for a given quality and quantity of the product at a given time and place; and buyers procurement and pricing methods. These are achieved via the buyers' profiles information and the price/product information services. Participants can use this suite to explore prevailing prices and use this information for setting reserve product prices. Based on their reserve prices, participants are placed at a better bargaining position with probable buyers.

Price Determination Process Guidelines

The main activity carried out in this suite involves determining and discovering product prices, which also includes an **optional** service of market dues and taxation issues. The following steps are provided to aid collaboration among participants carrying out this activity.

i. **Obtaining information on current product prices**, first from price/product information sub-suite, retrieve all the necessary prices for the product. Secondly, and if necessary, use the buyers' profiles sub-suite and collect more information directly from potential buyers. Participants should agree by consensus that information collected is sufficient,

ii. **Preliminary price examining**, examine the prices to formulate an overview on those that might be favorable. Use results obtained from Market Identification activity as much as possible to enrich the examination processes,

iii. **Setting Product Reserve Price, s**ummarize preliminary results from step (ii) above as much as possible (use pie charts, graphs and /or tables) and use them to guide/or set the reserve price for the product by consensus, and

iv. **Negotiating the final price,** through negotiation or directed brainstorming, evaluate the prices and by consensus reach an agreement. The outcome should be a price(s) for a given product(s).

3 Communications Suite

The main goal of the communication suite is to provide a model for enhancing decision making among actors. We note that decision making is a social-communicative process where people enter into relationship, exchange information, establish preferences and chose courses of action (see for instance Keen and Sol, 2008). These views equally apply to farmers' decisions (McCown, 2002), where communication services play a greater role. The Communication Suite is modeled to offer two inter-

dependent services of: 1) facilitating management of requests and feedback processes in the environment, and 2) facilitating information collection, interpretation and selective dissemination. These services are offered based on two models: 1) **Centralized**, where market actors communicate to each other via a central moderator (facilitator in this case), and 2) **Distributed**, where actors directly communicate with each other.

In addition, the above services can be deployed based on two techniques:

- The directional technique, where messages are sent to individuals or group (explicitly listed) actors based on the information requests received. This enables passing of current market and price information such as buyers' price offers and product preferences, adding more market and price information to the central repository, etc. In this technique, each request is individually handled using various available means such as a Simple Object Access Protocol (SOAP) based environment.
- The broadcast technique, market and price information is published to the public or some group of market actors not explicitly listed. This enables announcements of information such as general buyers' profiles and preferences, general market conditions, transport and logistics opportunities, etc. This technique uses public notice boards placed at market places, public repository (e.g. web site in this case), or again by aid of a software agent (for this case SOAP environment) to facilitate "polling" (see Boon *et al*., 2011) by specific market actors who may have the resources and skills. Polling options facilitate easy scheduling (Wierman *et al*., 2007) which is necessary for the problem domain.

Within the Communication Suite are the Interpretation and Selective Dissemination Services, which are fundamental in the overall studio environment. If executed properly, the conventional environment scanning for instance, may yield a constant and substantial both noise and vital signals of emerging market trends (Day and Schoemaker, 2004). This may lead to variations in the main input(s) for developing market and price alternatives and strategy (Luca and Atuahene-Gima, 2007). If market actors have to act on this information, it requires collective routines of transforming it into meaningful market intelligence that can enhance the market decision making process. During interpretation, market actors try to make a sense of the gathered market and price alternatives based on the available information. Hence, the primary role of the interpretation and selective dissemination services is to "assemble the myriad pieces of market and price information into meaningful mosaic" (Day and Schoemaker, 2004) that enhances farmers' decision making process and final decisions.

Figure 11 below represents the sequence of activity and guidelines flow within the Communication suite.

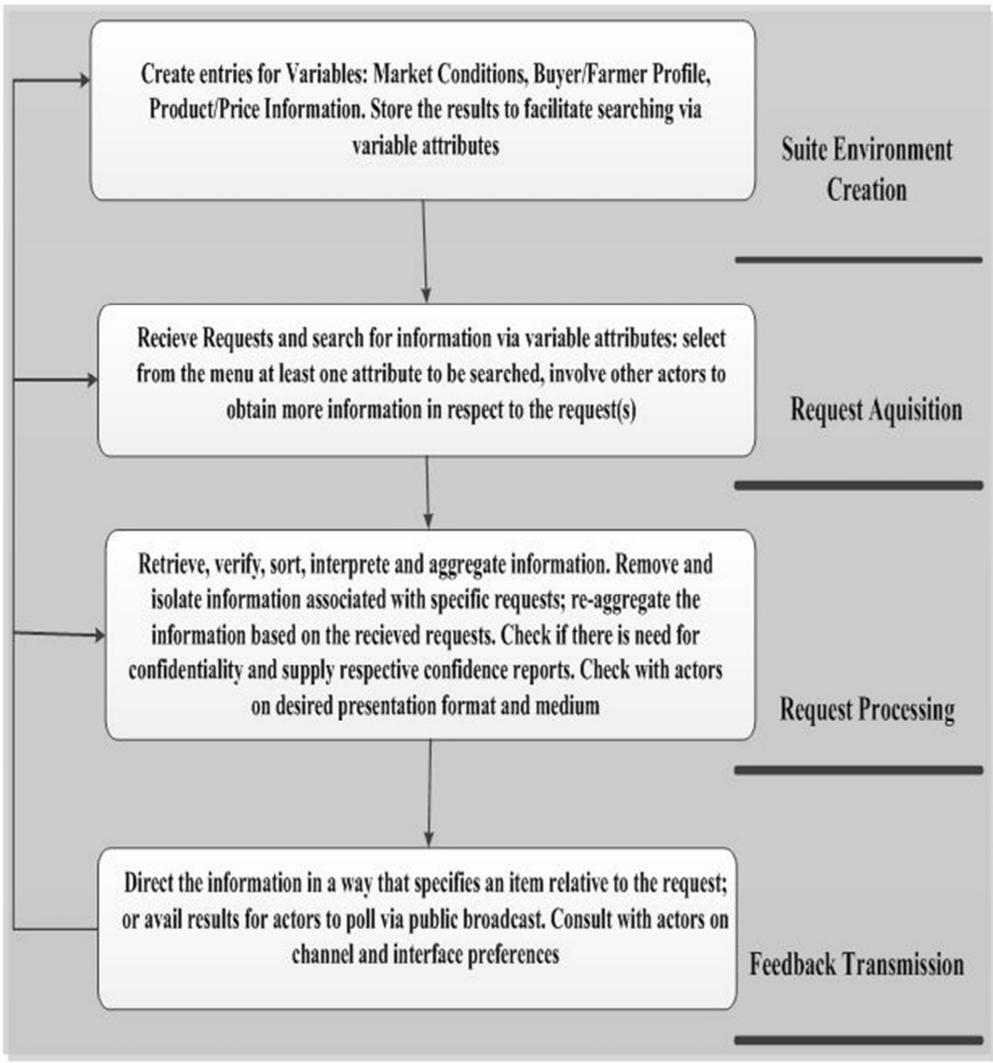


Figure 11: Communications Activity Process Guidelines and Sequence Diagram

FDES Recipes

In this study, recipes are intended to facilitate the means of market choice(s) and final decisions on product price agreements between farmer(s) and buyer(s). Hence, our focus is to use recipes to stimulate visual thinking and catalyze collaborative negotiations among market participants, and therefore, they are "domain specific" (Ejiri, 2012; Keen and Sol, 2008). In addition, the recipes act as vehicles for stimulating and capturing collaborative commitments among willing participants. We design recipes to stimulate and capture collaborative commitments among individual farmers, farmers and traders, and potentially among traders and traders. The recipes also provide insights to policy makers on how the farming communities engage on market and price decision making. These specific recipes were derived from literature review, interviews and supplemented by our own experience.

Specifically, recipes are used to address the general question of, *"How can market and price decisions of farmers in developing countries be enhanced?"* and they broadly:

- Facilitate identification and evaluation of market and price alternatives,
- Support the acquisition and access to tacit information,
- Identify and create awareness of transport and logistics opportunities,
- Support the determination and access to tacit price and product information,
- Facilitate communication between farmer-to-farmer, and farmer-to-buyer.

Table 7: Summary Descriptions of FDES Recipes

Table 7: Description of FDES Recipes *How can farmers' market decisions and decision making processes be enhanced?*	
FDES recipe	Recipe description
Facilitate identification and evaluation of market alternatives	How can decisions to initiate and carrying out market alternative evaluation process be enhanced? Market Identification Suite; Market Identification Services
	1.1 Ensure there is need and commitment to start a market search exercise 1.2 Ensure other key stakeholders are participating and are involved from the very beginning 1.3 Check for a soft copy of the evaluation criteria from doc downloads

	menu, else go to next step 1.4 Request for a hard copy of the criteria from the facilitator or colleague 1.5 Study the criteria and ensure there is consensus with other stakeholders 1.6 Provide feedback on any section of the criteria that needs changes and ensure there is consensus to the changes 1.7 Confirm that all the steps above have gained consensus 1.8 Adopt the Market Identification Suite a) From the Market Condition Suite generate a list of all potential market alternatives b) Go to 3 and perform the tasks indicated there, then return to the next steps below 1.9 Go to 2(a) and carry out instructions given, then return and proceed to the next steps below 1.10 Based on the evaluation criteria, evaluate all the market alternatives obtained 1.11 Generate consensus with other relevant actors 1.12 Decide on the market(s) alternative after interaction with the above tools and other relevant actors
Support the acquisition and access to tacit market information	How can farmers' decision son market choices be enhanced? Market Identification Suite; Market Identification Services
	2.1 Ensure the actors who need market information are known, including their needs 2.2 Ensure there is evidence of commitment from the actors to provide or use the needed information 2.3 Explore other potential secondary sources of the needed information 2.4 Ensure the information format to be used has been generated by consensus and known to all relevant actors 2.5 Make sure the format(s) adopted can be transmitted and received via all the available tools and media

	2.6 Put in place a template for collecting market information 2.7 Ensure there is guidance on how to request and submit information 2.8 Make sure information on market alternatives meets requirements a-i below a) Market name is clearly indicated b) The market location is indicated in kilometers, direction, sub-county, parish, and sub-parish where its located, including dates when it is operating c) the market ownership is spelt out (private or public) with telephone or email contact provided d) The accessibility of the market, the nature of the road and if there is any security precaution e) The taxation and dues details if any f) the products traded, their quality, quantity usual prices and the contacts of common product suppliers g) storage facilities, their owners' contacts (phone and email) and terms (rent in shillings, per day, per week, per month), and its level of security and reliability h) if transport is available to and from the market, owner details (phone and email), transport capacity and charges (per day, per tonnage, per kilometer) i) Ensure to consider any other market attribute that may arise 2.9 Adopt the Market Identification Suite and generate a list of potential market alternatives 2.10 Return to 1.10 and continue with instructions as given
	How can farmers' decisions on market choices be enhanced? Selective Dissemination Sub-Suite; Communication Suite:-

Support the acquisition and access to tacit market information	Communication Services 2.10 Check if there are unfilled and pending information requests 2.11 Determine whether the requests are from farmers or buyers or both 2.12 Check if there are market seller or buyer alternatives that can meet those pending requests perform a-b below a) If there is need for a thorough evaluation go to 1 above b) If the alternative match the requests by consensus, proceed with the next steps below 2.13 Initiate an SDI action from the SDI sub-suite of the Communications Suite 2.14 Ensure the target users will be in position to interpret the information, if yes proceed to the next step, else go to 5(b) below 2.15 Adopt either of the farmer or buyer profiles sub-suite in the Price Determination Suite 2.16 Adopt the Profiles sub-suite then Search and compare the requests for verification 2.17 Using the Alert services of the SDI Sub-Suite, generate the information for use 2.18 Evaluate the impact of the information and agree on potential improvements
Identify and create awareness of transport and logistics	How can decisions on selecting transport& logistics based on opportunities be enhanced? Transport & Logistics Sub-Suite; Market Identification Suite:- Market Identification Services 3.1 Explore on transport and other relevant logistics opportunities 3.2 Gain consent from the owners, and commitment that they will avail the facilities if needed

opportunities	3.3 Obtain their contacts (phone, email, physical location: sub-county, parish, sub-parish village) 3.4 Ensure if the facilities are shared, all the shareholders provide consent and commitment 3.5 Ensure area local authorities, LCI, contacts and knowledge is obtained 3.6 Ensure the facilities terms are clearly spelt out, and for transport the following must be indicated (costs per kilometer, per day, per week, per tonnage, fuel provision, driver's upkeep, third party insurance and original log book) 3.7 Decide which information to acquire and use 3.8 Adopt the Transport and Logistics sub-Suite from the Market Identification Services 3.9 Information acquired is stored in a repository for easy access by actors 3.10 Generate paper print copies of the information and display at the markets during market days 3.11 Distribute printed copies to participating actors
Support determination and access to tacit price and product information	How can price decisions be enhanced? Price Determination Suite; Price Determination Services
	4.1 Ensure there is a group of actors whose price decisions need to be enhanced 4.2 Ensure commitment from actors to provide product details and their prices a) Ensure product name is precisely indicated b) Ensure product availability is stated c) Ensure product quality and quantity is indicated d) Ensure product price, units of measure are indicated 4.3 Ensure commitment from buyers to provide the range of products they want and their prices, quantities and quality needed 4.4 Ensure all participants profiles are archived, and these should include a) Individual farmer's name, contacts (phone, email, sub-county, parish, sub-parish, village, or any geographical identifying feature)

	b) Individual buyer's name, contacts (phone, email, sub-county, parish, sub-parish, village, or any geographical identifying feature) 4.5 Go to 5 and adopt the Communication Suite
Facilitate direct communication between farmer-to-farmers, and farmer-to-buyer	How can farmer-to-farmer, farmer-to-buyer linkages be enhanced? Communication Suite; Communication Services
	5.1 Make sure there is need, commitment and justification to initiate linkage(s) 5.2 Then from screen, adopt Profile Sub-Suite, From Price Determination Suite 5.3 Check if there is provision for farmer profiles 5.4 Check if there is provision for buyer profiles 5.5 Reflect on the type of linkage to be enhanced 5.6 Check the type of contact option indicated 5.6.1 If its telephone, ensure to confirm if its landline or mobile 5.6.2 If its mobile, ensure to use sms first for its cost effective and more reliable 5.6.3 If its landline, consider 5.5.4 and 5.5.5 below otherwise establish the linkage 5.6.4 If physical address, go to 2 above 5.6.5 If is Email, check whether email services can be accessed by the recipient 5.7 Involve other market actors whenever as much as possible 5.8 Seek for help from the facilitator 5.9 Ones sure of all the above steps, establish the linkage
	How can farmer-to-farmer, farmer-to-buyer linkage be enhanced?

Facilitate direct communication between farmer-to-farmer, and farmer-to-buyer	Interpretation Sub-Suite; Communication Suite:- Communication Services
	5.9 Check if there is some information that requires interpretation, conversion or explanation 5.10 Adopt the Interpretation sub-suite of the communication suite 5.11 Seek the help of the facilitator and other actors 5.12 Consult an outsider who may be able to carry out the needed interpretation 5.13 Archive all the interpretation history 5.14 Adopt the Interpretation Sub-Suite and deploy actions based on consensus

4.6 Summary

In this chapter, we have particularly presented our way of thinking, way of governance, and way of working and modeling. Key activities, upon which services were identified, have been presented including discussions on suites and domain recipes. Generally, we may look upon FDES as a collaborative negotiation support system for farmers engaged in making market identification and product price determination decisions. Hence, in addition to group decision support systems, insights on negotiation support systems (sometimes-called negotiation software agents) as in Maes *et al.* (1999) and Kersten and Lo (2001) were found useful. The ways of framework is presented based on three aspects of people, technology and process, which are derived from decision enhancement services of Keen and Sol (2008).

The people aspect facilitates the definition of actor roles, activities and tasks performed during market and price decision making arenas. The technology aspect deals with enabling technological tools, services and infrastructures such as the internet, telecommunications networks etc. While the process aspect is used to define and scope the farmers' market and price decision making process. UML activity diagrams and notations have been used to represent the farmers' market and price decision making process. Three specific suites comprising of the Market Identification suite, Price Determination Suite, and the Communication Suite have been derived for the studio.

In particular, these studio suites are designed to enhance decision making via various services such as Market Identification Service, Price Determination Service and the Communication Services. Each of the services comprise a number of other sub-services such as the Market Details Services, Buyers and Farmers' Profiles Services, and the Transport and Logistics Services among others. All these services are described in detail in chapter 5 of this thesis.

FDES Prototype and Implementation

This chapter is concerned with discussions on FDES prototyping and implementation. In particular, we describe the studio prototype strategies that were employed, hardware and software requirements, and studio implementation including implementation constraints and considerations. The studio architecture, specific hardware and software specifications, studio description, and verification are discussed in this chapter. Furthermore, we use the prototype to test if we are able to implement pilot services according to the scenarios from the farmers' market and price decision arenas.

5.1 Introductory Overview

Design science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation (an implemented prototype system) (Hevner *et al*., 2004). In this study, a prototype of a Farmers' Decision Enhancement Studio is developed and implemented. The overall purpose of the studio is to provide a collaborative market-based decision enhancement service for farmers and other potential market participants. In this section, relevant insights are cited to gain an understanding in prototyping and implementing a studio in real life environments. First, we note that what differentiates service prototypes with other prototypes is the attention paid to the external factors that could influence with the service delivery, including factors that have a great impact on user experience (Diana *et al.*, 2009). Service prototyping focuses on the users' emotional impact (Rae, 2007); it is a collaborative, explorative, iterative and open-ended activity, which can be conducted in many ways such as scenario building and role-playing (Miettinen, 2009).

Specifically, we were able to exploit and learn from three collaboratively facilitated decision enhancement scenarios involving use of the formal meeting room as in Keen and Sol (2008); 'casual cocktails' (Hamzah and Ismail, 2007) and "mobile meetings" (Bravo and Garcia, 2006; Meyers *et al.*, 2009). Other than prototyping, service system implementation has equally been described (see Van de Kar, 2004; Mulira, 2007; Blomkvist and Holmlid, 2010). Similarly, insights from the prototyping approach of farming systems (Sterk *et al*., 2007) proved very useful. Using these (farming systems prototyping) insights, keen interest was put on the elaboration of theoretical underpinnings, assessment of the verification criteria, identification of constraints, and reconciliation with farmers' market and price goals.

5.2 Requirements

First we note that requirements can evolve via a number of steps such as those recommended by Nuseibeh and Easterbrook (2000). In this study, these steps have involved identification of key actors and soliciting their needs; building abstract descriptions based on these needs; providing feedback; and finally a set of usable requirements are generated. We emphasize "usable" because they do not constitute the final requirements given the difficulty in generating actual requirements in the problem domain. Requirements at this stage of the studio development life cycle describe what the studio should do, constraints to the studio behavior, including presenting the studio operational perspective. We use natural language (Ambriola and Gervasi, 2003; Richards and Bottger, 2003; Francu and Hnetynka, 2009; Casamayor *et al*., 2012) to describe requirements as explicitly as possible. The requirements are discussed in three parts comprising of general requirements, hardware requirements and operational requirements. In addition, the focus is on farmers' market and price decision enhancement requirements as outlined in the previous chapters.

General Requirements

In order to enable market actors achieve their goals, the studio has to fulfill a number of general requirements such as information integration, frequency of actors' activities and ensuring availability of services with minimal limiting factors.

Information Integration has many connotations. For this study, we consider the views of Bernstein and Haas (2008). Information integration should form one of the core functions of the studio since the market is diverse, with many actors and highly dynamic. The market and/or price information needed originates from several sources (tacit, secondary or even from the web) and terminates at different points, all of which vary by actor characteristics, technology and decision process. An example of the strategy used to ensure information integration involves effective management of user feedback (Jeffrey *et al.*, 2008), which the studio should enhance.

Frequency of actors' activities, most farmers' market activities are either of short term or long duration i.e. activities are frequently or less frequently performed over time, resulting in on-and-off decision processes. The studio should support both processes, for instance the studio should be adapted to all cropping and market seasons.

The studio is open source, modification, deleting and updating information held within the studio environment should evolve more-or-less based on the Wikipedia model (Leuf and Cunningham, 2001) and as resources permit.

Hardware Requirements

Designing service systems is constraint with an environment of evolving hardware and other enabling technologies. In such an evolving environment, the system under development runs the risk of being doomed to failure even before it has been launched. Jain and Ramdas (2005) have noted this similar view on their study of product market positioning. In this study, we consider hardware to include the infrastructure that describes the value of configuration necessary for prototyping and potentially delivering FDES. It relates to the available capabilities in hardware and technology resources needed for delivering the studio value proposition. It also includes the communication and network activity configuration and the technology at the disposal of market actors to collaboratively utilize studio services.

Two major issues relating to scanning available and usable technologies; and making an overview of functional and technological decisions have to be considered. The users' technological context has to be taken into account, and this calls for a thorough investigation of available technologies, which are reliable and robust enough to function as farmers' market decision enhancement enablers (refer to Chapter 2 and 3). Moreover, there is the Internet that holds content, servers, content platforms, gateways, networks and clients (Natsuno, 2003). Based on discussions from section 2.5, insights are gained regarding which functionalities and technologies are feasible for implementation of the studio.

Operational Requirements

Operational requirements describe how FDES is actually running and or being operated by users. They include:

- The studio should enable acquisition (from among market actors) information on market details and products prices, which may consist of;
    - Market details (location, name, contact of ownership, product preference, market dues, means of reaching a specific market, days and time of operation, etc.); transport and other logistic opportunities (owner(s) of transport means, contacts, location, capacity in tones, costs, storage opportunities, credit opportunities, sponsorships, etc.),

  - Buyers and famers' profiles (name, contact details, product offerings (type and quantity) and product details and their prices),
- The studio should enable receipt and delivery of information requests and feedback respectively via appropriate and accessible media,
- The studio should facilitate sorting of information based on user defined attribute(s), and if the defined attribute is not yet included, allow it to be included by respective users,
- Users can log into the web-based option of the studio, carry out search, select information items from drop down menus or browse through information items. Information items include for instance buyer: names, product preference, price offer, location, phone contact, email contact, etc.,
- The main agenda for the participants concerns selling of their products, and this agenda is implemented mainly via sms, web based and mobile phone call-based negotiations. Hence, the studio should enable the relevant negotiation interface for market participants using appropriate and available technology. The studio should be usable in the current environment and change gradually as circumstances improve,
- In particular users should among others:
  - Create and edit milestones, tasks, negotiations or documents,
  - Track time for tasks and generate reports,
  - Contact the facilitator via a contact form provided in their interface,

Prototype and Implementation Considerations

Two issues needed to be taken care of in the studio prototyping and implementation road map. These consisted of the capabilities for real-time communication among actors; information repository hosting and administration**.**

On real-time information request and feedback considerations, we note the traditional view of a group support system whereby each user has a copy of the software on their personal computer, which communicates with the other users' copies over the network (typically a LAN). This often occurred in synchronous mode. Similarly, modern communication technologies, such as instant messaging (IMs) and mobile phones, allow for immediate, real time communication (Quan-Haase *et al*., 2005) and they support both formal and informal communications (Handel and Herbsleb, 2002; Isaacs *et al.*, 2002; Quan-Haase *et al.*, 2005) which are the major characteristics of farmers' market and price decision making activities.

While on information repository considerations, we note that for effective decision enhancement services, organizations require the development of an information repository to improve their collaboration and service offering with stakeholders (Okharedia, 2007). Information repository plays an important role in the business process of organizations by integrating organizational information from various sources into a single and consistent knowledge base that supports analysis and decision making (Okharedia, 2007; Keen and Sol, 2008). For this study, an information repository is the environment that provides mechanisms facilitating information submission, access and sharing among market participants.

5.3 Studio Architecture

The studio architecture proposed is based on insights from Service Oriented Architecture (SOA) principles (Kamoun, 2007; Amiyo, 2012). The integration of SOA principles and technology enables the building of applications with unprecedented levels of flexibility, agility and simplification, as well as leveraging existing environments (Kamoun, 2007; Keen and Sol, 2008). Based on the SOA principles, the studio allows for cross-platform implementation, loose coupling and set up of well-defined interfaces.

Figure 12 below (see next page) describes the studio architecture. It is the framework and set of tools for ensuring that all studio elements work together with no programming required (Keen and Sol, 2008) and are cross-platform (Kamoun, 2007). In general, the studio architecture consists of: 1) the users (or actors), 2) the facilitator, 3) users interface (which is either web-based or mobile device based), 4) search engine and/or mobile device application (or gateway), 5) studio administration interface, and 6) the remote integrating repository. Decisions have to be made regarding the choice, set up and installation of platforms on which to run the studio suites and services. These range from client side, device (e.g. mobile phones), web services and hardware platforms.

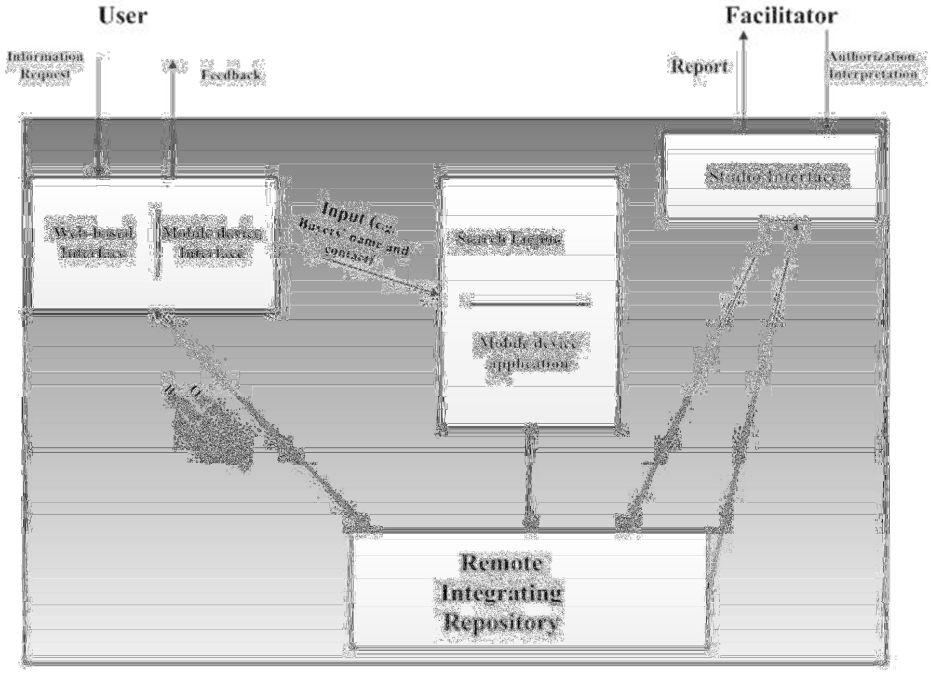


Figure 12: FDES Architecture

Users perform key roles comprising of primary information provision, initiate and submit information requests, and finally obtain feedback. In performing these functions, users are enhanced by an interactive web-based or mobile device-based interface, and hence they generate inputs via either a search engine or mobile device application (or gateway). The facilitator's function is concerned with ensuring that the received information is integrated and is in a remote repository for users to retrieve. The facilitator also administers the overall studio performance as well as ensuring interpretation of the information to match users' needs and cognitive levels. The repository acts as an information management tier and holds suite structures, market and price information, and request and feedback feeds. The search engine and mobile application interfaces enhance the transmission of information requests and feedback.

5.4 Hardware and Software Specifications

Hardware Specifications

On the server side, there should be a wireless or cable connection on LAN. The studio environment can be run on a desktop computer (with a minimum of 1GB of RAM, 80 or above GB of hard disk capacity and 2 GHz of processing speed. This can be actualized using a router or ADSL modem (any can work when connected on a LAN (local area network).

Similarly, on client side there is need for a wireless or cable connection on LAN. The clients can access the studio services on a simple desktop computer with a minimum of 128 MB of RAM, 40 or above GB of hard disk capacity and 1GHz of processing speed. If on a laptop computer, the same minimum requirements are desirable (i.e. 128 MB of RAM capacity, 40 or above GB of hard disk capacity and 1GHz Processing speed.

If on a mobile phone, the studio services can be accessed via an opera mini browser or an android technology phone with wireless connection “wifi”.

Software Specifications

An open source web server environment consisting of Wamp5 1.7.1 is required on the server side to run the studio and its services. The studio suites and services were designed using a number of programming languages, including HTML, PHP, AJAX, CSS, SQL and JAVASCRIPT. HTM was used for designing interfaces like putting images, input forms for capturing data; PHP was used for data manipulation i.e. it handles data that is being captured from the input forms. It validates data and uses SQL to generate database for storage and retrieval purposes. AJAX was used for refreshing the page automatically as users use the search form while instantly typing search keywords, enabling users to automatically pull data from the database without refreshing the entire web page. This is mainly used to enhance farmers’ market identification and price determination tasks, since they are not capable of performing complex searches. Specifically, users do not need to press the enter key [Return Key] after typing search phrases.

Cascading Style Sheet (CSS) was used for decorating the link by giving different colors depending on the processes like visited pages. We used SQL to enhance querying the database either by posting in, selecting, deleting or updating data from and to the database. The database is developed based on the ontology defined in section 5.5.1. All search engines are using SQL command to fetch search results

from the database. Finally, JAVASCRIPT was used for triggering the print command to print the page needed as a hard copy by the users.

5.5 Description of the Studio Prototype

The purpose of this section is to present the studio description in order for users and the research community to understand its fundamental structure and functioning. We specifically describe the key word construction and the implementation of the various suites and services. Figure 13 shows the studio web-based main page, which is available at http://www.fdesug.info.

Figure 13: Web-based Main Page of FDES

Information Representation and Keyword Construction

We use both UML sequence diagrams to construct and describe desired keywords as well as partition information used in the studio repository. This results in an ontology-based information description, where ontology describes explicitly the specification of the domain information needed for farmers' market and price decision enhancement services. We use an ontology to express an abstract and simplified view of the world (Gruber, 1995), which in this case is an information model used to represent sets of concepts and their relationships within the domain. As indicated in Figure 14 below,

ontology facilitates the exchange and partitioning of information representation into a generic information model description. Generally, ontology is a structured framework of organizing information and has been applied in various domains such as artificial intelligence (Gruber, 1995), semantic web (Devedzic, 2004) and software engineering (Villela *et al*., 2005; Henderson-Sellers, 2011).

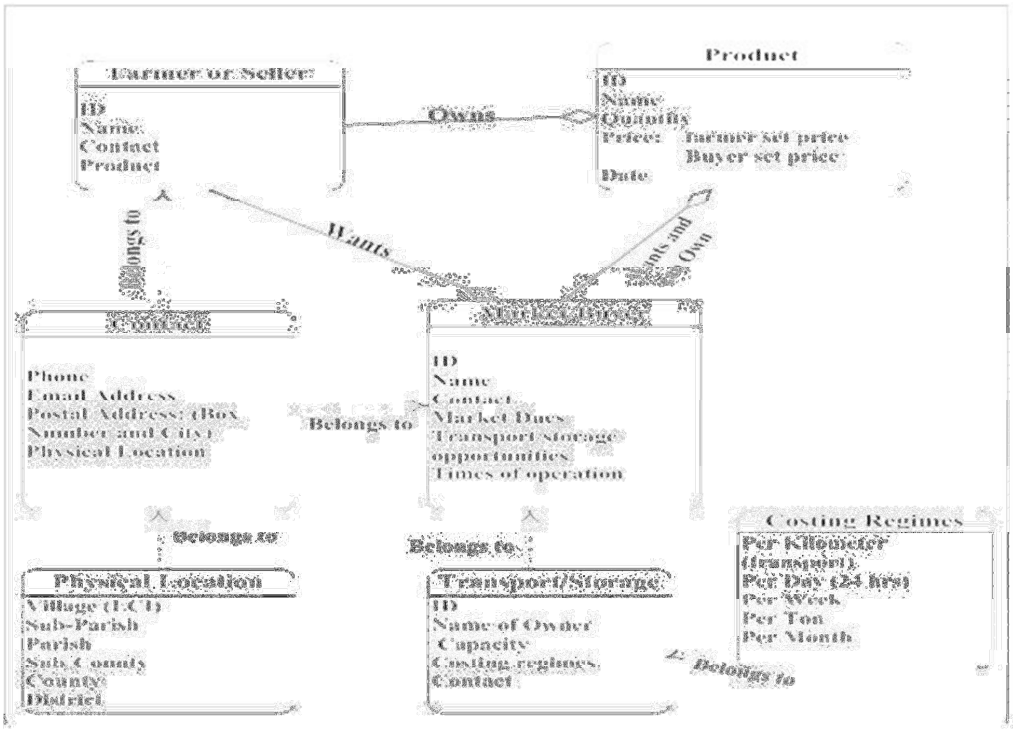


Figure 14: Studio Information Model Description

Market Identification Suite

FDES Market Identification Suite is a set of services that enables farmers and other actors efficiently manage information regarding to market details, transport and other logistic opportunities. It consists of the Market Details Information, Transport, and Logistics Opportunities, as shown in Figure 15 below and the web-based option is available at http://www.fdesug.info/market.php.

Figure 15: Market Identification Suite of FDES

In this section, we describe the implementation of this suite, suite navigation scripts and guides. The key features and benefits of the suite include:

i) Market Details Information via the web based interface

The feature (or sub-suite) enables users to send and /or retrieve, and examine information on market alternatives based on user's defined criteria. This is enabled via the integrated information repository, where each market alternative is assigned an identifier (ID) followed by details of its respective attributes as in Figure 14. The sub-suite allows users to submit market details information; search for alternative markets via the web interface; submit or request market details information via voice calls or by sms; browses the information repository by either drop down list, or just selecting list of items; access market details information by sub-county and /or village name. Refer to Appendix 4 (A (i)) forfurther details on how to use the suite.

ii) Market Details Information- SMS Interface

As indicated in (i) above, the service provides an interface linking users with simple basic phones (i.e. non-smart phones) via sms messages and voice calls. Users with smart phones can access the web-based interface from any location with internet access, and follow the steps similar to those in (i) above. Users can call the given numbers and talk to service facilitator(s), or follow the sequence below to submit information request via sms or voice calls. Sending sms from the web interface is performed via a local

machine using Ozekisms server gateway. Ozekisms server is the sms gateway that allows sending and receiving sms on desktop and laptop computers. Ozekisms server gateway is used to store sms in two ways:

i) the gateway has its own database where all the in-coming or outgoing sms can be stored, and it works well when using an in-built form for sending sms.
ii) the gateway allows data to be stored on external database software like Microsoft access, MYSQL, MSSQL, oracle and many other database software. For this study, we choose to use Microsoft access to store the data (i.e. sms) which is outgoing to specified users.

Refer to Appendix 4 (A (ii)) for additional details on how to use the service.

iii) Information on Transport and Other Logistic Opportunities

Transport and related logistics play a key role in enhancing accessibility to agricultural product markets (Robbins *et al*., 2004). Omole *et al.* (2012) find transport to directly affect market patronage of farm products. Therefore, providing access to information on transport and other logistics opportunities for farmers enhances farmers' agility in accessing market(s). The purpose of the Transport and Other Logistics sub-suite of the studio is to collect and provide a one stop web-based portal for information on transport and other logistics opportunities. The common means of transport available in the study areas is privately owned and include lorries, omnibuses, buses, pick-ups, motor cycles (popularly known as "bodabodas") and bicycles. The sub-suite is implemented using a web-based searchable MySQL database, with an option for sms alerts and information submission by providers.

Via this sub-suite, (which is available at http://www.fdesug.info/transports.php) users can submit and /or obtain information on transport and other logistics details such as the name and contacts of the transport owner, transport capacity, destinations, transport costing regimes, transport availability status, etc. Secondly, users can angange interactively with transport and input dealers until consensus on a particular decision outcome is reached. Other logistics information consists of credit and input opportunities, skills development opportunities, and product receipting and value addition. This may also enhance farmers' decisions on sharing transport costs by pooling their products together, in doing so, the transaction costs upon each individual actor are lowered (see for example Robbins *et al*., 2004). Refer to Appendix 4 (A (iii)) on details of how to use the transport and other logistics services. Acknowledgement is sent automatically (via sms or email) back to participants confirming receipts of information submission and requests.

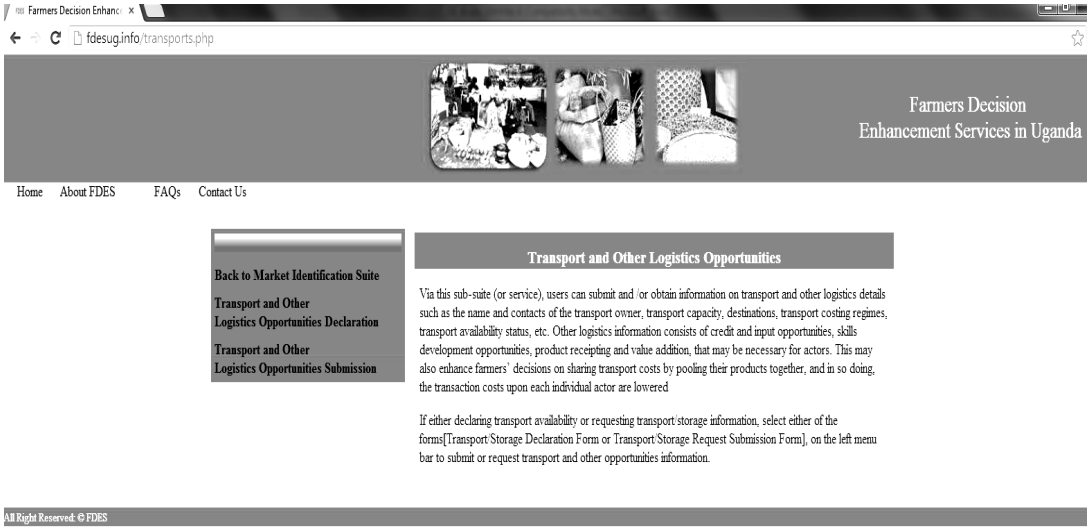


Figure 16: Transport and Other Logistics Opportunities Management Interface of FDES

Through the market identification services, the studio enhances farmers' access to markets by providing trading platforms and facilitating links between commodity exchanges between farmers and traders. Secondly, farmers are able to gain interactive access to buyers, input dealers and fellow farmers.

Price Determination Suite

The aim of this section is to describe the implementation of the Price Determination suite, provide screen shots, suite navigation scripts and guidelines. As indicated in the design, this suite is concerned with enhancing farmers' market decisions relating to price determination and discovery. Hence, the functional purpose of the suite is to provide access to price information, which participants can use for benchmarking and guiding pricing strategy decisions. Farmers are enabled to announce their products and prices, while either a buyer can also announce his/her product preferences and price offers via the web based or phone based interface. It should be noted that the suite does not provide computational or price analysis functions, as this was outside the scope of this study.

The suite offers two services of product/price information and buyers' and /or farmers' profiles indicated in Figure 17 below, and may be accessed at http://www.fdesug.info/price.php.

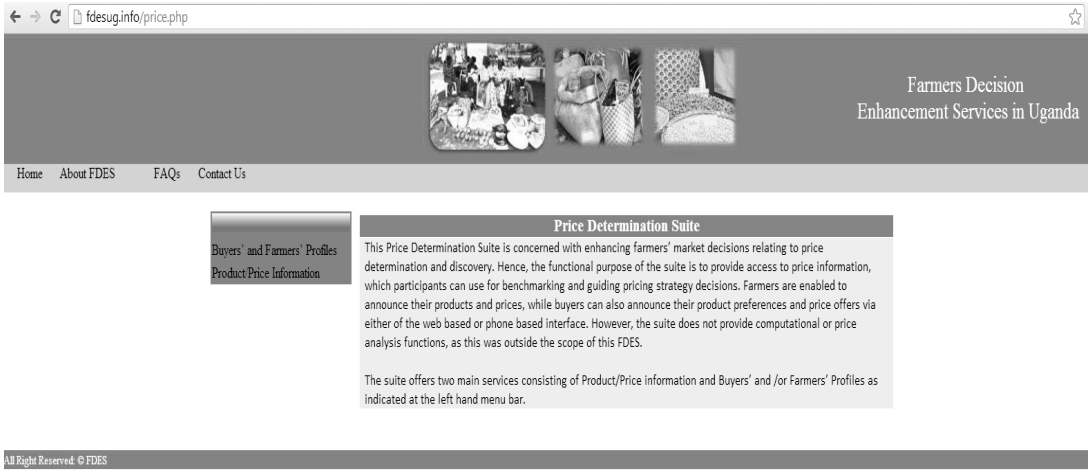


Figure 17: Price Determination Suite of FDES

i) Product/Price Information Services

Within the product/price services, farmers can submit information regarding products and their prices, query the service to determine commonly traded products and competition, including querying the service to access prices announced by buyers. On the other hand, buyers query the service to identify available products to buy, announce their product preferences and prices and determine the level of demand for a given product by looking at the frequency of purchase and availability. Refer to Appendix 4 (B (i)) for details on how to use product/price information services.

ii) Buyers' and Farmers' Profiles

Profiles represent models of farmers' and buyers details, preferences and sometimes habits, and similar to what is discussed by Godoy and Amandi (2006). This sub-menu (or service) enhances farmers' direct contact with buyers by presenting information on farmers' and buyers' details such as farmers' IDs, names, contacts, etc; and buyers' contacts, names, products preferences among others. The information is maintained in a MySQL database that is queried via keyword containing buyers' or farmers' names. It can be used mainly when the name of the farmer or buyer is known, or through random browsing to identify potential trading contacts.

Secondly, during SDI services, the profiles are extracted and used on one hand for alerting farmers on potential buyers; while on the other hand buyers are also alerted on product availability and prices. This is achieved either via the web interface or via mobile interface using a GSM modem connected to the

computer. Mainly via stereotyping (Kuflik *et al.*, 2003; Godoy and Amandi, 2006), farmers and buyers provide valuable information about themselves as they interact with various studio services. In addition, profiles are built based on users shared activities, experience and domain knowledge by the facilitator. The profiles' information is generated using a template form via the web interface or by sms via a GSM modem connected to the computer. Refer to Appendix 4 (B (ii) for details on how to use the profile services.

Figure 18 below illustrates part of the buyers' profile submission form, which may be accessed at http://www.fdesug.info/buyer%20form.php.

Figure 18: Buyers' Profiles Submission Form of FDES

Communication Suite

In this section, we describe the implementation of the communication suite; provide screen shot illustration, suite navigation scripts and guidelines. The essence of the communication suite is to offer communication services between farmers, farmers and buyers and farmers with the facilitator. This is done via information requests, feedback, SDI and interpretation services. These services are represented by accessible template forms, which are filled and submitted by users. The facilitator uses the feedback template forms to transmit feedback to users either via the web or sms. Users can access the template

forms by selecting the relevant form from the Communication menu of the Communication Suite, or as linked to other services of the studio interfaces. Users can also access part of the communication services via the contacts menu of the main studio interface.

- Information request submission enables farmers to send market information requests to the service facilitator and/or directly to the buyers. The users fill template forms with the required details such as their names, product details and prices, contacts etc. Farmers can also suggest the buyer(s) to whom the information request is directed from the buyers' profiles,
- Feedback management allows the facilitator; farmers and buyers transmit feedback based on information requests submitted. This is achieved by sending the required information to the respective user via either email or sms, or posted on the feedback list. The feedback list is a collection of market information requests from users (either farmers or buyers) with respective answers, similar to FAQs,
- SDI and interpretation services enable the facilitator generate alerts based on identified market information for particular target users. The interpretation service is carried out manually by the facilitator and involves language matching, information targeting, simplifying some technicalities with information among others, before delivering to the target users.

Figure 19 below represents the main page of the communication suite and it is available at http://www.fdesug.info/communication%20suite.php.

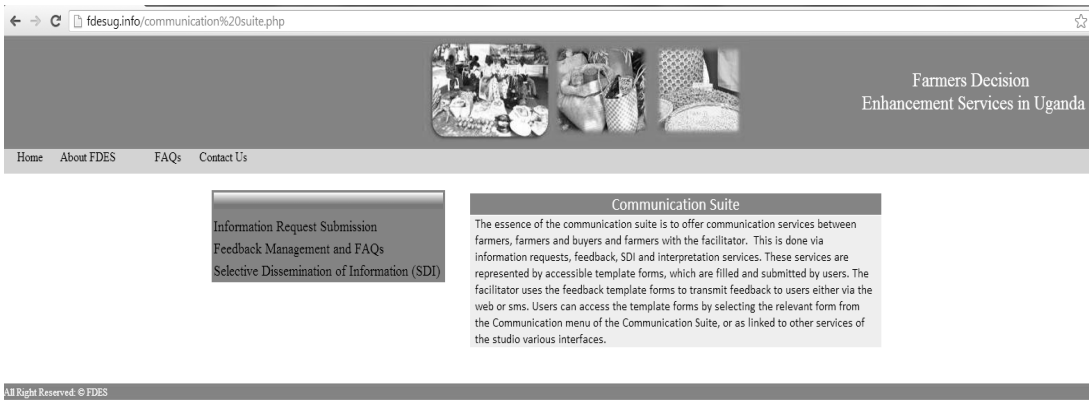


Figure 19: Communication Suite Main Page of FDES

The studio further offers alert services to individual or group of interested farmers and/ or buyers. This service is extended via the alert submission forms of the Selective Information Dissemination sub-suite of the Communication Suite. Figure 20 below represents part of sms and email alert web-based interface of the Communication Suite, which may be accessed at http://www.fdesug.info/Selective%20Dissemination%20of%20Information%20form.php.

Figure 20: Sms and email web-based alert service of FDES

In conclusion, farmers use the studio for enhancing various decisions, such as:

- Announcing products and seeking transport, organizing transport from the farms to the markets or to buyers,
- Contacting market centers, traders, dealers and check prices and stocks of crops before setting deals with middlemen/agents or deciding to travel, or to obtain better opportunities, and
- Reaching agreement on product prices and quantities.

5.6 Verification of the FDES

The verification of the studio prototype formed an important task during implementation. This was mainly to ensure that the studio is built right and it complies with requirements and design (Bahill and Henderson, 2004). Though not well documented, systems verification test acts as apparatus for systems reliability improvement and assurance (Cai *et al*., 2008). However, there is no standard testing method

nor technique that can be used or applied, which has led to various empirical attempts (see for example Cai, 2006; Henningsson and Wohlin, 2004; Briand *et al*., 2001). From Boehm's (1981) perspective, this section is concerned with verifying the studio to make sure it behaves in the desired way, and whether it is the right one depicted by users' requirements and the design.

The verification aimed at checking integration of the suites and services of the studio via a sandwich strategy. This level of testing formed an initial preparation exercise and aimed at decomposing the suites for implementation.

Table 8: The studio verification process

Functionalities for Verification	Procedure of verification
Home Page All other suites are accessible from the home page and are linked	• Select and enter information for the Homepage, • Change the layout of the Homepage information, verify that the changes can be seen on the Homepage, and sub-pages, • Make some information mandatory on the Homepage, login as a user and attempt to change or disable it, • Sign up for Homepage e-mail subscription feature, verify that you can send and receive the contents in the email, • Login as a user, verify that you can view Homepage information set up by the administrator.
Market Identification Suite Enable creation of market identification process, enter and retrieve information on markets,	• Verify the it is possible to add in market details information via the form, • Verify that users can also add market details information, • Check if the drop down and selection market alternatives' menus are working, • Check whether a user can submit information request and obtain feedback on market details information via sms.
Price Determination Suite Enable creation of farmers' and buyers' profiles, enter	• Verify that it is possible to create users and that users can login and create their profiles, • Verify that users can access the service and its menu steps

and retrieve product and price information,	consisting of subscription, registration process, user types (farmer, buyer facilitator), and approval option Submit, • Verify that products details and prices can be created and submitted (entered).
Communication Suite Enable communication process, Linking farmers and buyers, track information requests, enable feedback transmission, enable FAQs and suggestions	• Verify information request functionality is working, a) Create an information request, verify files can be attached including images, b) Close the information request, verify that it can be re-opened, c) Set up information request default duration, verify that the information request is off immediately after the default duration, • Verify that users can access the template forms for submitting information, a) Create a template form and fill, verify that all the needed information is captured, b) Create template form as user, verify that it can be submitted and information received, • Login as a user, verify that you can edit Information Request Quick Link; Information Requests sent and saved; and Quick links bin, • Verify that basic and advanced search options are working.

The verification methodology involved target group orientation, diagnosis (gaining insights into group capabilities, needs and constraints), and actual verification experiments involving use of the studio services. Farmers' individual capacities comprises of the farm resources, farm business level, farming system practiced, the family, the farm life cycle (farmers' age) farmer skills and knowledge (education) – and how these factors constrain or enable opportunities. Further to this, the verification exercise involved both the web-based and sms-based interfaces as proposed in the studio architecture. As an example, participants recommended that the "email-based option of the web-based interface is made

optional", since many of them did not have access to internet. The verification exercise involved 5 farmers' association executives, 30 students of computer science from Gulu University and expert feedback.

During the verification exercise, users were able to access the studio main page including other suites (i.e. the Market Identification Suite, Price Determination Suite and Communication Suite). In particular, users were able to perform all activities identified for verification. There was however, a strong need for facilitation to guide users on how to go about accessing and using the various services of the studio suites. The verification also involved applying the recipes outlined in section 4.5. Users noted an exemption while verifying log in, i.e. users were not required to enter log in details since the studio is designed as open source.

During verification, participants were able to perform a number of activities such as entering their names, product details and send to the sms gateway server. Users were able to create information requests, access information requests template forms, fill the sms-interface forms and submit via their mobile phones. Similarly, the studio is designed to allow for continual interaction between farmers, farmers and traders including other market participants. This interaction should allow for a consensus on specific market and price decisions among actors. This was noticed during the verification to be possible since participants were able to direct messages among themselves instantly and obtain feedback.

Particularly, the verification results indicate that farmers who need to mitigate on their market and price decision making challenges can benefit from the studio. For instance, participants were able to access the studio services, use them and contribute suggestions for improvements.

Generally, a few challenges were faced during the implementation exercise of the studio. These mainly included lack of hardware resources, limited internet connectivity, generating a unifying and representative ontology among others. The participants' level of ICT literacy equally had a considerable bearing on the verification process. Most of the participants had little knowledge of using the internet and desktop computers. However, participants were comfortable accessing the studio services via their mobile phones. During the verification exercise, it was evident that for the studio implementation to succeed, participants must be committed. For this commitment to be possible, the farmers should be active participants in the various stages of the studio development, though ensuring farmers' commitment was always a challenge.

5.7 Summary

In this chapter, we have presented the studio prototyping and implementation road map covering requirements, development and prototyping considerations, studio description and verification. The prototyping and implementation exercise took keen consideration of external factors, users' emotional impact and experiences and reliance on available resources. As an open-ended activity, the exercise was performed iteratively involving both scenario building and role-playing. Role-playing was particularly employed among Gulu University students of ICT and Computer Science, where students acted as farmers, traders and facilitators.

The studio whose implementation is described in this chapter is primarily proposed to bridge the farmers' market and price decision making gaps through combining a number of strategies. Some of these strategies include creating a platform where market actors can share codified, systematic knowledge and information, and at the sametime collaborate creatively in the market place. The studio, through its targeted services, offers market actors the opportunity to participate in discussions, present and challenge ideas and reaching consensus on outstanding issues. Similarly, the verification results confirmed the applicability of the studio services, interface and environment to requirements.

6 Evaluations of FDES

The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods. The evaluation of the artefact provides feedback information and a better understanding of the problem in order to improve both the quality of the product and the design process. Hence, in this chapter, we report on the evaluation exercise involving farmers from the study districts of Gulu and Soroti in Uganda. The chapter presents discussions on evaluation overview and planning, construction of the evaluation instruments and their administration and the results of the FDES usefulness, usability and usage evaluation. Evaluation results are presented in two parts of results' analysis and discussions and interpretation.

6.1 Evaluation Overview and Planning

March and Smith (1995) emphasize evaluation as one of the two activities in design science: "build and evaluate". Hevner *et al*. (2004) recommend for researchers to rigorously evaluate the design artefact. While Venable (2006) classifies design science research evaluation approaches into two primary forms namely: "artificial and naturalistic"; where naturalistic evaluation explores the performance of an artefact in its real setting.

At this stage of FDES realization, the studio was presented to selected farmers for actual use and assessment. Specifically, for FDES, evaluation is carried out based on the criteria advanced by Keen and Sol (2008) and involving the three constructs of usefulness, usability and usage. Additional insights are gained from Davis (1989) in which we consider usefulness as the degree to which an individual market participant believes in using the studio as a whole enhanced his/her behavior towards achieving a given market identification, choice and product pricing decision. This also includes the ability for users to easily learn to use the studio in achieving effective decision outcomes. Consequently, usefulness and ease of use construct combine to enable an improved understanding of the studio's usage behavior of users (Venkatesh, 2000; Venkatesh *et al*., 2003). Hence, perceived ease of use is the construct tied to an individual's assessment of the effort involved in the process of using the studio.

On the other hand, usability has mainly been defined to refer to the user interface (Venkatesh *et al.*, 2003). It is the environment that the farmers and other market actors use to conduct communication, information requests, feedback, information search and interactions. As outlined in section 5.5, primary studio beneficiaries (farmers and traders) submit product, market and price details interactively via pre-defined interfaces consisting of information capture forms. Usability also extends to the practical

applicability of information generated by the studio services via its suites. Hence, usability has to deal with user context in respect of layout, terminology and navigation. The studio usability had to be taken into consideration, since from Venkatesh *et al.* (2003), usability forms the biggest source of user frustrations in technology adoption.

Finally, our additional understanding of FDES usage was built on DeLone and McLean (1992) and Taylor and Todd (1995) discussions on information systems usage and technology adoption respectively. In this case, usage can be considered as a surrogate measure for the studio's value proposition and successful implementation and includes constructs such as documentation, training/guidance, help and support etc. In other words the studio supports the market participants' tasks within their cognitive perspectives and abilities. In practice, the studio usage impact can be realized over a given time.

Based on Keen and Sol (2008) 3Us of decision enhancement, the studio is useful if it adds value to the farmers' market identification and price determination decisions. Secondly, it is perceived usable by users as defined by their ease of interaction with the studio services; and the usage is realized by the actual application of the studio in enhancing the farmers' market identification and price determination decisions. This chapter, therefore, describes the evaluation exercise and provides its results and it is structured into evaluation planning, implementation and results, with a brief ending summary on key lessons learnt during evaluation.

Evaluation Planning

Evaluation planning formed a critical step of FDES evaluation in that it did not only re-specify the studio perspective, but helped us define evaluation boundaries, stakeholders and their roles, required resources, and strategies to be used. The planning steps involved a number of tasks namely:

- Creating shared understanding of expectations and assess the capacity needed,
- Re-assessing stakeholders (i.e. identify evaluation team and define their roles), run introductory presentations, review the plan, define boundary and scope through further synthesis,
- Introducing the evaluation plan, develop evaluation questions and measurements, develop sampling plan, and refine the evaluation design. Develop an analysis plan, define a reporting plan, and develop the evaluation schedule(s), and last but not least,
- Carrying-out implementation, including monitoring the evaluation exercise.

Initial Preparation of the Evaluation Environment

The studio evaluation environment consisted of an evaluation team, technology resources and roles, which were performed by individual team members. The testing team and their roles are summarized in Table 9 below, while technological resources that were used are described in Chapter 5.

Table 9: Composition of Evaluation Team and their Roles

Evaluation Team	Roles
Facilitator in collaboration with team members (the researcher performed this role)	Co-decomposition of the implemented studio, Develop evaluation plan and design, including scheduling, Develop memoranda of understanding, Define stakeholders and select evaluation team, Lead and guide evaluation exercise, Organize resources and logistics, Generate information to use during evaluation, Agree on scenarios and use cases, Compile and communicate to stakeholders evaluation results.
Users (sellers and buyers) in collaboration with team members	Run each defined use case, Provide information needed for evaluation purposes, Suggest other scenarios and use cases, Suggest other functionalities that could be incorporated, Use the functionalities via provided interfaces, Provide feedback on defects noticed.
Developer in collaboration with the Facilitator (Researcher)	Refine FDES for implementation, Contribute to FDES documentation.

Decision Tasks for the Evaluation Exercise

Our strategy was to carry out black box testing (Beizer, 1996) of the studio, since emphasis was on functional testing. Decision scenarios (or cases) acted as a means to capture the studio's functionality and behavior in a user-centered perspective (Ryser and Glinz, 1999). In this section, we describe a procedure to use decision scenarios in a defined way and to systematically derive market identification and price determination decision tasks for our evaluation purposes. The sampled decision tasks and pattern are presented in Table 10 below:

Table 10: Selected Decision Tasks for the Evaluation Exercise

Decision Task	Functionality	Initial system state	Input(s) or event(s)	Output(s) Desired
Making a decision on a market choice (where to sell)	Select from among available markets: drop down menu or listed market alternatives	Market identification Interface is on: drop down and list options	Market ID, Name, contact, transport logistics information, range of product etc.	List of alternative markets with their respective details. List is presented in an excel spreadsheet, with possibility to print copies
Determining and agreeing on product price	Generate a list of potential individual buyers via search, selecting among the listed ones, or by browsing.	Market information details, buyers' profiles, and product/price information menus	Product Details: e.g. product owner name, contact, ID; product ID, product name, quantity, price (owner's or Buyer's value), Date):	List of potential buyers upon which one is selected based on set criteria; price was key in the criteria
Ability to send information	Enable user information requests to be submitted via the	Admin and User Information Request Management	Information Requests from users: e.g. Market ID, Name, and Product Name, ID, quantity,	Tested Information Request Management Interface

and Request via the suite menus	web or sms	Interfaces are on	price:	
Collaboration potential	A seller has access to a variety of market and price options, sources and individuals to choose from via web, sms or in a specific location.	An Interface with various market and price options are on; both drop down box and list and listed items are accessible and allow interactions	Details on various markets, individual buyers, farmers and price options	Users can post potential markets, products, prices, other opportunities and are able to retrieve needed ones
Integration status	The Studio Suites are linked and are interdependent; they allow users to obtain specific information needed with ease	Studio suites are on and the various services such as transmitting product details and price by farmers is enabled	Navigating from one suite to another by users can easily be achieved, the user is able to verify and obtain feedback on the transmission performed.	Suites are interlinked, the feedback service is working
Information presentation and layout	Users can generate and evaluate a list of products/or prices in a spreadsheet or visually (graphical),	Interface for generating product or price information is on, including uploading rights.	Product and price information in the repository is organized according to defied ontology	Spreadsheet or graphical presentation of information

	including uploading additional documents, photographs etc.			

Using the prescribed decision tasks in Table 10 above, tests are carried out to determine whether users are able, for instance, to generate list of markets, buyers and products. The way the interface enhances users' decision on where to sell, to whom to sell to, and at what price is observed and recorded. Since some users may not be able to access the service via the web, there was need to carry out two parallel tests involving web and mobile device interface simultaneously. Inputs are generated and /or submitted by filling an online template- the templates themselves were a subject of testing.

Evaluation setting and samples

Several strategies that could have been used for running the studio testing were reviewed, however, for the case of this study, a sandwich strategy was employed. Pressman (2005) describes a sandwich strategy as an incremental process that employs a mixture of top-down and bottom-up integration of selected test scenarios. Consequently, testing was performed logically and iteratively following a specific sequence, the needed inputs (events) prepared in advance, and the system state set as required (see table 10 above). Two tests involving two different settings were conducted based on the black-box approach (IEEE, 1990; Martin, 2003). In addition, the two settings involved four different samples so as to ensure reliability and validity of the evaluation results (Trochim, 2006). The two evaluation settings covered members of Soroti and Gulu district farmers' associations.

However, the evaluation exercise had to deal with the intricacies of selecting the different team members, and especially farmers' representatives, since the representatives were to provide feedback on whether the studio meets their requirements. Lessons were drawn from requirements' elicitation sample selection guidelines recommended by Den Hengst *et al.* (2004), namely:

- Participants needed to be reasonably knowledgeable about the problem domain. The problem domain focused on farmers, buyers and transporters who often need to share information and interact during product selling and buying,

- Participants should be interested in taking part and sharing their tacit insights willingly. This was achieved by seeking participants' commitment in advance through phone calls, emails and written texts,
- Participants should not be drawn from too many different types of people with highly varying opinions and backgrounds. This required that each of the evaluation sessions has to be conducted involving farmers and traders from the same district,
- Participants should not be over familiar with each other, but be able to exchange ideas freely and with ease. Participants selected only interact during the sell and buying of farm product as the key activity of interest for consensus.

The evaluation exercise was then conducted in two settings involving farmers from Soroti and Gulu districts. As indicated in Chapter 3, farmers in both districts have operational networks coordinated under their district farmers' association. Their offices are located within Soroti and Gulu town respectively, and there is access to power and telecom coverage. During evaluation sessions, internet was obtained via three different GSM modems, which were connected to laptops and one desktop. The modems ran on two different networks (i.e. MTN and Orange). Purposively, 9 farmers and 3 traders were selected among Soroti farmers based on expert and snowball sampling technique (Trochim, 2006). This enabled selection of team members with the requisite skills, commitment and yet has expert knowledge of the problem domain. Secondly, the aim was to select farmers from the rural households, though the evaluation was conducted in the respective towns because of internet accessibility. Each evaluation session lasted the whole day starting with gaining insights into individual participant's background and interests, followed by the studio walk through.

Similarly, 7 farmers and 1 trader were purposively selected from among the Gulu District Farmers Association members with the help of their coordinator. The identification of the participants began with phone contacts, email exchanges and face to face discussions with the farmers' association coordinator. The face-to-face discussions were in the farmers' association offices located in Gulu town, and mainly involved a walkthrough of the studio suites and services. During these meetings, a run of the studio was specifically conducted covering market identification and price determination tasks. Participants were guided through facilitation on opening and accessing the studio suites and sub-suites on shared computers. Evaluation emphasis was placed on sms-based services due to the limited access to computers at the evaluation sites.

Evaluations of FDES

Altogether, 20 participants participated in the evaluation exercise, and there brief democratic characteristics, sms and internet use are presented in table 11 below.

Table 11: Characteristics of the Sample Selected

Demographic		**Soroti District**	**Gulu District**	**Total**	**Percent**	**Totals**
Age	Under 20	0	0	0	0	20
	20-25	1	3	4	20	
	25-35	5	4	9	45	
	Above 35	6	1	7	35	
Gender	Male	7	5	12	60	20
	Female	5	3	8	40	
Education Level	Up to primary or none	4	1	5	25	20
	Secondary	4	0	4	20	
	Above secondary	4	7	11	55	
Internet use	Not at all (one does not use internet)	3	3	6	30	20
	Regularly (one uses internet once in time)	3	4	7	35	
	Frequently (one uses internet frequently)	6	1	7	35	
SMS Use	Not at all (one does not use sms)	0	2	2	10	20
	Regularly (one uses sms once in a while)	6	3	9	45	
	Frequently (one uses sms	6	3	9	45	

	frequently)					
Reason for Using Internet or SMS	Locate market	9	6	15	75	20
	Contact Buyer	10	6	16	80	
	Reach fellow farmer	7	3	10	50	
	Know product price	6	2	8	40	
	Announce product	5	6	11	55	
	Agree price with buyer	5	5	10	50	

From Table 11 above, many of the farmers sampled are aged between 25 to 35 years (45%), 55% of those sampled are educated above secondary level; while if combined, at least 75% have gained secondary education and above. On internet use, 30% do not use internet at all, while a combined 70% use internet regularly or frequently. Soroti district has the highest number of those using internet (45%) as opposed to Gulu's 25%. On the part of using sms, a majority of the respondents use sms either regularly (45%) or frequently (45%). The results also indicate that many of the farmers use internet or sms on decisions that require them to contact buyers (80%) and locating markets. The use of internet and sms also helps farmers announce their products (55%), reach fellow farmers (50%) and negotiate a product price with buyer (50%). However, few farmers (40%) would use internet and sms for knowing prices of similar products being traded in the market.

6.2 Evaluation Instruments and Exercise

From a design science perspective, researchers have proposed many different approaches to evaluating artefacts. For example, traditional research techniques such as case studies, field studies, and experimentation can be used (Hevner *et al*. 2004; Vaishnavi and Kuechler, 2008). For the case of this study, field studies were supplemented with experiments where participants executed sample processes under observation of the researcher.

The researcher (acting as a facilitator) conducted the evaluation using a web based and standalone version of FDES using two laptops, one as a server and the other as a client. A camera was used to capture the participant's face, comments and navigation choices. In addition, each participant's navigational choices, task completion rates, comments, overall satisfaction ratings, questions and

feedback were captured using MS Power Point template. These were used to guide further analysis and interpretation of the overall results.

The format of evaluation questions was adopted and customized from previous work (such as Van der Kar (2004); Tsakonas and Papatheodorou, 2006; Yonazi, 2010; Ejiri, 2012). Two sets of evaluation instruments were employed, consisting of 1) a closed questionnaire containing four point Likert scales (Trochim. 2006) to measure users' perceived behaviours, 2) a short open-ended questionnaire for capturing further qualitative opinions from users that could be missed. The Likert scale used gave users no option of being neutral or undecided, i.e. the neutral alternative was eliminated as in Clason and Dormody (1994). The reason was to encourage participants to select a value that represent their individual opinion under bisectional conditions. As a result, this enabled participants reveal what attributes of the studio had more or less significance to them. Similarly, the four-point Likert scale was developed based on insights from others studies (Jamieson, 2004; Knol, 2013), and contains statements with values ranging from 1 (Strongly Disagree), 2 (Disagree), 3 (Agree) and 4 (Strongly Agree).

Explanatory text for each value was also given to assist participants in making their individual responses. Though each evaluation session lasted for 3 to 5 hours and was successful, there was lack of computer hardware to fully engage participants on the studio's web interface. On the studio's sms interface, all participants selected had basic mobile phone onto which airtime was loaded in advance. Generally, the instrument consisted of 22 questions aimed at evaluating the studio's usefulness, usability and usage among the selected farmers from Gulu and Soroti districts. The evaluation was carried out from July to September 2013, which also included presentation of evaluation results to experts. Presentation to experts was via individual contacts, workshops and research seminar presentations.

Below we present the structure of FDES usefulness, usability and usage evaluation results' analysis, interpretation and discussions. Evaluation results' analysis is presented in tables consisting of the respective means, modes and standard deviations. ANOVA analysis is separately performed for each of the constructs in order to determine the respective significance p-values on participants' perceptions. Finally, the evaluation was carried out using questions presented in Appendix 3.

6.3 Evaluation Results

In this section, we present the analysis results of the studio's usefulness, usability and usage evaluation. For each evaluation session, a fixed set of guiding test criteria (i.e. selected market identification and

price determination decision scenarios) was followed as shown on Table 10. The results are presented based on the descriptive statistics recommended by Jamieson (2004) and applied by other researchers such as Ejiri (2012). Specifically, data analysis was done using non-parametric strategies (Brown and Saunders, 2008), which were supplemented by parametric procedures (Lubke and Muthen, 2004) because the instruments used generated mainly ordinal data (Trochim, 2006; Brown and Saunders, 2008). Insights from numerical data analysis procedures (Lubke and Muthen, 2004) were equally necessary. Secondly, using Likert data in parametric instances is sometimes necessary and produces valid results (Lubke and Muthen, 2004).

Similarly, we choose to use ANOVA (Penny and Henson, 2006) with the premise that the F-tests return accurate P-values on each of the Likert item under consideration. The quantitative evaluation results are presented in tables 12 to 17 using the mean value (x), standard deviation (σ) and mode (m).

Further to the above, attempts were made to ensure instrument reproducibility using a combined Cronbach's alpha (α) value (Howitt and Cramer, 2005). However, the conditions prevailing had the potential to lower the alpha value for each of the constructs evaluated (Gadermann *et al*., 2012). Practically, **α** values of below or even 0.7 can, realistitically, be expected because of the diversity of measurement constructs in relation to test groups (Field, 2005). In the case of this study, demographic characteristics of the respondents have a bearing on the reliability of evaluation instruments. Secondly, due to the need for language translation in some instances, computer access, internet availability and literacy among others, the evaluation sample was generally small as indicated in the tables below. From Gadermann *et al*. (2012), a smaller sample lowers the Cronbach's alpha value, and this could cause considerable implications on the respondents' feedback. However, as indicated under each construct, the alpha values were sufficiently good.

In some instances, we experienced multimodal values, in which case, an attribute with the lowest value was preferred[8]. Secondly, during the analysis and discussion of the evaluation results, P-values were considered to be significant if they were less or equal to 0.05 (i.e. $p \leq 0.05$) (Goodman, 2008; Browner and Newman, 1987).

---

[8]*In this particular example, a similar number of participants also indicated an attribute "agree" mode 3 on the same usefulness evaluation statement. We have considered "multimodal" to refer to a distribution with two or more modes as in Javaras, K.N. (2004). Statistical analysis of likert data on attitudes. Doctoral Dissertation, Balliol College, University of Oxford, UK.*

Table 12: Evaluating Usefulness of the studio (α = 0.607)

	Gulu N=8			Soroti N= 12		
Studio Usefulness Evaluation	**x**	**σ**	**m**	**x**	**σ**	**m**
1. Using FDES enhances my decision making on market and price choices	3.62	.518	4	4.00	.000	4
2. I find FDES services useful for even my other non-market decision tasks	3.00	.000	3	3.42	.515	3
3. I don't see any advantage in using FDES during my product pricing decisions	2.12	.835	2	2.00	1.279	1
4. I cannot make decisive market decisions using FDES services	1.62	.518	2	2.00	1.414	1
5. I would prefer to achieve the same tasks of selling my product without using FDES	2.62	.744	3	2.50	1.168	1
6. FDES services enable me have greater control over the price of my products	3.00	.756	3	3.25	.866	3
7. I would not recommend FDES to my friends since it does not assist in crucial market decisions	2.00	.926	1	1.83	.835	1
8. FDES Suite guidelines need to be modified for a number of reasons	3.25	.463	3	3.17	.718	3
9. FDES suites provide environment I need for making valuable product buyer selections	3.00	1.069	3	3.67	.492	4

Table 13: ANOVA analysis for Usefulness for all respondents (n = 20)

Questions		Sum of squares	df	Mean square	F-value	P-value
Using FDES enhances my decision making on market and price choices	Between Groups	.675	1	.675	6.480	.020
	Within Groups	1.875	18	.104		

	Total	2.550	19			
I find FDES services useful for even my other non-market decision tasks	Between Groups Within Groups Total	.833 2.917 3.750	1 18 19	.833 .162	5.143	.036
I don't see any advantage in using FDES during my product pricing decisions	Between Groups Within Groups Total	.000 22.00 22.00	1 18 19	.000 1.222	.000	1.000
I cannot make decisive market decisions using FDES services	Between Groups Within Groups Total	1.875 20.125 22.000	1 18 19	1.875 1.118	1.677	.792
I would prefer to achieve the same tasks of selling my product without using FDES	Between Groups Within Groups Total	.075 18.875 18.950	1 18 19	.075 1.049	.072	.792
FDES services enable me have greater control over the price of my products	Between Groups Within Groups Total	.300 12.250 12.550	1 18 19	.300 .681	.441	.515
I would not recommend FDES to my friends since it does not assist in crucial market decisions	Between Groups Within Groups Total	.033 16.917 16.950	1 18 19	.033 .940	.035	.853
FDES suite guidelines need to be modified for a number of reasons	Between Groups Within	.133	1	.133	.374	.548

	Groups Total	6.417 6.550	18 19	.356		
FDES suites provide environment I need for making valuable product buyer selections	Between Groups Within Groups Total	2.133 10.667 12.800	1 18 19	2.133 .593	3.600	.074

The interpretation and discussions of the ANOVA analysis above are presented under section 6.4 below. However, from table 13 above, the general overview of the studio evaluation results indicates that, the studio is useful. For example, the studio provides the environment needed by farmers for making buyer selection decisions, participants recommended some reasons for modification of the studio design and implementation. These included among others making email field optional, providing room for language selection, product picture upload and involving more farmers. However, there was need to interpret and explain some of the evaluation questions in local language, which might have distorted some meanings and contexts. We also notice the way the studio helps enhances farmers' decision making on market and price choices varies between the two groups of farmers (those from Soroti and Gulu). The P-value for question 1 is significant, and the means between the two groups (Gulu and Soroti farmers) are different.

Table 14: Evaluating Usability of the studio (α = 0.730)

	Gulu N=8			Soroti, N= 12		
Studio Usability Evaluation	**x**	**σ**	**m**	**x**	**σ**	**m**
10. The interface explains itself and I can easily use it	3.38	.744	4	3.08	1.165	4
11. I have to go through irrelevant steps in order to get the information I want	2.38	.916	2	2.50	1.087	3
12. Learning to use FDES is not easy for me	2.38	.916	3	1.92	.900	2
13. I am able to access different market alternatives using FDES services	3.25	1.035	4	2.67	1.371	3
14. I have experienced difficulties using FDES	2.50	1.95	1	2.58	.793	3

functionalities						
15. I can use and understand the terminology used in FDES	3.25	.707	3	3.08	.515	4
16. The way information is generated makes it easy to determine product prices	3.38	.518	3	3.08	.515	4

Table 15: ANOVA analysis for Usability for all respondents (n = 20)

Questions		Sum of squares	df	Mean square	F-value	P-value
The interface explains itself and I can easily use it	Between Groups Within Groups Total	.833 16.917 12.800	1 18 19	.833 .940	.887	.359
I have to go through irrelevant steps in order to get the information I want	Between Groups Within Groups Total	.075 18.875 18.950	1 18 19	.075 1.049	.072	.792
Learning to use FDES is not easy for me	Between Groups Within Groups Total	1.008 14.792 15.800	1 18 19	1.008 . 822	1.227	.283
I am able to access different market alternatives using FDES services and suites	Between Groups Within Groups Total	.300 21.500 21.800	1 18 19	.300 1.194	.251	.622
I have experienced difficulties using FDES functionalities	Between Groups Within	.075	1	.075	.059	.811

	Groups Total	22.875 22.950	18 19	1.271		
I can use and understand the terminology used in FDES	Between Groups Within Groups Total	.675 5.875 6.550	1 18 19	.675 .326	2.068	.168
The way information is generated makes it easy to determine product prices	Between Groups Within Groups Total	.208 4.792 5.000	1 18 19	.208 .266	.783	.388

Similar to usefulness, evaluation results suggest the usability of the studio is satisfactory among selected farmers and traders. For instance, participants did not find difficulties with the studio interfaces, experienced few challenges using the studio services as well as understanding the terminology used. The detailed usability evaluation results discussion is presented under section 6.4 below.

Table 16: Evaluating Usage of the Studio (α = 0.930)

	Gulu N=8			Soroti, N= 12		
Studio Usage Evaluation Questions	**x**	**σ**	**m**	**x**	**σ**	**m**
17. FDES services have added value to my product's market identification and price determination decisions	2.50	1.069	3	3.58	.515	4
18. I can assist my other colleague sell his product using FDES services	3.38	.518	3	3.17	.835	3
19. I can only use FDES to identify and make market and price decisions with assistance	2.88	.991	3	2.58	1.084	2
20. I am unable to submit market information request and obtain feedback via sms	2.38	.744	3	2.08	1.240	1
21. Contents of sms feedback are not conclusive	2.62	.916	3	3.00	.853	3

enough to enhance my effort in selecting a buyer						
22. I find FDES Useful for all farmers in Uganda who are engaged in market identification decisions	3.62	.518	4	3.58	.515	4

Table 17: ANOVA analysis for Usage for all respondents (n = 20)

Questions		Sum of squares	df	Mean square	F-value	P-value
FDES services have added value to my product's market identification and price determination decisions	Between Groups	4.800	1	4.800	7.855	.012
	Within Groups	11.000	18	.611		
	Total	15.800	19			
I can assist my other colleague sell his product using FDES services	Between Groups	.208	1	.208	.393	.539
	Within Groups	9.542	18	.530		
	Total	9.750	19			
I can only use FDES to identify and make market and price decisions with assistance	Between Groups	.675	1	.675	.680	.420
	Within Groups	17.875	18	.993		
	Total	18.550	19			
I am unable to submit market information request and obtain feedback via sms	Between Groups	1.408	1	1.408	1.077	.313
	Within Groups	23.542	18	1.308		
	Total	24.950	19			
Contents of sms feedback are not conclusive enough to enhance my effort in selecting a buyer	Between Groups	.408	1	.408	.575	.458
	Within Groups	12.792	18	.711		
	Total	13.200	19			

I find FDES useful for all farmers in Uganda who are engaged in market identification decisions	Between Groups Within Groups Total	.008 4.792 4.800	1 18 19	.008 .266	.031	.862

Due to time and resource limitations, it was not possible to subject the studio for long term interaction with participants. However, for those who continued using the web interface provided some feedback in form of questions. For instance, the programme coordinator of SODFA sent the email message presented in Figure 21 below after interacting with the studio services for some time.

FDES WEBSITE

From: ejoku samuel peter

11/01/13

To: Raphael Aregu

Dear Raphael,
How is Gulu and work?
I am finding problems accessing FDES menu. It no longer comes readily like it used to. Has anything gone wrong with the service? I have 2 acres of water melon that may be ready in 2 wks or so. We needed to start advertising it.
Your response and help on this please.

Thanks,
Samuel

Figure 21: Sample Email Feedback from SODIFA

A response was sent to the inquiry through a phone call and an email message providing addition help on how to access the studio web interface. The inquirer had wrongly entered the studio web address, hence, the failed access.

6.4 Interpretation and Discussions of Evaluation Results

In this section, we present the discussions and interpretation of the studio's evaluation results covering the three identified criteria above i.e. 1) usefulness, 2) usability and 3) usage.

Studio Usefulness among Primary Users

In addition to insights from Keen and Sol (2008), we note that the overall acceptability of a service system follows a combination of its social and practical attributes (Nielsen, 1993). The practical acceptability includes some traditional categories such as cost, reliability, support etc. and of most importance "**usefulness**" (Nielsen, 1993). Hence, our focus in this section is to present discussion on the studio usefulness based on the results of Table 12 and Table 13 above.

In general, the studio helps farmers achieve their market identification and price determination tasks as shown on Table 12. In particular, whereas farmers from both districts find the use of the studio to enhance their decision making on market identification and price choices (mode of 4), there is a significant variance on how this is achieved between the two districts. All respondents in Soroti agreed with the statement (of question1) and hence the value of the corresponding standard deviation (**σ)** is zero**.** However, the critical P-value for question 1 (Table 13) seems to point to the contrary of the respondents' feedback. A majority of the respondents (mode =3) (particularly all from Gulu) agreed that the studio was equally useful for their other non-market-based decisions (question 2). On the other hand, results of question 3 and 4 strongly indicate that most farmers would depend on the studio in making their market identification and price determination decisions. This is true since a majority of the respondents show either disagreement or strongly disagree with the statement, whose p-values equally support the initial assumptions.

Whereas farmers in Gulu would achieve the same tasks of market identification and price determination with limited use of the studio, the case was the opposite in Soroti (as shown in question 5). This could be due to the different levels of sms usage as indicated on Table 11, where we indicated that more Soroti farmers use sms than those in Gulu. Another contributing factor for the variation between the two districts is that a large part of the evaluation was conducted via the sms-based interface. There was limited evaluation of the web-based interface. This was mainly due to a number of factors already highlighted in chapter 5. Similarly, using the studio enables farmers have greater control of their product prices (question 6) with little variance between respondents from Gulu and Soroti.

The many respondents who strongly disagreed with the seventh statement (mode of 4) further reflect the potential usefulness of the studio among farmers. Similarly, results indicate that the studio guidelines required modifications (mode of question 8 is 3), the corresponding P-value of .548 is insignificant at 5% level of significance. The studio suites, however, provide an environment generally needed by farmers and traders in making valuable products' buyer selection decisions. This was evidenced by

participants' feedback to question 9 results whose mode is 3, though the P-value was near significant (i.e. P-value is .074). Consequently, some of the studio guidelines (such as making email address optional) were adjusted; while others will continue to be modified as the studio gains further applicability.

Usability Evaluation

As pointed earlier, usability was concerned with the ease of use of the studio by farmers and other key stakeholders with expert facilitation. Analysis of the usability evaluation results is presented in Table 14, with Table 15 as the corresponding ANOVA presentation. Since respondents were using their own phones during evaluation sessions, the sms-based interface was easily learnt and understood by participants. It was quite easy for the respondents to use the interface as shown by feedback of question 10. There is also insignificant variation between participants from the two districts in respect to ease of use. However, since there were no computers (leave alone having them being connected to the internet), the web-based interface was effectively not evaluated among the respondents.

Expert opinion was mainly obtained from a UNESCO representative and participants of a research seminar hosted by Uganda Technology and Management University in August 2013, among others. Additional discussions were conducted with the coordinator of Northern Uganda Media Institute (NUMEC) whose activities majorly cover mass mobilization of citizens towards development interventions using media. Results from expert interactions confirmed among others that the web-based interface was easy to use, though with some few suggestions for modifications, such as a need to allow "automatic language selection through language lists".

In relation to other aspects (question 11-16), respondents' feedback provides a mixed perspective- from being positive to pointing out some usability difficulties. For example, results from Soroti indicate that using the studio involved going through irrelevant steps in order to get market and price information required for decision making (mode is 3), though Gulu results indicate the contrary (mode is 2). As a result, there was (and there is still) need to reduce the number of steps that users go through, for instance, the email option was made optional. Similarly, learning to use the studio (especially the web-interface) was found not easy particularly among Gulu respondents, hence the need for facilitation (question 12). Feedback from question 13 indicates that, respondents were unable to easily learn how to obtain market alternatives during the market identification tasks. This called for a detailed walkthrough of the studio over a period through facilitative services, which are a key to decision enhancement (Keen

and Sol, 2008). However, there was a constraint of time and enhancing decisions on market identification tasks could not be fully practiced by participants.

From question 14 feedback, respondent from Gulu did not experience difficulties using the studio functionalities (i.e. its suites and services) (mode is 1), the contrary was for Soroti farmers (mode is 3). This could be because the evaluation exercise started in Soroti where even the facilitator was being acquainted with the evaluation exercise, translation practicability etc. In addition, more of Gulu respondents have an education level above secondary compared to Soroti respondents (Table 11) as another of the potential contributing factor to the variance between the two districts. Similarly, results of question 15 show that a majority of the respondents in both districts had no challenges in learning, understanding and using the studio terminology.

The evaluation exercise allowed participants to use their own language and content, including technology available with them- mainly mobile phones. Hence, most content for the studio is generated from among the users; it makes it easy for farmers and traders alike to make decisions regarding product prices as indicated by results of question 16 whose corresponding p-value is insignificant. This means that emphasis should be placed on further encouraging participants to adopt the way information is generated in the studio environment. Generally as shown in Table 15, the studio was easy to learn and use since there are no significant P-values in all the usability evaluation test questions.

Evaluation of Usage

For the problem domain, we have considered usage to represent the surrogate measure of the studio's value proposition and successful implementation. The efforts therefore, were to evaluate the effectiveness of the studio's documentation, help and support options, whose primary indicator lies in the studio's ability to enhance farmers' market identification and price determination decisions. However, to obtain more valuable participants' usage perceptions requires that the studio is put into use and evaluation is done after a longer period. This longer period would allow detailed interaction between participants via studio services. On the contrary, the resource and time limitations dictate otherwise and the evaluation relied on the limited participants' studio usage. The analysis of the usage results is presented in Table 16, with its corresponding ANOVA structure in Table 17.

From Table 16, we sought to explore whether the studio adds value to individual farmer market identification and price determination decision outcomes (question 17 and 18). As results show, a majority of the respondents agreed that in addition to adding value to their product price decisions,

individual respondents were willing to assist their friends sell their produce using the studio services (mode 3 for question 18). However, the significant P-value (of 0.012) for question 17 suggests that participants did not realize value addition from the studio. In an agricultural environment, adding value is the process of changing or transforming a product from its original state to a more valuable state (Brown and Petrulis, 1993). We consider product in this case to encompass not only product to be traded but also the decision making process of an individual farmer. It is, therefore, critical for the studio to transform the farmers' current product and /or decision making to a state that they can feel makes a difference. It is possible most participants did not realize this change during the evaluation primarily due to the limited time of usage.

Whereas more respondents from Gulu (mode 3) needed facilitation assistance to arrive at market identification decisions, those from Soroti appear not to need much assistance (mode 2). Similarly, the studio benefit to respondents tasks that required submitting and receiving feedback via sms interface (question 20), though those from Gulu found some difficulties as shown by results where the mode is 3 for question 20. For instance, participants needed extensive facilitation in submitting requests via sms interface at the initial usage stages. This could also partly be due to variations of the mobile network signal strength between the two places during the evaluation times. Participants also indicated that contents of sms were not conclusive enough to add value to their product buyer selection decision outcomes, since a majority of them agreed with the statement of question 21. Hence, emphasis could be placed on availing internet access solutions such as mobile XG and village internet cafes. In question 22, respondents generally find the studio useful and of value to all farmers who are engaged in market identification decisions in Uganda (mode 4, with P-value indicating no significance).

In conclusion, because of the big variance between the two districts the combined p-value seems to suggest that the overall studio value proposition in relation to its usage is low (question 1, Table 17). However, the majority of the results (Table 17) indicate the studio has the potential of adding value to the farmers' market identification and price determination decisions.

6.5 Summary

Evaluation results largely indicate that the studio is useful to the users, its usability is at an acceptable level, and at the same time users find value addition if they used the studio. Other than the quantitative analysis, the evaluation also included a brief qualitative aspect to enable respondents provide additional relevant and concluding overviews that may have been missed by using the quantitative measurement scale. Specifically, the use of the mobile phone sms interface of the studio made it easier for farmers to

communicate with their older customers by informing them on the availability and quantities of agricultural produce. Through mobile phone communication, the real tradable quantities of produce were ascertained and farmers were able to mobilize themselves to bulk their produce and sell as a group. This increased cooperation among farmers within the village. Mobile phone services also enabled farmers to know the prevailing market prices of agricultural commodities in various markets in Gulu and Soroti, which enabled them to negotiate and sell produce at competitive prices. It is probable that new buyers/contacts were established during these transactions. The link to market was also related to acquisition of inputs (seed and pesticides) from stockists and accessing price and market information in order to match harvesting (and bulking) of products with better prices.

Together with the expert feedback, evaluation results further suggest the need to consider the following in the studio design:

Automatic language translation

Results from experts confirm the need to have a provision for automatic language translation. The default language of the studio is English, but users in the study area operate in local language (i.e. Ateso, Kumam and Acholi). Other communities that may use the studio services may also need to operate in their languages. Language translation involves the process of localizing and modifying IT-based services and/or software from one culture to another (Katushemererwe, 2013). It is an extensive exercise that comprises of five key phases (Kinston, 2011; Newmark, 1988) and was not the focus of this study. Also not much translation was required in achieving the objects of the study. As the problem domain focus, the studio content is generated within a group of users with similar cultural characteristics, and most likely accessible to each other. In addition, generating automatic language translation lists would require additional time, resources and learning, none of which were feasible.

Drop down menu language selector

The results indicate a need where users are enabled to select information and request submission forms, including feedback transmission in a desired language (languages involved included English, Ateso, Kumam and Acholi). However, achieving this required re-configuring all the database settings, coming up with individual language-based forms, including the sms-gateway structure. This was not possible within the time and resources available.

Organized and committed group of farmers

As pointed out in Chapter 2, the studio's effective implementation largely depends on an organized and committed group of farmers with group membership evidence. During the evaluation process, all respondents who participated were contributory members of their respective farmers' association. Consequently, the other lesson learnt was that, in designing the studio, it was critical to keep in mind the 4Ps perspective. From the 4Ps perspective, the design sought to ensure that the studio is people centric, personalized, process enabled and participatory developed. Personalization makes it possible to enable farmers and other market actors to work together to manage risk and resources, and leads to services which are farmer-centered.

More time needed to realize the studio usage

The time available during evaluation was not adequate to enable effective usage assessment of the studio. As indicated the usage evaluation results, respondents' feedback reflected little experience with service, some of the respondents did not understand some of the evaluation questions well.

7 Epilogue

The work presented in this thesis involved designing market and price decision enhancement services for farmers in Uganda. It was specifically carriedout involving farmers in the districts of Gulu and Soroti of Uganda, with additional insights gained from experts and other agricultural market stakeholders. As part of our contribution, the study among others seeks to derive solutions to the farmers' market and price decision making challenges. Subsequently, the approach that framed the research activities of this study consisted of initiation, abstraction, theory formulation, implementation and evaluation. In this chapter, we provide an abridged overview of the overall thesis covering a brief introduction, reflections on our problem domain, research questions, philosophy and strategies.

7.1 Introduction

In their paper, Gregor and Hevner (2013) indicate that, "the development of a particular novel artefact with high utility can be seen as a contribution to knowledge, even if the full understanding of why the artefact works is partial and incomplete". They continue their discussions by arguing that design science research encompasses two types of knowledge, namely descriptive and prescriptive. As discussed in the sections that follow below, this study has contributed to both dimensions of knowledge, including recommending a research agenda based on insights gained during its verification and evaluation exercise. Specifically, descriptive knowledge is created via problem landscaping, analysis of the farmers' market and price decision making environment, exploratory studies including an approach to design the studio.

Prescriptive knowledge consists of constructs, models, methods and instantiations (Gregor and Hevner, 2013), and it has been created through designing, instantiating and implementing, including evaluating the studio among farmers. This has involved eliciting farmers' market and price decision making requirements; generating an abstract model of the desired studio, describing design methods employed including techniques and guidelines for using the studio. A design theory is created via an abstract representation of the studio, which starts from conception and initiation (chapter 1), further understanding and building a conceptual model (chapter 2 and 3), design as an artefact (chapter 4), instantiation and realization (chapter 5 and 6). Therefore, this study has generated design knowledge, which we summarize in this chapter covering an overview of the problem domain, reflection on the research questions, theory formulation, instantiation, evaluation and a research agenda. Further to this, we find the studio concept advanced by Keen and Sol (2008) useful in the problem domain.

7.2 Overview of the Problem Domain

As an initiation to the research problem, we have pointed out that, in an increasingly competitive and rapidly changing agricultural market place, making decisions that matter, decisions that are urgent, consequential and irreversible becomes more important but also more difficult. The situation is made complex due to the volatility of agricultural markets and product prices (Lehmann *et al*., 2012). In addition, final product buyers are inspired by their own values and demand transparency, which implies reaching shared understanding, and access to product and process related information (Hofstede, 2003). Particularly, the Ugandan agricultural market place is dominated by village markets and individual buyers, which function as outlets for a majority of the smallholder farmers. Through the course of this study, results indicate that farmers are faced with several challenges in their pursuit to make effective market and price decisions. These challenges arose because of the economic, technological and social transformations that have taken place in the agricultural product market place over the past few decades (Tollens, 2006).

For the case of Uganda, prior to 1990s, farmers were organized on geographical basis into primary societies. This was done to support extension services, access to inputs and purchasing of farmers' products among others (Robbins, 1999). However, as a departure, the government instituted a programme of market liberalization where many farmers'-based societies became non-functional. Coupled with changes in consumer demands (Francis and James, 2003; Benin *et al.*, 2007) and communication technologies (Aker, 2010; Lwonga *et al*., 2006), farmers continue facing daunting challenges in their market and price decision making processes.

Moreover many of the initiatives that have been set up to bridge existing gaps focus on information collection and dissemination. They lack capabilities for collaboration, instant feedback including user-to-user links. Similarly, the issues relating to farmers' market and price decision arenas are not adequately addressed. Yet farmers are constantly required to increase their level of participation in the market so as to improve their well being. For the case of Uganda, farmers face daunting challenges since they are required to transform from the predominant subsistence systems to commercial engagements (MFPED, 2008). For example, smallholder farmers have continued to operate on dismal market access conditions, high levels of remoteness, associated high overhead costs, including poor access to support services (Chamberlin and Jayne, 2013). It is in this perspective that this study was initiated.

Similarly, the motivation for this study was to develop, prototype and evaluate the farmers' market and price decision enhancement services in developing countries, with emphasis on Uganda. Since decision science is generally a wide concept, our thinking was specifically shaped by decision enhancement services (DE) as advanced by Keen and Sol (2008). Decision enhancement incorporates three aspects of people, technology and process to solve indentified human problems. The farmers' limited access to markets and products' prices underpinned the rationale of this study from its research setting to epilogue. Inspired among others by the service systems' way of thinking and best of practice, a Farmers' Decision Enhancement Studio (FDES) was developed and evaluated among farmers in Uganda. Strategically, the studio was formulated based on insights obtained using the inductive-hypothetical research strategy advanced by Sol (1982).

7.3 Reflection on Research Questions

Specifically, the focus of this study was "developing, implementing and evaluating the farmers' market and price decision enhancement services". In order to address this focus, four research questions, based on an overall question were specified. The overall research question as indicated in section 1.4 concerns with *"how can market and product price decisions of farmers in developing countries be enhanced?"* The specific research questions were meant to address key issues comprising of:

- Formulating an in-depth understanding on the existing market channels and their conditions, weaknesses, what kind of services they offer and how do farmers use them,
- Delineating and describing the very pertinent farmers' market and products' price decision making requirements. This was addressed using the knowledge base and exploration involving farmers from the study areas,
- Exploration into the factors that influence farmers' market and price decisions. The purpose was to narrow our research scope and gain an in-depth understanding on key activities, tasks and decision processes performed by farmers, particularly from the chosen research areas,
- Gaining insights on what strategies and resources are needed for designing, prototyping and testing a decision enhancement service for farmers. This was further addressed using literature reviews, exploratory studies including expert consultations.

In particular, the research objective and questions were addressed using insights from the design science paradigm of Hevner *et al*. (2004) and Hevner (2007). The design science approaches enabled rigorous analysis and development of farmers' decision enhancement service based on the decision enhancement

lens of Keen and Sol (2008). Designing in the problem domain was concerned with the design and management of "a farmers' decision enhancement studio" as the resultant artefact, which provides collaborative decision making opportunities to farmers and other market participants. Insights from collaborative engineering (Briggs *et al*., 2003) were very useful during the design and development of the identified services. From the design science perspective, an inductive-hypothetical research strategy advanced by Sol (1982) was used to facilitate problem initiation, abstraction, theory formulation, solution implementation and evaluation.

Explorative techniques (Trochim, 2006) were used to elicit farmers' market and products' price decision making requirements. We specifically employed literature reviews, unstructured interviews and observations for gaining an increased understanding of the key domain requirements. Whereas from the results farmers have many requirements, the study focused on market identification and price determination decisions. Key factors that influence these decisions were identified to include among others information, transport facilities, family influences, organizational networks, etc. These factors , among others, helped in conceptualizing the proposed farmers' decision enhancement services. The exploratory investigations also helped in gaining knowledge on the resources required (and potentially available) for designing, prototyping and testing a decision enhancement service for farmers.

It was also necessary to engage farmers and other stakeholders at all stages of the studio design and implementation. Insights were gained from Chilvers (2009) who identifies three types of engagements namely: informing stakeholders, learning from stakeholders and collaborating with stakeholders. We derived additional inspirational insights from these types of engagements during exploration, mainly focusing on:

i) Informing stakeholders-, which involved an interactive engagement, designed to disseminate information on the studio services. Particularly, engagement techniques were employed to make farmers and other market actors aware of the existence and potential utility of the studio,

ii) Learning from stakeholders- an interactive engagement aimed to take account of the views, interests, insights and capacity of the stakeholders. This step of engagement helped us draw out farmers' and other market actors decision making requirements,

iii) Collaborating with stakeholders- involved shared approaches to decision making with stakeholders based on dialogue, discussion, deliberation and collective problem framing. In this way, farmers and other market stakeholders work directly with specialists and the research team to create the studio.

Through exploration, it was further possible to engage farmers and other market actors. Specifically, exploration enabled us address three key issues, namely:

i) Inclusiveness, individual studio users have a legitimate right to influence decision processes that have a bearing on them. In this sense, engagement with farmers in the studio design was seen as a pre-requisite of the inquiry process because FDES (as a service system) design evolves overtime and implies change,

ii) Acceptability, that greater trust and legitimacy can be built into what is proposed by the decision enhancement studio, and

iii) Effectiveness, outcomes and outputs are more realized since active engagement of farmers provided a source of practical know-how that helped inform the design and lead to a better artefact.

In conclusion, based on our research questions, a number of key considerations have been recommended, among which are:

- Designing and implementing a decision enhancement service for farmers should be positioned within a coherent national strategy, and with integrated approach focusing on identified challenges. For this study, we have paid attention to farmers' market and price decision challenges,
- Further dissemination of the objectives and outcome of this study is needed to encourage wider engagement of market actors, experts and the research community, which may open possibilities for additional insights and new research agendas,
- In designing similar services for farmers, it is a requirement to ensure that the design is farmer-centric, personalized, process enabled and participatory developed. Personalization makes it possible to enable farmers and other market actors to work together to manage risk and resources, and leads to services which are farmer-centered,
- In order to improve the utility of the studio, it is important to precisely define critical market and price decision making activities of farmers. These activities facilitate and inform the design, instantiation and evaluation of the studio among a specific group of farmers and other market actors.

7.4 Theory formulation

Theory and theorizing are continuously being recognized as important ingredients in design science research (Goldkuhl, 2013; Markus *et al*., 2002; March and Smith, 1995; Nunamaker *et al*., 1991). In this study, it represents the design cycle, which results in the creation and implementation of an artefact

(Knol, 2013; Hevner *et al*, 2004), the "Farmers' Decision Enhancement Studio". Based on Nunamaker and co-authors' insights, this study involved theory building, systems development, observations and field experimentations. Observations and experimentations were key elements of our evaluation exercise presented in chapter six. This particular section provides an abridged discussion on theory building and covers the development of new ideas and concepts on farmers' market and price decision making. It is also concerned with the construction of the conceptual framework, new methods and models as in Hevner *et al.* (2004). Our theorizing strategy is further informed by insights from abductive reasoning as shown in Vaishnavi and Kuechler (2004) and Gonzalez and Sol (2012) including "reasoning in the design cycle", Gregor and Hevner (2013).

The focus of theory formulation was on defining key service values that the proposed decision enhancement service seeks to offer to primary users- mainly "farmers and traders". This required an active engagement with farmers and other market actors, which started at an early stage in order to understand the empirical market decision making needs of farmers. The domain requirement for an active engagement significantly adds to the design science knowledge base of Hevner *et al.,* (2004). Similarly, while referring to Van de Ven (2007), Sol (2014) talks of engaged scholarship, which in effect represents the process of active engagement. Embracing farmers and encapsulating their critical market knowledge into the design seeks to ensure that the studio is more reflective of the farmers' systems and perhaps more accessible or appealing to them. Supplemented by literature review, expert feedback, the engagement process enabled realization of new ideas, concepts, requirements and constraints relevant for building the proposed farmers' decision enhancement studio. Subsequently, a theory is proposed based on the farmers' market and price decision making activities, and involving three aspects of people, process and technology.

Generally, results of this study indicate that the studio concept is sutiatble for addressing the farmers' market and price decision making requirements. This is because many of the market decision making challenges faced by farmers arise from causes that are social, ecological and technological in nature. Hence, our aim was to design a service system, which would enhance farmers' market and products' price choices. Designing service systems in this kind of domain is often difficult to manage and understand due to their none-linear multi-scale dynamics, the potential for rapid change in the service drivers and the reflexivity of human action (Mulira, 2007; Van de Kar, 2004). However, by analyzing information systems development methodologies using the "ways of" framework (Seligmann *et al*.,

1989; Sol, 1988), additional insights to handle the problem domain were gained. Further insights were developed from the exploratory field studies and feedback from experts.

Similarly, since collaborative decision making is essential for effective market participation by farmers, insights from collaborative engineering (De Vreede *et al*., 2003; De Vreede and Briggs, 2005) were necessary. Given the domain characteristics, more useful insights were gained from the 4Ps strategy introduced by Sol (2013)[9]. Results also indicate ever changing market environment, continuously shifting farmers' preferences, dynamic consumer needs among others. Hence, other necessary knowledge was required from the evolutionary perspective, user centered development, waterfall model, etc, all of which are described in detail in section 2.4.

In Chapter 4, we have concluded that FDES is ´"*a service system comprising of people, technology and processes, that provides a collaborative decision making environment for enhancing farmers' market and products' price decisions, by facilitating market information discovery, processing and making available the market information to all market actors via services packed in studios, recipes and suites"*.

From literature and exploratory results, a better understanding of an approach to design FDES was formulated around several concepts. Some of these concepts mainly comprise of key activities performed by farmers during market and price determination decisions, specific tasks that are to be undertaken to attain a particular decision outcome and processes that need to be carried out- including considerations of enabling technology. These have been structured and presented following the decision enhancement framework of Keen and Sol (2008) and covering the people, process and technology aspects. For the problem domain, key activities had to be identified through an abstraction exercise including their relationships. This is addressed in chapter 4.

Similar to Van Schaik (1988) discussions, FDES enhances farmers' decisions by facilitating collaborative decision making; and by mainly enabling information acquisition, information evaluation, action or choice taking and feedback and learning. Results equally suggest that FDES enhances farmers' ability in recognizing market and products' price problem existence, conceptualization, empirical definition of the problem, solution formulation, and leading to implementation. This is in line

[9]In a presentation titled "Smart Conversations for Smart Development: the Collagen Approach for Engaged Research" , which was presented at the Foundations of Government Information Leadership Workshop at Uganda Technology and Management University in Kampala, Uganda from 22-26 July 2013. Sol (2013) advances the principle of the 4Ps.

with the earlier arguments of Sol (1982) concerning choice making by decision makers who are faced with ill-defined problems.

7.5 Instantiation

Instantiation was carried out through prototyping and implementation of FDES as presented in Chapter 5. The purpose of instantiation was to measure the performance of the proposed farmers' decision enhancement services, a service packed in technology suites, services and recipes and underpinned by Keen and Sol (2008) notion of decision enhancement. Hence, from a philosophical perspective, the research at this stage sought to actualize an artefact in the form of an instantiation, see Hevner *et al.* (2004) and Gregor and Hevner (2013) among others. Generally, FDES instantiation was meant to demonstrate its feasibility both of the design process and of the resulting decision enhancement studio.

During instantiation, we epitomized FDES as a complex service system where introducing new technologies and methods may add further complexity to farmers' decision making process. This in addition may result in changes to existing farmers' decision making processes and requirements. Consequently, challenges were experienced during implementation and the evaluation exercise. Information was identified as the critical component of FDES since it is required to aid collaborative decision making among market actors. Hence, in understanding information requirements of farmers' decision making, it was necessary to break the critical component into sub-categories based on a generic ontology. At this stage, the search for an effective problem representation was crucial for finding an effective solution for enhancing farmers' market and price decisions. This is in agreement and in line with the knowledge base where Weber (2003) discusses design as an artefact.

Additionally, FDES functionality had to be instantiated based on identified activities and tasks, and by the aid of available technologies. There was need to improve our understanding of FDES instantiation, and specifically to examine mechanisms leading to its successful performance. Therefore, at the instantiation phase, the study re-directed efforts on the evocation of available resources in an unprecedented way to achieve a common farmers' decision making goal. At this stage of design and development, it was important to ensure instant representation of agricultural products' market actors, their decision issues, requirements, opportunities and constraints. In this way, the studio design and development may allow market actors to adjust and fine-tune their core activities, and hence benefit from the studio services. However, no single or special methodology was used to develop the studio, but instead a combination and adaptation of methods and empirical techniques with the overarching goal that the studio was: 1) highly user-friendly, 2) farm and user specific, 3) grounded on the best

scientific information available, 4) remaining relevant throughout time, and 5) providing fast, concrete, and simple answer to complex farmers' market and price inquiries.

At an empirical level, FDES instantiation strategy focused on web and sms services that enable market actors to send information requests, and receive feedback collaboratively. Pre-defined templates were necessary due to the heuristic nature of the farmers' market and price decision making process. These forms enable simple and easy information capturing and sending. On the other hand, users retrieve information via the search and browse functionalities. By the aid of AJAX capabilities, users were facilitated to easily retrieve information by just entering a single letter of an item required. All related items are displayed on the screen for the user to select.

Specifically, the studio verification mainly focused on service accessibility, enhancing creation of market identification process, enter and retrieve information on markets; creation of farmers' and buyers' profiles; entering and retrieving product and price information, and facilitating the communication process by linking farmers and buyers, tracking information requests, feedback transmission, managing FAQs and suggestions.

From the verification results, FDES performance was generally satisfactory. Participants were able to access and use the studio suites and services. They were also in position to recommend some modification and improvements to the studio design and implementation.

7.6 Evaluation Exercise

From the design science perspective, utility, quality and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods (Gregor and Hevner, 2013; Hevner *et al.*, 2004), which we have presented in Chapter 6. This exercise relates to observation and experimentation in design science as described by Nunamaker *et al.* (1991). Supplemented by the behavioral science theory, evaluation of FDES required the definition of appropriate metrics, gathering and analysis of appropriate data. Empirically, FDES evaluation was performed following the Keen and Sol (2008) constructs of usefulness, usability and usage. The evaluation exercise in addition utilized methods and techniques available within existing knowledge base. Therefore, we provide an epilogue of the evaluation process and its results under this section.

The evaluation exercise started with the planning step where we were able to reflect and re-define research domain perspective, set out our boundaries, re-define key stakeholders and their roles during evaluation, gain insight into available resources and agree on evaluation strategies with respondents.

Epilogue

Based on insights from user-centered methodologies (Van de Kar, 2004; Ryser and Glinz, 1999; Nielsen, 1993) among others, key decision scenarios were used to capture the studio's functionalities and constraints. Evaluation results were analyzed using non-parametric strategies (Brown and Saunders, 2008) because the instruments used generated ordinal data (Trochim, 2006; Brown and Saunders, 2008). Analyzed results are presented in chapter 6.

On usefulness evaluation, results show that the studio helps enhance farmers' market identification and price determination decision making process. There is also empirical evidence that the studio can enhance farmers' other non-market decisions- such as alerting a colleague in case of illness. Though this could need further investigation, results seem to suggest a direct relationship between the studio usefulness and the farmers' rate of sms use. Generally, the studio's usefulness is reflected on a number of decision tasks among which are:

- Facilitating effective market identification and selection,
- Promoting collaboration among farmers and other market actors,
- Enabling farmers have control of their products' prices,
- Easing information seeking, transmission and feedback.

On usability evaluation, the main aim was to measure *how* easy and understandable was the studio interface, language and context to the users. Whereas, users largely find the studio's usability satisfactory, there were some noticeable constraints. Requiring users to go through many steps was one of the constraints, (such as filling information submission forms and retrieving information). Secondly, there was a challenge obtaining market alternatives by farmers, hence, the need for a more simplified facilitated process was required. On language and layout of the content, users did not find any challenges. This could be due to the design strategy that promotes local content generation i.e. most of the market, product and price content is generated by the users themselves. In addition, the generic ontology employed, facilitates capturing of content based on locally used names, values and attributes.

Unlike the usefulness and usability evaluation, the usage evaluation was limited due to a number of factors outlined in chapter 6.

7.7 Summary and Research Agenda

Decision enhancement as advanced by Keen and Sol (2008) could drive progress in improving farmers' market access in developing countries. However, to understand any potential benefits, and overall effects on agricultural market environment, there is need to examine the organizational and social issues

surrounding farmers' decision making processes. This study focused on the farmers' market price decision making arenas with the case of two districts in Uganda. The results of this study could be used within a general research landscape to enable development of more research projects. In addition, the decision making research landscape portrays the process of research and how it relates to operational aspects of service delivery to farmers. Hence, in this section, we specifically focus our attention to briefly describe our contribution and some of the issues that require further consideration. Based on Gregor and Hevner (2013), this research is summarized in the table below:

Section	**Contents**
Introduction	The problem landscape presented in chapter 1 defines the relevance, the fit, relevance and goal of the study. The objective being to develop a market and price decision enhancement studio for farmers in Uganda.
Literature or the knowledge base	Prior knowledge regarding farmers' market and price decision making, their decision making practices are discussed, including different design approaches. The design approaches are particularly reviewed using the "ways of" framework. Similarly, literature on ICT and farmers' market and price decisions and covered. The knowledge base is used to enrich our understanding of both the instantaion and evaluation exercises.
Method	The study follows decision enhancement theory as in Keen and Sol (2008). Based on design science (Hevner, 2007; Hevner *et al*., 2004 among others), an inductive-hypothetical strategy is employed to better understand the farmers' market and price decision making arenas. This is followed by an exploratory field study involving groups of purposively selected farmers from the study areas. The exploratory study is discussed in chapter 3. Based on the "ways of" framework (Seligmann *et al*. 1989), and the three aspects of decision enhancement (Keen and Sol, 2008), an approach to design the studio is presented in chapter 4.
Artefact description	Based on a number of insights such as Diana *et al.*, (2009); Hevner *et al.*, (2004), the studio is instantiated and described in chapter 5. This involves prototyping and implementation among different groups of farmers.
Evaluation and	The studio was evaluated based on Keen and Sol (2008) constructs of

discussion	usefulness, usability and usage. These constructs were specifically evaluated using Liker scale (Knol, 2013; Jamieson, 2004). The evaluation results and discussions are presented in chapter 6. Generally, the results indicate the studio is useful among farmers since it meets their market and price decision needs. Hence, from landscaping to exploration, and to an approach to design the studio, the study contributes a theory for design and action (prescriptive knowledge) (Gregor and Hevner, 2013). A contribution to mitigating farmers' market and price decision making challenges adds to the descriptive knowledge base.
Conclusions	The overall work is presented in this thesis, including recommending a research agenda.

Contributions

Our study has equally contributed to the literature on decision enhancement, and particularly farmers' market and price decision making processes, in two ways: First, we develop, implement and evaluate a relevant artefact, the Farmers' Decision Enhancement Studio (FDES) targeted towards the farmers' market and price decision related tasks, and second we propose design principles for the problem domain. From the results of exploratory study and literature review, one of the key weaknesses with existing systems concerns the lack of awareness mechanisms among market actors. Awareness mechanisms are a critical requirement for group support systems (Kirsch-Pinheiro, et al., 2003) in general. For FDES, we have incorporated an "Alert Service" with the Communication Suite to facilitate capturing of information and relaying feedback to participants of interest via either e-mail and /or sms.

Research Agenda

Like any other scientific inquiry, this research creates an avenue for further investigations on farmers' market and price decision making arenas. Some of the issues that may require further exploration include:

- The subsistence nature of farming systems in developing countries,
- Specifically investigate the effect of sms usage on the studio utility,

- Other than market identification and price determination, there is need to identify and scope other activities that farmers may be involved in,
- There is need to explore how the different languages used by farmers may automatically be translated.

The subsistence nature of farming systems

During the research process, it was noted that many farmers practice subsistence farming, and grow different crops across different seasons. However, how this farmers' characteristic influences their market and price decision making process was not investigated. Hence, there is need to further investigate effects of these (subsistence) farming systems' characteristic of farmers (which involve different crop types) on the farmers' market and price decision making processes.

Investigate which effect sms-usage has on studio utility

Further research to investigate the impact of sms use rate on the studio's usefulness among farmers is recommended. Results sought to suggest that, farmers who frequently use sms in their market identification and price determination tasks seem to find the studio more useful. Such investigations could similarly be carried out based on the concepts of usefulness, usability and usage (as in Keen and Sol, 2008) of the studio.

Need to identify and scope further activities

In this study, we identified two core activities that farmers engage in making market and price choices. These include Market Identification and Price Determination activities. From these activities, we have proposed and modeled two key services including the Market Identification Service and Price Determinations Service. However, we feel there is need to identify and model more activities that farmers engage in while making market and price decisions. Moreover, activities are likely to vary from individual farmer's settings, technology, goals and capabilities among different farming communities.

APPENDICES

Appendix 1: Interview and Observation Guides

During exploration field studies, we used two sets of instruments covering mainly farmers, NAADS and other related agencies. Under this appendix, these instruments are presented.

Market and Price Decision Enhancement Services for Farmers in Uganda

1 Interview and observation guide for Farmers and Agro-produce dealers

Arriving at effective market and price choices for farmers has continued being a challenge despite the many interventions that have been put in place by governments and the donor community. Effective decision making is vital for improving farmers' production and farming systems, and most importantly their access to markets. This research is being conducted so that services that may support content acquisition, transformation and information delivery to farmers, including collaboration among farmers can be developed.

It is in this background that we are requesting a few minutes of your time for a short interview session, and a brief look and observation of your activities.

Thank you for your time and support.

Raphael Aregu

Investigator

Faculty of Economics and Business, University of Groningen, The Netherlands. Email: arnold_anyau@hotmail.com, raregu@rug.nl. Phone: +256782682088

1 Background information

1.1 Location and size of farm/business

Location:

Indicate the Size (in acres):

#	Size (Acres): 1 acre ~ 5000sqm	Tick only one that applies
a	1-5	
b	6-10	
c	11-15	
d	Above 15	

1.2 Indicate your highest level of Educational.

Table 1.2: Education level

#	Education level	Tick the highest level attained
a	Primary	
b	Secondary	
c	College	
d	University	
e	None	

1.3 Gender: Male …… Female ……[tick the one which is applicable]

1.4 Age of the farmer (years):

Table 1.4: Farmer's age

#	Age range	Tick the age range which is applicable to you
a	20-30	
b	31-40	
c	Above 40	

1.5 What is your total annual expenditure?

Table 1.5: Annual expenditure

#	Budget (Million UgX)	Tick the one that applies to you
a	Less than 5	
b	6-10	
c	11-15	
d	16-20	
f	Above 20	

1.6 What are your sources of funding?

Table 1.6: Sources of Funding

#	Source of funding	Tick all that apply, and if donor indicate the name of the donor
a	Own funds	
b	Government	
c	Donor(s)	
d	Other, give details	

1.7 How long has the farming activity been going on?

#	Duration of the farming activity (years)	Tick the one that is applicable to you
a	1-5	
b	6-10	
c	11-15	
d	Above 15	

1.8 What is the farm ownership type?

Table 1.8: Type of Farm ownership

#	Ownership type	Tick the most relevant one
a	Sole (includes family)	
b	Cooperative	
c	Group	
d	Association	
d	Other, give details	

2 Farm Characteristics

2.1 What are your objectives?

a ……

b ……

c ……

2.2 Which farming activities are you involved in other than crop cultivation? [REM: Verify through observations]

Table 2.2: Other farming activities

#	Farming activity	Tick all those that apply
a	Animal husbandry	
b	Poultry	
c	Apiary	
d	Others	

2.3 Which types of crops are you growing? [tick relevant ones] [REM: verify through observations]

Table 2.3: Types of Crops grown

#	Crops grown	Tick all those that apply
a	Beans	
b	Rice	
c	Maize	

d	Sweet Potatoes	
e	Groundnuts	
f	Simsim	
g	Other	

3 Knowledge of some decision support services

3.1 Which of the following service(s) are you aware off, also indicate there level of usefulness to you?

Table 3.1: Awareness of existing services

#	Existing service	Tick all that you are aware off	Indicate the level of usefulness[1-not useful, 2-useful, 3-very useful: please tick that which applies		
a	FoodNet		1	2	3
b	BROSDI		1	2	3
c	Farmers' Friend		1	2	3
d	Other, give details:		1	2	3

3.2 How did you get to know about them?

Table 3.2: How one got to know about existing service(s)

#	Radio	Tick all those that apply
a	Newspaper and press release	
b	Service Website	
c	Field staff	
d	Community members and group members	
e	Area local leader	
f	Through the web	
g	From radio announcement	
h	Others, give details	

3.3 What are the names of the providers or institutions offering those services?

…….

……

…….

……..

3.4 What types of services are provided by the above service (s) and which of those are relevant to you? [tick all those relevant]

Table 3.4: Types of services provided

#	Type of information	Tick all those that are provided	Tick all those that are relevant to you
a	Prices		
b	Traders, market and consumers'' contacts or opportunities		
c	Storage facilities		
d	Transport opportunities		
e	Credit and funding sources		
f	Policies and regulations		
g	Others		

3.5 How frequent do you make market and/or price decisions?

Table 3.5: Frequency

#	Frequency	Tick only one that is relevant to you
a	Daily	
b	Ones a week	
c	Ones a fortnight	
d	Ones a month	
e	Others, give details:	

3.6 What are the reasons for your frequency level of decision making?

a ……

b ……..

c ……

3.7 How useful is the service you get to your decision making needs?

Table 3.7: Usefulness of the current service(s)

#	Level of usefulness	Tick only one that applies
a	Very useful	
b	Useful	
c	Not useful	
d	Not sure	

3.8 What makes you seek service(s) from the above service(s)?

Table 3.8: Reasons for using the current service(s)

#	Reasons	Tick all those that apply
a	Lack of alternative service	
b	It is the best among those available	
c	I gain some improvement after using them	
d	It is being used by other farmers	
f	Others, give details:	

4 Farmers' Information needs

4.1 What types of market information do you often need, and which of them does current service(s) answer?

Table 4.1: Types of information needed

#	Type of information	Tick all those that are provided	Tick all those that are answered by current service(s)

a	Prices		
b	Traders, market and consumers'' contacts or opportunities		
c	Storage facilities		
d	Transport opportunities		
e	Credit and funding sources		
f	Policies and regulations		
g	Others, give details		

4.2 In which format would you prefer information to be available? [REM: verify those which may be observable]

Table 4.2: Preferred information presentation format

#	Preferred presentation format	Indicate the Rank from 1-3. 1-least relevant; 2-relevant; 3- most relevant
a	Printed copy	
b	Radio broadcast	
c	TV Broadcast	
d	Orally communicated	
e	Mobile phone SMSes	
f	Others, give details:	

4.3 How do you consider the information received from the current service(s)?

Table 4.3: Quality of information received

#	Information quality	Tick all those that apply
a	Relevant	
b	Timely	
c	Complete	
d	Accurate	

e	Current	
f	Consistent	

4.4 Are you consulted before information (content) is acquired by the service(s)?

Yes …….. No …….

4.5 Indicate your level of satisfaction on the way information (content) is acquired.

Table 4.4: Perception on content acquisition method (s)

#	Level of satisfaction	Tick only one that applies
a	Very Satisfactory	
b	Satisfactory	
c	Not satisfactory	
d	Not sure	

5 Service Development and Implementation

5.1 What method(s) of service delivery are best suitable for you and which ones are you using? [REM: Verify those observable]

Table 5.1: Preferred delivery method

#	Delivery method	Tick all those you prefer	Tick all those that you actually using
a	Radio or TV		
b	Newspaper		
c	Website		
d	From the web		
e	Mobile phone sms		
f	At resource centre/library		

g	Through cooperative, group members		
h	Leaflets		
i	Fax		
j	Others, give details		

5.2 Why are those chosen methods the best for you?

…….

……

……

Use of Mobile phones and SMS

5.3 Do you own a mobile phone? Yes ….. No ……

5.4 If yes, which make and model? [REM: verify through observations]

Make: ……..

Model: …….

5.5 Indicate which capabilities your phone has, and the ones that you use?

#	Capability	Tick all those that your phone has	Tick all those that you use
a	Basic functions (voice, sms, calculator etc)		
b	Web access		
c	Camera and video		
d	Radio		
e	Blue tooth		
f	Other, give details		

5.6 For how long (years) have you used a mobile phone to support your market and price decision making needs?

Table 5.7: Duration (in years) of using the mobile phone

#	Duration (years)	Tick only one that is applicable
a	Below 5	
b	5-10	
c	10-15	
d	above 15	

5.7 What type of market information do you receive using your mobile phone?

Table 5.5: Types of information received via mobile phone

#	Type of information	Tick all those that apply
a	Prices	
b	Traders, market and consumers'' contacts or opportunities	
c	Storage facilities	
d	Transport opportunities	
e	Credit and funding sources	
f	Policies and regulations	
g	Others, give details	

Is the mobile phone-based service user friendly to you?

5.8 Yes …….. No ……

5.9 If yes, what are the specific reasons for your use of mobile phone?

a ……

b ……..

c ……..

5.10 Do you pay for receiving information through your mobile phone?

Yes …… No ……..

5.11 Indicate your level of willingness to pay for the services you receive via your mobile phone.

Table 5.11: Level of willingness to pay for the mobile phone-based service

#	Level of willingness to pay	Tick only one that applies to you
a	Very Willing	
b	Willing	
c	Not willing	

5.12 Indicate your opinion on service pricing, how a payment for the service is collected; and how the service pricing could be improved?

#	#	Indicate your opinion
a	Service pricing	
b	How payment is collected	
c	How pricing and payment collection could be improved	

6 Challenges:

6.1 Which of these problems do you often face while attempting to reach at market/price decision? [REM: Obtain more details on each relevant one]

Table 6.1: Challenges faced

#	Problem faced	Tick all those that apply
a	Ignorance of information sources	
b	Availability of information	
c	Reliability of information sources	
d	Outdated information	
e	Language barrier	
f	Relevance and usefulness of information	

g	Presentation/poor format of information	
h	Lack of funds to acquire information	
i	Others, give details	

6.2 Are there any other improvement areas for the services you have been using?

Yes …….. No ……..

6.3 If yes, indicate them.

a …….

b …….

c ……

6.3 Briefly explain how these improvements may be implemented?

……
…….

……
…….

……
….

6.4 What other problems do you face for being a farmer?

a …….

b …….

c ……

6.5 Would you be willing to receive feedback? Yes ….. No …..

Thank you for your time and input

2 Interview and observation guide for existing service providers

Arriving at effective market and price choices for farmers has continued being a challenge despite the many interventions that have been put in place by governments and the donor community. Effective decision making is vital for improving farmers' production and farming systems, and most importantly their access to markets. This research is being conducted so that services that may support content acquisition, transformation and information delivery to farmers, including collaboration among farmers can be developed. This interview is being administered to among others NAADS, BROSDI, ASARECA and FOODNet.

It is in this background that we are requesting a few minutes of your time for a short interview session, and a brief look and observation of your activities.

Thank you for your time and support.

Raphael Aregu

Investigator

Faculty of Economics and Business, University of Groningen, The Netherlands. Email: arnold_anyau@hotmail.com, raregu@rug.nl. Phone: +256782682088

1 Background Information

1.1 Name and address:

1.2 State the date when service was set up, or established: ……

1.3 The service is:

Part of a parent organization ……

[Name of the parent Org] ……..

Existing as an independent entity.....

1.4 What are the objectives of the service?

a ……

b ……

c ……

d ……

1.5 What percentage of the users are, (indicate percentage):

Table 1.4: Percentage of service Users

#	**User Category**	**Percentage**
a	Farmers	
b	Local Produce dealers	
c	Importers	

d	Exporters	
e	Direct Consumers	
f	Supermarkets	
	Others (specify)	

2 How the service content is acquired?

2.1 How often are farmers' decision making needs conducted?

Table 2.1: Frequency of assessment

#	**Frequency**	**Tick the one which is most applicable**
a	Every two years	
B	Annually	
c	Semi annually	
d	Quarterly	
e	Monthly	
f	Weekly	
g	Daily	
h	Others (specify)	
i	Never	

2.2 Before starting the operation, did you find out about the other service(s)?

Yes …….. No ……..

If Yes, indicate their names and the services they provide

Table 2.2: Service(s) that existed before operationalizing your service

#	Name of service	Indicate Service(s) Offered
a		
b		
c		

2.3 If yes, indicate their names and contact details:

2.4 How do you acquire information (content) for the service: [Give details on each applicable one]

Table 2.4: Methods of acquiring content

#	Method of acquiring content	Tick all those that are applicable
a	Internally generated from staff of the organization (IGS)	
b	Purchased (PU)	
c	Submitted by farmers & other users (F&OS)	
d	Donations (Ds)	
e	Downloaded from similar service(s)/ Web links (www)	
f	Others (specify):	

2.5 How is information/information sources obtained by the service?

Table 2.5: How information is obtained

#	**How information is obtained**	**Tick one all those most relevant**
a	The company looks for information	
b	Based on farmers' request for the information	
c	On request and recommendation by farmers	
d	Based on request from other stakeholders	
e	Others: give details	

2.6 What type of market information do you provide support farmers decisions?

Table 2.6: Types of Information Provided

#	**Information Type**	**Please tick all those that apply**	**Assign Relevance Ranks 1-3: 1- Not relevant; 2- Relevant; 3- Very Relevant**
a	Information on current prices		
b	Forecast of market trends		
c	Improved/required market standards		
d	Opportunities for group marketing		
e	Traders' contacts including their price offerings		
f	Storage opportunities		
g	Distribution and transportation		
h	Trade and market regulations and access		
i	Location and types of credit sources		

j	Loan terms and conditions		
k	Others, (please specify):		

2.7 Indicate other types of information that you don't provide but would be beneficial to farmers' decision making process.

Table 2.7: Other beneficial Information Types not provided

#	**Type of Information**
a	
b	
c	

3 Content Packaging (and re-packaging) and Storage

3.1 Which of the content (or information) packaging and re-packaging activities do you carry out? [tick all those relevant]

Table 3.1: Packaging and re-packaging activities done

#	**Activity (ies)**	**Tick all those which are relevant**
a	Selective Dissemination of Information (SDI) to users	
b	Language Translation	
c	Text Indexing	
d	Keyword/subject generation	
e	Content classification	
f	Cross referencing	
g	Others: give details	

3.2 Which media is used for storing the acquired content/ packaged information?

Table 3.2: Information Storage media

#	**Storage Media**	**Tick all those that apply**
a	Printed (in library resource centre etc)	
b	Centralized Database/Repository/server	
c	CDs	
d	External Database/Repository/server	
e	Others: give details.	

3.3 Indicate any software used to support content storage and retrieval?

Table 3.3: Software used for storage (Circle all those that apply)

#	**Databases**	**Word Processors**	**Web based**	**Spreadsheets**
a	Ms Access	Ms Word	PHP	Excel
b	MYSQL		HTML	
c	Imagic			
d	WINISIS			
f	Others (specify)			

3.4 Indicate your knowledge and use of any of the following metadata standards.

Table 3.4: Knowledge and use of metadata standards

Standard	Tick all standard (s) known to you	Tick those you are using	Indicate how it is being used (refer to the list below and put the relevant roman numbers)
AGROVOC			
AGRIS AP			
AgMES			
Others			

[**REM**: How metadata standards may be used (i)

- Generating Item datasets for indexing (ii)
- Support summarization of information (iii)
- Support information cross-referencing (iv)
- Ease information delivery to users (v)
- Ease users' inquiries (vi)
- Managing inventory of information datasets and resources (vi)]

3.5 Indicate the level of usage, Understandability, Ease of training and learning, and Availability of the metadata standards[10].

[10] The AgMES (Agricultural Metadata Element set) initiative was developed by the Food and Agriculture Organization (FAO) of the United Nations and aims to encompass issues of semantic standards in the domain of agriculture with respect to description, resource discovery, interoperability and data exchange for different types of information resources.

Table 3.5: Evaluating metadata standards

#	#Metadata Standard	True	Falls	Briefly give an explanation for your choice
a	Is useful			
b	Is easily understood			
c	Easy to train users to adopt it			
d	Staff and Users easily learn to use it			
e	It is readily available			

Yes…….: No. …….. Don't Know ……..

3.6 What improvements would you feel could be made on the metadata standards?

Table 3.6: Improvements to Metadata Standards

#	Improvement	How to implement
a	Translation to local language	
b	Training	
c	Add codes	
d	Generating manuals	
e	Other	

3.7 Are there any other storage improvements you would wish to recommend? Yes ……: No …..

3.8 If Yes, what are they:

i). ……

……

……..……..

3.9 Are there any other packaging (and re-packaging) improvements you would wish to recommend? Yes …….; No. ……..

3.10 If yes, name them.

……..

……..

……

4 Service Development and implementation

4.1 Indicate the stages you go through when developing the service.

Table 4.1: Stages followed in developing service

#	Stage	Tick all those that are relevant
a	Feasibility studies (Problem Identification)	
b	Collect target User requirements	
c	Consulting and involving other stakeholders	

d	Identify useful development methods	
e	Identify existing applications and tools	
f	Analyze and interpret requirements	
g	Development and Implementation	
h	Testing	
i	Deployment	
j	Others:	

4.2 (i) Indicate the software (and equipments) used by your organization to develop the service.

Table 4.2: Software used for developing service

#	Software	Tick all those that apply
a	WINISIS	
b	INMAGIC	
c	MYSQL with PHP	
d	FrontLineSMS	
e	PlaySMS	
f	RapidSMS	
g	OpenXdata	
i	Other (Specify):	

4.2 (ii) How do you acquire the software?

Bought ……. Open Source ……

4.3 (i) How many staff operates the service?

Number Staff: Male …….. Female ……

4.3 (ii) Indicate the specialization of the service staff:

Table 4.3 (ii): Specialization of the service Staff

#	**Specialization**	**Tick all those that are applicable**
a	Computer/IT Scientists	
b	Agriculturalists	
c	Information Scientists	
d	Marketing specialists	
d	Others (Specify):	

4.4 Are there any specialized skills needed by those staff that develop and implement the service?

Yes …….. No …….

If Yes, indicate them, including how they may be acquired.

Table 4.2: Needed skills for service Development

#	**Required skill**	**Tick all those that apply**	**Indicate how the skills may be acquired**
a	Training on PHP, Java etc		
b	Public Relations		
c	Documentation and SDI		
d	Operating systems installation, configuration and use		

e	Server system installation, configuration and use		
f	Others: give details		

4.5 Briefly indicate how the implementation of service was done?

……

……

4.6 Was service testing done prior to deployment?

Yes:…… No. ……

4.7 If Yes, how was the testing conducted?

……..

……..

4.8 How were test results implemented?

……

……

……

4.9 Are there any development and implementation methods you consider necessary?

Yes ……. No. …….

4.10 If Yes, what are they?

……

……..

……

5 Information delivery

5.1 How do users get to know about the available services offered by your service? [Tick all those applicable]

Table 5.1: Methods of publicizing service to Users

#	Method of publicizing service to users	Tick all those that apply
a	Press releases	
b	Mobile phone SMSes	
c	Service Website	
d	From the web	
e	Field staff visits and meetings	
f	Service website	
g	Radio and TV	
h	Friends and relatives	
i	Others: give details	

5.2 What delivery media do you provide and which one(s)-do farmers prefer?

Table 5.2: Delivery medium and their preference by farmers

#	Delivery method	Tick all those that	Indicate level of preference by

		apply	**farmers:** **1-less preferred; 2-preferred; 3-most preferred**
a	Mobile phone SMSes		
b	Own Website		
c	Through the web		
d	Field staff		
e	Radio and TV		
f	Newspapers		
g	Farmers networks and groups		
h	Family system		
i	Others: Specify:		

5.3 What factors made you to choose the above delivery media?

a ……

b ……

c ……

d ……..

5.4 Which of the delivery media do feel is/(or are) most cost effective to you and /or to the farmer?

Table 5.4: Preference of delivery media

#	**Delivery media**	**tick all those that apply To you**	**tick all those that apply to the Farmer**
a	Mobile Phone SMSes		
b	Own Website		
c	Google search		

d	Field staff		
e	Radio and TV		
f	Newspapers		
g	Farmers networks and groups		
h	Family system		
i	Press releases		
j	Others: Specify:		

5.5 Which delivery media do you consider most sustainable to you and /or to the farmer? [**rank from 1-3; 1-least sustainable; 2-sustainable; 3-most sustainable**]

Table 5.5: Sustainable delivery media

#	**Delivery media**	**From 1-3, rank all those that apply to you**	**From 1-3, rank all those that apply to the Farmer**
a	Mobile phone SMSes		
b	Own Website		
c	Through the web		
d	Field staff		
e	Radio and TV		
f	Newspapers		
g	Farmers networks and groups		
h	Family system		
i	Others: Specify:		

5.6 Do you have the means for collecting information available from other related sources/external information services for delivery to farmers?

Yes ……. No ……..

5.7 If Yes, name the sources and how this is done?

Table 5.7: External Information Sources and how they are used

#	**External Source**	**How information is obtained from it**
a		
b		
c		
d		

5.8 Do you charge farmers for the information services?

Yes ……. No ……

5.9 If Yes, indicate how much is charged, how it is collected, and derived?

Amount: ……..

How it is collected: …….

……

……

How it is derived: …….

……

……

5.10 What is the aim of charging for the Service(s): [Tick those most relevant to you]

Table 5.10: Aim of charging farmers for the service

#	Goal	Tick all those that apply
a	Partial cost recovery	
b	Gain profit	
c	Reinforcing the value of the service	
d	Discouraging non-core users	
e	Others: give details:	

5.11 How do you rate the farmers' response to paying for the service?

Table 5.11: Farmers' response to paying for service

#	Response	Tick the most applicable one
a	Good	
b	Fair	
c	Bad	

5.12 Use of Mobile Phones

5.12(i) what capabilities of mobile phones do you expect farmers to have and which ones are they actually using?

Table 5.12(i): Phone capabilities

#	Capability	Tick all those that You Expect	Tick all those that are actual being used by farmers
a	SMSes and voice		

b	MMS		
c	Web Browsing		
d	Video		
e	Others, give details:		

5.12(ii) What level of mobile SMS-based service are you providing, and which ones are actually used by farmers?

#	**Level of sms-based service**	**Tick all those you are providing**	**Tick all those being used by farmers**
a	Text Blasting (bulk sms)		
b	Keyword response		
c	Smart texting		
d	Others, give details		

6 General Problems

6.1 Are there any specific problems faced in operating the service?

Yes ……. No. ……..

6.2 If Yes, what are these problems?

a ……

b ……..

c ……

d …….

6.3 Briefly explain how these problems are address

……..……
……
…..

6.4 Are users involved in generating solutions to these problems?

Yes. …… No. ……

6.5 If Yes, briefly explain how this is done?

……

……

.....

7 Sustainability Issues

7.1 What is the approximate annual current budget of the service (in UGX):

Table 7.2 Service Annual budget

Annual budget (Millions)	**Tick the one that is applicable**
Below 5	
5 – 20	
20 – 40	
40 – 60	
Above 60	

7.2 What percentage of the budget is funded by:

Table 7.3: Service percentage sources of funding

#	**Funding source**	**Percentage**
a	Public funds	
b	Membership fees	
c	Donor support	
d	Income from information services & products	
e	Income from other services	
f	Others, (Specify)	

(**REM**: If service is part of a parent organization, find out whether):

a) The allocation is specifically for the service?: Yes …. No ……

b) If Yes, how is the budget allocated:

Allocation method	**Tick the one that is applicable**
Regularly based on the policy of parent organization	
Ad-hoc basis	
Others, give details	

c) If No, what then is the total service annual budget? …….

8 Recommendations

8.1 Are there any additional suggestions you wish to make concerning acquisition, transformation and delivery of market information to rural commercial farmers?

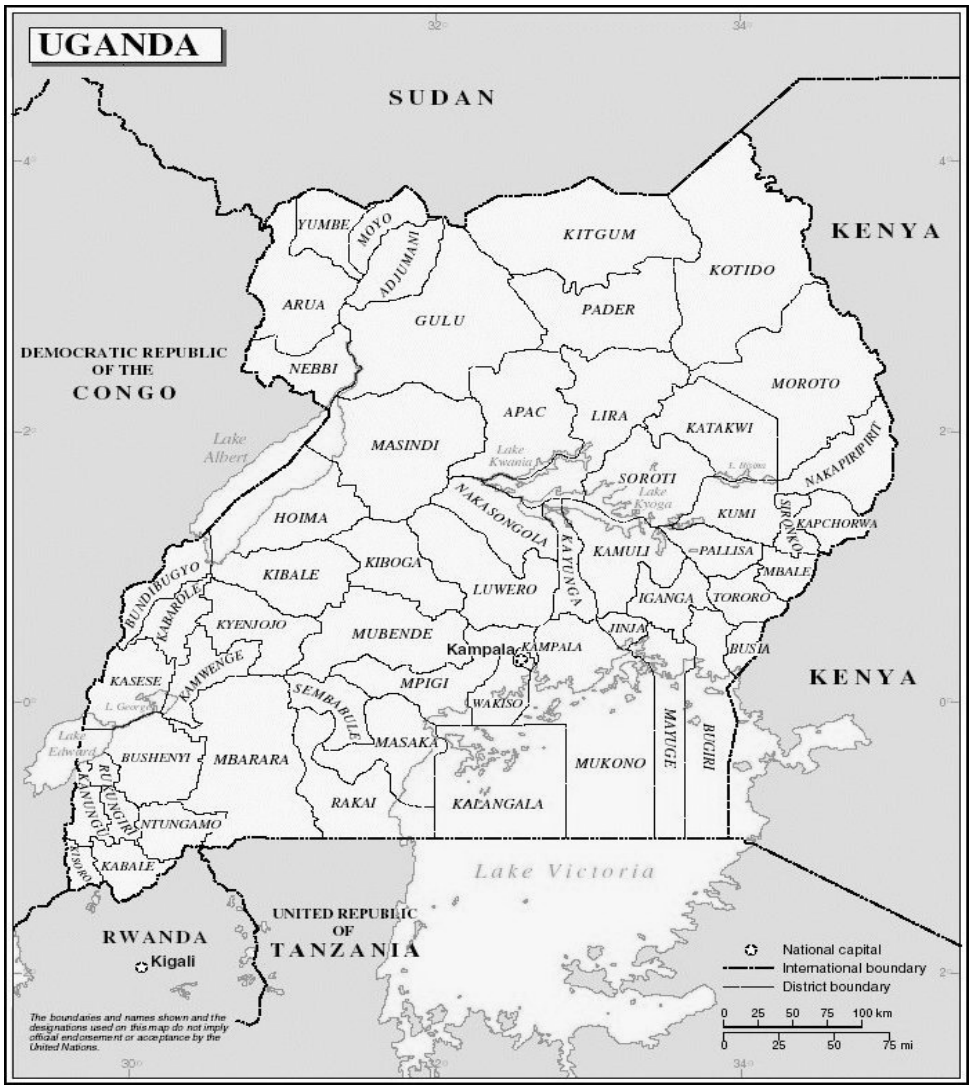
a ……..

b ……

c ……

Thank you for your time and efforts.

Appendix 2: Map of Uganda showing Gulu and Soroti Districts



Appendix 3: Evaluation Questionnaire

i) Perceived Usefulness

Informants were requested to indicate how much they agree or disagree with each of the following statements by encircling the applicable point on the right hand scale-by encircling only one scale against each of the statements.

Usefulness	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
1. Using FDES enhances my decision making on market and price choices	4	3	2	1
2. I find FDES services useful for even my other non-market decision tasks	4	3	2	1
3. I don't see any advantage in using FDES during my product pricing decisions	4	3	2	1
4. I cannot make decisive market decisions using FDES services	4	3	2	1
5. I would prefer to achieve the same tasks of selling my product without using FDES	4	3	2	1
6. FDES services enable me have greater control over the price of my products	4	3	2	1
7. I would not recommend FDES to my friends since it does not assist in crucial market decisions	4	3	2	1
8. FDES Suite guidelines need to be modified for a number of reasons	4	3	2	1
9. FDES suites provide environment I need for making valuable product buyer selections	4	3	2	1

ii) Perceived Usability

FDES usability test is intended to determine the extent it facilitates a farmer's ability to complete routine market identification and price determination tasks. Typically the test is conducted with a group of farmers and traders in a usability testing room and remotely (using mobile software and telephone connection). Users are asked to complete a series of routine tasks under the guidance of a facilitator. Sessions are recorded and analyzed to identify potential areas for current and future improvement

Usability	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
10. The interface explains itself and I can easily use it	4	3	2	1
11. I have to go through irrelevant steps in order to get the information I want	4	3	2	1
12. Learning to use FDES is not easy for me	4	3	2	1
13. I am able to access different market alternatives using FDES services	4	3	2	1
14. I have experienced difficulties using FDES functionalities	4	3	2	1
15. I can use and understand the terminology used in FDES	4	3	2	1
16. The way information is generated makes it easy to determine product prices	4	3	2	1

iii) Perceived Usage

Usage evaluation is concerned with how market actors perceive added values of FDES and efforts needed to use it.

Usage	Strongly Agree	Agree	Disagree	Strongly Disagree
17. FDES services have added value to my product's market and price decisions	4	3	2	1
18. I can assist my other colleague sell his product using FDES services	4	3	2	1
19. I can only use FDES to identify a market with assistance	4	3	2	1
20. I am unable to submit market information request and obtain feedback via sms	4	3	2	1
21. Contents of sms feedback are not conclusive enough to enhance my effort in selecting a buyer	4	3	2	1
22. I find FDES Useful for all farmers in Uganda who are engaged in market identification decisions	4	3	2	1

Thank you for your time, dedication and feedback.

Appendix 4: Guidelines on How to Use the Studio Suites

A. Market Identification Suite

i) Market Details Information via the web interface

To access and use the sub-suite, users follow the following sequence:

- Log into the studio main page (or home page), and Choose the Market Identification Menu of the FDES,
- If submitting a new market details information, select the Market Details submission Form,
    - Do not Change the ID as this is generated automatically, users have no rights to change it,
    - Fill the Form with all the information needed,
    - Add additional information under Others,
    - If finished, select view to view what is filled and verify,
    - Confirm, then select Submit to submit the information filled,
    - Repeat the process for another new submission by selecting Yes from the dialogue box presented, otherwise select No to end.
- If wanting to identify a market, perform a Search or Browse
    - If a Search, use a known name of the Market, Sub-County or Village
        - Enter relevant keyword above and select search, view and review the results
        - Repeat the Search by changing the keywords e.g. Market Name, Sub-County Name, or Village Name
    - If Browse, select the List of Markets, which is arranged alphabetically by sub-county
        - Browse and select the desired market(s) by ticking on the left box provided against each market name,
        - If finished, select Generate to obtain a list of selected market(s),
        - Either evaluate the list on Screen or select Print, to obtain a print a copy.

ii) Market Details Information-sms interface

Obtain the service dedicated telephone number(s) from a colleague, publication guides or by visiting the service web page at.

a) Submitting information on market details

- Type a short message containing your name, market name, sub-county name, village name, product preference, price etc
- Send the sms via the service phone number(s).

b) Want to identify a market

- Type and send sms containing your name, product name, product price, and phrase "MarketNeeded",
- Send the sms to service phone number,
- Pay attention to market alerts sent by the service to your phone number.

Detailed sms gateway instructions:

How do we send the sms to users

1. The source of telephone numbers is got from users who posted into alert submission form via the alert submission and feedback management; or via the contacts submission forms.
2. The sms are downloaded from the web based interface by the facilitator, and by checking the selected telephone(s), who then proceeds to type the message to be sent to selected users (via their phone numbers).
3. The sending of sms is performed using the Ozeki sms gateway installed on the local machine. This is because Ozeki does not work via web-based interface.
4. Access the linked form from the web-based interface to the sms system on desktop or laptop computer where Ozeki is installed.
5. The sms from the web interface will be posted to a database linked to Ozeki, then the sms gateway will sense that there is a new message inserted into "my database". If the sim card inserted into a modem or any phone which can support Ozeki is connected to the computer and there is credit in the sim card, the message will be processed and then to the specified phone number. The user should be able to receive the message on his/her phone.

iii) Transport and Other Logistics Opportunities Services

The service is implemented following the steps below:

- From the Market Identification Suite, select Transport and Logistics menu,

- If wanting to get transport means, do any of the following:

a) From the menu, select the Transport Information Request Form, and fill in your name, contact, product name and quantity, how long transport is needed, destination(s), etc.

b) Obtain the facilitator's or service phone number and either send an sms or call and provide your name, location, product name and quantity, how long transport is needed, destination(s), etc.

c) Login into the service web based interface and search using desired keywords; or Browse by selecting from drop down menu or from the list by ticking, then select Generate to populate the selected list.

- If wanting to submit (as in a provider) transport availability and looking for one to hire:

a) Select the Transport Information Submit Form and fill in your name, contact, transport type and capacity, cost, how long transport is available if hired, desired destination(s), then select Submit to submit the information, or

b) Obtain the facilitator or service phone then either call and/or send an sms and provide the same details as in (a) above.

B) Price Determination Services

i) *Product/Price Details Services*

To use the sub-suite, follow the sequence below:

a) If submitting product's details and price

- From the Product/Price Sub-Suite, select Product/Price Information Submission Form,
- Fill the Form as indicated,
- Review the form to confirm correctness of information filled,
- Press the Submit option below the form and submit the information filled,
- You will be asked whether you need to submit information for another product, select Yes, to repeat the same process for another product, else, select No.
- You will receive a text message, an email response confirming your submission
- If using phone submission, send an sms containing the same details above to the central service number, or call the facilitator directly.

b) If looking for a product to buy (for buyers)

- Enter a search keyword using either of the Product Name, Sellers Name or Market Name,
- Browse the list of products arranged alphabetically, and select the one(s) of your interest,

- Or select the Information Request Form, fill in the details of the product you require and your details and then Submit; you will be alerted via sms or email ones the product you need is available,
- From the Farmers' Profile sub-menu, obtain the Farmers' (or sellers) phone number and either send an sms to the seller, or call and talk directly with the seller,

ii) Buyers' and Farmers' Profiles Services

To use the profile services, users go through the following sequence:

a) Profiles Creation

Select the respective Profiles Submission Form from the Buyers' or Farmers' Profiles sub-menus and fill with the relevant information. Verify that the information filled is correct and press Submit to submit the information.

b) Using profile details to enhance decision making

- The facilitator matches users' information requests with available product/price or market information. Where results match a particular information request, the facilitator sends the information via email or sms, or calls the individual users based on users details extracted from the respective user profile,
- The buyers' can query via the studio web interface, the farmers' profiles to obtain the kind of product on offer and their respective prices, if the query matches a particular farmer, the buyer directly or via the facilitator contacts the concerned farmer,

Appendix 5: Open-ended Evaluation Questionnaire

Demographics

The questionnaire aims to give us an outline of your opinions regarding the usefulness, usability and usage of FDES. Please kindly answer the questions by completing with sincerity your characteristics and preferences.

Age: Under 20 ____ 20-25_____ 25-35_____ Above 35_____

Education: Primary_____ Secondary____ Above Secondary_____

Gender: Male_____ Female_____

Internet Use: Not at all____ Regularly_____ Frequently_____

SMS Use: Not at all_____ Regularly_____ Frequently_____

What is the reason of using Internet or SMS:

Locate Market_____ Contact Buyer_____ Reach fellow Farmer_____

Know Product Price____ Announce Product_____ Agree price with Buyer___

Under question below, give us you're an outline of your satisfaction with the use of FDES. Please answer the questions by providing brief and concise responses in bullet form.

1.0 Usefulness

- 1.1 How significant is the role of relevance of information generated by FDES
- 1.2 Give some suggestions that you feel can improve usefulness of FDES
- 1.3 Can FDES enhance your market access agility, if not give reasons

2.0 Usability

- 2.1 Indicate one factor that constrains your effective use of FDES
- 2.2 What is your feeling on FDES interface layout?
- 2.3 How can FDES usability be made even much better

3.0 Usage

- 3.1 How can the benefits of FDES be extended to other potential users
- 3.2 In your view, should users pay for FDES services? If yes, give a brief how?

Thanks you for you kind contributions

Appendix 6: Information Request and Submission Forms

1. *Product Owner Details Submission Form (Farmer Profiles*)

The form consists of three parts namely: product owner information, product information, and suggested buyer information. By filling and submitting this form, the farmer provides information about him/her, declares the kind of product he/she has for sale by providing the product details.

A: Name of Product Owner (Farmer): ……..

Phone Number (Mobile): ……

Email Address: ……

Village (LCI): ……Sub-Parish: ……

Parish: …… Sub-County: ……

B: Product Name: ……..

Product Quantity: …….

Product Reserve Price: …….

C: Potential Buyer Name (if identified): ……

Phone Contact (mobile phone): ……

Email Address: ……

Village (LCI): …… Sub-Parish: ……

Parish: …… Sub-County: ……

2. Buyer Profile Submission Form

The form consist of three parts namely: buyer contact information, buyer product preference, and suggested product owner contact.

A: Name of Buyer: ……;

Phone Number (Mobile): ……

Email Address: ……

Village (LCI): …… Sub-Parish: ……

Parish: …… Sub-County: ……

B: Product Preference:

Product Name: ……..

Product Quantity Required: …….

Product Price Offer: …….

Date when product is required: ……..

Place of delivery (if different from Buyer's contact above): ……

C: product Owner Details

Potential Owner Name (if identified): ……

Phone Contact (mobile phone): ……

Email Address: ……

Village (LCI): …… Sub-Parish: ……

Parish: …… Sub-County: ……

3. Transport and other Logistics Opportunities Submission Form

This form is used by transport and /or storage facilities' owners to declare the kind of transport/storage they have, while farmers as well as buyers use the form for submitting information requests for transport and storage opportunities.

a) Transport Means Declaration Form

Name of Transport/Storage facility owner: …….

Capacity of the facility (in tons): ……

Phone contact (mobile): …… Email Address: …….

Village (LCI): ……. Sub-Parish: …….

Parish: …… Sub-County: …… District: ……

Costing (shs): Per Day: …… Per Week: …… Per month: …….. Per ton: ……

Per Kilometer (transport): …….

b) Requests Submission for Transport/Storage Opportunities Form

Name of Transport/Storage Requester: …….

Capacity of the facility needed (in tons): ……

Phone contact (mobile): …… Email Address: …….

Village (LCI): ……. Sub-Parish: …….

Parish: …… Sub-County: …… District: ……

Costing range desired(shs): Per Day: …… Per Week: …… Per month: ……..

Per ton: …… Per Kilometer (transport): …….

Dates or duration: …… Destination: ……..

Other relevant information: …….

……

4. Available Market Opportunity Submission Form

This form is used by the facilitator or any other market participant with the knowledge of any available market opportunity. In this way, market actors share information on available markets by self-posting the information via a web-based interface. Actors who cannot access the web based interface, can send an sms to the facilitator who will submit the information to the shared repository by using this form. The form template is presented below, and is accessible from the Market Details Information menu of the Market Identification Suite.

Name of the Market: …… Dates and Days of Operation: ……..

Location of the Market:

Village (LCI): ……. Sub-Parish: ……

Parish: ……. Sub-county: ……..

County: …… District: ……..

Products Traded at the Market:

Product Names: ……

Required Quantities: …….

Regular Prices: …….

Market Dues: …….

Phone (mobile) Contact if any: ……

5 **Product Details Submission Form**

Product ID: ……. Product Name: …….

Product Quantity: …… (tons) Product price: ……

Product Owner Details (if known):

Name of Product Owner (Farmer): ……..

Phone Number (Mobile): ……

Email Address: ……

Village (LCI): ……Sub-Parish: ……

Parish: …… Sub-County: ……

References

Aalst, W.M.P., Hofstede, A. & Weske, M. (2003). Business process management: a survey. Lecture Notes on Computer Science: Business Process Management, 2678.

Ackoff, R.L. (1978). The Art of Problem Solving: Accompanied by Ackoff's Fables, Wiley, USA

Adam, S., Brewer, M. & Walker, I. (2005), Modeling Take-Up of Family Credit and Working Families' Tax Credit, Inland Revenue Working Paper 1a, Accessed 20th October, 2012, From: www.hmrc.gov.uk/research/).

Adomi, E. E., Ogbomo, M. O. & Inoni, O. E. (2003), "Gender factor in crop farmers' access to agricultural information in rural areas of Delta State, Nigeria". Library Review, 52(8), 388-393.

Aker, J.C.(2011). Dial "A" for agriculture: using information and communication technologies for agricultural extension in developing countries. Conference Agriculture for Development-Revisited. University of California, Berkeley. 1–32.

Aker, J. C. (2010). Information from markets near and far: mobile phones and agricultural markets in Niger. American Economic Journal: Applied Economics, 2, (July), 46-59

Aker, J. C., and Mbiti, I. (2010). Mobile phones and economic development in Africa. Journal of Economic Perspectives. 24(3). 207–232.

Alam, I. and Perry, C. (2002). A customer-oriented service development process. Journal of Services Marketing, 16 (6), 515-534.

Ali, J. and Kumar, S. (2010). Information and communication technologies (ICTs)and farmers' decision making across the agricultural supply chain. International Journal of Information Management, 11 pages, Accessed July 28th, 2010 from Elsevier online database.

Alonge, A.J. (2004). Between government and market failure: Issues, perceptions and policy challenges in reforming public sector extension services in Sub-Saharan Africa. Proceedings of the 20th Annual Conference of the Association of International Agricultural Extension and education (AIAEE), Dublin Ireland.

Alter, A. (1996). Information systems: a management perspective. New York: Benjamin Cunnings.

References

Alvarez, J. and Nuthal, P. (2006). Adoption of computer-based information systems: the case of dairy farmers in Canterbury, Newzealand, Florida and Uruguay. Computers and Electronics in Agriculture, 50, 48-60.

Ambriola, V. and Gervasi, V. (2003). The circle approach to semantic analysis of natural language requirements. Technical Report, TR-03-05, Pisa, Italy.

Amiyo, R.M. (2012). Decision enhancement and business process agility. PhD Thesis, Groningen University, The Netherlands.

Antonelli, C. (1991). The diffusion of advanced technologies in developing countries. Paris, OECD.

Antunes, F., Melo, P. & Costa, J.P. (2007). Information management in distributed collaborative systems: the case of collaboration studio. European Journal of Operational Research, 177, 1385-1399.

Arnott, D. (2006). Cognitive biases and decision support systems development: a design science approach. Information Systems Journal, 16, 55-78.

Arunthari, S. (2005). Information technology adoption by companies in Thailand: a study of enterprise resource planning systems usage. A doctoral dissertation, University of Wollongong, Thailand

Asfaw, A., & Admassie, A. (2004). The role of education on the adoption of chemical fertilizer under different socioeconomic environments in Ethiopia. Agricultural Economics, 30(3), 215-228.

Aubry, C., Papy, F. & Capillon, A. (1998). Modeling decision making processes for annual crop management. Agricultural Systems, 56(1), 45-65.

Avgerou, C. (2005). Doing critical research in information systems: some further thoughts. Information Systems Journal, 15, 103-109.

Avgerou, C. and Corenford, T. (1998). Developing information systems, issues and practice. 2nd ed. Palgrave: Great Britain.

Avison, D.E., and Fitzgerald, G. (2003). Information Systems Development: Methodologies, Techniques and Tools, (3rd ed.) McGraw-Hill, London.

Babar, M.A., Lago, P. & Van Deursen, A. (2011). Empirical research in software architecture: opportunities, challenges and approaches. Empire Software Engineering, 16, 539-543.

Bahill, A.T. and Henderson, J. (2004). Requirements development, verification, and validation exhibited in famous failures. Systems Engineering, 8(1), 1-14.

Ballsun-Stanton, B. (2010). Asking about data: experimental philosophy of information technology. Proceedings- 5th International Conference on Computer Science and Convergence Information Technology, ICCIT 2010, 119-124.

Barjis, J. (2009). Collaborative, participative and interactive enterprise modeling. In J. Filipe, & J. Cordeiro (Eds.), Enterprise Information Systems (Vol. 24 Lecture Notes in Business Information Processing, pp. 651-662). Heidelberg, Berlin, Germany: Springer.

Batt, R., Nohara, H. & Kwon, H. (2010). 'Employer strategies and wages in new service activities: A comparison of co-ordinated and liberal market economies. British Journal of Industrial Relations, 42(2), 400- 435.

Beckford, C.L. (2002). Decision making and innovation among small-scale yam farmers in central Jamaica: a dynamic, pragmatic and adaptive process. The Geographical Journal, 168(3), 248-259.

Beizer, W. (1996). IEEE black box testing: techniques for functional testing of software and systems. Wiley.

Benin, S., Nkonya, E., Okecho, G., Pender, J., Nahdy, S., Mugarura,S., Kato, E. & Kayobyo, G. (2007). Assessing the Impact of the National Agricultural Advisory Services (NAADS) in the Uganda Rural Livelihoods: IFPRI Discussion Paper 00724, October

Bernard, H.R. (2002). Research methods in anthropology: qualitative and quantitative methods, 3rd ed. Altamira Press: Walnut Creek, CA.

Bernstein, P.A. and Haas, L.M. (2008). Information integration in the enterprise. Communication of the ACM, 51(9), 72-79.

Beulens, A.J.M., Broens, D.-F., Folstar, P. & Hofstede, G.J. (2005). Food safety and transparency in food chains and networks – relationships and challenges. Food Control 16 (6), 481–486.

Bhattacherjee, A. (2001). Understanding information systems continuance: an expectation-confirmation model. MIS Quarterly, 25, 351-370.

References

Bhavnani, A, Chiu, R W, Janakiram, S & Silarszky, P. (2008). The role of mobile phones in sustainable rural poverty reduction. ICT Policy Division, Global ICT Department, The World Bank. Retrieved 2nd October, 2009

From:http://siteresources.worldbank.org/extinformationandcommunicationtechnologies/Resources/The_Role_of_Mobile_Phones_in_Sustainable_Rural_Poverty_Reduction_June_2008.pdf

Bijman, J. and Wollni, M. (2008). Producer organizations and vertical coordination: an economic organization theory perspective. Paper presented at the International Conference on Cooperative Studies, 7-9 October, Koln, Germany.

Bijman, J., Omta, S.W.F., Trienekens, J.H., Wijnands, J.H.M & Wubben, E.F.M. (eds.) (2006). International Agri-Food Chains and Networks: Management and Organization. Wageningen: Wageningen Academic Publishers.

Blomkvist, J. and Holmlid, S. (2010). Service prototyping according to service design practitioners. Second Nordic Conference on service design and service innovation.

Boehm, B.W., Grunbacher, P. & Briggs, R. (2001). Developing groupware for requirements negotiation: lessons learned. IEEE Software, May/June, 46-55.

Boehm, B.W. (1981). Software engineering economics. Eaglewood Cliffs, NJ: Prentice-Hall.

Boehm, B. W. (1988). A spiral model of software development and enhancement. IEEE Computer, 21, 61-72.

Boon, M.A.A., van der Mei, R.D. & Winands, E.M.M. (2011). Application of polling systems. Surveys in Operational Research and Management Science, 16(2), 67-82.

Bowen, S. (2010). Critical theory and participatory design. CHI conference proceedings, April, 10-15, Atlanta, Georgia, USA.

Brian, L. C., Wust, J. & Lounis, K. (2001). Replicable case studies for investigating quality factors in object-oriented design. Empirical Software Engineering, 6, 11-58.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3 (2), 77-101.

Bravo, C. and Garcia, P. (2006). A system to support collaborative mobile electronic meetings. Comparative design, visualization and engineering lecture notes in Computer Science, 4101, 200-210, Springer Link.

Briggs, R.O. and de Vreede, G.J. (2009). ThinkLets- building blocks for concerted collaboration. University of Nebraska, Center for Collaboration Science.

Briggs, R.O., Kolfschoten, G.L., de Vreede, G.J. & Nunamaker, J.F. (2003). Collaboration engineering with ThinkLets to pursue sustained success with Group Support Systems. Journal of Management Information Systems, 19(4), 31-63.

Brown, G.W. (2009). Value chains, value streams, value nets and value delivery chains. BP Trends. Accessed 3rd , April, 2011 From: http://media.wiley.com/product-data/excerpt/90/04713600/0471360090.pdf.

Brown, A.W. (2000). Large-scale component-based development. In: Van der Kar,E. (2004). Designing Mobile Information services: an approach for organizations in a value network. PhD Thesis, Delft University, Netherlands

Brown, R.B. and Saunders, M. (2008). Dealing with statistics: what you need to know. Bershire: Open University Press.

Brown, J. R. and Goolsbee, A. (2002). Does the Internet make markets more competitive? Evidence from life insurance industry. Journal of Political Economy, 110 (3), 481-507.

Brown, M. and M. Petrulis. (1993). Value-Added Agriculture as a Growth Strategy, Bulletin 644-10, USDA Economic Research Service, Washington, D.C

Browne, G.J. and Rogich, M. B. (2001). An empirical investigation of user requirements elicitation: comparing the effectiveness of prompting techniques. Journal of Management Information Systems, 17(4), p.223.

Bussler, C. (2001). The role of B2B protocols in inter-enterprise process execution. In: Proceedings of the TES 2001, Computer Science Lecture notes, Springer, Verlag, 16-29.

Cadle, J. and Yeates, D. (2001). Project management for information systems. Pearson Education, Essex.

Cai, K.Y., Dong, Z. & Liu, K. (2008). Software testing processes as a linear dynamic system. Information Systems, 178, 1158-1597.

References

Cai, K.Y. (2006). Software reliability experimentation and control. Journal of Computer Science and Technology, 21(5), 697-707.

Campos, J P, Afonso, A P, & Silva, M J (1999). GIL: a software tool for the construction of information dissemination systems. Retrieved 28th March, 2009 From: http://www.di.fc.ul.pt/biblioteka/tech-reports.

Carlsson, S.A., Henningsson, S., Hrastinski, S. & Keller, C. (2011). Socio-technical IS design science research: developing design theory for IS integration management. Information Systems E-Business Management, 9, 109-131, Springer.

Carlsson, C. and Walden, P. (2010). Supporting Tourists at the Bomarsund Fortress with a Mobile Value Service, Journal of Information Technology Theory and Application, 11(1), 43-56.

Casamayor, A., Godoy, D. & Campo, M. (2012). Functional grouping of natural language requirements for assistance in architectural software design. Knowledge based systems, 30, 78-86.

Cater, S. (1998). Portfolio entrepreneurship in the farm sector: indigenous growth in rural areas. Entrepreneurship and Regional Development, 10(1), 17-32.

Cater, S. and Ram, M. (2002). Reassessing portfolio entrepreneurship. Small Business Economics, 21, 371-380.

Chamberlin, J. and Jayne, T.S. (2013). Population density, remoteness and farm size- small farms amidst land abundance in Zambia. Accessed 20th November 2013 From:

http://fsq.afre.msu.edu/qisama/Chamber_Jayne_Population_density_remoteness.pdf.

Chan, H.C., Wei, K.K. & Siau, K.L. (1993). User-database interface: the effect of abstraction levels on query performance. MIS Quarterly, 17(4), 441-464.

Checkland, P. (1993). Systems thinking, systems practice. Chichester: Wiley.

Chen, W. and Hirschheim, R. (2004). A paradigmatic and methodological examination of information systems research from 1991 to 2001. Information Systems Journal, 14(3), 197-235.

Chen, Q. and Hsu, M. (2001). Inter-enterprise business process management. IEEE, DOI: 106-6382/01.

Chianu, J.N., Mairura, F. & Ekise, I. (2008). Farm input marketing in Western Kenya: challenges and opportunities. African Journal of Agricultural Research, 3(3), 167-173.

Chilvers, J. (2009). Deliberate and participatory approaches in environmental geography. In: Castree, N., Demeritt, D., Liverman, D. & Rhoads, D. (eds.). A companion to environmental geography. Oxford: Blackwells, 400-417.

Chisenga, J. (2006). Information and communication Technologies: Opportunities and Challenges For National and University Libraries in Eastern, Central and Southern Africa. Keynote paper presented at the standing conference of African National and University libraries of Eastern, Central and Southern Africa (SCANUL-ECS), Dar esSalaam, Tanzania, 9-10 July 2006

Churi, A.J, Mlozi, M.R.S., Mahoo, H., Tumbo, S.D. & Casmir, R. (2013). A decision support system for enhancing crop productivity of smallholder farmers in semi-arid agriculture. International Journal of Information and Communication Techno9logy Research, 3(8), July-August, 238-248

Chuttur, M.Y. (2009). Overview of TAM: origins, developments and future directions. Sprout working paper on Information Systems, 9(37). Accessed 28th April 2013 from: http://sprouts.aisnet.prg/9- 37.

Cilvers, J. (2009). Deliberative and participatory approaches in environmental geography. In: Catree, N., Dimeritt, D. Liverman, D., Rhoads, B. (Eds.), A companion to environmental geography, Blackwell, Oxford, 400-417.

Cilliers, P. (2005). Complexity, deconstruction and relativism. Theory, Culture and Society, 22(5), 255-267.

Clason, D. L., & Dormody, T. J. (1994) Analyzing data measured by individual Likert-type items. *Journal of Agricultural Education,* 35(4), 31- 35.

Clemnets, P.C. (2000). Constructing superior software. Macmillan Technical, USA.

Cockburn, C. (2000). Writing effective use cases. Addison-Wisley.

Collagen, L., Rich, C. & Sidner, C. (1997). When agents collaborate with people. In: proceedings of the 1st International Conference on autonomous agents, Marinadel Ray, California.

Collett, K. and Gale, C. (2008). Training for rural development: agricultural and enterprise skills for women smallholders. City & Guilds Centre for Skills Development, London. Accessed 11th May From:www.skillsdevelopment.org/T4RD

Collis, J. and Hussey, R. (2003). Business research, 2nd ed. MacMillan Cooperate Plan for 2007-2010.

References

Conboy, K. (2009). Agility from first principles: reconstructing the concept of agility in Information Systems' Development. Information Systems Research, 20(3), 329-354.

Coughlan, K., Lycett, M. & Macredie, R.D. (2003). Communication issues in requirements elicitation: a content analysis of stakeholder experience. Information and Software Engineering, 45, 525-537, Elsevier.

Cousin, K. and Varshney, U. (2001). A product location framework for mobile commerce environment. In: proceedings of first International Workshop on mobile commerce, July, Rome, Italy, 43-48.

Crawford, I.M. (2006). Agricultural and food marketing for Africa. FAO, Rome.

Cresswell, J.W. (2003). Research design: qualitative, quantitative and mixed methods approaches, 2nd ed. Sage: CA, USA.

Crossan, F. (2003). Research philosophy: towards an understanding. Nurse Researcher, 11(1), 46-55.

Davis, K. (2008). Extension in sub-Saharan Africa: overview and assessment of past and current models and future prospects, Journal of International Agricultural and Extension Education, 15(3), 15-28.

Davis, G., Gable, G. & Orlikowski, W. (1994). "Evolving an Information Systems Research Strategy" (1994). *ICIS 1994 Proceedings.* Paper24. Accessed 20th October 2013 From: http://aisel.aisnet.org/icis1994/24

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of Information Technology. MIS Quarterly, 13 (3), 319-339.

Dawey, B. and Cope, C. (2008). Requirements elicitation- what is missing? Issues in Informing Science and Information Technology, 5, 543-551.

Day, G.S. and Schoemaker, P.J. (2004). Driving through the fog: managing at the edge. Long Range Planning, 37(2), 127-142.

Defermos, G. (2005). Management and virtual decentralized networks: the linux project. First Monday Special Issue no. 2. October 3. De Villiers, R. (2005). Interpretive research models for informatics: action research, grounded theory, and the family of design- and development research. Alternations, 12(2), 10-52.

De Bruijn, H., ten Heuvelhof, E. & Veld, R. (2002), Process Management. Dordrecht : Kluwer Academic Publishers.

De Haes, U. H.A. and de Snoo, G. R. (1997). The Agro-production chain. Environmental management in the agricultural production-consumption chain. International Journal of Life Cycle Assessment, 2 (1), 33-38.

De Silva, H. and Ratnadiwakara, D. (2008). Using ICT to reduce transaction costs in agriculture through better communication: a case study from Sri Lanka, LIRNEasia, Colombia.

De Vreede, G.J. and Briggs, R.O. (2005). Collaboration engineering: designing repeatable processes for information value collaboration tasks. Proceedings of the 38th Hawaii International Conference on Systems Sciences, IEEE Computer Society Press.

De Vreede, G.J., Davison, R. & Briggs, R.O. (2003). How a silver bullet lose its shine- learning from failures with group support systems. Communications of the ACM, 46(8), 96-101.

De Vreede, G.J. and Dickson, G.W. (2000). Using GSS to support designing organizational processes and information systems: an action research on collaborative business engineering. Group Decisions and Negotiation, 9(2), 161-183.

De Vreede, G.J. (1995). Facilitating organizational change. PhD Thesis, Delft University of technology, The Netherlands.

DeLone, W. and McLean, E. (1992). Information systems success: the quest of the dependent variable. Information Systems Research, 3(1), 60-95.

Den Hengst, M., Dean, D.L., Kolfschoten, G. & Chakrapani, A. (2006). Assessing the quality of collaborative processes. Proceedings of the 39th Annual Hawaii International Conference on systems sciences, (HICSS'06).

Den Hengst, M., Van de Kar, E.A.M. & Appelman, J.H. (2004). Designing mobile information services: user requirements with GSS design and application of repeatable process. Proceedings of the 37th Annual Hawaii International Conference on Systems Science, Big Island, Hawaii.

Den Hengst, M. and de Vreede, G.J. (2004). 10 years of lessons learnt with collaborative business engineering. Journal of Management Information Systems, 20, 85-113.

Dennis, A., Wixom, B.H. & Tegarden, D. (2012). Systems analysis and design, UML version 2.0: an object- oriented approach. 4th ed. Hoboken, NJ: Jon Wiley & Sons.

References

Desel, J. (2005). Process modeling using Petri nets. In M. Dumas, W. van der Aalst, & A. ter Hofstede(Eds.), Process-Aware Information Systems: Bridging People and Software through Process Technology (pp. 147-177). Hoboken, NJ, USA: John Wiley & Sons.

Devedzic, V. (2004). Education and the semantic web. International Journal of Artificial Intelligence in Education, 14, 39-65.

Diana, C., Pacent, E. & Tassi, R. (2009). Visualizing communication tools for service design. 1st Nordic Conference on Service Design and Service Innovation, Oslo, Norway.

Difrancesco, E., Gatto, P., Runge, F. & Trestini, S. (2008). Factors affecting farmers' participation in agri-environmental measures: a northern Italian perspective. Journal Agricultural Economics, 59 (1), 114-131.

Dimara, E. and Skuras, D. (2003). Adoption of agricultural innovations as a two-stage partial observability process. Agricultural Economics, 28(3), 187-196.

Dixon, J., Gulliver, A. & Gibbon. D. (2001). Farming systems and poverty. Improving farmers' livelihoods in a changing world. Rome, Italy & Washington D.C.: FAO & World Bank

Do, E. and Gross, M.D. (2001). Thinking with diagrams in architecture design. Artificial Intelligence Review, 15, 135-149.

Donner, J. (2008). Research approaches to mobile use in the developing world: a review of the literature. The Information Society, 24(3), 140-159.

Dose, H. (2007). Securing household income among small-scale farmers in Kakamega district: possibilities and limitations of diversification. German Institute of Global and Area Studies, Working Paper No. 41.

Drossos, D. and Giaglis, G.M. (2006). Mobile advertising effectiveness: an exploratory study, In Proceedings of the 5th International Conference on Mobile Business (ICMB), June 26-27, IEEE, Copenhagen, Denmark

Dumas, M., & ter Hofstede, A. (2001). UML activity diagrams as a workflow specification language. In M. Gogolla, & C. Kobryn (Eds.), UML 2001 - The Unified Modeling Language. Modeling Languages, Concepts, and Tools (Vol. 2185 Lecture Notes in Computer Science, 76-90). Heidelberg, Berlin, Germany: Springer.

Dupraz, P., Vaslembrouck, F., Bonnieux, F. & van Huylenbrouck, G. (2002). Farmers' participation in European agri-environmental policies. Proceedings of X EAAE Congress on exploring diversity in European agri-food system, Zaragoza, Spain, 28-31.

Dustdar, S. and Gall, H. (2003). Architectural concerns in distributed and mobile collaborative systems. Journal of Systems Architecture, 49, 457-473.

ECA (2007). Africa review report on agriculture and rural development. Addis Ababa

Edita, K. and Denysiuk, V. (2012). Decision making: the way to solve problems and discover opportunities. International Journal of Economics and Law, 2(5), 42.

Edvardsson, B. and Olsson, J. (1996). Key concepts for new service development. The Service Industries Journal, 16(2), 140-164.

Edwards-Jones, G. (2006). Modeling farmer decision making: concepts, progress and challenges. Animal Science, 82, 783-790.

Eisenbach, S., Kayhan, D. & Saddler, C. (2004). Keeping control of re-usable components. Component deployment lecture notes computer science, 3083, 144-158. Springer Link.

Eisenfuhr, F. (2011). Decision making. New York, NY: Routledge.

Ejiri, H. A. D. (2012). A decision enhancement studio for starting a miners' enterprise in Uganda. PhD Thesis, University of Groningen, The Netherlands

El-Kiki, T. and Lawrence, E. (2006). Government as a Mobile Enterprise: Real-time, Ubiquitous Government. IEEE Proceedings of the Third International Conference on Information Technology: New Generations, 320- 327, April 10- 12, Las Vegas, Nevada.

Emmerich W. and Gruhn, V. (1991). FUNSOFT nets: a petri-net-based software process modeling language. In: Proceedings of the International Workshop on Software Specification and design. IEEE Computer Society Press, 175-184.

Eriksson, H.E. and Penker, M. (2000). Business modeling with UML: business patterns at work. Wiley Computer Publishing.

Erl, T. (2005). Service-oriented architecture: concepts, technology and design. Prentice Hall.

Eshuis, R. (2002). Semantics and verification of UML activity diagrams for workflow modeling. Doctoral Dissertation, University of Twenty, The Netherlands..

References

Etzo, S. and Collender, G. (2010). The mobile phone revolution in Africa: rhetoric or reality. African Affairs, 109/437, 659-668.

Fafchamps, M. and Hill, R. V. (2005). Selling at the farm-gate or travelling to the market. American Journal of Agricultural Economics, 87, 717-734.

Fafchamps, M. and Minten, B. (2012). Impact of sms-based information on Indian farmers. The World Bank Economic Review, 2(27), 1-32.

FAO (2006). Farmer Field Schools Networks' Operational Manual. FAO, Kampala. Accessed 6th October,2010From:http://infobridge.org/asp/documents/2503.pdf

FAO (2004). Price transmission in selected agricultural markets. Commodity and trade research paper no. 7, March, 91 pages.

FAO, (2004). Information and communication for development in support of rural livelihoods: project document, FAO/Government Cooperative Programme, version 19/1-/04.

FAO (2003). "Market integration and price transmission in selected Food and cash crop markets of developing countries: Review and applications", by Rapsomanikis, G., Hallam, D., and P. Conforti, In: Commodity Market Review 2003-2004., Commodities and trade division, FAO, Rome.

FAO (2001). Guide to the establishment of Market Information Services. FAO, Rome.

FAO and World Bank (2000). Agricultural knowledge and information systems for rural development: strategic vision and guiding principles. FAO, Rome.

Farley, T (2007). Mobile telephone industry. Retrieved 16th March 2008, From:

http://www.privateline.com/archive/TelenorPage_022-034.pdf.

Federal Communication Commission, (2008). Code of Federal Regulations: title 47-Telecommunications: Universal Service. USA. Accessed 17th October, 2010 From: http://law.justia.com/us/cfr/title47/47cfr54_main_02.html.

Ferguson, E.S. (1993). Engineering and mind's eye. MIT Press.

Ferris, D. S. and Robbins, P. (2004). Developing market information services in East Africa: the FOODNet experience, (local, national and regional market information services), IITA/ASARECA, Entebbe, Uganda.

Ferris, D.S., Kaganzi, E., Rupert, I., Ostertag, C., Lundy, M. & Tiago, V. (2006). A market facilitator's guide to participatory agro-enterprise development.

Field, A. P. (2005). Discovering statistics using SPSS, 2nd ed., London: Sage.

Fischer, E. and Quin, M. (2012). Linking smallholder to markets: determinants and impacts of farmer collective action in Kenya. World Development, 40(6), 1255-1268.

Fitzherbert, A.R. (1983). Information, organization and agricultural change. Ege University, Agricultural Faculty.

Fontana, A. and Frey, J. H. (2000). The interview: from structured questions to negotiated text. In: N.K. Denzin & Y.S. Lincoln (eds). Handbook of qualitative research, 2nd ed. Sage: Thousand Oaks, CA, 645-672.

Forwell, S. (2002). Bridging the gap between the information resource design and enterprise content management. ICADL Conference proceedings, Springer-Verlag, Berlin, 507-515.

Fowler, M. and Scott, K. (1999). UML distilled: a brief guide to the standard object modeling language, 2nd ed. Addison-Wesley.

Fountas, S., Wulfsohn, D., Blackmore, B.S., Jacobsen, H.L. & Pedersen, S.M. (2006). A model of decision making and information flows for information-intensive agriculture. Agricultural Systems, 87, 192-210.

Francis, P. and James, R. (2003). Balancing rural poverty reduction and citizen participation: the contradictions of Uganda's decentralization program. *World Development* 31(2): 325-337.

Francu, J. and Hnetynka, P. (2009). Automated code generation from system requirements in natural language. e-Informatica Software Engineering Journal, 3(1).

Freeman, R. E. (1984). Strategic management: a stakeholder approach. Cambridge, Mass Ballinger Pub. Co.

Furletti, B.,Gabrielli, L. & Rinzivillo, S. (2012). Identifying users profiles from mobile cells habits. Urb Coup'12, August, Beijing, China, ACM.

Gadermann, A.M, Guhn, M. & Zumbo, B.D.(2012). Estimating ordinal reliability for liker-type and ordinal item response data: a conceptual, empirical and practical guide. Practical Assessment, Research & Evaluation, 17(3), 2-13.

References

Galliers, B. (1992). Information systems research: issues, methods and practical guidelines.

Garcia, J.M. and Steinmueller, W.E. (2003). The open source way of working: a new paradigm for division of labour in software development. Science and Technology policy Research, Working paper no. 92, The Freeman Center, University of Sussex.

Garg, K. (2013). Data dissemination bounds in people-centric systems. INFOCOM Conference proceedings, IEEE.

George, R.T. (2007). Information flow to support front end planning. PhD Thesis, Clemson University, USA.

Getnet, K., Verbeke, W., D'Haese, M., Viaene, J & D'Haese, L. (2011). The farm decision role of price information from commodity exchanges: an ex-ante evaluation using quasi-rational price expectations in Ethiopia. African Journal of Agricultural Research, 6(15), August, 3610-3618.

Giaglis, G.M., Zeimpekis, V. & Lekakos, G. (2003). A taxonomy of indoor and outdoor positioning techniques for mobile location services. ACM SIGECOM Exchanges, 3, 19-27.

Gibbon, D. (1994). Farming systems research/extension: background concepts, experience and networking. In: Rural and Farming Systems Analysis, European Perspectives, J.B. Dent and M.J. McGregor (eds.) CAB International, Edinburgh, 3-18.

Giné , X. (2005). DRUMNET Case Study. Washing DC: The World Bank

Gillham, B. (2000). Case study research methods. Continuum.

Godoy, D. and Amandi, A. (2006). User profiling in personal information agents: a survey. The Knowledge Engineering Review, 20(4), 329-361. Cambridge University Press.

Goldkuhl, G. (2013). The empirics of design research: activities, outcomes and functions. Thirty Fourth International Conference on Information Systems, Milan, Italy.

Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. European Journal of Information Systems, 21(2), 135-146.

Goldstein, S.M., Johnston, R., Duffy, J. & Rao, J. (2002). The service concept: missing link in service design research. Journal of Operations Management, 20(2), 121-134.

Gonzalez, R.A. and Sol, H.G. (2012). Validation and design science research in information systems. In: Mora, M., Gelmann, O., Steenkamp. A.L. & Raisnghani, M. (eds.). Research methodologies,

innovations and philosophies in software engineering and information systems, IGI Global, 403-426.

Gonzalez, R.A. (2010). A framework for ICT-supported coordination in crisis response. Doctoral dissertation, Delft University of Technology, The Netherlands.

Gray, D., Parker, W. &Kemp, E. (2009) Farm management research: a discussion of some of the important issues. Journal of International. Farm Management, 5(1), 1-24.

Gray, A. W. and Boehlje, M. D. (2007). The industrialization of agriculture: implications for future policy. Accessed July 27th 2011, From: http://ageconsearch.umn.edu/bitstream/6712/2wp070010.pdf.

Gregg, D.G., Kulkarni, U.R. & Vinze, A.S. (2001). Understanding the philosophical underpinnings of software engineering research in information systems. Information Systems Frontiers, 3(2), 169-183.

Gregor, S. and Hevner, A.R. (2013). Positioning and presenting design science research for maximum impact: Research essay. MSI Quarterly, 37(2, June), 1-6.

Gronroos, C. (1990). Service management and marketing. Lexington Books: Lexington, MA.

Gruber, T.R. (1995). Towards principles for the design of ontologies used for knowledge sharing. International Journal of Human-Computer studies, 43(5/6), 907-928.

Gu, Q. and Lago, P. (2011). Guiding the selection of service-oriented software engineering methodologies. Service Oriented Computing and Applications, 5(4), December, 203-223.

Guilhon, B. (2001). Technology and markets for knowledge: knowledge creation, diffusion and exchange within a growing economy. Boston: Kluwer

Gulu District (2007). 2002 Population and Housing Census analytical report.

Gurbaxani, V., Melville, N. & Kraemer, K. (2000). The production of information services: a firm-level analysis of information systems budgets. Information Systems Research, 11 (2), 159-176.

Haesen, R., Snoeck, M., Lemahjeu, W. & Paelmans, S. (2009). Existence dependency-based domain modeling for improving stateless process enactment. Proceedings of the IEEE Services –I world conference, 6-7 July, Los Angeles, CA, USA.

References

Hampe, J.F. and Schwabe, G. (2003). Enhancing Mobile Commerce: Instant Music Purchasing Over the Air, In: Seeking success in E-Business, 107-130, Kluwer Academic Publishers, Dordrecht.

Hamzah, N. and Ismail, M.N. (2007). Alignment between strategy and intellectual capital development. Journal of Pengurusan, 26, 49-66.

Han, J., Han, Y., Jin, Y., Wang, J. & Yu, J. (2006). Personalized active service spaces for end-user service composition. In Service computing, SCC '06 IEEE International Conference, September, 198-205.

Handel, M. And Herbsleb, J.D. (2002). What is chat doing in the work place? In: proceedings of CSCW, 1-10.

Handy, C. (1999). Understanding organizations. Penguin Books.

Haneveld, W. K. K. and Stegeman, A. W. (2005). Crop succession requirements in agricultural production planning. European Journal of Operational Research, 166, 406-429

Harsh, S.B., Conner, L.J. & Schwab, G.D. (1981). Managing the farm business. Englewood Cliffs, NJ: Prentice Hall.

Henerson-Sellers, B. (2011). Bridging meta-models and ontologies in software engineering. The Journal of Systems and Software, 84, 301-313.

Henningsson, K. and Wohlin, C. (2004). Assuring fault classification agreement- an empirical evaluation. Proceedings of 2004 International Symposium on Empirical Software Engineering, 95-104.

Heong, K.L. and Escalada, M.M. (1999). Quantifying rice farmers' pest management decisions: beliefs and subjective norms in stem borer control. Crop Protection, 18(5), 315-322.

Herrala, M. (2007). The value of transport information. VTT Technical Research Centre, Finland. Accessed 30th April 2013 from http://www.vtt.fi/publications/index.jsp.

Harty, C. (2010). Implementing innovation: designers, users and actor-networks. Technology, Analysis and Strategic Management, 22(3), 297-315.

Hererra, F., Martinez, L. & Sanchez, P.J. (2005). Managing non-homogenous information in group decision making. European Journal of Operations Research, 166, 115-132.

Hevner, A., and Chatterjee, S. (2010). Design Research in Information Systems: Theory and Practice. Integrated Series in Information Systems. 22, Springer

Hevner, A. R., March, S. T., Park, J. & Ram, S. (2004). Design science in information systems research, MIS quarterly, 28 (1), March, 75-105.

Hevner, A.R. (2007). A three cycle view of design science research. Scandinavian Journal of Information Systems, 19(2), 87-92.

Hofstede, G.J. (2003). Transparency in netchains. In Harnos, Z. *et al.* (Eds.). Information Technology for a better agri-food sector, environment and rural living. Debrecen, 17-29.

Hovorka, D.S. and Germonprez, M. (2009). Identification-Interaction-Innovation: a phenomenological basis for an information service view. Accessed 18th Sept, 2010 From:

http://infs.fec.anu.edu.au/workshop/documents/hovorka_ISF_Submit.pdf

Howitt, D. and Cramer, D. (2005). Introduction to research methods in psychology. Harlow Essex: Pearson Education.

Humphrey, J. and Schimtz, H. (1998). Trust and inter-firm relations in developing and transition economies. The Journal of Development Studies, 34(4), 32-61.

Iivari, J. and Venable, J. (2009). A pragmatic analysis of information systems as a design science. Scandinavian Journal of Information Systems, 19(20, 39-64.

Isaacs, E., Walendowski, A., Whittaker, S., Schiano, D.J. & Kamm, C. (2002). The character, functions and styles of instant messaging in the work place. Proceedings of CSCW, 11-22.

Islam, M. S. and Gronlund, A. (2007). Agricultural market information e-service in Bangladesh: a stakeholder oriented case study analysis. Electronic government, proceedings of the 6th international EGOV conference, Regensburg, Germany, September, 3-7, 167-178.

Izza, S. and Imache, R. (2010). An approach to achieve IT agility by combining SOA with ITSM. International Journal of Information Technology and Management, 9(4), 423-445.

Jamieson, S. (2004). Likert scales: how to use them. Medical Education, 38(2), 1217-1218.

Jani, S. and Ramdas, K. (2005). Up or out, or stay put? : product positioning in an evolving technology environment. Product and Operations Management, 14(3), Fall, 362-376.

References

Jarvinen, P. (2005). Action research as an approach in design science. The European Academy of Management Conference, Munich.

Jensen, R. (2007). The digital provide: information (technology), market performance, and welfare in the south Indian fisheries sector. The Quarterly Journal of Economics, (CXXII), August, (3), 879-824.

Jeffrey, S.R., Franlin, M.J. & Halevy, A.Y. (2008). Pay-as-you-go user feedback for database systms. Proceedings of the ACM SIGMOD International Conference on Managmenr of data, Vancouver, BC, Canada.

Jégou F. and Manzini, E. (2008), Collaborative services, social Innovation and design for sustainability. Polidesign. Milano. Jiang, J., Klein, J. & Carr, C. (2002). Measuring information systems service quality: SERVQUAL from the other side. MIS Quarterly, 26 (2), 145-166.

Jih, J. W.K., Braford, D.A., Suyder, C.A. & Thompson, N.G.A. (1989). The effects of relational and entity relationship data models on query performance of end users. International Journal of Man-Machine Studies, 31(3), 257-267.

Johnson, G.L. (1976). Some lessons from IMS. Paper presented at the Agricultural Development Conference, CIMMYT, Mexico.

Just, D.R., Wolf, S. & Zilberman, D. (2003). Principles of risk management service relation in agriculture. Agricultural Systems, 75(2-3), 199-213.

Kaddu. S.B. (2007) Information and Communication Technologies (ICTs) Contribution to the Provision of Agricultural Information to the Rural Women in Selected districts of Uganda. Msc Thesis, Makerere University, Uganda.

Kamoun, F. (2007). A roadmap towards the convergence of business process management and service oriented architecture. ACM, Ubiquity, 8(14).

Kang, G. (2006). The hierarchical structure of service quality: integration of technical and functional quality. Managing Service Quality, 16 (1), 37-50.

Kapange, B. (2006). ICTs in agricultural development: the case of Tanzania. In Cunningham, Miriam & Cunningham, Paul (eds), Proceedings from IST-Africa Conference proceedings.

Karestos, S., Costopoulou, C. & Sideridis, A. (2007). Bio@agro- An on-line-multilingual organic agriculture e-services platform. Information Services and Use, 27 123-132.

Karim, S A, Darus, S H & Hussin, R (2006). Mobile phone applications in academic library: a students' feedback survey. Campus-Wide Information Systems, (23), 1, 35-51. Retrieved 21st April, 2009From Emerald Online database.

Kastens, T.L. and H. Nivens. (1998). Precision Agriculture: Is it Time to Get Involved? Risk and Profit Conference, Manhattan, KS, August 20-21, 1998

Katungi, E M (2006). Social capital and technology adoption on small farms: the case of banana production technology in Uganda. PhD Dissertation, University of Pretoria, South Africa

Katungi, E M and Smale, M (2006). Gender, social capital and information accessing rural Uganda. CPRi working paper No. 59. Retrieved 20th April, 2009 From:

http://www.capri.cgiar.org/pdf/capriwp59.pdf

Katushemererwe, F. (2013). Computational morphology and Bantu language learning: an implementation for Runyakitara. PhD Thesis, University of Groningen, The Netherlands.

Keen, P.G.W. and Sol, H.G. (2008). Decision enhancement services: rehearsing the future for decisions that matter. IOS Press, Amsterdam.

Kensing, F. and Blomberg, J. (1998). Participatory design: issues and concerns. Computer Supported Cooperative Work, 7(3-4), 167-185, Kluwer Academic Publishers.

Kenston, K.(1999). Language power and software. In Cultural attitudes towards technology, C. Ess (ed), New York: Sunny Press.

Kersten, G. E. and Lo, G. (2001). Negotiation support systems and software agents in e-business negotiations. 1st International conference on Electronic Business, Hong Kong.

Kettinger, W. J. and Teng, J. T. C. (1997) "Business Process Change: A Study of Methodologies, Techniques and Tools" MIS Quarterly, 21(1), 55-80.

Khatiwada, Y. (2005). Agricultural knowledge and information systems in Ethiopia. In: Dixon, J., Wattenbach, H. & Bishop-Sambrook, C. (eds.). Improving information flows to the rural community, FAO, Rome, October.

Kim, M., Sumbaly, R. & Shah, S. (2013). Root cause detection in a service-oriented architecture. SIGMTRICS'13, June 17-21, Pittsburgh, PA, USA.

References

Kim, D.H., Atluri, V., Biebe,r M., Adam, N., &Yesha, Y. (2004). Web personalization: A click-stream-based collaborative filtering personalization model: towards a better performance. Proceedings of the 6th annual ACM international workshop on Web information and data management, 88 - 95 Kinston, W. (2011). Purposes and the translation of values into action. Systems Research and Behavioral Sciences, 3(3), 147-160.

Kirsch-Pinheiro, M., Lima, J.V., Borges, M.R.S. (2003). Framework for Awareness Support in Groupware Systems. Computers in Industry, 52(3) Sept, 47-57 Kohls, R. L. and Uhl, J.N. (1990). Marketing of agricultural products. 6th ed. Macmillan: NY, 18-21.

Kolfschoten, G., Duivenvoorde, G. Briggs, R. & De Vreede, G.J. (2009). Practitioners vs facilitators: a comparison of participants perceptions on success. Proceedings of the 42nd Hawaii International Conference on Systems Science, Hawaii, IEEE.

Konana, P., Gupta, A. & Whinston, A. (2000). Integrating user preferences and real-time workloads in Information Services. Information Systems Research, 11 (2), 177-196.

Kotler, P. (1988). Marketing management. Prentice-Hall, Englewood Cliffs, NJ.

Knol, A.J. (2013). Decision enhancement for sourcing and sharing in the Dutch government. PhD Thesis, University of Groningen, The Netherlands.

Kroeze, J.H. (2011). Interpretivism in information systems: a postmodern epistemology? Sprouts: working paper on Information Systems, 11 (171).

Kuflik, T., Shapira, B. & Shoval, P. (2003). Stereo-type-based versus personal-based filtering rules in information filtering systems. Journal of the American Society for Information Science and Technology, 54(3), 243-250.

Kuechler, B. and Vaishnavi, V. (2008). On theory development in design science research: an atomy of a research project. European Journal of Information Systems, 17(5), 489-504.

Labone, J. and Chase, R.S. (2009). The power of information- the impact of phones on farmers' welfare in the Philippines. Policy Research Paper 4996, World Bank: Washington DC

Lankhorst, M. (ed.) (2004). Enterprise architecture at work, Springer, Berlin.

Laszlo, A. (2001). Epistemological foundations of evolutionary systems design: research paper. System Research and Behavioral Science, 18, 307-321.

Latour, B. (1986). The powers of association. In: J. Law (ed.), Power action belief: a new sociology of knowledge, Routledge and Kegan: London, 264-280.

Lehmann, R.J., Reiche, R. & Schiefer, G. (2012). Future internet and the agri-food sector: state-of-the-art in literature research. Computers and Electronics in Agriculture, 89, 158-174.

Lehman, M.M. and Ramil, J.F. (2001). Rules and tools for software evolution, planning and management. Annals of Software Engineering, 11(1), 15-44.

Lei, S., Zhang, K. & Sha, E. (2007). Applying situation awareness to mobile proactive information delivery. In: Denko, M. et al (eds). EUC Workshops , LNCS 4809.International Federation for Information Processing, 592-603.

Leitheiser, R.L. and March, S.T. (1996). The influence of a database structure representation on database system learning and use.

Leuf, B. and Cunningham, W. (2001). The wiki way quick collaboration on the web. Boston: Addison-Wisley.

Lokanathan, S. and de Silva, H. (2010). Leveraging Mobile 2.0 in India for agricultural market access. Accessed 29th August 2010, Fromwww.lirneasia.net.

Lubke, G.H. and Muthen, B.O. (2004). Applying multiple confirmatory factor models for continuous outcomes to Likert scale data complicates meaningful group comparisons. Structural Equation Modeling, 11, 514-534.

Luca, L.M.D. and Atuahane-Gima, K. (2007). Market knowledge dimensions and cross-functional collaboration: examining the different routes to product innovation performance. Journal of Marketing, 71(1), 95-112.

Lwonga, E.T., Stilwell, C. & Ngulube, P. (2011). Access and use of agricultural information and knowledge in Tanzania. Library Review, 60(5), 383-395.

Mabota, A., Arlindo, P., Paulo, A. & Donovan, C. (2003). Market information: a low-cost tool for agricultural market development. Accessed 20th August, 2010 From:

http://www.aec.msu.edu/fs2/Mozambique/flash/flash37e.pdf

Mackrell, D. (2006). Women as Farm Partners: Agricultural Decision Support Systems in the Australian Cotton Industry, PhD Dissertation, Griffith Business School, Griffith University, Brisbane.

References

MacManus, J. and Wood-Harper, T. (2003). Information systems project management: methods, tools & techniques. Pearson Education, NY.

Maes, P., Gutman, R.H. & Monkas, A.G. (1999). Agents that buy and sell. Communications of ACM, 42(3), 81-91.

Maier, M.W. and Rechtin, E. (2002). The art of systems architecting. Boca Raton FL: CRC Press.

Mallick, M. and Alyott, E. (2005). Facilitating practice learning in registration programmes: a comparative review of the Bournemouth Collaborative model and Australian models. Nurse Education in Practice, 27(1), 152-160.

Maningas, R.V., Perez, V. O., Macaraig, A.J., Alesna, W.T & Villagonzallo, J. (2000). Electronic Information Dissemination through the Farmers' Information and Technology Services (FITS)/Techno Pinoy Program: bringing information and technology within the reach of the farmers. Retrieved January 20th, 2010 From http://jsai.or.jp/afita/afita-conf/2000/part08/p231.pdf.

March, J. G. (2010). Primer on decision making: How decisions happen. New York, NY: Simon & Schuster

March, S. T. and Smith, G. F. (1995). Design and natural science research on information technology. Decision support systems, 15, Elsevier.

Marcucci, P. (2001). Jobs, gender and small enterprises in Africa and Asia. SEED working paper no. 18, Geneva, ILO.

Markelova, H., Meinzen-Dick, R., Hellin, J. & Dohrn, S. (2009). Collective action for smallholder market access. Food Policy, 34, 1-7.

Marku, M.L. and Jacobson, D.D. (2010). Business process governance: handbook on business process management 2. International Handbooks on Information Systems, 201-222, Springer.

Markus, M.L., Majchrzak, A., &Gasser, L. (2002). A Design Theory for Systems that Support Emergent Knowledge Processes. MIS Quarterly, 26(3), 179-212.

Marocchino, C. (2009). A guide to upgrading rural agricultural retail markets, FAO, Rome, Italy.

Marsh, B. (2002). Heuristics as social tools. New Ideas in Psychology, 20, 49-57.

Martin, R.C. (2003). Agile software development: principles, patterns and practices. Upper Saddle River: Prentice-Hall.

Mason, J (2002). Qualitative Researching, 2nd ed. Sage Publications: London.

Mathiassen, L. & C. Sørensen (2008): Towards A Theory of Organizational Information Services. Journal of Information Technology, 23(4), 1-17.

Mathijs, E. (2003). Social capital and farmers' willingness to adopt countryside stewardship schemes. Outlook on Agriculture, 32, 13-16.

McCorriston, S. (2010). Trade liberalization under imperfect competition in commodity markets. Proceedings of the FAO workshop on governance, coordination and distribution along commodity value chains, FAO, Rome, Italy.

McCorriston, S., Morgan, C.W & Rayner, A.J. (2001). Price transmission: the interaction between firm behavior and returns to scale. European Review of Agricultural Economics, 28.

McCown, R.L. (2002). Changing systems for supporting farmers' decisions: problems, paradigms, and prospects. Agricultural Systems, 74, 179–220.

McElwee, P. (2008). Forest environmental income in Vietnam: household socio-economic factors influencing forest use. Environmental Conservation, 35(2), 1-13.

McElwee, G. and Robson, A. (2005). Diversifying the farm: opportunities and barriers. Finnish Journal of Rural Research and Policy 4, 84-96

Meder, B. Hagmayer, Y. (2009). Causal induction enables adaptive decision making. In: Proceedings of the 31st annual conference of the Cognitive Science Society

Meroni A. (2007). Creative communities. People inventing sustainable ways of living. Polidesign, Milano.

Meroni, A. (2008). Strategic design: where are we now? Reflection around the foundations of a recent discipline. Strategic Design Research Journal, 1(1), July-December, 31-38

Metlay, D. and Sarewitz, D. (2012). Decision strategies for addressing complex, 'messy' problems. The Bridge on Social Sciences and Engineering Practice, 42(3), 6-16

References

Meyers, N., Gray, H.L. & Sanzogni, L. (2009). Codes of conduct for mobile devices use in meetings: an exploratory analysis. Proceedings of Australian-New Zealand Communication Association Conference, 8th-10th, July, Brisbane.

Mevius, M. and Oberweis, A. (2005). A petri-net based approach to performance management of collaborative business processes. Proceedings of the 16th International Workshop on database and Expert Systems applications, (DEX A, '05), IEEE Computer Society.

Mingers, J. (2004). Real-izing Information Systems: critical realism as an underpinning philosophy for information systems. Information and Organization, 14(2), 87-103

Mingers, J. (2001). Combining IS research methods: towards a pluralist methodology. Information Systems Research, 12 (3), 240.

Miettinen, S. (2009). Prototyping social design in Finland and in Namibia: service design as a method for designing services for wellbeing. IASDR, Rigor and Relevance, Seoul.

Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and Ministry of Finance, Planning and Economic Development (MFPED) (1999). Plan for Modernization of Agriculture: eradicating poverty in Uganda. (Government Strategy and Operational Framework).

Ministry of Finance, Planning and Economic Development (MFPED) (2008).Poverty Eradication Action Plan (2004/5-2007/8). Kampala.

Mintzberg, H., Rasinghani, D., & Theoret, A. (1976). The structure of unstructured decision processes. Administrative Science Quarterly, 21(2), 246-275.

Mishler, E. G. (1986). Research Interviewing: Context and Narrative. Cambridge: Harvard UP, 1986.

Mokotjo, W. and Kalusopa, T. (2010). Evaluation of the Agricultural Information Service (AIS) in Lesotho. International Journal of Information Management, 30,350-356.

Moyer, S. and Kriens, P. (2009). Enabling Service Aggregation for Providers of Consumer Services and Applications. IEEE, 978-4244-2309-5/09

Mulira, N., Kyeyune, A., & Ndiwalana, A. (2010). Uganda ICT sector performance review 2009/2010. Towards Evidenced-Based ICT Policy and Regulation, 2, Policy Paper 13.

Mulira, N. K. (2007). Implementing Inter-Organizational Service Systems: an approach for emerging networks in volatile contexts. Doctoral Thesis, Delft University of Technology, Delft, Netherlands.

Muller, G. (2010). Requirements elicitation and selection: GAUDI system architecture. In: Systems architecturing, CRC Press.

Muniafu, S.M. (2007). Developing ICT enabled services in transition countries- a studio-based approach for logistics brokering. PhD Thesis, Delft University of Technology, The Netherlands.

Murray, M. (2003). Narrative psychology. In: Smith, J.A. (ed.), Qualitative psychology: a practical guide to research methods. Sage, 111-131.

Murray-Prior, R.B. and Wright, V.E. (2001). Influence of strategies and heuristics on farmers' response to change under uncertainty. The Australian Journal of Agricultural and Resources Economics, 45(4), 573-598.

Myers, M.D. and Newman, M. (2007). The qualitative interview in IS research: examining the craft. Information and organization, 17, 2-26.

NAADS (2010). NAADS information guidelines: farmer selection and report for progression from subsistence to commercialization. Government of Uganda.

Nair, R.R. (2006). Agricultural information service for the farmers and the public: a study. ILA Bulletin, 42 (3), 5-12.

Nakono, R. (2001). Web Content Management: a collaborative approach. Addition Wesley, Boston.

Nalukenge, I., Antle, J.M. & Stoorvogel, J. (2009). Assessing the Feasibility of Wetlands Conservation: Using Payments for Ecosystem Services in Pallisa, Uganda. In: Lipper L., Sakuyama, T., Stringer, R., Zilberman, D. (eds.). Payment for environmental services in agricultural landscapes: economic policies and poverty reduction in developing countries. FAO/Springer. Rome, 239-253.

Nandhakumar, J. and Jones, M. (2002). Development gain: participant observation in interpretive management information systems research, Qualitative research, 2, 323-341.

Natsuno, T. (2003). The i-mode wireless ecosystem. Chichester: Wiley.

References

Ndagu, W., & Obuobi. R. (2010). Strengthening SMEs: A Guide to Business Management and Governance for Small and Medium Enterprises in East Africa. 1-60. Newman, S., Lynch, T. & Plummer, A.A. (2000). Success and failure of decision support systems: learning as we go. Journal of Animal Science, 77, 1-12.

Newmark, P. (1988). A text book of translation. New York: Prentice Hall.

Nielsen, J. (1993). Usability engineering. Boston: Academic Press.

NITA-U (2012). Data connectivity and internet usage in government ministries, departments and agencies in Uganda. Kampala: NITA-U.

Nkonya, E. (2002). Uganda crop market characteristics, constraints and opportunities. The International Food Policy Research Institute, Washington D.C.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. Organizational Science, 5(1), 14-37.

Norman D., Siebert J., Modiakgotla, E. & Worman F., (1994). Farming systems research approach: A primer for Eastern and Southern Africa. Gaborone, Botswana: Farming Systems Programme.

Nuseibeh, B. and Easterbrook, S. (2000). Requirements elicitation: road map. In The Future of Software Engineering, Special Issues, 22nd International Conference on Software Engineering, ACM, IEEE.

Nunamaker, J.F. Jr., Chen, M., & Purdin, T.D.M. (1991). Systems Development in Information Systems Research. Journal of Management Information Systems, 7(3), Winter, 89-106.

Nysveen, H., Pedersen, P. E. and Thorbjornsen, H. (2005). Intentions to Use Mobile Services: Antecedents and Cross-Service Comparisons. Journal of the Academy of Marketing Science,33 (3), 330-346.

Oates, B.J. (2006). Researching information systems and computing. Los Angeles: Sage.

Ohlmer, B. (2007). The need and design of computerized farm management tools: lessons learnt from a Swedish case. Working paper series, 5, Department of Economics, SLU, Uppsala.

Ohlmer, B. (1998). Models of farmers' decision making- problem definition. Swedish Journal of Agricultural Research, 28, 17-27.

Okharedia, J. A. (2007). Design of partnership-centered information repository. Msc Dissertation, University of Zululand, South Africa.

Omole, F.K., Owoeye, J. & Ogundiran, A.O. (2012). Towards efficient transport connectivity for sustainable market patronage in Nigeria. International Journal of Developing Societies, 1(2), 88-96.

Ostertag, C., Lundy, M., Gottret, M., Best, R. & Ferris, S. (2007). Identifying market opportunities for smallholder farmers. CIAT Rural Agroenterprise Development, Good Practice Guide 3, CIAT, Colombia.

O'Sullivan, J., Edmond, D. & Ter Hofstede, A. (2002). What is a service?: towards accurate description of non-functional service properties. Distributed and Parallel databases, 12, 117-133.

Palmer, A. (1994). Principles of services marketing, McGraw-Hill, England.

Parker, C. (2001). An approach to requirements analysis for decision support systems. International Journal of Human-Computer Studies, 55, 423-433.

Parikh, T. S., Patel, N., & Schwartzman, Y. (2007). A survey of information systems reaching small producers in global agricultural value chain. Accessed 2nd, November, 2009 from:

http://www.stanford.edu/~neilp/pubs/ictd2007.pdf.

Penny, W. Henson, R. (2006). Analysis of variance. In: Friston K, Ashburner J, Kiebel S, (eds). Statistical Parametric Mapping. Elsevier.

Picault, J., Ribiere, M., Bonnefoy, D. & Mercer, K. (2011). How to get the recommender out of the lab. Recommender Systems Handbooks, Springer, 333-365.

Pingali, P.L., Rozelle, S.D. & Gerpacio, R.V. (2001). The farmer voice in priority setting: a cross-country experiment in eliciting technological preferences. Economic Development and Cultural Change, 49(3), 591-610.

Pol, G., Merlo, C., Legardeur, J. & Jared, G. (2007). Analyzing collaborative practices in design to support project managers. International Journal of Computer Integrated Manufacturing, 20(7), 654-668.

References

Poppenborg, P. and Koellner, T. (2013). Do attitude toward ecosystem services determine agricultural land use practices? An analysis of farmers' decision making in South Korea watershed. Land Use Policy, 31, 422-429.

Pouloudi, A. (1999). Aspects of Stakeholder Concept and their Implications for Information Systems Development. Proceedings of the 32nd Hawaii International Conference on Systems Sciences. IEEE

Poulton, C., Kydd, J. & Dorward, A. (2006). Overcoming market constraints on pro-poor agricultural growth in sub-Saharan Africa. Development Policy Review, 24(3), 243-277.

Pressman, R. (2005). Software Engineering: a practitioner's approach. McGraw-Hill.

Proctor, S. (1998). Linking philosophy and method in the research process: the case of realism. Nurse researcher, 5(4), 73-90

Pura, M. (2005). Linking percieved value and loyalty in location-based mobile services. Managing Services, 15(6), 509-538.

Qiang, C. Z., Kuek, C.S, Dymond, C & Esselaar. S. (2012). "Mobile Applications for Agriculture and Rural Development." World Bank

Quan-Haase, A., Cothrel, J. & Wellman, B. (2005). Instant messaging for collaboration: a case study of a high-tech firm. Journal of Computer-mediated Communications, 10(4), articl 13.

Rae, J. (2007). Seek the magic with service prototypes. Accessed 30 July 2012 from: http://www.businessweek.com/innovate/content/sep2007/id2007091`2_418827.htm

Raelin, J.A. (2005). The role of facilitation in praxis. Organizational Dynamics, 35(1), 83-95.

Rajanen, M., Iivari, N. & Keskitalo, E. (2012). Introducing usability activities into open source software development projects- a participative approach. Nordi HCI'12, October, Copenhagen, Denmark, ACM.

Rajasekaran, N. (1993). Decision making process of farmers with respect price and non-price factors. PhD thesis, Institute for Social and Economic Change, Bangalore University.

Reddy, P.K. (2004). A Framework of Information Technology Based Agriculture Information Dissemination System to Improve Crop Productivity. Proceedings of 22nd Annual Conference of Andhra Pradesh Economic Association 2004. D.N.R. College. Bhimavaram

Restrom, J. (2008). Requirements elicitation: definitions of use. Design Studies, 29(4).

Reyman, I.M.M.J. (2001). Improving Design Processes through Structured Reflection: Case Studies, SAI Report 2001/3, Eindhoven, ISSN 1570-0143

Richards, D. And Bottger, K. (2003). Representing requirements in natural language as concept lattices. Research and Development in Intelligent Systems, XIX, 425-438.

Robbins, P., Bilkande, F., Ferris, S., Kleih, U. & Okoboi, G. (2004). Collective marketing for small-holder farmers. FAO, Rome, Italy.

Robbins, P. and Ferris, S. (2000). Design of a Market Information System for Small-scale Producers and Traders in Three Districts of Uganda, CTA No. 8019. Kampala: IITA/FOODNet Project; London: Commodity Marketing Information Services (CMIS).

Robbins, P. and Ferris, S. (1999). A preliminary study of the maize marketing system in Uganda and the design of a market information system: preliminary study report. CTA/IITA Contract No. 4-1-06-215-9, London.

Robey, D., Khoo, H. M. & Powers, C. (2000). "Situated-learning in cross-functional virtual teams." IEEE Transactions on Professional Communication (Feb/Mar): 51--66. Robinson, W. I. (2008). Latin America and Global Capitalism: A Critical Globalization Perspective. Baltimore: Johns Hopkins University Press

Rosson, M. and Carrol. J. (2002). Usability engineering: scenario-based development of human-computer interaction. San Francisco: Morgan-Kaufman.

Rothermel, G., Elbaum, S., Malishevsky, A.G.,Kallakui, P. & Qiu, X. (2004). On test suite composition and cost effective regression testing. ACM Transactions on Software Engineering methodology, 13(3), 277-331.

Roulston, K. (2001). Data analysis and 'theorizing as ideology'. Qualitative Research, 1 (3), 279-302.

Ryser, J. and Glinz, M. (1999). A practical approach to validating and testing software systems using scenarios. QWE '99, 3rd International Software Quality Week, Europe.

Samuel, G.S. (2001). The development of integrated management information systems for agricultural extension institutions of developing countries: the case of Oromia Agricultural Development Bureau of Ethiopia, Achen: Shakar, 18-33.

References

Schiefer, G., Reiche, R., Hannus, T., Fritz, M., 2008. Food Chain Environment. CuteLoop Deliverable 1.2: Scenarios and Requirement, Analysis, 16–35.

Schubert, P. and Hampe, J.F. (2006). Mobile communities: how viable are their business models? An exemplary investigation of the leisure industry, *Electronic Commerce Research*, 6, 103-121.

Scott, N., Ndiwalana, A., Summer, A., Batchelor, S., Bahadur, A. & Mulira, N.(2008). Rural communities and communication needs (Uganda): a needs assessment report. Grameen Foundation, Kampla.

Sejati, K.W., Sulaiman, F. Busuno, E. Suradisastra, K. Syam, A. et al. (2002). The development of technology dissemination systems in support of regional agricultural development. Accessed 20th May 2013 from http://pustaka.bogor.net/caser2/hasilo2.htm

Selingman, P.S., Wijers, G.M. & Sol, H.G. (1989). Analyzing the structure of information systems methodologies: an alternative approach. First Dutch Conference on Information Systems.

Sembado, L.A.A.T. (2007). The decision making process of semi-commercial farmers: a case study of technology adoption in Indonesia. PhD thesis, Lincoln University, USA.

Sen, K., Marinov, D. & Agha, G. (2005). CUTE: a concolic unit testing engine for C. ESEC-FSE '05, September 5th-9th, Lisbon, Portugal, ACM.

Shekar, A. (2007). An innovative model of service development: a process guide for service managers. The Innovation Journal: The Public Sector Innovation Journal, 12 (1), article 4.

Shepherd, A.W. (2011). Understanding and using market information: marketing extension guide. FAO, Rome. Reprint.

Shepherd, A. (2005). Bringing market information to farmers: opportunities through FM radio. In: Dixon, J., Wattenbach, H. & Bishop-Sambrook, C. (eds.). Improving Information Flows to the Rural Community, FAO, Rome, October.

Shepherd, A. W. (2003). Market research for agro processors. Marketing extension guide, 3, FAO, Rome.

Shilakes, C. C. and Tylman, J. (1998). "Enterprise Information Portals". Merrill Lynch & Co,

Siegel, J. (2008). In OMG's OCEB certification program, what is the definition of business process: Accessed 30th June 2012, From: http://www.omg.org/oceb/defbusinessprocess.htm.

Simon, H. A. (2009). Economics, bounded rationality, and the cognitive revolution. Northampton, MA: Edward Elgar Publishing.

Simon, H. A. (1997). Models of bounded rationality: Empirically grounded economic reason. Cambridge, MA: MIT Press.

Simon, H.A. (1960). The new science of management decisions. NY: Harper and Row.

Simonsen, J. and Hertzum, M. (2008). Participatory design of large-scale information systems: a reconstruction of the iterative prototyping approach. Proceedings of the Conference on perspectives on practice-oriented design science. Roskilde University, May 15th, 57-72.

Slavova, M. (2007). Integrated design of technology-based marketplaces for agriculture in developing countries. In Cunningham, Miriam & Cunningham, Paul (eds.), Proceedings from IST-Africa Conference proceedings

Smith, A. (2007). Evaluating personalized services. Journal of Integrated Care, 15(2), 43-50.

Smith, M.J. (1998). Social science in question. Sage: London.

Sol, H.G. (2014). Enhancing issues that matter: providing collagen for ennovations. 16th IEEE Conference on Business Informatics, 14-17, July, Geneva, Switzerland.

Sol, H.G. and Crosslin, R.L. (eds.) (1992). Dynamic modeling of Information Systems, II. North-Holland, Amsterdam.

Sol, H.G. (1982). Simulation in information systems development. Doctoral dissertation, University of Groningen, Groningen, The Netherlands.

Sol, H.G. (1988). Information systems development: a problem solving approach. Proceedings of 1988 INTEC symposium, Systems Analysis and Design: A research strategy. Atlanta, Georgia, USA.

Solano, C., Leon, H., Perez, E. & Herrero, M. (2003). The role of personal information services on the decision making process of Costa Rican dairy farmers. Agricultural Systems, 76, 3-18.

Solano, C., Leon, H., Perez, E. & Herrero, M. (2001). Who makes farming decisions? A study of the Costa Rican dairy farmers. Agricultural Systems, 67, 181-199.

Speier, C. and Morris, M. G. (2003). The influence of query interface design on decision making performance. MIS Quarterly, 27(3), 397-423.

References

Spohrer, J. and Kwan, S.K. (2009). Service science, management, engineering and design (SSMED)- an engineering discipline, outline and references. International Journal on Information Systems in Service Sector, 1(3).

Steinberg, J. (2003). "INFORMATION Technology & Development BEYOND 'EITHER/OR,". Brookings Review, 21(2), 45.

Sterk, B., van Ittersum, M.K., Leewis, C. & Wijnands, F.G. (2007). Prototyping and farm systems modeling- partners on the road towards more sustainable farm systems? European Journal of Agronomy, 26, 401-409.

Stockbridge, M., Dorward, A., Kydd, J. Morrison, J. & Poole, N. (2003). Farmer organizations for market access; an international review. Wye, Ashford Centre for Development and Poverty Reduction, Imperial College, London.

Suit, M. (2011). Modeling and analysis of human collaboration processes in organizations. Doctoral Dissertation, University of Groningen, The Netherlands.

Tan, Y., Hofman, W., Gordijn, J. & Hulstijn, J. (2011). A framework for the design of service systems. In: Demirkan H. *et al*. (eds.). Service Systems Implementation, Service Science, Springer.

Tarantino, A. (2008). Governance, Risk and Compliance Handbook : Technology, Finance, Environmental and International Guidance and Best Practices. John Wiley & Sons, Hoboken, N.J.

Talug, C. (1990). Agricultural research, development and the examination of extension services for agricultural productivity, MPM Publishing, Ankara.

Taper, M. T. and Lele, S. R. (2004). The nature of scientific evidence: statistical, philosophical and empirical considerations. University of Chicago Press: Chicago, xv-xvi.

Taylor, S. and Todd, P.A. (1995). Understanding IT usage: a test of computing models. Information Systems Research, 6(2), 144-176.

Thornsbury, S., Davis, K. & Minton, T. (2003). Adding value to agricultural data: a golden opportunity. Applied Economic Perspectives and Policy, 25(2), 550-568.

Tollens, E.F. (2006). Market information systems in sub-Saharan Africa: challenges and opportunities. International Association of Agricultural Economics Conference, Gold Coast, Australia, August.

Tong, D., Ren, F. & Mack, J. (2012). Locating farmers' markets with an incorporation of spatio-temporal variation. Socio-Economic Planning Sciences, 46, 149-156.

Tongco, Ma. D.C. (2007). Purposive sampling as a tool for informant selection. Ethnography Research and Applications, 5, 147-158.

Torero, M. (2011). A framework for linking small farmers to markets. Conference on new directions for smallholder agriculture. 24-25, Jan. Rome: IFAD.

Towler, M. (2010). Rational decision making: An introduction. New York, NY: Wiley.

Trochim, W. M. K. (2006). Social research methods: research methods knowledgebase. Accessed 4thOctober, 2010, From: http://www.socialresearchmethods.net

Tsakonas, G. and Papatheodorou, C. (2006). Analyzing and evaluating usefulness and usability in electronic information services. Journal of Information Sciences, 32, 400-419.

Tscherning, H. and Damsgaard, J. (2008). Understanding the diffusion and adoption of telecommunication innovations: what we know and what we don't know. In: Bernardos, L., Kautz, C. & de Gross (eds.) International Federation for Information Processing, 287, 39-60.

Tufte, E.R. (2001). The Visual Display of QuantitativeInformation,2nd ed. Cheshire CT: Graphics Press.

Umali, L.S. and Dina, L. (1994). Public and private agricultural extension: beyond traditional frontiers, World Bank discussion paper, 236, 15-26.

Uganda Communication Commission (UCC) (2010). RCDF: RCDF project in Soroti District: a report.

United Nations (UN), (2010). Information economy report 2010: ICTS, Enterprises and poverty alleviation. New York

Vaishnavi, V., and Kuechler, W. 2008. "Design Research in Information Systems," AISNet. Accessed 20th October 2010 from:

http://ais.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=279)

Vaishnavi, V. and Kuechler, B. (2004). Design research in information systems. Accessed 29th August, 2009 From: http://www.isworld.org/Researchdesign/drisISworld.htm

Van de Kar, E. and Verbraeck, A. (2007). Designing Mobile Service Systems. Research in Design Series, vol. 2. IOS Press, Amsterdam.

References

Van de Kar, E. (2004). Designing Mobile Information services: an approach for organizations in a value network. PhD Thesis, Delft University, Netherlands

Van de Ven, A.H. (2007). Engaged scholarship: a guide to organizational and social research. Oxford University Press.

Van der Aalst, W. (2004). Business process management: A personal view. Business Process Management Journal, 10(2), 135-139

Van der Aalst, W.M.P. (1998). The application of Petri nets to workflow management. The Journal of Circuits, Systems and Computers, 8(1), 21-26.

Van Schaik, F.D.J. (1988). Effectiveness of decision support systems. PhD Thesis, Technical University Delft, The Netherlands.

Venable, J. (2006). A Framework for Design Science Research Activities. In Proceedings of the 2006 Information Resource Management Association Conference. Washington, DC, USA

Venkatesh, V., Morris, M.G., Davis, G.B. & Davis, F.D. (2003). User acceptance of information technology: toward a unified view. MIS Quarterly, 27, 425-478.

Venkatesh, V., Ramesh, V. & Massey, A.P. (2003). Understanding usability in mobile commerce: ramifications for wireless design. Communications of the ACM, Dec, 46(12), 53-56.

Venkatesh, V. (2000). Determinants of perceived ease of use: integrating control, intrinsic motivation and emotion into the technology acceptance model. IS Research 11(4), 342-365.

Verdouw, C.N. (2010). Business Process Modeling in Demand-Driven Agri-Food Supply Chains - A Reference Framework. PhD Dissertation, Wageningen University, The Netherlands.

Verdouw, C. N., Wolfert, J. & Beulens, A. J. M. (2007). Information integration in multi-dimensional agri-food supply chain networks: a service oriented approach. In: Cunningham, P. and Cunningham, M. (eds). Expanding the knowledge economy: issues, applications, case studies. IOS Press: Amsterdam, 1024-1031.

Vidal, R.V.V. (2009). Community facilitation of problem structuring and decision making processes: experiences from the EU LEADER+ programme. European Journal of Operational Research, 199, 803-810.

Vidgen R.T., Avison D.E., Wood J.R.G. & Wood-Harper T.A. (2002), Developing Web Information Systems, Butterworth Heinemann

Villela, K., Santos, S., Schnaider, L., Rocha, A.R. & Travossos, G.H. (2005). The use of enterprise ontology to support knowledge management in software development environments. Journal of Brazilian Computer Society, 11(2), 45-59.

Wade, R. (2002). Bridging the digital divide: new route to development on new form of dependency. Global Governance, 8, 365-388.

Walls, J., Widmeyer, G.& El Sawy, O. (2004). Assessing Information Systems Design theory perspective: how useful was our 1992 Initial Rendition, Journal of Information Technology Theory & Application (JITTA), 6 (2), 43-58.

Wang, L. (2009). Web-based decision making for collaborative manufacturing. International Journal of Computer Integrated Manufacturing, 22(4), 334-344.

Weber, R. (2003). Editor's comments: Still desperately seeking the IT Artefact. MIS Quarterly, 27(2), iii-xi.

Weill, P. and Ross, J. (2004). How do performers manage IT decision rights for superior results. Harvard Business School Press.

Weske, M. (2007). Business process management: Concepts, languages, architectures. Heidelberg, Berlin, Germany: Springer

Wierda, F. (1991). Designing inter-organizational information systems. Technology, Management and Policy, PhD Thesis, Delft University of Technology, The Netherlands.

Wieringa, R.J. (2002). Design methods for software systems: Yourdon, statement and the UML. Morgan Kaufmann.

Wierman, A., Winands, E.M.M. & Boxma, O.J. (2007). Scheduling in polling systems. Performance Evaluation, 26th International Conference on Computer modeling, measurements and Evaluation, 64(9-12), 1009-1028.

Willing, C. (2003). Discourse analysis. In: Smith, J.A. (ed.), Qualitative psychology: a practical guide to research methods. Sage, 159-183.

References

Wijnhoven, F. (2008). Process Design Theory for digital information services. In: Bernard, A. and Tichkiewitch, S. (eds.). Methods and Tools for effective knowledge life-cycle-management, Springer, 533-546.

Wijnhoven, F. and Kraaijenbrink, J. (2008). Product-oriented design theory of digital information services: a literature review. Internet Research, 18 (1), 93-120.

Woods, M. (1997). Researching rural conflicts: hunting local politics and actor-networks. Journal of Rural Studies, 14(3), 321-340.

World Bank (2009). Information and Communications for Development 2009:extending reach and increasing impact. Washington, DC.

World Bank (2008). World Development Report 2008: Agriculture for Development.

World Bank (2005). Managing agricultural production Risks: innovations in developing countries. Report 32727, Agriculture and Rural Development Department, Washington, DC.

World Bank (2003). ICTs and MDGs, a World Bank group perspective: Global ICT Development, Geneva, . World Bank Group

WOUGNET (2006); A gender assessment of Uganda's Rural Communications Development Fund.

Xiao, L. and Greer, T. (2007). Towards agent-oriented model-driven architecture. European Journal of Information System, 16, 390-406

Yang, C.C. and Wang, F.L. (2005). An information delivery system with automatic summarization for mobile commerce, Decision Support Systems

Yin, R. (1994). Case study research: Design and methods, 2nd ed. Sage Publishing: Beverly Hills, CA.

Yonasi, J.J (2010). Enhancing adoption of e-government initiatives in Tanzania. PhD Thesis, University of Groningen, The Netherlands.

Zajonc, R.B. (1965). Social facilitation. Science, 149, 269-274.

Zhang, Z. (2007). Effective requirements development – a comparison of requirements elicitation techniques. A working paper for SQM 2007 Conference.

List of Abbreviations

ACP	African and Caribbean/Pacific Countries
AIS	Agricultural Information Service
AIM	Agricultural Information Management
AMIS	Agricultural Market Information Services
ARIS	Agricultural Research Information Service
Agrotags	A Tagging Scheme for Agricultural Digital Content
ASARECA	Association for Agricultural Research in East and Central Africa
CAPRi	Collective Action and Property Rights
B2B	Business to Business
DES	Decision Enhancement Services
ECA	Economic Commission for Africa
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FDES	Farmers' Decision Enhancement Services
HTML	Hypertext Markup Language
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
IS	Information Service (or System)
AGRIS	International Information Systems on Agricultural Science and Technology
IICD	International Institute for Communication and Development
ISNAR	International Service for National Agricultural Research

KB	Knowledge Base
MAAIF	Ministry of Agriculture Animal Industries and Fisheries, Uganda
AGROVOC	Multilingual Agricultural Thesaurus
NAADS	National Agricultural Advisory Services
NARO	National Agricultural Research Organization
NARS	National Agricultural Research Systems
NITA-U	National Information Authority of Uganda
NUCFA	Northern Uganda Farmers Association
PDAs	Personal Digital Assistants
PMA	Plan for the Modernization of Agriculture
PFA	Prosperity for All
RAIS	Regional Agricultural Information Systems
RCDF	Rural Communication Development Fund
CTA	Technical Center for Agricultural and Rural Cooperation
UBOS	Uganda Bureau of Statistics
UNFA	Uganda National Farmers Association
UNESC	United Nations Economic and Social Council, Economic Commission for Africa
WIS	World Information Society
WOUGNET	Women of Uganda Network
WSIS	World Summit on Information Society
WB	World Bank

Summary

Due to the smaller profit margins and increasing restrictions on markets and product pricing, decision-making in the agricultural sector in developing countries has become not only more important but also more challenging. This applies in particular to market and price choices by farmers, which constitute the core of this research. The agricultural market is complex and includes a number of interactive processes, including field crops, crop harvest, market and consumer choices, pricing, and product delivery. In addition, farmers in developing countries represent a greater part of the working population, which makes market and price decisions to be of far-reaching implications for national development. The agricultural markets are the most important link between the development of a wider economy and the lives of individual farmers alike.

A brief overview of the Ugandan agricultural market shows that farmers have to deal with a number of challenges in the process of their market and price decision making. Some of these challenges include information; the increasing demand for competition in the marketplace; constantly changing market attributes; the unpredictable consumer preferences; inadequate access to infrastructural facilities (e.g. telecommunications, transport and an effective road network); organizational networks; and changing public policies and priorities.

The purpose of this research was to develop, implement and evaluate a *market and price decision enhancement service* for farmers in Uganda. The main research question concerned with: "how Ugandan farmers can improve their decision making on market and price choices?". From the main research question, we derived four specific questions, which enabled us to:

- Offer a profound understanding of the existing market outlets and their circumstances, their weaknesses, the services offered and the way in which farmers use the existing support services,
- Define the requirements for market and price decision enhancement services for farmers,
- Examine factors that influence the farmers' market and price decision-making,
- Provide insight into the strategies and tools necessary for the design, prototyping and evaluation of a *decision enhancement studio* for farmers.

Uganda agricultural market place provides an interesting environment for studying the farmers' market and price decision making processes. This is confirmed by studies that indicate that more than 80% of

Summary

the Ugandan population is involved in agricultural activities and that 44% of the GDP comes from agriculture, as well as 38% of the export earnings. Secondly, smaller holder activities constitute the hallmark of agriculture in Uganda, where intensity and density of poverty remain high (Torero, 2011). To answer our research question, insights are used from the *decision enhancement lens* of Keen and Sol (2008). Decision enhancement provides in particular a *management lens* to the dynamic and volatile landscape of the farmers' market and price decision making arenas. Decision-making is considered in this research as a series of actions that begins with the identification of an incentive for the action and ends with a specific commitment to this action (Mintzberg et al. , 1976; Keen and Sol, 2008).

On the research philosophy, this study employed design science as outlined by Hevner *et al.* (2004), Hevner and Chatterjee (2010) among others. The aim is to create an innovative artefact in the form of a *Farmers' Decision Enhancement Studio* (FDES). Consequently, understanding insights from complementary perspectives was necessary due to the characteristics of the problem domain. In particular, this research looked at positivism and postpositivism (Gonzalez and Sol, 2012; Crossan, 2003; March and Smith, 1995); critical theory (Avgerou, 2005; Mingers, 2001); and interpretivism and pragmatism (Knol, 2013; Goldkuhl, 2012; Gonzalez and Sol, 2012). Similarly, insights from the three iterative phases of design science (Hevner *et al.*, 2004) facilitated the identification of our research strategy.

Arising from the above design science perspectives (as in Carlsson *et al*., 2011; Hevner, 2007; Hevner *et al*., 2004; March and Smith, 1995), an inductive-hypothetical research strategy proposed by Sol (1982) was used. Subsequently, an analysis of the farmers' decision making environment involved the use of the knowledge base, exploratory field studies, including the researchers' own experience and feedback from experts. The existing knowledge was particularly useful for understanding problems in the domain of market and price decision making by farmers . These mainly covered: information as a requirement for decision enhancement; service-based theoretical insights; the decision-making practices of farmers ; relevant design and development methodologies; and ICT and decision enhancement services for farmers.

For the purposes of field exploration, farmers from Gulu and Soroti districts were purposively selected with the help of their association's programme officers. Supplemented by insights from the knowledge base and experts' feedback, exploration exercises helped us map the operational requirements for designing the proposed decision enhancement studio. Our exploration particularly focused on farm and

farm household characteristics of individual farmers, information needs and decision making, farmers' knowledge on existing services, types of information needed and decision making, information presentation and delivery, and whether the farmers' make use of the Uganda National Agricultural Advisory Services (NAADS). A number of challenges were identified, among which are transport infrastructure, market attributes, family and/or group influence, telecommunication infrastructure and services, opportunities and risks, cultural values, organizational structures and market and price information. From the identified challenges, we can conclude that farmers are engaged in making decisions that matter (Keen and Sol, 2008) regarding the selling of their products.

During exploration, both interviews and observation enabled us extract empirical insights from farmers' and other market stakeholders' decision making arenas. The insights gained suggest that, the nature of the research problem needed a solution that would handle unstructured information, provide an interactive and collaborative decision making environment, and accommodate the continuous changes that are prone to agricultural markets, technology and consumer preferences. Hence, there is need for knowledge from different schools of thought such as evolutionary, collaborative, service oriented architecture among others. Specifically, insights grounded on information systems' perspective (Sol, 1982; Checkland, 1993) were essential in mapping potential solutions to the farmers' market and price decision making challenges. Of most importance were insights from the school of thought, where the studio design has to be people centric, process enabled, participatory developed and personalized.

An approach to design the studio was informed by insights from systems thinking and problem solving perspectives. Similarly, the "ways of" framework (Sol, 1988; Seligmann *et al*, 1989) underpins the strategy for the studio design approach. Our approach is presented covering the way of thinking, way of governance, way of working and modeling, leading to the studio suites and recipes. The design approach is presented following the three aspects that underpin decision enhancement services (Keen and Sol, 2008), namely: the people who make market and price decisions, the processes undertaken by these people and the technology that can improve the decision-making process.

Arising from the service system insights (as in Van der Kar, 2004; Mulira, 2007), the people aspect of FDES was essential for understanding the primary actors, their needs, environment and capabilities. Specifically, market actors were found to be pre-occupied with making Market Identification and Price Determination decisions. Secondly, the technology aspect deals with the types and levels of technology support directed to enhancing decision making among market actors. A number of technological options such as internet, telecommunication networks, gateways etc proved to be relevant for the realisation of

FDES services. It was necessary to appreciate the existing technological capabilities of farmers regarding access, availability, capability to own and use. On the "process aspect", we consider a decision process as that process that has the purpose of "making real impact for stakeholders in handling decisions that really matter in their spheres of responsibility" (Keen and Sol, 2008).

Based on collaborative engineering, UML diagrams were used to model the farmers' market and price decision making processes. To this end, we identified, developed, implemented and evaluated three studio services namely: Market Identification Service, Price Determination Service and Communication Services. On an operational point of view, the studio provides useful information and services that helps market actors to 1) improve their level of market and price decision making process; 2) explore scenarios of future market evolution; 3) establish the basis of market access planning; and 4) enhance the negotiation between actors involved in market and price decisions.

The studio with its accompanying services was prototyped and implemented in Gulu and Soroti districts of Uganda. Based on insights from a number of perspectives such as service oriented architecture, we implemented both the web-based and sms based interfaces of the studio. The implementation mainly relied on open source tools enabled by the available farmers' resources and capabilities. An open source sms gateway was used to both verify and test the studio performance regarding farmers' market and price decision making. The implementation mainly focused on ensuring suitability to requirements and participants' expectations. In addition, the implementation helped us further define hardware and software specifications, provide a description of the studio, and carry out verification.

Verification results indicate that farmers who need to mitigate on their market and price decision making challenges can benefit from the studio. For instance, participants were able to access the studio services, use them and contribute suggestions for improvements. The verification exercise involved both the web-based and sms-based interfaces as proposed in the studio architecture. As an example, participants recommended that the "email-based option of the web-based interface is made optional", since many of them did not have access to internet. The verification exercise involved 5 farmers' association executives, 30 students of computer science from Gulu University and feedback from experts was taken into account.

Finally, the studio effectiveness was evaluated among purposively selected farmers and traders from Gulu and Soroti districts. The evaluation was conducted based on the 3Us (usefulness, usability and usage) of decisions enhancement services proposed by Keen and Sol (2008), and which have been used by other similar studies such as Amiyo (2012), Ejiri (2012) and Knol (2013). The evaluation was

conducted in Gulu and Soroti districts involving 22 participants who were purposively selected. The analysis and interpretation of the evaluation results led to the conclusion that the studio generally is useful and usable. It can help participants focus on market identification and price determination activities. It also has an additional benefit since participants can obtain other services that enhances their ability of locate markets for their products. Examples include, for instance, locating and getting in touch with agencies that carry out bulk buying of products such as World Food Programme, uploading pictures of their products on the web interface of the studio etc.

There are a few areas that have been recommended for further refinement and investigation. These include issues regarding the subsistence nature of the farming systems, to investigate which effect sms usage has on the studio utility, the need to identify and scope further activities that farmers are engaged in while making market and price decisions, the automatic language translation and a provision for a drop down option that facilitates language selection.

Samenvatting

Door kleinere winstmarges en steeds grotere beperkingen op markten en productprijzen is besluitvorming in de agrarische sector in ontwikkelingslanden niet alleen belangrijker maar ook uitdagender geworden. Dit geldt met name voor markt- en prijsbesluiten door boeren, welke de kern van dit onderzoek vormen. De agrarische markt is complex en omvat een aantal interactieve processen, waaronder gewassenteelt, gewassenoogst, markt- en consumentenkeuzes, prijsstelling en productlevering. Bovendien vertegenwoordigen boeren in ontwikkelingslanden een groter deel van de beroepsbevolking, waardoor markt- en prijskeuzes verregaande implicaties voor de nationale ontwikkeling kunnen hebben. De markten vormen de belangrijkste schakel tussen de ontwikkeling tot een bredere economie en het leven van de boeren.

Een kort overzicht van de Oegandese agrarische markt laat zien dat boeren te maken hebben met verschillende uitdagingen op het gebied van markt- en prijsbesluiten. Tot deze uitdagingen behoren: informatievoorziening; de toenemende roep om slagvaardigheid op de marktplaats; voortdurend veranderende marktattributen; de onvoorspelbare consumentenvraag; onvoldoende toegang tot infrastructuurfaciliteiten (bijv. telecommunicatiediensten, transport en een effectief wegennetwerk); organisatienetwerken; en een veranderend overheidsbeleid en -prioriteiten.

Het doel van dit onderzoek is “het ontwikkelen,implementeren en evalueren van een *decision enhancement studio*op het gebied van markten en prijzen voor boeren in Oeganda”. De belangrijkste onderzoeksvraag luidt: “hoe kunnen Oegandese boeren hun besluitvorming aangaande markten en prijzen verbeteren?”Om de belangrijkste onderzoeksvraag te kunnen beantwoorden, zijn hiervan vier specifieke vragen afgeleid. Deze vier deelvragen:

- bieden een verregaand begrip van de bestaande marktkanalen en hun omstandigheden, hun zwakke plekken, de diensten die worden aangeboden en de wijze waarop boeren hiervan gebruikmaken;
- bakenen de eisen af die aan de besluitvorming betreffende markten en productprijzen worden gesteld en geven een beschrijving daarvan;
- onderzoeken de factoren die de markt- en prijsbesluiten van boeren beïnvloeden;
- bieden inzicht in welke strategieën en hulpmiddelen nodig zijn voor het ontwerp, prototyping en evaluatie van een *decision enhancement service* voor boeren.

Oeganda is een interessante omgeving om besluitvorming op het gebied van markten en prijzen te onderzoeken. Dit wordt bevestigd door studies die aangeven dat meer dan 80% van de Oegandese bevolking betrokken is bij agrarische activiteiten en dat 44% van het bbp afkomstig is uit de landbouw, evenals 38% van de exportinkomsten. Bovendien zijn de activiteiten van kleinere houderijen kenmerkend voor de landbouw van Oeganda, een land waar de intensiteit en dichtheid van armoede nog steeds hoog zijn (Torero, 2011). Om de onderzoeksvraag te beantwoorden zijn inzichten gebruikt uit de *decision enhancement lens* van Keen en Sol (2008). Decision enhancement biedt met name een *management lens* om het dynamische en vluchtige landschap van de arena's onder de loep te nemen waarin boeren markt- en prijsbesluiten nemen. Besluitvorming moet in dit onderzoek worden beschouwd als een reeks acties die begint met het identificeren van een stimulans voor de actie en eindigt met een specifieke toewijding aan deze actie (Mintzberg et al., 1976; Keen en Sol, 2008).

In termen van onderzoeksfilosofie wordt in dit onderzoek *design science* gehanteerd zoals omschreven in o.a. Hevner et al. (2004) en Hevner en Chatterjee (2010). Er wordt gestreefd naar het creëren van een innovatief artefact in de vorm van een *Farmers' Decision Enhancement Studio* (FDES). Gezien de kenmerken van het probleemdomein zijn inzichten uit aanvullende perspectieven noodzakelijk. Met name is gekeken naar: positivisme en postpositivisme (Gonzalez en Sol, 2012; Crossan, 2003; March en Smith, 1995); kritische theorie (Avgerou, 2005; Mingers, 2001); en interpretivisme en pragmatisme (Knol, 2013; Goldkuhl, 2012; Gonzalez en Sol, 2012). Om de onderzoeksstrategie vast te stellen, zijn met name inzichten uit de drie iteratieve fases van design science (Hevner et al., 2004) toegepast.

Op basis van de design science (zoals in Carlsson et al., 2011; Hevner, 2007; Hevner et al., 2004; March en Smith, 1995) is gekozen voor een inductief-hypothetische onderzoeksstrategie zoals voorgesteld door Sol (1982). In dit onderzoek is de analyse van de omgeving waarin boeren prijsbesluiten nemen uitgevoerd aan de hand van aanwezige kennis en verkennende veldonderzoeken, waaronder de ervaring van de onderzoeker zelf en feedback van deskundigen.

De aanwezige kennis was met name van nut om problemen op het gebied van markt- en prijsbesluiten te doorgronden. Tot deze probleemgebieden behoren: informatie als een vereiste voor decision enhancement; op service gebaseerde theoretische inzichten; de besluitvorming door boeren in de praktijk; relevante ontwerp- en ontwikkelingsmethodologieën; en ICT en decision enhancement services voor boeren.

In het kader van het veldonderzoek werd er, met behulp van de programmamedewerkers van hun organisatie, een bewuste selectie gemaakt van boeren uit de districten Gulu en Soroti.

Op basis van deze verkenning – en de aanwezige kennis en feedback van deskundigen – konden de operationele vereisten voor het ontwerp van de voorgestelde decision enhancement studio in kaart worden gebracht. Onze verkenning focuste met name op: de achtergrondinformatie over individuele boeren; informatiebehoeften en besluitvorming; de kennis van boeren van bestaande services; de benodigde soorten informatie en besluitvorming; de presentatie en levering van informatie; en of de boeren gebruikmaken van de diensten van de Uganda National Agricultural Advisory Services (NAADS). Er werd een aantal uitdagingen vastgesteld, waaronder de transportinfrastructuur, marktattributen, familie- en/of groepsdruk, telecommunicatie-infrastructuur en -services, kansen en risico's, culturele waarden, organisatiestructuren en markt- en prijsinformatie.

De interviews en observaties uit de verkenningsfase hebben tot empirische inzichten geleid die betrekking hebben op boeren en andere belanghebbenden in de besluitvormingsarena's. Deze inzichten suggereren dat het onderzoeksprobleem om een oplossing vraagt die ongestructureerde informatie aankan, die een interactieve en collaboratieve besluitvormingsomgeving biedt, en die plaats biedt aan de voortdurende veranderingen waaraan de agrarische markten, technologie en consumentenvoorkeuren onderhevig zijn. Derhalve is er behoefte aan kennis uit diverse disciplines. Met name ideeën op het gebied van informatiesystemen (Sol, 1982; Checkland, 1993) waren essentieel bij het in kaart brengen van oplossingen voor besluitvorming door boeren op het gebied van markten en prijzen. Van groot belang waren ideeën uit stromingen waarin het studio-ontwerp focust op mensen, processen mogelijk maakt, participatie ontwikkelt en gepersonaliseerd is.

Het ontwerp van de studio werd tevens gebaseerd op *systems thinking* en probleemoplossing, en op het *ways of*-kader (Sol, 1988; Seligmann et al., 1989). Dit kader houdt rekening met de manier van (*way of*) denken, de manier van governance, de manier van werken en modellering, die vervolgens leiden tot studio suites en recepten. De decision enhancement services (Keen en Sol, 2008) zijn gebaseerd op drie aspecten: de mensen die de markt- en prijsbesluiten nemen; de processen die door deze mensen worden uitgevoerd; en de technologie die het besluitvormingsproces kan verbeteren.

Uit inzichten op het gebied van servicesystemen (Van der Kar, 2004; Mulira, 2007) bleek dat het menselijke aspect van de FDES cruciaal is om de primaire actoren, hun behoeften, omgeving en capaciteiten te begrijpen. Zo bleken marktactoren met name bezig te zijn met besluiten op het gebied van marktidentificatie en prijsbepaling. Het technologische aspect betreft de types en niveaus van technologische ondersteuning bij decision enhancement door marktactoren. Een aantal technologische opties, zoals het internet, telecommunicatienetwerken en gateways, bleek relevant te zijn voor de

realisatie van FDES services. Ook moesten de aanwezige technologische capaciteiten van boeren in kaart worden gebracht, bijv. de toegang tot en beschikbaarheid van technologie en het vermogen om deze te bezitten en gebruiken, etc. Wat betreft het procesaspect heeft het besluitvormingsproces het volgende doel: een aanzienlijke impact hebben op belanghebbenden bij het nemen van besluiten die er in hun verantwoordelijkheidssfeer werkelijk toe doen.

Aan de hand van op collaboratieve technologie gebaseerde UML-diagrammen kan de besluitvorming door boeren over markten en prijzen in een model worden weergegeven. Hiertoe zijn er drie studio services geïdentificeerd, ontwikkeld, geïmplementeerd en geëvalueerd, namelijk de *market identification service*, *price determination service* en de *communication services*. Vanuit een operationeel perspectief biedt de studio nuttige informatie en services aan de hand waarvan marktactoren 1) het niveau van hun besluitvormingsproces aangaande markten en prijzen kunnen verhogen; 2) toekomstscenario's voor marktevolutie kunnen verkennen; 3) de basis kunnen leggen voor een markttoegangsplanning; en 4) het onderhandelen tussen bij markt- en prijsbesluiten betrokken actoren kunnen verbeteren.

De studio met bijbehorende services is geprototyped en geïmplementeerd in de Oegandese districten Gulu en Soroti. Op basis van een aantal inzichten, zoals de servicegerichte architectuur, is gekozen voor de implementatie van zowel de web- als de sms-gebaseerde interfaces van de studio. De implementatie vond voornamelijk plaats aan de hand van *open source tools* en van de beschikbare middelen en capaciteiten van de boeren. Er werd een *open source sms gateway* gebruikt om de studioprestaties op het gebied van besluitvorming over markten en prijzen te verifiëren en te testen. Bij de implementatie werd met name gekeken of er voldaan werd aan de eisen en aan de verwachtingen van de deelnemers. Op deze manier was het mogelijk om de hardware- en softwarespecificaties verder te definiëren, een beschrijving van de studio te geven en een verificatie uit te voeren.

De verificatieresultaten laten zien dat de boeren die voor uitdagingen op het gebied van markt- en prijsbesluiten staan, baat hebben bij de studio. De deelnemers hadden bijvoorbeeld toegang tot de studio services, konden deze gebruiken en suggesties doen voor verbeteringen. Deelnemers raadden bijvoorbeeld aan om 'de emailgebaseerde optie van de webgebaseerde interface optioneel te maken', daar velen van hen geen toegang hebben tot internet. Bij de verificatie waren 5 bestuursleden van agrarische organisaties betrokken, evenals 30 studenten Informatica van de Gulu University en werd feedback van deskundigen in aanmerking genomen.

Als laatste werd de doeltreffendheid van de studio geëvalueerd door bewust geselecteerde boeren en handelaren uit de districten Gulu en Soroti. De evaluatie werd uitgevoerd op basis van de drie *u*'s (*usefulness*, *usability* en *usage*) van de decision enhancement services (Keen en Sol, 2008); deze zijn ook gebruikt in soortgelijke studies als Amiyo (2012), Ejiri (2012) en Knol (2013). De evaluatie werd uitgevoerd in Gulu en Soroti en omvatte 22 bewust geselecteerde deelnemers. De analyse en interpretatie van de evaluatieresultaten leidde tot de conclusie dat de studio nuttig (*useful*) en bruikbaar (*usable*) is. Aan de hand van de studio konden deelnemers focussen op marktidentificatie en prijsbepaling. Daarnaast bood de studio het voordeel dat deelnemers toegang hebben tot andere diensten waarmee ze beter markten voor hun producten kunnen lokaliseren. Door bijvoorbeeld in de studio afbeeldingen van hun producten op de webinterface te uploaden, kunnen deelnemers organisaties die grote partijen afnemen, zoals het Wereldvoedselprogramma, lokaliseren en daarmee in contact komen.

Er zijn enkele aspecten die verdere verfijning en onderzoek behoeven: het feit dat boerenbedrijven bovenal gericht zijn op levensonderhoud; het onderzoek naar het effect van sms-gebruik op de *studioutility*; de noodzaak om andere activiteiten van boeren tijdens het nemen van markt- en prijsbesluiten te identificeren en in kaart te brengen; automatische vertaling en het aanbieden van een dropdownoptie om een taal te selecteren.

Curriculum Vitae

Education

Born in Soroti district, Uganda, Raphael Aregu started his career path in Abeko Primary School between 1977-1980. In 1981-1982, Raphael Aregu joined Tirir Primary School, from where he moved to The Pioneer School in Soroti town in 1983. After completing his primary level, Raphael Aregu sat for his O and A level education in Soroti Senior School and Teso Collage Aloet respectively, between 1984 to 1990. In October 1993, Raphael Aregu completed his Bachelor's Degree in Library and Information Sciences from Makerere University. In 1997, Raphael Aregu enrolled for the Master of Science (Msc) degree in Information Science in Makerere University specializing in information services and systems, and graduated in January 2000.

Raphael Aregu is a Fellow of the Mortenson Centre for International Library Leadership Programmes of the Illinois University, Urbana-Champaign, USA, that he obtained in 2004. He is equally a Commowealth Professional Fellow, which he obtained in 2014 at the University of East London, UK.

Employment and Work

Raphael Aregu has held various positions while still at school and after studies. A few of the responsibilities Raphael Aregu has held include:

- Assistant Librarian, and In-Charge Teachers Resource Centers at the then Institute of Teacher Education Kyambogo, now Kyambogo University, (1994-1995),
- Librarian II and Head of Users Services; Agricultural Library and Information Services, Makerere University (May, 1995-2003 January),
- Lecturer, Management Information Systems for the Agribusiness Masters course, Makerere University, (2000-2002),
- University Librarian, Gulu University (September 2002-Todate),
- Chairperson, Inter-University Council for East Africa, Chapter on University Libraries and ICT Services, 2006-2009,
- Pioneer Board member, Research and Education Network for Uganda, 2007-2011.